# The Efficacy of School-Based Classroom Learning and Physical Activity Interventions for Children's Cognitive Performance and Wellbeing

N McCullogh

PhD

2019

# The Efficacy of School-Based Classroom Learning and Physical Activity Interventions for Children's Cognitive Performance and Wellbeing

Nicola McCullogh

A thesis submitted in partial fulfilment of the requirements of the University of Northumbria at Newcastle for the degree of Doctor of Philosophy

Research undertaken in the Faculty of Health and Life Sciences

August 2019

# Abstract

This programme of research investigated children's cognitive performance, academic achievement and wellbeing in association with their participation in primary school-based interventions in which healthy lifestyle/positive choices messages were delivered through classroom learning and physical activity.

A positive correlation was found between the time children spent in moderate-to-vigorous physical activity during intervention sessions and their post-session long-term memory performance (Study 2). Taking a more chronic perspective of intervention participation, in a quasi-experiment testing whether children experienced improvements in cognitive performance, academic achievement and wellbeing over and above those of a control group, results were inconclusive but potentially suggestive of increases in reading and mathematics achievement for the intervention group at the conclusion of the 6-week programme (Study 3). Finally, qualitative data from interviews/focus groups with stakeholders including children, parents and school staff showed that interventions were viewed favourably in relation to children's engagement and outcomes (Study 4); pupils enjoyed their participation, particularly in the physical activity, and they were thought to benefit in terms of their wellbeing and personal development (e.g. increased healthy lifestyle knowledge, enhanced self-esteem). Parents did however feel that they themselves were not well informed about the interventions and that they could have reinforced programme messages had they known more. In the long term, these findings will assist in informing policy and practice regarding school provision of healthy lifestyle and physical activity opportunities, for instance supporting their inclusion in the timetable despite pressures for schools to prioritise core curriculum subjects.

The thesis contributes to the literature in its focus on cognitive performance and academic achievement, outcomes not often measured for physical activity and positive choices interventions. It also recognises a lack of consistency in the measurement of cognitive performance in the existing research, with Study 1 piloting a cognitive test battery for use in school settings.

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# Acknowledgements

I undertook this programme of research in the hopes of supporting school staff in delivering a varied, engaging curriculum for their pupils. Many of my friends and family work in primary schools and I am aware there are a lot of pressures on you all; I hope the findings from this research help to give you confidence that you are all doing great and that you know your work is appreciated.

I would like to thank my primary supervisor, Dr Spencer E. Boyle, for all of his academic and moral support throughout my research programme – having a mentor with a level head and a ready smile really does make all the difference! Thanks also to the other members of my supervisory team, Dr Melissa Fothergill and Professor Greta Defeyter, for their much appreciated guidance through the tricky times, and to Northumbria University for providing the studentship fund that enabled me to undertake the research programme.

Many thanks go to the football club foundations who allowed me to conduct research into their intervention programmes, and to the members of intervention staff, school staff, parents and children who took part in the studies. Special thanks to my family and friends who were able to suggest schools that might be willing to take part, and to the schools who said yes – this project would not have been possible without you.

As always, I could never have undertaken this project without all of the brilliant people in my life spurring me on. To Dr Sarah Partington and Dr Elizabeth Partington, thank you for inspiring me to go on to further study. To the friends I have made at Northumbria, to my fellow archers and to my family, you are all amazing. To the cast and crew of *Marvel's Agents of S.H.I.E.L.D.*, thank you for some much-needed escapism!

To Mam, Dad and my brother Andy, this thesis is dedicated to you. Thank you all for always being there for me.

# Author's Declaration

I declare that the work contained in this thesis has not been submitted for any other award and that it is all my own work. I also confirm that this work fully acknowledges opinions, ideas and contributions from the work of others.

Any ethical clearance for the research presented in this thesis has been approved. Approval has been sought and granted by the Faculty of Health and Life Sciences Research Ethics Committee on 15.02.17 for Study 1, 18.07.16 for Studies 2, 3 and 3a, and 13.06.16 for Study 4.

**I declare that the Word Count of this Thesis is 83,560 words.**

Name:

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# Chapter 1: Background Context

This thesis provides an account of a PhD programme of research examining combined classroom learning and physical activity (PA) interventions delivered by football club foundations to primary schools in the North East of England. The interventions deliver content mapping to Personal, Social, Health and Economic education (PSHE) topics such as maintaining a healthy lifestyle via diet and exercise, developing an awareness of drugs and recognising the effects of bullying and discrimination (PSHE Association, 2017), and their target audience is 9–11-year-old pupils. The issues of central interest in the thesis are the unusual inclusion of PA to complement the classroom component of the sessions, and also the outcomes of programme participation for pupils' cognitive performance and academic achievement, as well as for their wellbeing.

The programme of research comprised four studies. Study 1 assessed the reliability and validity of a cognitive test battery designed for use in Studies 2 and 3, which constituted an acute quantitative study into children's cognitive performance immediately following the PA component of one of the intervention sessions (Study 2) and a chronic quantitative study into children's cognitive performance, academic achievement and wellbeing following intervention participation (Study 3). Study 3 also contained a pilot study (Study 3a) into daily PA participation as a potential mechanism for intervention outcomes. Finally, Study 4 took a qualitative approach and explored stakeholders' views on classroom/PA-format PSHE interventions. A more detailed overview of the studies is provided at the end of this chapter.

## 1.1 Physical Activity, Health and Wellbeing Provision in Schools

In England, PSHE is a non-statutory subject in which schools can deliver programmes of their own design in order to help their pupils to understand risks and develop the skills and knowledge for making safe and informed decisions (Department for Education, 2013). Some PSHE topics are however statutory requirements in other subjects, for instance with the impact of diet, exercise and drugs on the body being covered in science. Schools are not obliged to allocate a certain amount of their

teaching time to PSHE, but the PSHE Association (2018) recommends 1 hour per week of discrete PSHE education.

The national curriculum in England does make stipulations regarding the delivery of Physical Education (PE) in primary schools, some of the aims of this subject being to ensure that children lead healthy, active lives, that they develop physical competence and that they have the opportunity to communicate, collaborate and compete with others (Department for Education, 2015). Although academy schools are not required to follow the national curriculum, it was clear from their published curricula that all of the schools involved in the studies in this research programme pertaining directly to interventions (i.e. Studies 2, 3 and 4) followed the national curriculum for PE or very similar programmes with the same aims regarding children's health, movement skills and teamwork.

While the amount of school time to be spent on PE is again unspecified, an Office for Standards in Education, Children's Services and Skills (Ofsted) report based on inspections conducted between 2008 and 2012 stated that most primary schools provided 2 hours of PE per week for their pupils (Ofsted, 2013). In a similar manner, despite being valued by pupils and school staff as a chance for children to engage in PA, as well as to socialise, there is no clear guidance regarding the provision of recreational breaks during the school day, and the duration of breaks in England and Wales has declined over time (Blatchford & Baines, 2006). Further opportunities for PA might exist through before- and after-school clubs but the current discussion will focus on only structured school time provision (e.g. PE) as this is available to all children and explicitly aims for children to be active.

A recent article by Bailey (2017) discusses the place of PA in education and identifies as "the heart of the issue" (p. 779) that the value placed on educational attainment by parents/guardians (referred to throughout the thesis as parents for brevity), teachers and policymakers often results in priority being given in the school day to core subjects such as mathematics and reading over non-core subjects including PE. Indeed, reading, writing and mathematics receive almost exclusive attention in the primary school performance tables for England (Department for Education, 2018). However, both PA, as a central component of PE, and wellbeing, as an anticipated outcome of

PA *and* PSHE, have been positively associated with academic achievement (as discussed in Chapter 2). It has been suggested that teachers and administrators may not be aware of the benefits of PA for learning, possibly therefore missing opportunities to integrate it into the curriculum (Castelli et al., 2014). On the other hand, there have been few UK studies into school-based health and wellbeing interventions which report on educational outcomes (White, 2017), so the relationship between participation in PSHE-type programmes and learning requires further exploration. The interventions explored in this research programme provide a window into the contribution of PSHE and PA to children's cognitive performance and academic achievement, with the research results being anticipated in the long term – when combined with the results of other research into PSHE and PA delivery – to help shape policy and practice around the provision of PSHE and PA opportunities in primary school education.

## 1.2 Research Setting

To place the research in context, all of the studies were conducted in the North East of England. A statistical bulletin released in 2014 by the Office for National Statistics, reporting on data from 2012, calculated the Gross Disposable Household Income for the North East of England to be the lowest of all of the UK regions, at a figure of £14,393 per head compared to £17,066 per head for England overall. Furthermore, the English Indices of Deprivation 2015 placed the local authority districts of seven of the nine schools involved in the studies pertaining directly to the interventions (Studies 2, 3 and 4) amongst the most deprived 20% of local authority districts – and the remaining two schools amongst the most deprived 30% – according to the Index of Multiple Deprivation. This measure combines information on seven domains of deprivation: income; employment; education; health; crime; barriers to housing and services; and living environment (Department for Communities and Local Government, 2015). As outlined in '*The impact of social and economic inequalities on children's health*', a report by the All-Party Parliamentary Group on a Fit and Healthy Childhood (2018), socioeconomically disadvantaged children are more likely than those in more affluent areas to experience poor health including overweight/obesity and poorer mental wellbeing, adverse educational outcomes and lower levels of sport participation. It would therefore appear to be particularly

appropriate for PSHE interventions with a PA component to be conducted with children from deprived geographical areas; however, the purpose of the research programme was not to comment on socioeconomic status (SES) as an impetus for intervention delivery, nor to explore its role for children's outcomes; the information in this section is provided simply to assist the reader in understanding the context of the studies.

Data for all of the studies constituting the research programme were collected between August 2016 and July 2018. The data collection period was a time of political and economic uncertainty for the UK in the wake of the June 2016 referendum in which the country voted to leave the European Union ("EU Referendum: England Leads UK to Exit," 2016). As such, the continuation of one of the interventions explored in Study 4 was under question at the point of data collection due to the intervention being funded by the local council: an issue noted by the intervention staff to have been of concern. Furthermore, school staff had been primed to anticipate changes to the targets to which they were working, the UK government having announced as part of its goal for all schools in England to convert to academies that in the north of the country there would be a new focus on school performance (Sellgren, 2016). This may have increased the pressure discussed by Bailey (2017) upon schools to prioritise core curriculum subjects.

## 1.3 Details of the Interventions

The main intervention investigated in this research programme – explored in Studies 2 and 3 and discussed by nine of the participants in Study 4 – ran as a 6-week course for Key Stage 2 pupils (upper primary school; 7–11-year-old children). Year 5 pupils (9–10-year-olds) took part in the research. The intention was for each of the weekly intervention sessions to constitute 60 minutes of classroom work and 60 minutes of physical activity; a sense check conducted through the researcher's observation of a number of sessions and via reports from school and intervention staff in Study 4 revealed that these time allocations were sometimes reduced due to the need to accommodate school events such as assemblies, and the PA component sometimes included time for children to change into their PE kits.

Two PSHE topics were taught within the classroom/PA intervention model, one addressing fitness and nutrition and the other addressing discrimination. The fitness and nutrition programme had five aims: to improve children's knowledge in relation to health and wellbeing; to develop their understanding of a healthy, balanced diet; to improve their physical fitness through PA participation; to promote increased PA participation; and to increase their confidence in participating in PA. Intervention staff reported in Study 4 that further messages included the roles for health of hydration, adequate sleep and not smoking. The discrimination programme similarly aimed to promote increased PA participation and children's confidence in this, as well as raising their awareness of discrimination and hate crime and increasing their knowledge and understanding around topics including bullying, sexism, racism and disability awareness.

The organisation behind the intervention was a football club foundation, with charitable foundations being common to many professional football clubs in the UK as a means through which to provide PA- and education-related opportunities for their local communities. Two facilitators wearing football club-branded clothing delivered each of the intervention sessions. The classroom component included group/class discussions and activities and centred around the completion of tasks in a workbook provided for each child; workbooks were produced specifically for the programmes, such that their structure and content directly complemented the delivery of the sessions. Where possible, materials such as videos featured players from the football team. The PA component involved various games and challenges including football, handball, tag-style games and activities such as passing a ball alternately over and under members of the group; these aimed to encourage movement, balance, agility and speed, and incorporated teamwork through regularly asking pupils to take part in group or paired tasks. School and intervention staff reported links between the classroom and PA content, for example that when the association between PA and heart rate was explained in the classroom, the PA session asked children to check their pulses before and after their PA participation. The planned structure for the sessions was for the PA component to take place after the classroom component but again researcher observation and the reports of intervention staff established that children took part in the PA first when this was practical for timetabling reasons, for instance

when two classes from a school were taking part in a programme simultaneously and changed over between the classroom and PA aspects at the halfway point.

Intervention outcomes were monitored by the football club foundation through a comparison of pupils' performance during the first and final sessions of the programmes on: i) a multiple-choice quiz, measuring their knowledge of nutrition and PA or discrimination – a mode of assessment in line with the recommendations of the PSHE Association (2017) – and ii) walking and balance tests, measuring their physical fitness.

A second intervention was additionally investigated in Study 4. It had been intended for this intervention to be the focus of the thesis but this unfortunately became impossible due to its replacement with separate PSHE and PE programmes. While this very occurrence demonstrates the need to consider issues around sustainability (e.g. the funding and potential adaptation of programmes) in any analysis of intervention delivery, the inclusion of two interventions in Study 4 did allow for the exploration of stakeholders' views of classroom/PA-format PSHE programmes more broadly. Where recommendations are made for intervention development, these are still expressed in the plural as those responsible for the design and delivery of the second intervention may reinstate it in the future.

The second intervention was also provided by a football club foundation, ran for 6 weeks and consisted of classroom and PA components, but its sessions were shorter at approximately 30 rather than 60 minutes per component. The researcher observed that the sessions were generally delivered by a single facilitator, with the classroom activities preceding the PA. Intervention facilitators reported that on occasion, for instance if the school hall was in use and the weather was poor, they would run two classroom sessions back-to-back and compensate for this by providing a 60-minute PA session the following week.

By following one of a number of workbooks with an assortment of themes, the second intervention model again contained a series of programmes. These aimed to challenge the attitudes and perceptions of young people towards issues including self-esteem, substance misuse and racism. Classroom activities were of a similar pupil-centred

nature to those in the intervention described above, and the PA was observed by the researcher and reported by participants in Study 4 to include football, tag-style games and coordination challenges. Facilitators linked PA to classroom content through offering examples such as for the children to consider how success affected their self-esteem. As in the first intervention, a quiz was employed at the beginning and end of the programmes to measure improvements in pupils' knowledge but there was no physical fitness test because the focus of the intervention was on children's understanding of the PSHE content.

Although neither of the interventions was explicitly based on theory, it became apparent during the Study 4 interviews that some behaviour change techniques were employed. These are considered in Chapter 8.

## 1.4 Intervention Participation and Physical Activity

Even when the primary aim of an intervention programme was to support children in making positive choices (e.g. resisting peer pressure), the inclusion of a PA component and encouragement of a healthy lifestyle meant that both interventions additionally went some way to addressing an issue of recent concern in the UK: that of physical inactivity and its consequences. This was a particular goal of the first intervention, which explicitly aimed to promote increased PA participation and to increase children's confidence in participating in PA. With such emphasis being placed upon children's activity by the main intervention in the research programme (investigated in Studies 2, 3 and 4), one of the themes running throughout the thesis is on PA and its promotion to schoolchildren.

At the time of the research, UK PA guidelines recommended that all 5–18-year-olds took part in at least 60 minutes – and up to several hours – of moderate-to-vigorous intensity physical activity (MVPA) every day, defined as activity that raises one's temperature, heart rate and breathing rate (Department of Health and Social Care, 2011). Although the need for daily engagement in PA has been called into question because it is not yet known whether there are greater benefits to participation in 1 hour of activity every day as compared to 7 hours of activity distributed unevenly over the course of a week (Janssen & LeBlanc, 2010) – which is one of the factors being

considered in the current review of the PA guidelines (Foster, 2018) – it is generally acknowledged that children are not as active as they should be. The exact figures vary but tend to indicate that less than 50% of children in England meet the activity guidelines (Health and Social Care Information Centre, 2015) and show that boys spend significantly more time in MVPA than girls (e.g. van Sluijs et al., 2008). Furthermore, it is well recognised that there is a decline in PA with age (e.g. Sallis, 2000). A recent longitudinal study in which the habitual PA of participants from the North East of England was measured via accelerometry between the ages of 7 and 15 years demonstrated that total volume of PA (from light to vigorous intensity) declined for both males and females across this period; this objectively-measured, contemporary finding of a childhood reduction in PA being contrary to the prevailing view that there is a dramatic decline in PA in *adolescence*, particularly for females (Farooq et al., 2018). The same study indicated a reduction in MVPA between the ages of 7 and 15 years for most participants.

It may be difficult for some young people to engage in 60 minutes of MVPA per day, with lack of time having long been recognised as a barrier to PA participation (e.g. National Center for Chronic Disease Prevention and Health Promotion and Centers for Disease Control and Prevention, 1997). However, including opportunities for PA participation within school hours – as in the intervention sessions – reduces the onus on self- or parent-directed PA and may make the goal seem more attainable. On the other hand, 8–9-year-olds from Essex were found to spend on average only 9.5% of their time in PE lessons in MVPA (Wood & Hall, 2015), so if interventions are to contribute to children meeting the PA recommendations then it is important that participants are sufficiently active during the sessions.

The main limitation of the interventions in increasing children's MVPA is that the PA component of the sessions lasts for only 30–60 minutes per week. On the other hand, as acknowledged in articles such as Fox, Cooper and McKenna (2004) and Gortmaker et al. (1999), school-based interventions are able to reach almost all of the target population and – perhaps because they have the potential to increase children's PA self-efficacy, where low self-efficacy is another well-recognised barrier to PA participation (Bandura, 1977) – school-based PA sessions appear to encourage children's PA participation at other times in the day.

Studies into interventions promoting physical activity in primary school settings have however reported mixed results in relation to PA outcomes. For instance, the *'Be Smart'* intervention, designed to prevent obesity and based on the principles of social learning theory, was delivered over four school terms to groups of 5–7-year-old children in Oxford to promote PA alone, nutrition alone or PA and nutrition combined. Intervention participation did not affect children's PA patterns outside of school, as reported in questionnaires completed by their parents, despite the intervention having both school- *and* family-based components (Warren, Henry, Lightowler, Bradshaw & Perwaiz, 2003). Similarly, the year-long *'Active Programme Promoting Lifestyle Education in Schools'* (APPLES) was delivered to 7–11-year-olds in Leeds in a whole-school approach which included environmental changes (e.g. school lunches) and playground activities, and no difference in self-reported PA was found between children from intervention schools and children from control schools (Sahota et al., 2001). Intervention children did however show higher levels of knowledge and understanding of the health benefits of diet and PA in end-of-year focus groups with facilitators who were blind to the schools' intervention status.

Counter to the above evidence, the more recent *'Sport for LIFE'* healthy lifestyle intervention for 8–9-year-olds in Northern Ireland led to significant increases in light, moderate and vigorous intensity PA between baseline and the conclusion of the programme, measured via accelerometry (Breslin, Brennan, Rafferty, Gallagher & Hanna, 2012). This 12-week programme was based on elements of social cognitive theory, with sports outreach officers and class teachers delivering lessons of 1 hour per week covering the topics of nutrition, indoor/outdoor games and the effects of PA on health. The programme culminated in a PA festival attended by an Olympic gold medal winning guest. Another study used accelerometry to measure the outcomes in the North East of England of the *'GreatFun2Run'* intervention, again based on social cognitive theory but this time running over the course of 10 months and supplemented with a local media campaign and an interactive website for pupils, teachers and parents (Gorely, Nevill, Morris, Stensel & Nevill, 2009). The 7–11-year-old participants in intervention schools increased their total time in MVPA by 9 minutes per day while those in control schools decreased this time by 10 minutes per day; a significant difference between the groups.

As can be seen from even this short summary, it can be difficult to draw comparisons across studies due to the heterogeneity of intervention formats and outcome measures used, a matter discussed throughout the thesis. Despite the mixed findings, the *'Everybody Active, Every Day'* framework (Public Health England, 2014a) recommends the increased use of professionals and volunteers outside of the field of health to drive PA participation, including those in education. Speaking to the difficulty discussed earlier concerning limited time in the school day, publication of the framework was closely followed by a briefing for staff in education settings on *'The link between pupil health and wellbeing and attainment'* (Public Health England, 2014b). This emphasised the value of promoting health for children's social and emotional development and for their academic achievement, as an outcome especially likely to appeal to school staff. In a similar vein, Bailey, Hillman, Arent and Petitpas (2013) noted that "the physical health outcomes of regular exercise… are so compelling and urgent that they are in danger of excluding other outcomes" (p. 302), their Human Capital Model by contrast encompassing a total of 88 benefits of PA from the literature including wellbeing and education-related outcomes such as improved self-esteem, the development of prosocial behaviour, improved concentration and higher academic assessment scores.

It is possible that the interventions under investigation in this research programme are especially well-positioned to aid academic achievement by not only addressing PSHE issues which would be expected to improve children's wellbeing and potentially therefore their achievement, but by additionally including a PA component with complementary benefits. Furthermore, it was raised as recently as April 2018 at the Fuse Physical Activity Group Workshop for academics and practitioners in the field of PA promotion that much of the research in this area investigates interventions designed specifically for the purposes of the research studies, rather than exploring existing interventions. As the current research programme reflects intervention provision as it naturally occurs in school settings, it therefore makes a valuable contribution to the evidence base.

## 1.5 Overview of the Thesis

The thesis contains nine chapters: in addition to the background context presented in the current chapter, there is a literature review (Chapter 2), details of the methodology (Chapter 3), the chapters reporting on each of the individual studies (Chapters 4, 6, 7 and 8, with Chapter 5 providing an account of the general methods for Studies 2 and 3), and finally the general discussion, integrating the findings from across the research programme (Chapter 9). By way of an overview of the developing argument throughout the thesis, the rationale and research questions/aims and hypotheses for each of the individual studies are given below, with Figure 1.1 providing a visual representation of the programme of work. Literature supporting the hypotheses is presented in Chapter 2.

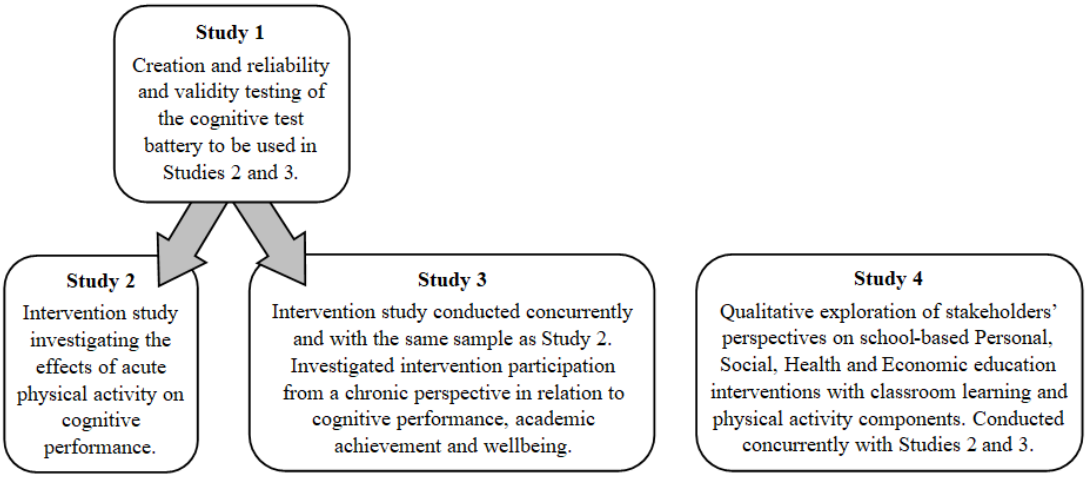



*Figure 1.1. Summary of the programme of work*

***Study 1: The creation and reliability and validity testing of CogS: 9–11, a cognitive test battery for researchers working with 9–11-year-olds in school settings.***

*Rationale:* Studies 2 and 3 were to involve an assessment of children's cognitive performance as a possible outcome of participation in a PSHE intervention delivered via classroom learning and PA participation, but the tools used to measure cognitive performance in past research have differed from study to study, making it difficult to compare results. Study 1 therefore set out to design and to assess the reliability and validity of a pilot cognitive test battery suitable for research with upper-Key Stage 2 pupils in a whole-class testing situation. The four alternate forms of the resultant Cognition in Schools: 9–11-year-olds (CogS: 9–11) test battery would be employed

in the repeated measures testing in Studies 2 and 3, and in the long-term it is hoped that CogS: 9–11 will be further developed in order to provide researchers with an instrument for regular use in studies into cognitive performance with 9–11-year-olds in school settings.

*Aim:* To assess the parallel forms reliability, test–retest reliability and construct validity of the pilot CogS: 9–11 test battery.

*Hypotheses:*

1. There will be no significant difference in the performance of 9–11-year-old children on each of the seven cognitive tests between the four alternate versions of the CogS: 9–11 test battery, demonstrating parallel forms reliability;
2. There will be no significant difference in the performance of 9–11-year-old children on each of the seven CogS: 9–11 tests between the first and second testing sessions, conducted 1–2 weeks apart, demonstrating test–retest reliability; and
3. In principal component analysis, children's scores for the seven CogS: 9–11 tests will load onto four components representing processing speed, attention, long-term memory and executive function, demonstrating construct validity.

***Study 2: The effects of acute physical activity participation during classroom- and physical activity-based intervention sessions on children's cognitive performance.***

*Rationale:* Research suggests there may be positive effects of acute PA on cognition (Chapter 2), and due to the relationship between cognitive performance and academic achievement any effects of an intervention on cognition are likely to be of interest to school staff and other intervention/education stakeholders. Children's cognitive performance was therefore assessed immediately following their participation in the PA component of one of the intervention sessions – or following a normal classroom lesson for the control group – in relation to pretest measurements. The duration and intensity of PA in which children engaged during the PA session was also recorded via accelerometry to explore the role of PA more deeply than simply participation/non-participation, with a positive relationship being anticipated between time spent in MVPA and post-PA cognitive performance, accounting for pretest cognitive performance.

*Aim:* To assess the effects of participation in the PA component of one of the intervention sessions – as an acute bout of PA – on children's cognitive performance, assessing cognitive performance in comparison with a control group and in relation to pretest measurements.

*Hypotheses:*

1. Participants' cognitive performance – recorded as scores for the CogS: 9–11 test battery – will improve to a significantly greater extent from pretest following participation in an acute bout of PA (PA group) than following a normal classroom lesson (classroom group); and
2. Accounting for prettest scores, there will be significant positive correlations between time spent by children in MVPA during the PA component of the intervention session and their post-PA cognitive performance scores.

***Study 3: Children's wellbeing, cognitive performance and academic achievement following participation in a combined classroom learning and physical activity intervention.***

*Rationale:* The literature indicates that primary school teachers are under pressure to prioritise core curriculum subjects in the school timetable, the reason for this appearing to be the argument that more time spent in lessons focused on these subjects will correspond with children's greater educational achievement in core areas of learning. Reading, writing and mathematics are key aspects of the primary school performance tables for England and it is easy to see why the school day can become concentrated on these subjects. However, if participation in other aspects of the curriculum is shown to boost educational achievement – or at least not to have a detrimental impact upon it – then this would support practice and policy concerning the provision of a varied timetable potentially offering additional outcomes such as improved wellbeing.

Study 3 constituted an investigation of the same PSHE intervention as Study 2 but from a chronic perspective. Quantitative data were gathered regarding the cognitive performance, academic achievement and wellbeing of intervention and control children, it being more reasonable to expect changes in academic achievement and wellbeing over the course of a complete intervention than in an acute study. As

described further in Chapter 2, there is evidence suggesting that benefits for these three constructs might be anticipated from PSHE and/or PA participation; however, research tends to be restricted to measuring a limited number of variables, with studies of PSHE interventions tending to favour outcomes pertaining to subject-specific knowledge and studies of PA interventions most frequently measuring post-intervention PA participation. It is also common for studies to investigate interventions delivered in schools for the purposes of the research as opposed to provision as it is currently occurring, whereas Study 3 represented an opportunity to investigate an intervention unusually combining PSHE and PA elements and already taking place in primary school settings.

*Aim:* To examine children's cognitive performance, academic achievement and wellbeing following participation in a 6-week school-based PSHE intervention delivered via classroom learning and PA, assessing these variables in comparison with a control group and in relation to pretest measurements.

*Hypotheses:*

1. There will be a significantly greater increase from pretest to posttest in the wellbeing scores (physical wellbeing, psychological wellbeing, wellbeing pertaining to peers and social support, and wellbeing pertaining to the school environment, measured via the KIDSCREEN-27 questionnaire; Ravens-Sieberer et al., 2005; The KIDSCREEN Group Europe, 2006) of intervention participants compared to control participants;
2. There will be a significantly greater increase from pretest to posttest in the cognitive performance (scores for the seven CogS: 9–11 tests) of intervention participants compared to control participants; and
3. There will be a significantly greater increase from pretest to posttest in the academic achievement (reading, writing and mathematics scores, as tracked via school assessment systems and reported by class teachers) of intervention participants compared to control participants.

*Pilot Study (Study 3a):* In addition to the above measurements, a small number of participants were asked to wear accelerometers to record their physical activity for 9 days at pretest and posttest. This allowed for a preliminary investigation into whether

intervention children increased their MVPA levels to a greater extent than control children, with such an increase being one mechanism via which intervention participation might lead to any improvements in cognitive performance, academic achievement and wellbeing. It was hypothesised that there would be a significantly greater increase from pretest to posttest in the percentage of time spent in MVPA by intervention participants compared to control participants.

***Study 4: The views of stakeholders on combined classroom learning and physical activity PSHE interventions for schoolchildren: A thematic analysis.***

*Rationale:* Conducted concurrently with Studies 2 and 3, the purpose of Study 4 was to explore the views of stakeholders (children, parents/guardians, school staff and intervention staff) in relation to primary school-based PSHE interventions delivered via classroom learning and PA participation. An appreciation of the value placed particularly by parents/guardians and children upon PSHE/PA interventions and their outcomes would support school staff in making decisions about the inclusion of such PSHE and PA opportunities in the school day, consistent with the goals of Studies 2 and 3. The qualitative data gathered on the interventions would also provide contextual information regarding the outcomes investigated in the quantitative studies, as factors such as whether participants buy into the combined classroom learning and PA format and the extent to which children engage in the sessions are likely to influence intervention outcomes. In addition, stakeholders were asked questions relating to the likely continued provision of the interventions because recommendations for their future development would be informed by their anticipated sustainability.

*Research Questions:* What are the views of stakeholders on:

1. The role of PA in the interventions?
2. Children's engagement in the sessions?
3. The outcomes of intervention participation?
4. The sustainability of intervention delivery?

# Chapter 2: Literature Review

As indicated in Chapter 1, the outcomes of children's participation in PSHE and PA programmes are anticipated to extend beyond improvements in subject knowledge and physical health. A child's wellbeing in areas additional to physical health, for instance in relation to their psychological wellbeing and interactions with others, would be expected to improve as a result of their understanding of concepts such as self-esteem and development of their ability to work in a team. Indeed, wellbeing is at the centre of PSHE delivery in schools and pupils' wellbeing is further promoted through the provision of opportunities for PA participation. However, of particular note to education stakeholders following pupils' participation in school-based programmes of any variety are likely to be any benefits for children's learning, for example achievement in core curriculum subjects and cognitive processes supportive of the completion of classroom activities.

This chapter presents a review of the literature pertaining to the relationships between each of the four main constructs explored in the quantitative arm of the research programme: cognitive performance, academic achievement, wellbeing and physical activity, providing a background as to why positive associations might be expected between participation in a classroom/PA-format PSHE intervention and children's cognitive performance and academic achievement if such an intervention were to improve participants' wellbeing and increase their PA as anticipated. Study 3 investigates cognitive performance, academic achievement and wellbeing as potential outcomes of children's participation in a PSHE/PA intervention, with the focus of Study 2 being the more immediate effect of the PA component of the intervention on cognitive performance. The chapter concludes with a discussion of research into stakeholders' views on PSHE and PA interventions from a feasibility and acceptability perspective, for instance considering children's engagement in intervention sessions as one of the matters of interest in the qualitative arm of the research programme.

## 2.1 Definitions of Key Constructs in the Thesis

In order to set the scope of the investigation, the following sections describe how each

of the key terms has been applied in the thesis. There have been inconsistencies in the definitions of constructs in the literature and differences in the application of terms are highlighted where appropriate in the literature review as discrepancies constitute possible reasons for conflicting results.

### *2.1.1 Defining Cognitive Performance*

Although the description, categorisation and assessment of different aspects of cognitive performance is still the subject of much debate, which has unfortunately complicated the research in this area (Best & Miller, 2010), this thesis will focus on the cognitive domains of processing speed, attention, executive functioning and long-term memory (LTM), defined as outlined below. These are domains recognised – often under different names – in the literature in cognitive psychology and neuropsychology (e.g. Reisberg, 2007), which additionally refers to elements such as knowledge and expertise. They were selected due to their likely roles in school learning, for instance in attending and responding to information presented, in working through classroom tasks, and in retaining what has been learnt.

#### *2.1.1.1 Processing Speed*

It has been argued that there are two aspects to processing speed: *simple speed/reaction time*, which concerns basic elements of attention and concentration and which is measured using tasks involving the recognition of and production of motor responses to stimuli; and *complex information processing speed*, which refers to attention and concentration involving mental manipulations (Chiaravalloti, Christodoulou, Demaree & DeLuca, 2003). The current research sought to capture processing speed in its most fundamental form, with mental manipulations being explored separately (see the 'Executive Function' section); while it is therefore simple speed/reaction time which is being measured, this is henceforth referred to as 'processing speed' for concision. As with all of the aspects of cognition under investigation, processing speed has been associated with classroom learning, an inverse relationship having been identified between 7–11-year-olds' reaction time variability and on-task behaviour for a mathematics task mimicking self-directed classwork in a laboratory setting (Antonini, Narad, Langberg & Epstein, 2013).

#### *2.1.1.2 Attention*

The definitions for both aspects of processing speed refer to attention, indicating an overlap in these two areas of cognition. A further complication in defining attention is recognised in that there are a variety of forms of attention, with researchers sometimes considering the same task to measure different types; the article by Chiaravalloti et al. (2003), for example, states that the Paced Auditory Serial Addition Test, in which participants add a series of digits presented in sequence, has been referred to as a test of simple attention, attention maintenance and divided attention (used when completing multiple tasks at once), as well as of processing speed. The current research employed a test designed to measure *sustained attention*, or "the ability to maintain attention on a series of stimuli over a period of time" (Coull, Frith, Frackowiak & Grasby, 1996, p. 1085), and *selective attention*, which allows a person "to select and focus on particular input for further processing while simultaneously suppressing irrelevant or distracting information" (Stevens & Bavelier, 2012, p. 30). These types of attention were chosen because schoolchildren are routinely tasked with keeping their attention on task throughout a lesson whilst ignoring any distractors.

#### *2.1.1.3 Executive Function*

'Executive function' is a term used to refer to cognitive processes which pertain to the control and regulation of cognitive subprocesses and behaviour in pursuit of a goal (Banich, 2009; Miyake & Friedman, 2012). Components of executive function include, amongst others: planning; updating and processing information in working memory; shifting between multiple tasks and operations; and inhibiting prepotent responses (Anderson, 2002; Miyake et al., 2000). As with most cognitive functions there are differential uses of terms between papers and potential overlaps with other cognitive domains: it might be argued, for example, that selective attention involves inhibition, but on the other hand sustained and selective attention have been found to be distinct from 'attention control' (measured via tasks involving inhibition and switching) in 6–16-year-olds (Manly et al., 2001). This issue is discussed further in Chapter 4.

Executive function develops throughout childhood and adolescence, with implications not only for an individual's cognitive performance and behaviour but also for their

emotional control and social interactions (Anderson, 2002). It is the cognitive aspect which has been of interest to researchers in the field of physical activity (Etnier & Chang, 2009), particularly with the suggestion that PA has a larger effect on executive function than other cognitive domains, as discussed later in the chapter. In this thesis, the term 'executive function' refers specifically to cognitive function; emotional and social functioning are assessed as aspects of wellbeing.

Studies often differentiate between *updating*, *shifting* and *inhibition* as three core dimensions of executive function, though there is some variation of terms particularly for shifting, with researchers using the same tasks sometimes referring to the concept being measured as 'switching' or 'cognitive flexibility'. The three dimensions are notable not just due to their prevalence in the literature but also because they are relevant for classroom learning: updating means pupils can keep the contents of working memory relevant to current tasks by adding new information and deleting now-irrelevant information, shifting allows them to switch between tasks when required, and inhibition helps them to resist distraction (Daly-Smith, McKenna, Defeyter & Manley, 2018). Evidence for the distinction between the dimensions comes from Miyake et al. (2000), although it was later proposed that inhibition plays a role in updating and shifting (Miyake & Friedman, 2012). This is discussed further in Chapter 4.

#### *2.1.1.4 Long-Term Memory*

LTM is the system in which information including knowledge, experiences and rules is stored and from which it can be retrieved (Rumelhart, Lindsay & Norman, 1972). Intervention research tends to assess changes in participants' intervention-related knowledge between the beginning and end of a programme; however, despite the storage and retrieval of information being essential in education, memory has received little research interest in relation to children's PA, and LTM was thus felt to be an important inclusion in the current work.

LTM has been distinguished from short-term or working memory, a system which contains information relating to the current task for active processing (Baddeley, 2007) and which is therefore considered within the context of executive function in the

current thesis. The two are generally defined by duration, with information thought to be held in working memory for ≤30 seconds before it is lost through decay (Shiffrin & Atkinson, 1969), and information which is to be held for longer than this requiring rehearsal and/or transfer to LTM.

### *2.1.2 Defining Academic Achievement*

On conducting a review of studies into youth PA and academic performance, Castelli et al. (2014) noted a change in terminology in this area, with earlier studies referring to academic *behaviours* and *attitudes* and more recent ones referring to academic *achievement*. This is suggestive of a narrowing of the focus of research interest to test scores rather than behaviours that support learning (e.g. time spent on-task, completion of homework, school attendance). The current programme of research places a similar emphasis on achievement, while also investigating cognitive performance as a possible supporting factor.

Throughout the thesis, the term 'academic achievement' is used when referring to measures such as grades, standards (e.g. 'working towards the expected standard', one of the standards in use at the time of the research programme; Standards and Testing Agency, 2017) or quantification of standards in an examination or across a child's classwork in a specified subject. Although the term 'attainment' is also used when referring to test results, 'achievement' was favoured with the educational applications of the work in mind because every child's pretest performance will differ and it is improvement in the subject(s) under study which stakeholders can use as an indication of the value added by an intervention (for a discussion of value-added in education, see Brown, McNamara & O'Hara, 2016).

### *2.1.3 Defining Wellbeing*

Of the four constructs under investigation, wellbeing has been defined in by far the greatest number of ways. There is broad agreement that wellbeing refers to a positive state – rather than simply the absence of problems as it has sometimes previously been understood (Sancassiani et al., 2015) – and that it consists of several dimensions, for instance physical, psychological and social. However, the dimensions of interest often differ from study to study. Further complicating the issue are that an individual's sense of feeling 'well' is by its very nature personal and subjective, and that the expression

‘wellbeing’ has been used synonymously with ‘happiness’, ‘life satisfaction’ and other terms which are undoubtedly related but which have slightly different emphases (McLellan & Steward, 2015). This difficulty may stem from researchers’ varied philosophical standpoints (see Waterman, 1993): some may feel that wellbeing relates to the experience of pleasure (a hedonistic conceptualisation); others may favour an interpretation that wellbeing relates to self-realisation and personal expressiveness (a eudaimonic conceptualisation); and yet others may believe that it incorporates both (e.g. Seligman’s (2011) PERMA model of flourishing, which proposes that wellbeing comprises Positive emotion, Engagement, Relationships, Meaning and Achievement).

In the absence of a unified definition of wellbeing, the key for researchers is perhaps to bear in mind the impact they wish to achieve and to ensure that the way in which they conceptualise and measure wellbeing is compatible with their goals and is transparent to the reader. Mashford-Scott, Church and Tayler (2012) identified four major perspectives on wellbeing upon which researchers can draw to explain their positions: social and economic perspective; psychological and mental health perspective; philosophical perspective; and educational perspective. As might be expected, an educational perspective is adopted here. This position is described as exploring learning dispositions and behaviours (e.g. motivation), as concerning social-emotional-behavioural competencies and as being orientated towards the monitoring of affect. Social-emotional-behavioural competencies are however also of interest from a psychological and mental health perspective, meaning this perspective is represented to some extent in the thesis.

### *2.1.4 Defining Physical Activity*

Physical activity is defined as “any bodily movement produced by skeletal muscles that results in energy expenditure” (Caspersen, Powell & Christenson, 1985, p. 126). It should not be confused with *exercise*, which is a structured form of PA involving the repetition of certain movements in order to improve or maintain one’s physical health or fitness (Dishman et al., 2006). PA consequently encompasses a greater range of activities than exercise, including playing, active transportation (e.g. walking to school) and taking part in recreational activities such as sports (World Health Organization, 2016).

PA participation is defined by the frequency, duration and intensity of a person's activity. Unfortunately, the current lack of consensus surrounding the calculation of different PA intensities (usually employing the descriptors of 'light', 'moderate' or 'vigorous' PA) both complicates the establishment of dose–response relationships for PA and its outcomes and hinders the replication of research to assess the reliability of findings. Selection of the intensity criteria used in the current research is explained in Chapter 3.

It is worth stating here also what is meant by *fitness*, as this has been the subject of much investigation in relation to cognitive performance and academic achievement, often being employed by researchers as a proxy for PA. Fitness has been defined as "the ability to carry out daily tasks with vigor and alertness, without undue fatigue, and with ample energy to enjoy leisure-time pursuits and respond to emergencies" (Centers for Disease Control and Prevention, 2015). Although there are limitations to this description, such as difficulties surrounding the measurement of 'vigour and alertness', a larger problem for work in this area is that only a low to moderate correlation exists between fitness and regular PA in children (Malina & Katzmarzyk, 2006), with fitness being influenced by factors such as genetics, maturation and adiposity (see Syväoja, Tammelin, Ahonen, Kankaanpää & Kantomaa, 2014). Fitness was not measured in the research programme but features in some of the studies presented in the literature review.

## 2.2 Relationships between the Key Constructs

The following discussion examines how the four constructs defined above might be related and why participation in PSHE interventions – especially those with a specific PA component – might be expected to be associated with changes in these constructs. In order to provide a background for Study 2, there is a particular emphasis on the effects of PA participation on cognitive performance.

### *2.2.1 Cognitive Performance and Academic Achievement*

Cognitive performance is a variable of potential interest to education stakeholders because – as touched upon above – it is thought to at least partially underpin academic achievement due to the role of cognitive functions such as attention in academic study

(Keeley & Fox, 2009). Many researchers have treated academic achievement as a measure of cognitive performance in a real-life context, with children being ideal participants for applied cognition research due to their regular participation in academic testing (Hillman et al., 2009).

Unsurprisingly, given that conceptions of intelligence and general cognitive ability tend to reflect at least in part one's level of understanding (Mackintosh, 1998), general cognitive ability has been found to account for more variance than specific cognitive abilities in measures of academic achievement (e.g. Rohde & Thompson, 2007, with young adult participants). Furthermore, motivation must always be borne in mind because high levels of cognitive ability are unlikely to translate into high levels of academic achievement without effort, and motivation has been found to add to the prediction of teacher-reported English and mathematics achievement beyond general mental ability for 9-year-olds in the UK, with a degree of variance explained in common by the predictors (Spinath, Spinath, Harlaar & Plomin, 2006). However, evidence nonetheless exists for a positive relationship between young people's academic achievement and performance on tasks of executive function, as discussed below, though remarkably little research has been conducted using tests of attention and LTM.

In theory, selective attention might assist children in learning to read by helping them to identify letters and thus sound out words, while mathematics performance is thought to rely on attending to relevant information when working through calculations (Stevens & Bavelier, 2012). It appears however that much of the research into attention has compared the attainment of pupils with and without attentional disorders or has sought associations between academic outcomes and attention-related classroom behaviours (e.g. time spent on-task). In one of the few studies to have measured performance on an attentional test, 12–16-year-olds from schools in Spain completed an adapted version of the d2 test of attention, a paper-based test which involves marking every instance of the letter 'd' presented with two dashes whilst ignoring other visually similar stimuli (Fernández-Castillo & Gutiérrez-Rojas, 2009). Selective attention correlated with grades in only two of eight subjects: positively for mathematics ($r = .248$) and negatively for music ($r = –.292$). To focus on core subjects, the mathematics findings and lack of association between selective attention and

grades in language are consistent with the above theory in an adolescent population that would be expected to have already learnt to read.

Conversely, Manly et al. (2001) identified no significant corrected correlations between the selective or sustained attention and arithmetic scores of 6–16-year-olds in Australia, nor were there associations with reading or spelling. While selective attention was measured as performance on the Sky Search and Map Mission tests, both of which ask participants to circle target items presented amongst distractors and therefore share similarities with the d2 test, achievement was measured using the Wide Range Achievement Test (WRAT) Revised rather than participants' grades. Measurement differences such as these make it difficult to draw conclusions across studies.

While evidence regarding the link between attention and academic achievement is thus far limited, it has been suggested that research should seek to assess whether improvements in attention test scores translate to enhancements in academic performance (Janssen, Chinapaw et al., 2014).

Executive function would seemingly contribute to the performance of classroom tasks given that it pertains to the initiation, monitoring and adaptation of information processes and behaviour in pursuit of a goal. It is possible that similar processes operate also over extended periods, helping to maintain a child's motivation for longer-term goals (e.g. to receive a good school report at the end of the year). 'Complex' executive function (requiring coordination of different components of executive function; assessed in this case by performance on the Planning subtests of the Cognitive Assessment System [CAS]) has been positively associated for 5–17-year-olds with reading and mathematics, where achievement was measured using the Woodcock-Johnson Tests of Achievement – Revised (Best, Miller & Naglieri, 2011). To pick out the age groups of interest in the current research, for 8–11-year-olds correlation coefficients ranged from $r = .26$ to $r = .59$ for reading and from $r = .28$ to $r = .60$ for math and skill, demonstrating some variation between subtests but on the whole that executive function aligns with achievement in disparate subjects and may therefore relate to general learning ability.

Breaking down executive function into dimensions, St Clair-Thompson and Gathercole (2006) correlated the performance of 11–12-year-olds from the North East of England on tasks of updating, shifting and inhibition with their attainment in the Year 6 national curriculum tests (SATs), taken approximately 3 months earlier. Higher scores on the cognitive tests reflected poorer performance; controlling for age, English results (combined scores for reading, writing, spelling and handwriting) were significantly correlated with performance on both of the updating tasks ($r = -.43$ and $r = -.47$), while mathematics attainment was correlated with performance on the updating tasks ($r = -.34$ and $r = -.54$), one of the two shifting tasks ($r = -.42$) and one of the two inhibition tasks ($r = -.31$). The authors went on to identify two factors from these measures of cognitive performance and of working memory: one consisting of updating and working memory (consistent with the notion that updating constitutes the updating of information in working memory), and the other inhibition alone. Participants' scores for the two factors were associated with unique variance in English ($r = .62$ and $r = .31$ for updating/working memory and inhibition, respectively) and mathematics attainment ($r = .45$ and $r = .36$, respectively). That these correlation coefficients existed while partialling out the remaining factor indicates that the updating/working memory and inhibition dimensions of executive function related independently to academic attainment, although scores on the two shifting tasks did not load onto a single distinct factor and were excluded from the partial correlation analyses.

Following their study of Scottish 6–8-year-olds, Bull and Scerif (2001) suggested that poor inhibition and working memory might lead to problems with evaluating the success of and shifting between task strategies, thereby contributing to lower mathematical ability. This study also found mathematics and reading ability – assessed using the Group Mathematics Test and the British Ability Scales word-reading test – to be positively correlated ($r = .61$), and reading and IQ to account for much of the variance in mathematics ability. It is possible that performance in one academic area supports success in another (e.g. that proficient reading assists in the interpretation of mathematics problems). The current research did not seek to explain this association; if intervention participation was associated with gains in two or more academic subjects simultaneously, the main concern was that participation was potentially of benefit to pupils.

With a review of the literature suggesting that executive functions predict academic achievement and that it is possible to improve children's executive functions through means such as computer-based training, classroom curricula and aerobic exercise (Diamond & Lee, 2011), it would appear that if an intervention improves executive functions then it might also improve academic achievement. Diamond and Lee suggest that exercise might not improve executive functions to the same degree as exercise plus 'character development' (as in martial arts); as such, a PSHE programme with a PA component might be more beneficial for executive functions and academic achievement than an intervention based on PA participation alone.

The remaining cognitive domains of interest in the research programme – processing speed and LTM – were two of the variables explored in relation to 6–19-year-olds' performance on the Woodcock-Johnson III Tests of Cognitive Abilities and Tests of Achievement (Evans, Floyd, McGrew & Leforgee, 2002; Floyd, Evans & McGrew, 2003). Processing speed was moderately related to Basic Reading Skills and Reading Comprehension at approximately 6–10 years of age and Math Reasoning at 6–13 years, with a *strong* relation to Math Calculations at 7–15 years. As Evans et al. described, more efficient processing for basic operations will free up resources for more complex aspects of task performance, potentially explaining how processing speed supports the successful completion of academic activities. Long-term Retrieval was moderately related to Basic Reading Skills at 6–9 years and to Reading Comprehension at 6–11 years; the former is unsurprising given the authors' note that one of the two tests of Long-term Retrieval involved learning and recalling words associated with symbols, as does learning to read. The link with comprehension is also logical as previous knowledge may be used to help make sense of information presented. Long-term Retrieval was moderately related to Math Calculation Skills at 6–8 years, and the authors discussed how the impaired recall of arithmetic facts from LTM might delay the development of mathematics skills.

The above evidence demonstrates a series of potentially moderate associations between different elements of cognitive performance and academic achievement, though for those studies employing test batteries for achievement alongside tests of cognition the findings might to some degree reflect participants' test-taking

approach/abilities, with coefficients therefore being inflated. The evidence for attention is also limited. Nevertheless, with authors theorising that cognitive performance underpins academic achievement, it is reasonable to believe that if an intervention benefits cognition then it might also have more tangible benefits for schools and their stakeholders in terms of pupil performance.

### *2.2.2 Wellbeing, Cognitive Performance and Academic Achievement*

Any search of the literature quickly reveals that across a range of research topics wellbeing tends to be measured as a desirable variable in its own right, and its possible further impact upon/association with cognitive performance therefore appears to have received little research interest. However, in one PA-related example, significantly lower state anxiety scores and higher memory scores were found amongst young adult females following participation in yoga compared to aerobic exercise (Gothe, Hillman & McAuley, 2012), and the authors proposed that the decreased anxiety was responsible for the better memory performance. This proposal can be explained with reference to attentional control theory (Eysenck, Derakshan, Santos & Calvo, 2007), which suggests that anxious individuals are more susceptible to distraction because anxiety has a negative impact upon attentional control. An anxious child would therefore be expected to perform poorly on tests of attention and also on other cognitive and academic tasks due to the role of attention in successful performance.

Wellbeing appears to have received greater research attention in relation to academic achievement than cognitive performance. As noted in Chapter 1, a Public Health England (2014b) briefing outlines schools' responsibilities to promote children's wellbeing. It goes on to describe that pupils' health and wellbeing influences their engagement in learning and ability to reach their full academic potential, and that academic success can have a positive effect on their life satisfaction, creating a virtuous circle between wellbeing and academic outcomes. Amongst the studies cited are one in which achievement and school engagement were related to 12–14-year-olds' perceptions of their school environment, with items assessing factors such as whether they felt valued, understood and supported (Wang & Holcombe, 2010). In another study, lack of peer acceptance at the age of 9–10 years was reported to have a negative impact on academic achievement at 11–12 years (Flook, Repetti & Ullman, 2005). With an additional indirect relationship being identified in this study between

peer acceptance and academic achievement via the negative effects of lack of acceptance on academic self-concept, the authors concluded that social, emotional and cognitive development are highly interrelated. In terms of physical health, a negative association has been found between obesity/overweight and educational outcomes, although it has been difficult to establish causality (Suhrcke & de Paz Nieves, 2011).

To consider the outcomes of a wellbeing intervention, the *'Social and Emotional Aspects of Learning'* (SEAL) programme is an initiative for primary schools in England which aims to develop children's self-awareness, emotional management, motivation, empathy and social skills through an explicit curriculum, but which also emphasises a positive school environment. In an investigation of the pilot programme, Hallam (2009) found that head teachers, teachers and non-teaching staff generally agreed that SEAL had promoted children's emotional wellbeing; it was seen to have led to positive attitudes towards school, greater self-confidence, improvements in social and communication skills, reductions in bullying and increases in the ability to control emotions and resolve conflicts. School staff were however less certain about its impact on pupils' schoolwork. There were agreement levels of 44–62% that it had improved pupils' concentration and of 29–58% that it had raised the standard of learning they had achieved, but 13–15% and 25–38% of participants gave a *'don't know'* response to these items, respectively. Any schoolwork-related changes might therefore be difficult for school staff to detect or for them to attribute to the SEAL programme. Nevertheless, some of the teachers commented in interviews that pupils were calmer and therefore more able to focus on their work, had better motivation for and persistence with classroom activities, and that because there were fewer instances of misbehaviour, teachers were able to spend more time helping those who needed it. Potentially, therefore, improvements in children's emotional wellbeing support an effective environment for classroom learning and this might lead to improvements in academic achievement over a longer period than the single school year investigated in the study.

A reduction in disruptive classroom behaviours was also proposed as one of the mechanisms behind the improvements in the percentages of students performing at an average or proficient level in reading and mathematics following 1 year of the Positive Action programme in elementary schools in Hawaii (Snyder et al., 2009). Positive

Action is a schoolwide social-emotional and character development programme with a total of 35 hours per academic year of 15–20 minute interactive lessons on topics including self-concept, self-control, nutrition, physical activity, decision-making and empathy. The programme also includes the involvement of families and communities, and it appeared to be valued by the schools involved in Snyder et al.'s matched-pair cluster-randomised controlled trial, with intervention schools continuing to implement it during the following academic year and maintaining greater improvements in achievement compared to control schools at 1-year follow-up. Furthermore, the schools were in low-income areas and reading and mathematics achievement were below the state averages at baseline but almost met – and in one case exceeded – state averages at posttest and follow-up, with medium to large effect sizes ($g$ = 0.50 to $g$ = 1.10) across four measures of achievement at the two time points. Outcomes were however measured at the school level and variations in scores within students across years could not therefore be examined.

The following year, a meta-analysis of school-based social and emotional learning programmes for 5–18-year-olds found positive effects for students' social-emotional competencies and – amongst those studies that included measures of academic achievement – for students' performance on standardised reading and mathematics tests and school grades (Durlak, Weissberg, Dymnicki, Taylor & Schellinger, 2011). The authors even reported that the mean effect size for performance on standardised academic tests ($g$ = 0.27) was comparable to that from the literature concerning educational interventions. Interestingly, classroom programmes delivered by non-school staff did *not* improve students' academic achievement, although with only three studies in this category further research is required.

Notwithstanding the above evidence, the educational outcomes of wellbeing interventions are often overlooked; in a review of randomised controlled trials (RCTs) into the World Health Organization's Health Promoting Schools framework – a label applicable to any approach in which there is a formal health curriculum, promotion of health and wellbeing through the school environment and engagement with families/communities – only 2 of 67 studies reported academic outcomes (Langford et al., 2014). Conclusions could not therefore be drawn regarding the effect of school-based health promotion on academic achievement, despite the review being inclusive

of a vast array of interventions taking place worldwide. Again, it may be that the wellbeing outcomes of PSHE-type interventions are so obviously worthwhile that additional potential outcomes can be overlooked, but children's academic achievement following participation in any form of school-based intervention is likely to be an area of great interest to education staff and policymakers.

### *2.2.3 Physical Activity and Cognitive Performance*

As discussed later in the chapter, PA participation might improve individuals' wellbeing, and if this is the case then it might by virtue of the wellbeing effects also improve mental function (the umbrella term for cognition, academic achievement and intelligence used by Tomporowski, Lambourne & Okumura, 2011). Alternative explanations for an association between PA and mental function are however acknowledged. Briefly, physiological explanations deriving largely from studies of rodents include that PA participation increases brain volume in areas implicated in learning (e.g. van Praag, Christie, Sejnowski & Gage, 1999); induces the growth of new blood vessels (see Churchill et al., 2002); and boosts the level of brain-derived neurotrophic factor (BDNF), which plays a role in the growth and differentiation of the developing nervous system and in regulating synaptic transmission and plasticity (see Murray & Holmes, 2011). It would seem reasonable to conclude that these effects would support cognitive performance and that the effects of PA on BDNF are particularly important for children, whose brains at primary school age are undergoing a process of synaptic pruning to increase the efficiency of the neural network (see Bjorklund & Blasi, 2012).

As well as enhanced cerebral blood flow, any more immediate effects of PA on cognition may be due to changes in the availability of neurotransmitters and/or hormones. For example, cortisol is associated positively with attention and in an inverted 'U'-shaped relationship with memory performance (Erickson, Drevets & Schulkin, 2003), though cortisol elevation might not occur immediately post-PA but within 15 minutes of some forms of PA and not others (Heijsman et al., 2012). If the type of PA or the time at which cognitive testing takes place relative to PA participation differs between studies, then this could be at least partially responsible for any inconsistencies in results. Similarly, variability in participants' PA intensity could lead to differences in blood flow and neurotransmitter availability, leading to

different effects for cognitive performance. Though their review was not restricted to youth populations, Chang, Labban, Gapin and Etnier (2012) suggested that 'very hard' intensity exercise (>93% maximal heart rate [HRmax]) leads to the greatest effects if there is a delay of more than 60 seconds between exercise and cognitive testing, and that participation in at least 20 minutes of exercise is necessary for effects to occur.

Learning explanations instead propose that engaging in PA stimulates cognitive development because the child learns through the movements they make and by interacting with the environment and/or other individuals in what can be cognitively demanding activities (Sibley & Etnier, 2003). Koziol and Lutz (2013) even believe that children's sensorimotor interactions generate knowledge which becomes the basis for executive function, where executive function is defined in what the authors propose is a more 'real life' manner as the functions employed by an individual to act independently in their own best interest. A recent review concluded that in typically developing 4–16-year-olds there was weak-to-strong evidence for correlations between cognitive skills and three subcategories of motor skills: fine motor skills, bilateral body coordination and timed performance movements (van der Fels et al., 2015). There was however less of an association with cognitive skills for balance and strength/agility. It is possible that the extent to which motor skills require cognitive engagement plays a role in how strongly they are related to cognitive performance, and the degree of cognitive engagement involved when participating in PA is one of the variables considered in the account of research in this section.

The below discussion of research into PA and cognition is divided into two sections: the first relating to the immediate effects of a single bout of activity (*acute* PA) on cognitive performance, as the focus of Study 2; and the second pertaining to the relationship between longer-term (*chronic* PA) and cognitive performance, as one of the associations of interest in Study 3.

#### *2.2.3.1 Acute Physical Activity and Cognitive Performance*

Research into the outcomes of acute PA for youth populations (e.g. the impact of activity breaks on classroom-based learning) would be expected to be of great interest to stakeholders in education, with any immediate effects for children's cognition likely

to drive buy-in to the provision of opportunities for PA during the school day.

In a review of research into the effects of chronic and acute PA, positive results were generally found for children's cognition (Hillman, Kamijo & Scudder, 2011). The earliest of the included studies found that following participation in a 50-minute PE lesson comprising relay activities, 7–8-year-olds had significantly higher scores than at baseline on a mathematical computation test (Gabbard & Barton, 1979), suggesting a benefit of acute PA participation. There were however no differences between baseline and posttest scores following participation in the same activity for 20, 30 or 40 minutes, indicating that the duration of PA might have an influence on outcomes; it may be that an atypical amount of exertion is required to achieve the benefits because the children were accustomed to 30-minute PE lessons.

Returning to the meta-analysis of Chang et al. (2012) into the effects of a single session of exercise on performance on a range of cognitive tasks – grouped under headings including 'reaction time', 'attention', 'executive function' and 'memory' – an overall slight but significant positive effect was identified ($d = 0.097$, $p < .001$). Only 102 of the 1034 effect sizes were however obtained from studies of 6–13-year-old participants and the article reported a non-significant effect size for this age group of $d = 0.051$, suggesting at face value that acute PA does not influence cognitive performance for this population. On the other hand, as highlighted above – and throughout the thesis – there were many differences in methods between studies, for instance in the timing of cognitive testing relative to PA participation.

In the current research programme, the testing for Study 2 occurred >1 minute post-PA due to the field-based nature of the work and the associated practicalities of moving children from a PA session to an appropriate location for cognitive testing; across all studies with testing occurring >1 minute post-PA in Chang et al.'s (2012) meta-analysis an effect size of $d = 0.103$ was calculated, with two moderating variables being identified: exercise intensity and type of cognitive task. All intensities other than 'very light' exercise (<50% HRmax) had significant positive effects, from $d = 0.202$ for 'moderate' (64–76% HRmax) to $d = 0.465$ for 'very hard' (>93% HRmax), while very light exercise was found to have a significant *negative* effect ($d = –0.113$). Pertinent to the current work, the effect for tasks of executive function was significant

($d$ = 0.171) but those for tasks of reaction time and memory were not. The studies in which testing began immediately and >1 minute post-exercise were then combined and both the timing of the test administration and duration of the exercise sessions were found to be significant moderators: there was a significant effect on cognitive performance when testing began 0–15 minutes ($d$ = 0.139) but not >15 minutes post-exercise; and exercise sessions lasting for 11–20 minutes or >20 minutes had a significant positive effect ($d$ = 0.262 and $d$ = 0.171, respectively), but those lasting for 0–10 minutes had a significant *negative* effect ($d$ = –0.060). Although these calculations are largely based upon adult participants and PA in the form of structured exercise, it could be anticipated on this basis that children's participation in the intervention under investigation in Study 2 would enhance their performance at least in the tasks of executive function due to the anticipated 60-minute duration of PA, the aim for the children to be more than 'very lightly' active in the sessions, and the cognitive testing beginning <15 minutes post-PA.

In the current research, it was not possible to record response time to individual items in the cognitive testing due to the use of paper-based responding. It is however interesting to note that Tomporowski's (2003) review – although restricted to studies of adults, most of which involved laboratory-based exercise – reported that post-PA enhancements in response speed occurred for the most part in the absence of increases in error rates, indicating an improvement in efficiency at the response (but not the perceptual and sensory processing) stage of information processing. The later review of Chang et al. (2012) did not, on the other hand, find a significant effect of acute exercise on reaction time. With studies largely recording response speed within the context of other cognitive tests, further investigation is required to establish reliable findings regarding processing speed in its own right and also to determine whether these apply to different populations including primary school children. Two tests chosen specifically to measure processing speed were therefore included in the test battery employed in the current research.

Turning the focus of the remainder of the discussion to preadolescents, and specifically research conducted in school settings where possible, Janssen, Chinapaw et al. (2014) measured the selective attention of 10–11-year-olds in the classroom using the paper-based Sky Search test, which requires participants to find and circle pairs of identical

spacecraft arranged amongst non-identical spacecraft as quickly as possible. Children completed the test following 1 hour of regular school mathematics/language tasks as a baseline measurement and then again following 15 minutes of: continuing the mathematics/language tasks (no break); listening to a story (passive break); jogging and playing ball games (moderate intensity PA break); or running, jumping and rope skipping (vigorous intensity PA break). Participants wore accelerometers during the PA breaks and were excluded from the analysis if they did not meet the criteria for moderate or vigorous intensity activity for at least 12 minutes (for the PA intensity criteria adopted in this study see Ekelund et al., 2004). Selective attention was significantly better (faster identification times) following all three types of break than for the 'no break' condition, with performance following moderate intensity PA being significantly faster than that following the passive and vigorous intensity PA breaks. Aerobic fitness did not significantly moderate the effect. These results suggest that taking even a passive break from classwork can improve children's selective attention but that moderate intensity PA breaks might provide the greatest benefits, findings potentially indicative of an inverted 'U'-shaped relationship between PA intensity and attention. Unfortunately, the authors identified a significant difference in outcomes for one version of the test materials and despite randomisation this version had frequently been used for testing the moderate intensity PA break, meaning that the magnitude of the effect for this condition may have been no greater than for a passive or vigorous intensity PA break if not for this confound. Nevertheless, whereas a number of studies have assessed the impact of PA on brain function linked to attentional processes in the laboratory, this research provides initial insight into the effects of acute PA on the behavioural aspects of attention in a naturalistic setting. It might therefore be of greater interest to education stakeholders as it reflects tangible results as they might arise following PA participation of the sort typical in primary schools.

In the same year, researchers from the same team conducted a systematic review of studies into the effects of acute PA on attention (Janssen, Toussaint, van Mechelen & Verhagen, 2014). The variety of methods – particularly amongst the six studies conducted in school settings – meant that a meta-analysis was not possible, and none of the studies reported a power analysis so may have been underpowered. Overall, for the studies conducted in the school setting no significant difference was found between active lessons and classroom lessons; on the other hand, significant effects on attention

were found in five of the six laboratory studies, one of which involved improvements in reaction time and the others the maintenance of or improvements in accuracy. While the school studies used a range of measures of attention, including observation of on-task behaviour and the completion of CAS tests, most of the laboratory studies employed flanker tasks, potentially explaining the greater consistency in results. In flanker tasks, participants are asked to indicate the direction in which a central target figure points in a series of congruent and incongruent trials (i.e. trials in which surrounding or 'flanking' figures point in the same or opposite direction as the target, respectively), thus measuring what Janssen, Toussaint et al. referred to as 'cognitive control of attention'.

One example of a laboratory study from the review was that of Hillman et al. (2009). Preadolescents ($M = 9.6$ years, $SD = 0.7$) were asked to complete a flanker task on two separate days: once following 20 minutes of moderate-intensity aerobic treadmill exercise (60% of estimated HRmax), and once following 20 minutes of seated rest. The order of the conditions was counterbalanced across participants. Reaction time did not differ between conditions but there was increased response accuracy after exercise relative to rest for incongruent trials. Furthermore, while completing the flanker task participants wore an electrode cap to record any changes in neuroelectrical activity and in particular the P3 component of the event-related potential (a small voltage generated in the brain in response to a stimulus; Blackwood & Muir, 1990). Greater P3 amplitudes are thought to reflect greater allocation of attentional resources to a stimulus (as described in Meinhardt & Pekrun, 2003), and in the central–parietal region – the parietal cortex having been implicated in selective attention (Behrmann, Geng & Shomstein, 2004) – there was an effect mirroring that of the response accuracy findings, with increased P3 amplitude after exercise relative to rest only for incongruent trials. This led the authors to conclude that exercise has a facilitative effect on attentional resource allocation for tasks involving inhibition (an executive function, but one which the paper stated to be central to sustained attention due to the need to inhibit one's attention to task-irrelevant stimuli). Brain function and task performance effects were recorded approximately 25 minutes after the exercise bout had ended; if the onset of effects is immediate then education stakeholders may be interested to know that the outcomes of PA for attentional processes are more than fleeting. Also of potential interest to stakeholders, the same study tested the effects of the exercise

on academic achievement, and these findings are presented later in the chapter.

Pursuing the notion that acute PA might benefit executive function, Chen, Yan, Yin, Pan and Chang (2014) tested the performance of 9- and 11-year-old schoolchildren in Beijing on computerised tasks of updating, shifting and inhibition following 30 minutes of jogging on a playing field (moderate intensity: 60–70% of predicted HRmax) or 30 minutes of reading exercise-related books in the classroom. Despite the small sample (experimental group: $n = 44$; control group: $n = 39$), interactions between time point (pretest, posttest) and group were significant for all three components of executive function (updating: $\eta_p^2 = .17$; shifting: $\eta_p^2 = .17$; inhibition: $\eta_p^2 = .14$). Follow-up analyses showed no differences between the groups at pretest and no change from pretest to posttest performance for controls; however, significantly shorter response times were found for the experimental group at posttest compared to pretest for all three tasks, indicating a beneficial effect of PA on updating, shifting and inhibition. Similar to the study of Hillman et al. (2009), testing began 20–25 minutes post-PA, supporting the finding that the effects on cognition begin by/continue for at least this duration, and for shifting possibly even last up to 50 minutes; testing took approximately 25 minutes and the tests were always delivered in the same order, with shifting last. That no effects were observed for the control group indicates that those observed for the experimental group were due to PA participation rather than practice effects.

Although the research took place in a school setting and was therefore more ecologically valid than a laboratory-based study, the jogging task was not entirely reflective of children's usual PA. The authors argued there were social interactions and cognitive demands to the task, which required participants to jog in groups of 3–5, monitoring their distance from one another and adjusting their speed to maintain the target heart rate according to the lead of one child with a heart rate monitor. It is unlikely, however, that children would engage in 30 minutes of an activity such as this at school in the UK, whether at break time, in a PE lesson or in an after-school activity session. More representative of a PE lesson was the PA condition of a study conducted in Switzerland investigating the same components of executive function amongst 6–8-year-olds in the school setting (Jäger, Schmidt, Conzelmann & Roebers, 2014). Participants took part in approximately 20 minutes of acute PA including 'executive

function-specific cognitive engagement'; i.e. games containing cues to perform specified actions, with additional cues being added and the movements they represented being changed as the games progressed, in order that the children were required to *update* the information they held in working memory, *shift* between the different cues and corresponding movements and *inhibit* the now-incorrect movements they had made in previous rounds. This intervention is consistent with the rationale that PA involving complex movements and cognitive demands might regulate executive function (Pesce, 2012), and thus effects on post-PA executive function would be expected. By contrast, the control group listened to and answered easy comprehension questions on a story for the same 20-minute duration. Both groups were tested on computerised tasks of updating, shifting and inhibition before, immediately after and 40 minutes after the PA/story activity, and it was found that the group × time interaction was significant only for inhibition ($\eta_p^2$ = .04), with the reaction times of the experimental group improving more than those of the control group from pretest to immediately posttest ($\eta_p^2$ = .06), but declining by the 40-minute follow-up. The results thereby indicated a short-term benefit of acute PA for inhibition but not for the other components of executive function. While it is impossible to distinguish between the effects of PA and the effects of cognitive engagement in this study, such a distinction may be of more value for theory than for practice because if the benefits for cognition do not arise from cognitive engagement then there might still be benefits of this element of the activity for skills such as teamwork (according to the specific content being delivered), while if the benefits for cognition do not derive from PA participation then that element nevertheless has benefits for physical health.

In a paper published the following year, the same team noted a number of positive findings regarding the effects of acute PA on inhibition in children and observed that the research into updating and shifting was more limited but often indicated no significant effects on these processes (Jäger, Schmidt, Conzelmann & Roebers, 2015). On the assumption that acute PA might influence all three dimensions of executive function, but with inhibition perhaps benefiting the most easily, the researchers set out to extricate the effects on executive function of PA and cognitive engagement in natural settings. Children aged 10–12 took part in one of four conditions: physical games (PA with cognitive engagement); aerobic exercise (PA without cognitive engagement); cognitive games (cognitive engagement without PA); or a control

condition (neither PA nor cognitive engagement). There were no effects on executive function for the overall sample but when participants were divided into low- and high-fit groups (via median splits for males and females based on 20-m shuttle run test performance), there was a main effect of PA amongst children in the high-fit group for updating (accuracy on a computerised task; $\eta_p^2 = .09$), implicating PA rather than cognitive engagement in the effect. As the intensity of the PA was not adjusted to the same level for every individual, children demonstrated between 50% and 80% of estimated HRmax during the PA conditions and differing levels of physiological arousal between high- and low-fit participants may therefore underlie performance differences. When participants were divided into high- and low-achieving groups (via a median split for performance on standardised tests of reading, writing and mathematics), no significant effects of PA or cognitive engagement on executive function were found for low-achieving participants, but for high achievers there were again significant main effects on updating for PA ($\eta_p^2 = .11$) and also this time for cognitive engagement ($\eta_p^2 = .05$). On the basis of these findings it does not seem necessary for PA to include cognitive engagement in order for it to affect updating performance, but the effects of PA may be moderated by participants' fitness and academic achievement. It is not, however, clear why PA had an impact upon updating alone when inhibition had been more typically affected in prior research.

To conclude this section by reporting on research into LTM, the study of Pesce, Crova, Cereatti, Casella and Bellucci (2009) examined the effects of PA (40 minutes of aerobic circuit training or team games, performed at the same intensity as measured by ratings of perceived exhaustion and percentages of MVPA [heart rate >139 bpm]) on the free-recall memory task performance of 11–12-year-olds from middle schools in Rome. After a 12-minute delay following the memorisation period, during which rehearsal was prevented, the children remembered a greater number of words from the end of the 20-item list following participation in either of the PA conditions than in the absence of preceding activity. It was felt that physiological arousal might perhaps reduce the need for rehearsal by increasing the amount of available resources, facilitating the consolidation of information. On the other hand, only participation in team games led to improved recall over the no exercise condition for the initial free recall task involving a 100-second post-memorisation delay (still thought to assess LTM, supported perhaps by rehearsal in the absence of a distractor task), and this was

the case for words presented both early and late in the list. For LTM, then, physiological arousal associated with PA may be only one part of the story, with the cognitive and social aspects of participation in team games potentially supporting LTM processes.

There have been few other studies of the effects of PA on LTM in youth populations; in 2014, Etnier, Labban, Piepmeier, Davis and Henning reported that no others had been published since Pesce et al.'s 2009 paper when they followed up the research of Pesce's team with an investigation into the LTM of 11–12-year-olds from North Carolina. Testing was conducted via free recall of an auditory-presented word list rather than a visually-presented list as in Pesce et al.'s study, with testing taking place for the control group before a PE lesson and for the experimental group after exercise constituting a 5-minute warm-up followed by the Progressive Aerobic Cardiovascular Endurance Run (PACER) test (completion times of approximately 2–8 minutes, with a mean of 5 minutes and 1 second). Both groups also took part in a recognition task 24 hours later. Participants in the exercise condition remembered a significantly greater percentage of words in the free recall task, but not in the recognition task, compared to those in the control group, indicating that acute PA was beneficial at least for recall over a short time period containing an interference task. It is unfortunately unclear whether the results of the recognition task reflect a lack of effect 24 hours later or whether the use of a recognition protocol led to ceiling effects for both groups and was therefore unsuitable for identifying any differences in performance. Furthermore, the intensity of PA was not measured, although the authors felt from observation (e.g. of the children's breathing) that participants' PA had been of moderate intensity on the PACER test. A strength of the research was, however, the calculation of recall and recognition percentages against the highest number of words recalled by each participant across five initial learning trials in order to adjust for the verbal learning of every individual; pertinent to the later topic of PA and academic achievement, learning was found to be both faster and greater (more words recalled in learning trials 3–5 of 5) for those in the exercise compared to the control condition.

In summary, despite differences in methods across studies it would seem fair to state the following regarding acute PA and cognitive performance in preadolescent populations:

- Processing speed tends not to be a variable of research interest in its own right and studies involving children of primary school age are required.
- Improvements in speed and especially in accuracy have been observed on tests of attention following acute bouts of PA, with effects most apparent in laboratory studies. It is however difficult to separate the effects of PA on attention and executive function because attention requires the inhibition of attention to task-irrelevant stimuli. Further work in school settings should attempt to use comparable methods, allowing for conclusions to be drawn across studies.
- Inhibition appears to be the aspect of executive function most consistently improved by participation in acute PA, although improvements have also been demonstrated in the school setting for speed of updating and shifting following moderate PA, and also for updating accuracy amongst high-fit and high-achieving children following PA with and without cognitive engagement. Again, consistent methods would help to establish the benefits of PA for executive function in school settings.
- There are the beginnings of evidence that acute PA in the school setting – and perhaps particularly PA involving cognitive and social engagement – has beneficial effects for recall. However, research into LTM for preadolescents is limited and additional work in this area is necessary.

#### *2.2.3.2 Chronic Physical Activity and Cognitive Performance*

Whilst an appreciation of the effects of an acute bout of activity on cognition is of use to those working in education settings, for instance by helping school staff to plan when to include PA in the timetable for potential facilitation of pupils' learning, Bailey et al. (2013) draw attention also to *chronic* PA, noting that a well-planned programme of sustained PA is likely to support cognition and academic achievement. If so, it is possible that there are benefits for children's cognitive performance of any intervention with a PA component. Study 3 explored the same intervention as Study 2 but from a chronic rather than acute perspective. The evidence regarding chronic PA and cognition is presented below to provide a picture of the ways in which the PA aspect of the intervention might contribute to any cognitive outcomes, with habitual PA also being discussed as one of the aims of the intervention is to promote children's

increased PA participation (as measured in Study 3a) and this might be associated with changes in cognitive performance.

Before reviewing the research, it is worth noting that one of the major difficulties of conducting investigations into chronic PA interventions is that any number of variables might influence participants' cognitive performance between pretest and posttest, an issue which could underlie any effects – or lack of effects – identified. Despite its quasi-experimental design, Study 3 therefore takes the stance that any changes in cognitive performance indicate a *relationship with* rather than an *effect of* intervention participation, whereas the papers reported in this section of the literature review generally refer to effects. Hillman (2014) makes the intriguing point that causal evidence should comprise complete manipulation, requiring that some groups undergo a *reduction* in PA to determine whether this results in negative effects for cognition; however this is an ethically problematic manipulation to make due to the implications for a child's health and does not yet appear to have been attempted.

In 2003, Sibley and Etnier ran an early meta-analysis of studies into PA and cognition in children (4–18 years old) and established an overall effect size of $g = 0.32$ from 44 studies providing a total of 125 effect sizes. Findings from this article are especially noteworthy given that no evidence existed for the 'file drawer problem' (Rosenthal, 1979), with unpublished literature also supporting the effect. As well as cross-sectional/correlational designs, the analysis included effect sizes from both chronic ($n = 45$) and acute ($n = 25$) interventions, with no significant difference in average effect size between them ($g = 0.29$ and $g = 0.37$, respectively): participants were calculated to show an improvement in cognitive performance of approximately 0.5 SD when exposed to PA in experimental studies. The cognitive assessments did however encompass eight measures including achievement and academic readiness, of which only perceptual skills and memory would be categorised under the heading of 'cognitive performance' in the current thesis, and results suggested no effect of PA for the latter. Similar to the research into acute PA, the authors noted that a vast range of cognitive assessment methods were employed across the studies and they felt this variety to have contributed to inconsistencies in findings.

A more recent meta-analysis, this time of research published before April 2012 and

focusing on the effects of physical exercise exclusively on executive function, identified that "few studies reported on the effects of *chronic* (long-term) physical exercise interventions on cognitive functioning, and executive functions in particular, in healthy groups of children," with researchers having mainly investigated the relationships between *fitness* and cognitive performance/academic achievement in preadolescents (Verburgh, Königs, Scherder & Oosterlaan, 2014, p. 974). As described earlier, there are difficulties with using fitness as a proxy for regular PA but to provide just some examples of such studies, aerobic fitness has been positively associated with performance on the Stroop task described later in the thesis (suggesting greater executive control; Buck, Hillman & Castelli, 2008), and high-fit children demonstrated faster reaction times than low-fit children in a visual oddball discrimination task (suggesting better attention, processing speed and working memory; Hillman, Castelli & Buck, 2005). It seems, therefore, that there may be a positive relationship between fitness and cognitive performance.

The intervention study of Davis et al. (2007), billed as a study into fitness, constituted an RCT in which overweight 7–11-year-olds took part in gym-based exercise games for either 20 or 40 minutes per day, 5 days per week for ~13 weeks; as such, it is argued here that this was a chronic PA programme and results can reasonably be interpreted as stemming from children's PA participation as much as their fitness levels. At the end of the programme, both exercise groups demonstrated significantly greater fitness improvements than a control group and, controlling for pretest scores, the high-dose group also exhibited significantly higher scores for the Planning (executive function) component of the CAS in comparison to controls. A later paper expanded upon these findings by analysing five cohorts participating in the intervention over a 3-year period (Davis et al., 2011). There was no effect for the low dose group ($d$ = 0.00) but there was a significant effect for the high dose group ($d$ = 0.41), implicating the duration of PA in its effects on Planning performance.

A 2014 article from the same team looked into inhibition as a more elementary component of executive function (Krafft et al., 2014). Overweight 8–11-year-olds took part in 40 minutes of instructor-led aerobic activities after school for a longer period than in the previous studies (~8 months rather than ~13 weeks), and the researchers attempted to address a common limitation of intervention studies by

having their control group take part in instructor-led sedentary activities (e.g. art, board games). This allowed the pupils – unlike a waitlist control – to receive an equivalent level of attention from facilitators to that received by the PA group. Unfortunately, attendance at the university-based sessions was significantly lower for the intervention group (*M* = 58%, *SD* = 29%) than for controls (*M* = 75%, *SD* = 20%), meaning that the attention received was ultimately incomparable, a variable perhaps responsible for the lack of group × time interactions found for performance on a button-press flanker task and on an antisaccade task requiring children to inhibit their glance towards a stimulus and redirect it in the opposite direction. Differences in brain activation were however observed via functional magnetic resonance imaging (fMRI), yet correlations between neural activity and task performance were minimal. Nonetheless, the finding regarding attendance is in itself useful because the same time commitment was required from both groups and thus questions are raised around issues including the appeal of and value assigned to PA programmes by children and parties supporting their attendance (e.g. parents).

There have been a number of investigations into the *'Fitness Improves Thinking in Kids'* (FITKids) after-school PA programme in Illinois. This intervention focused on improving children's aerobic fitness, with its 2-hour sessions taking place at a university campus at the end of every school day for 9 months and the pupils participating in a total of at least 70 minutes of MVPA per session. One of the most recently-published FITKids papers is that of Hillman et al. (2014), who ran an RCT into the effects of the intervention on behavioural and electrophysiological measures of executive function amongst 8–9-year-olds. Participants were matched on variables such as sex, race, SES and baseline fitness ($VO_{2max}$) and randomly assigned to the intervention or a waitlist control condition, but unfortunately their habitual PA was not measured. This is problematic because although the increase in aerobic fitness was greater for intervention participants, the fitness of *both* groups improved over the course of the study. No explanation for the change in the control group was offered but in addition to biological maturation it could have been due to increased PA participation as the seasons became warmer over the course of the school year.

Nevertheless, the results regarding attentional inhibition (tested using a computer-based flanker task) showed that overall response accuracy increased in both groups

but to a greater extent for intervention than control participants (3.2% greater pretest to posttest change score, $d$ = 0.27); however, there was no significant difference between groups for reaction time. On incongruent trials, the intervention group also showed increased P3 amplitude and faster P3 latency (the latter indicating increased cognitive processing speed) at posttest compared to pretest, as well as a greater change relative to the control group on these measures. These results suggest that chronic PA participation – or fitness resulting from it – improves inhibition accuracy, as observed at a behavioural level, and leads to greater allocation of attentional resources to and faster processing of stimuli, as observed at a neurological level. In addition, both groups increased in pretest to posttest response accuracy on both types of trials constituting the colour-shape switch task of cognitive flexibility, in which participants made a single decision regarding *either* the colour *or* shape of each stimulus in a set (homogenous trials) or switched between making decisions regarding the colour and shape of different stimuli within a set (heterogeneous trials). On the more cognitively-demanding heterogeneous trials, the improvement in accuracy was greater for the intervention group (4.8% greater pretest to posttest change score, $d$ = 0.35), and this group also showed a greater increase in P3 amplitude relative to the control group. There was no significant difference between groups for P3 latency. Again, these findings are indicative of improvements in accuracy on an executive function task – this time assessing shifting – with an associated greater allocation of attentional resources according to neurological data.

Together, the results of Hillman et al.'s (2014) study illustrate improvements in behavioural and electrophysiological measures of inhibition and shifting following children's participation in an evidence-based chronic PA intervention with educational, behavioural and environmental components. The study is also one of very few to report on intervention attendance in relation to cognitive outcomes. To focus on the behavioural findings, a significant positive correlation ($r$ = .24) was identified between attendance and change in performance for the heterogeneous condition, but not for the homogeneous condition, of the shifting task, suggesting a dose–response relationship between PA and executive function. Results such as these offer support for the provision of programmes within school hours, removing some of the barriers to children's regular attendance (e.g. parental working patterns) which may affect their attendance at after-school sessions.

In another study of FITKids participants, the adult-like use of prefrontal brain areas might be interpreted as reflecting that children's chronic PA participation leads to the earlier adoption of more mature cognitive strategies for completing interference tasks (Chaddock-Heyman et al., 2013). Whilst in an fMRI scanner, 8–9-year-olds completed a button-response flanker task with three types of stimuli: left/right-facing targets with neutral flankers; left/right-facing targets with incongruent flankers (requiring attentional and interference control); and NoGo X-shaped targets (thought to require the inhibition of a prepotent tendency to respond, though this was questioned when near-ceiling accuracy was found across all children and analyses of NoGo findings were consequently deemphasised in the results). There was an improvement in pretest to posttest reaction time on incongruent trials for the intervention group only, accompanied by decreased brain activation in the right anterior prefrontal cortex (an area thought to help keep track of overall task goals while performing each trial). Unlike control children, the intervention group also demonstrated similar accuracy scores and activation in this brain region to that of young adults at posttest, although the reaction times of both groups of children remained significantly slower than those of young adults.

While results suggest that FITKids has positive influences on shifting and inhibition, participation in the programme places very high demands upon children's time and it is extremely unlikely that such a scheme could be run within school hours. Assessments are therefore required of programmes of shorter session/total duration which are more practical for implementation as part of the school day. The research teams noted as a limitation of their studies that the effects observed could not be entirely attributed to PA because there was a social (as well as a rather minimal dietary) component to the intervention; however, it is rarely the case that pure PA programmes are delivered outside of the context of experimental research, making the FITKids programme reflective of broader schemes in which additive and interactive effects from such factors would be expected. The intervention unfortunately remains one of very few healthy lifestyle programmes with a chronic PA component to have been investigated in relation to cognitive performance.

Of note also in a discussion around long-term PA and cognition are a child's habitual

activity levels, with research in this area generally seeking an association between habitual PA and cognitive performance. One recent investigation conducted in The Netherlands found significant but small relationships between the daily total volume of PA, measured via accelerometry, and the executive function of 8–12-year-olds, measured as both their score ($r$ = .24) and execution time ($r$ = –.29) for the Tower of London (ToL) task (van der Niet et al., 2015). Furthermore, a significant small to moderate correlation existed for ToL execution time and minutes per day spent in MVPA ($r$ = –.29). The ToL task was employed as a measure of planning, a higher-level executive function than updating, shifting and inhibition, but one which can potentially be accounted for by these more basic concepts (Miyake et al., 2000). However, no correlations were found between PA measures and performance on the Stroop test (as a measure of inhibition) or the Trailmaking test (assessing cognitive flexibility; i.e. shifting between response sets).

Results from a prior study had demonstrated that the total volume of PA of 11-year-olds – again measured via accelerometry – did not predict performance on tests of sustained attention, attentional control/switching or, for males, selective attention (Booth et al., 2013). Total PA even predicted *poorer* selective attention for females. These were however the findings from unadjusted models and total PA consisted mainly of light intensity activity. In adjusted models controlling for total PA and potential confounding variables associated with PA and cognition (e.g. weight status, SES), percentage of time spent in MVPA predicted increased performance for males on the selective attention and attentional control/switching tasks and for females on the attentional control/switching task. Conversely, in another investigation no association was found between MVPA (mins/day) and flexibility of attention for 11–13-year-olds in Finland – or between MVPA and sustained attention or visual memory performance – whether MVPA was self-reported or measured via accelerometry (Syväoja et al., 2014). Faster performance on the reaction time test was however associated with high levels of accelerometer-measured, though not self-reported, MVPA. The authors indicated a possible ceiling effect which might explain the lack of other significant correlations; the study employed the computerised Cambridge Neuropsychological Test Battery to measure cognitive performance and such batteries were designed to detect neurocognitive deficits so typically developing children might perform on them to a higher than average level.

When it comes to studies of habitual PA, differences in findings might not only result from limitations and variations in methods, however, but also from the particular content of children's PA; some forms of PA may be more cognitively and/or socially demanding than others and therefore possess different relationships with cognitive performance, as acknowledged by van der Niet et al. (2015). PA content cannot be captured via accelerometry alone but the alternative or supplemental recording of PA content by self- or parental report places a greater burden upon participants/parents and may not provide researchers with sufficient detail to determine the cognitive and social demands of the activities in which children have engaged.

To summarise, research into chronic PA and cognitive performance has largely focused on executive function, including inhibition, shifting and the higher-level concept of planning. There is growing evidence for a relationship between chronic PA and executive function but a need exists for further intervention research, especially into chronic PA programmes which are of an acceptable duration for delivery within school hours in order to maximise children's attendance.

As for acute PA, more research into chronic PA and processing speed is required as processing speed has received little attention as an aspect of cognitive performance in its own right. There may be positive associations between fitness (notionally caused by long-term PA participation) and processing speed and also between daily MVPA and reaction time. More pressingly, there has been almost no research into chronic PA and LTM. Studies from the meta-analysis of Sibley and Etnier (2003) suggested no effect of PA on memory but it is unclear from the paper whether this finding concerned both acute *and* chronic PA and whether the researchers' conception of memory was the same as the one described in this thesis or whether it included, for example, working memory processes.

Finally, the evidence regarding chronic PA and attention is mixed, for example with data from one study suggesting a positive association between children's habitual MVPA and selective and sustained attention, yet from another indicating no relationship between daily MVPA and sustained attention. Intervention research into chronic PA and selective and sustained attention would be valuable.

### *2.2.4 Physical Activity and Academic Achievement*

There is an increasing body of research demonstrating positive academic outcomes in relation to children's PA participation, and at the very least it appears that the inclusion of PA opportunities at school does not have a detrimental effect on performance in other subjects despite reducing the time available for lessons in these subjects (Howie & Pate, 2012; Sibley & Etnier, 2003; Singh, Uijtdewilligen, Twisk, van Mechelen & Chinapaw, 2012; Trudeau & Shephard, 2008). Differences in findings have again been suggested to result from differences in methods, for instance recording achievement from test results, grade-point average or academic records (Hillman, Erickson & Kramer, 2008), but it is promising that there are few negative results. It is also possible that PA has a more pronounced effect on cognitive performance than on academic achievement, at least in the manner in which these variables have been recorded in research to date; a review of published studies of the effects of exercise on the mental function of under-16s described that several researchers using global measures of intellectual functioning and academic achievement did not find effects, whereas those using process-specific cognitive tests often identified positive effects (Tomporowski, Davis, Miller & Naglieri, 2008).

To provide a flavour of the findings, one of the highly-cited reviews of PA, fitness, academic achievement and cognitive performance in 4–18-year-olds reports that correlational studies ($n$ = 5) indicated a weak relationship between academic achievement and PA, where PA was recorded via self-report or as the frequency and duration of PE lessons reported by teachers, and where achievement was recorded in a multitude of ways including self-report of average grades, examination results and ratings of scholastic ability by school staff (Keeley & Fox, 2009). However, quasi-experimental studies in which PE curriculum time was increased ($n$ = 5) reported no obvious dose–response relationship between academic achievement and increases in PE duration (min. 27 mins/week; max. 75 mins/day) or length of intervention (min. 6 months; max. 5 years). Academic achievement was again measured in a number of ways, including via standardised tests, examination results and teacher ratings.

A more recent review of research into the association between school-based PA and academic outcomes for 4–13-year-olds suggested that PA (physically active lessons

and active breaks with and without curriculum content) might have a positive effect on academic achievement (Watson, Timperio, Brown, Best & Hesketh, 2017). It seemed that improvements were more likely to be observed for interventions of shorter duration were a progress monitoring tool rather than a national standardised test to be used in assessing academic achievement, and the authors noted that standardised tests, which are usually designed to be administered less frequently (e.g. yearly), are likely to be less sensitive to short-term progress than progress monitoring tools. Various measures of achievement were also employed in a systematic review of studies into PA interventions for ≤18-year-olds (Singh et al., 2018); moreover, due to the considerable heterogeneity between studies (e.g. interventions ranging from 1 week to 9 years in duration, PA being delivered on between 1 and 6 days per week, differing control conditions), the conclusion that there was inconsistent evidence for a beneficial effect on pupils' language performance (e.g. literacy, reading) but strong evidence for a beneficial effect on their mathematics performance was stated to refer to the effects of extra PA or of adaptations to the PA curriculum, rather than of PA per se.

As noted for cognitive performance, different exercise tasks might mediate the association between exercise and academic achievement due to the variety in challenge and enrichment provided (Tomporowski et al., 2008). The learning context of the PA in different studies should therefore always be borne in mind when drawing conclusions based across the range of available evidence. PA might additionally need to be of sufficient intensity for effects to occur. Booth et al. (2014) considered the percentage of time per day spent in MVPA (% MVPA) for UK 11-year-olds, measured via accelerometry, as a potential predictor for performance in the Year 6 SATs and in the General Certificate of Secondary Education (GCSE) examinations (taken at the age of 15–16 years). Their comprehensive analysis controlled for an extensive number of confounders including participants' birth weight, body mass index (BMI) and ethnicity, as well as maternal educational attainment and age of mother at delivery. To focus on the academic subjects of interest in the current research, for every 1 SD increase in % MVPA at the age of 11 the regression equation predicted significant increases in results for Year 6 English (males: 0.096 SD; females: 0.151 SD), GCSE English (males: 0.158 SD; females: 0.111 SD) and GCSE Mathematics (males: 0.111 SD; females: 0.081 SD). This study indicated positive associations between MVPA and short- and long-term academic achievement but also highlighted the multitude of

variables that may serve to confound these relationships, with the associations between % MVPA and performance in Year 6 Mathematics having also been significant for children of both sexes in the minimally adjusted models.

Thus far, the discussion has centred around chronic and habitual PA. Hillman et al. (2009) reported that before their study (introduced above in relation to acute PA and cognitive performance), little research existed for the effects of acute PA on academic achievement tests. This is understandable given the likely longitudinal mechanisms behind any effects. For example, PA participation has been associated with prosocial behaviour at school, a sense of school connectedness and improved classroom behaviour (Stead & Nevill, 2010), over time creating a more facilitative environment for learning which would be expected to lead to improved achivement. Hillman et al. (2008) note that neural networks might also be relevant in that fitness – driven at least partly by PA participation over time – has been related to the frontoparietal network, with mathematics and reading also eliciting activation in these areas of the brain. On the other hand, if acute PA improves cognitive performance, and if cognitive performance supports academic achievement, then gains in achievement may be expected following acute PA. Hillman et al. (2009) found that after acute, moderate-intensity aerobic exercise, preadolescents' achievement improved in reading ($d$ = 0.59), but not in spelling ($d$ = 0.16) or arithmetic ($d$ = 0.06), as indicated by their performance on the WRAT (3rd edition). However, cognitive testing began approximately 25 minutes following exercise and the achievement testing followed, meaning WRAT administration occurred between approximately 32.5 and 52.5 minutes post-exercise. Being presented in a fixed order (reading, spelling, arithmetic), it might be that the post-exercise effects had diminished by the time of the spelling and mathematics tests. The current research programme would have suffered a similar problem with test duration were the effects of acute PA on academic achievement to have been studied, and although they are a tool well suited to post-PA testing sessions, there were in addition concerns regarding the relevance to stakeholders of pupils' scores on academic test batteries (discussed further in Chapter 3). Therefore only the chronic PA–achievement relationship was investigated, with achievement being recorded from teacher reports.

On the basis of the above evidence, it might be fair to expect that participation in the

short-term intervention under investigation in Study 3 (6 weeks × 60 mins PA/week) would be neither positively nor negatively associated with academic achievement. A lack of association is in itself valuable as it indicates that reductions in the time available for the study of core academic subjects should not be detrimental to achievement in these subjects. However, the integration of PSHE messages alongside PA participation might lead to a differential relationship of intervention participation with academic achievement than might be anticipated for an intervention promoting PA alone, and there is some evidence that social-emotional programmes are beneficial for reading and mathematics performance, as discussed earlier in the chapter. It is perhaps particularly important for studies of PSHE interventions to include measures of achievement; consistent with the notion that there is a growing emphasis on academic achievement in primary schools in England, as indicated in Chapter 1, Campbell et al. noted in a 2015 process evaluation that support for PSHE had been downgraded since their 2006–2009 feasibility study of the *'Active for Life Year 5'* (AFLY5) school-based diet and PA intervention conducted with 9–10-year-olds in Bristol and North Somerset. They acknowledged in the process evaluation that their research, and that of many others, did not measure educational outcomes but stated that this should be an essential requirement for studies into school-based health interventions as the inclusion of educational outcomes might help to address the potential misconceptions of school staff that such interventions detract from achievement.

### *2.2.5 Physical Activity and Wellbeing*

The final part of this section of the literature review brings the discussion back to wellbeing, and in particular the potential relationship between wellbeing and the PA component of intervention sessions and/or habitual PA participation as promoted by interventions.

It is well established that PA is important for children's health. Being physically active has beneficial effects, for instance, for the musculoskeletal and cardiovascular systems (Strong et al., 2005), and MVPA has been linked to improvements in obesity and symptoms of depression (Janssen & LeBlanc, 2010). At the beginning of the decade, a quantitative synthesis of the literature identified a total of 73 published and unpublished studies into the effects of PA on the mental health of 3–17-year-olds, and

although results varied depending on methods, intervention content/delivery and participant characteristics, the effects were generally small but significant (Ahn & Fedewa, 2011). Group comparison studies demonstrated that PA participation led to increased self-esteem (RCTs: $\bar{d}$ = 0.29; non-RCTs: $\bar{d}$ = 0.78) and, for RCTs only, that it enhanced self-concept ($\bar{d}$ = 0.16) and reduced depression ($\bar{d}$ = –0.41), anxiety ($\bar{d}$ = –0.35), psychological distress/post-traumatic stress disorder ($\bar{d}$ = –0.61) and emotional disturbance ($\bar{d}$ = –0.33). Correlational studies suggested a small negative association between PA and depression ($\bar{r}$ = –.14) and a small positive association between PA and self-concept ($\bar{r}$ = .14). Although Egger's regression tests identified a potential publication bias, the authors reported that the overall effect size for PA and mental health remained significant even when accounting for this, and that the results they found from comparison studies were similar to previous findings regarding exercise, anxiety and depression for 11–19-year-olds from both the general population and at-risk groups (Larun, Nordheim, Ekeland, Hagen & Heian, 2006).

Shortly after the publication of Ahn and Fedewa's (2011) article there followed a review of narrative, systematic and meta-analytic reviews into chronic PA and depression, anxiety, self-esteem and cognitive functioning in children and adolescents (Biddle & Asare, 2011). Due to the timing of its literature search, this review of reviews did not include the paper by Ahn and Fedewa but nonetheless similarly concluded that there appear to be beneficial effects of PA for reduced depression and anxiety and for at least short-term improvements in self-esteem. The authors were however critical of the limited evidence base and of the lack of high-quality research in these areas, especially due to the use of cross-sectional designs and small samples. They additionally found the associations between routine PA and cognitive performance and academic achievement to be small and inconsistent.

The effects of PA on mental health may be supported by other wellbeing benefits linked to PA such as enhanced social skills, reduced social isolation and the acquisition of strategies for emotional regulation (Bailey et al., 2013). Furthermore, both of the above reviews included self-esteem amongst their outcome measures, with the former also including self-concept. These two outcomes arguably constitute the evaluation and knowledge components of a person's self-schema, respectively (Campbell & Lavallee, 1993), and Babic et al. (2014) argue that a positive self-concept is vital to

psychological wellbeing because it supports among other things resilience and happiness. Their systematic review and meta-analysis revealed a significant association between PA and *physical* self-concept for children and adolescents, particularly for males and for the perceived competence subdomain of physical self-concept. It was not clear whether PA results in improved physical self-concept, whether having a positive physical self-concept increases the likelihood of PA participation, or whether there is a common cause for both variables, but a reciprocal relationship seems likely, in which greater PA leads to skill development and enhances an individual's physical self-concept, which then encourages them to participate in more PA.

A similar argument applies for a study of self-reported PA and wellbeing in a sample of 9–11-year-olds in Northern Ireland (Breslin et al., 2012). On average, children who achieved the recommended 60 minutes of MVPA per day (24% of participants) scored higher than those who did not meet this recommendation on the Rosenberg Self-Esteem Scale, modified for use with a child rather than adolescent sample. They also scored favourably on all five subscales of the Child Health and Illness Profile Child Edition, with significantly higher scores for Comfort, Satisfaction, Resilience and Achievement and significantly lower scores for Risk Avoidance. Of the three dimensions of the KIDSCREEN-52 quality of life questionnaire analysed in the study, there was no difference for the self-perception (body image) dimension, but children meeting the MVPA guidelines had higher scores for the social acceptance dimension and for the social support and peers dimension. Effect sizes for all of the results were at best small ($\eta_p^2 \leq .01$) but it is difficult to argue that any effects are unimportant in relation to children's wellbeing, especially across so many measures and particularly if intervention studies are able to demonstrate a positive – and ideally long-term – effect of PA on wellbeing without a detrimental impact on other variables such as academic achievement. However, cause and effect cannot be established from cross-sectional results. To take just one aspect of the findings, it is possible that children with greater social support become more active due to peer encouragement; that children who participate in PA receive social support from peers involved in the same activities; or that a virtuous cycle exists between PA participation and social support.

Intervention research may need to strike a balance between avoiding taking a narrow

view of wellbeing (e.g. assessing only one dimension) yet not expecting too much from a programme taking place over a limited duration and constituting only a small aspect of an individual's life. To draw on an example with adult participants, for instance, a study of office workers measured the effects of 15 weeks of light resistance training and found a small increase in subjective physical wellbeing but no effects on psychosocial functioning or general wellbeing (Sjögren et al., 2006). Such results would seem reasonable for training for an average of 5 minutes per working day; general wellbeing, comprising items relating to life satisfaction and meaning of life, is likely to require greater input for demonstrable change to occur. Another problem when it comes to the assessment of wellbeing is again the issue of heterogeneity of measurement tools, as noted by Rafferty, Breslin, Brennan and Hassan (2016) in their review of school-based PA interventions and the wellbeing of 6–12-year-olds. Although 8 of the 11 interventions in the review raised children's PA, only one of these also reported a significant increase for the intervention group in one of the measures of wellbeing (psychosocial quality of life), along with two further studies which did not report an increase in PA but found an increase in limited wellbeing measures (e.g. global self-worth for obese children in the intervention group). Some of the interventions also included wellbeing components (e.g. on body image) but reported no significant differences in the wellbeing of the intervention and control groups at posttest. Explanations offered for this included low implementation of the wellbeing component by school staff and possible ceiling effects for pretest wellbeing amongst the middle-class participants, neither of which should apply in the current research programme as the interventions were delivered by external providers to children in low SES areas.

The nature and context of PA have received attention as potential moderators in the relationship between PA and wellbeing. Bailey et al. (2013) note that having a positive experience is key and for children this is heavily influenced by PA facilitators, who are responsible for creating a supportive, fun environment during sessions and who can assist in the development of transferrable social/life skills by focusing on situations arising during the course of the sessions and relating these to other contexts. The inclusion of a PA component to support the delivery of PSHE messages in the interventions studied in the current research programme is consistent with this notion. In Study 4, intervention staff reported using behaviour displayed by pupils during the

PA component to demonstrate concepts introduced in the classroom (e.g. that trying something new can boost one's self-esteem), and children were encouraged to practise skills and behaviours they had discussed (e.g. raising other people's self-esteem by offering compliments on their contributions to games).

The review of Ahn and Fedewa (2011) included comprehensive analyses regarding which characteristics of children's PA had the greatest effects on mental health. Of the RCTs reporting activity intensity, only interventions with an 'intense' level of activity showed a significant effect (intensity was unfortunately not defined but 'intense' was the highest level), and interventions were most effective when delivered by PE specialists, followed by teachers and finally researchers. An intervention such as the one investigated in Studies 2 and 3 – delivered by staff from a football club foundation and with an aim to improve children's physical fitness through PA participation – might therefore be expected to improve pupils' wellbeing, as explored in Study 3. The total of just 6 hours of PA offered by the intervention over 6 weeks might however limit the outcomes of participation; the review found significant effects in RCTs for interventions of all total PA durations (grouped into three categories: <20 hours, 20–33 hours and >33 hours of PA), but the effect sizes increased with the number of hours of PA by category (reductions in mental health disturbance: $\bar{d} = -0.16$, $\bar{d} = -0.42$ and $\bar{d} = -0.55$, respectively). The interventions were also delivered over a mean of 11.1 weeks ($SD = 3.6$).

Despite the multitude of variables that might affect the strength of the link, the results tend to indicate a positive impact of PA participation on children's wellbeing. In terms of acute effects, two possible explanations discussed by Stathopoulou, Powers, Berry, Smits and Otto (2006) are that PA participation raises serotonin levels, which in turn leads to a state of relaxation and enhanced mood, and that engaging in PA offers an opportunity for distraction from worries or engagement in anxiety-reducing thoughts. Over time, however, PA participation provides opportunities for skill development and when undertaken as a group might enhance children's sense of belonging (e.g. to their class and/or school). Competence and relatedness are two of the three basic psychological needs identified as essential for wellbeing by self-determination theory (Ryan & Deci, 2000), and the remaining need for autonomy can also be met if children's participation is not overly controlled or forced, again highlighting the

importance of the way in which PA sessions are delivered.

It would be remiss to conclude this section without acknowledging that although the bulk of the studies presented concentrate on the positive effects or lack of effects of PA upon wellbeing, there also exists the possibility for PA to have a *negative* impact. Of the studies included in the earlier-referenced systematic review of the health benefits of PA for 5–17-year-olds (Janssen & LeBlanc, 2010), all three of the studies that made reference to injury supported a dose–response relationship: higher intensities of PA were associated with a greater likelihood of injury. However, in a systematic review of interventions designed to prevent obesity in children and adolescents, Flodmark, Marcus and Britton (2006) noted that while early research had failed to report on the risks of preventative programmes, some of the more recent studies had done so and had found no harmful effects for underweight, anorexia, body perception or self-confidence. The wellbeing questionnaire employed in Study 3 does not directly measure risks but negative associations between intervention participation and physical wellbeing can be assessed. In addition, Study 4 presented stakeholders with an opportunity to discuss perceived negative outcomes through wider, open-ended questioning.

## 2.3 Additional Variables Associated with the Key Constructs

There are many variables that might moderate or mediate the relationships between the key constructs in the thesis. A brief review of just some of these variables follows, with an emphasis on participant characteristics such as sex and age. It is beyond the scope of the discussion to explore *why*, for example, sex differences in wellbeing might exist, with the aim of this section being simply to acknowledge that such factors should be borne in mind when conducting intervention research.

Firstly, in middle childhood (approximately 6–10 years) and early adolescence (approximately 11–14 years), children experience biological, cognitive, social and emotional changes (e.g. beginning to spend more time at school and with peers; Eccles, 1999), which might account for changes in their wellbeing independent of intervention participation. Furthermore, Breslin et al. (2012) found considerable sex differences in the wellbeing of 9–11-year-olds, with males scoring significantly higher

on measures including self-perception, social acceptance and global self-esteem, and females scoring significantly higher on measures including resilience, achievement and social support. Data collected for 8–11-year-olds across 13 European countries via the KIDSCREEN-27 (a short form of the KIDSCREEN-52, and the wellbeing measure used in the current research) also show that aspects of wellbeing might differ between males and females; although effect sizes were negligible to small, significantly higher scores were found for males on the dimensions of Physical Wellbeing ($d = 0.15$) and Psychological Wellbeing ($d = 0.08$) and for females on the dimensions of Social Support and Peers ($d = 0.04$) and School Environment ($d = 0.22$; Ravens-Sieberer et al., 2007). Looking more broadly at life satisfaction, in testing the *'How I Feel About Myself and School'* questionnaire, designed to allow for the comparison of responses across participants aged from 7 to 16 years, McLellan and Steward (2015) found an age × sex interaction. The effect sizes were small and the study cross-sectional but the results indicated that life satisfaction for both sexes had declined between the ages of 7–8 and 14–16 years and that at primary school girls had higher life satisfaction than boys but at secondary school this was reversed.

The review of research into children's PA and mental health presented earlier in this chapter reported mixed results regarding the possible moderating effects of participants' sex, possibly due to differing methodologies: in RCTs, males and mixed-sex groups benefited the most from PA, while non-RCTs suggested that girls benefited more than boys (Ahn & Fedewa, 2011). Against the authors' expectations, there were no differential effects of PA on mental health by children's weight status, despite the potential greater scope for improvement for overweight/obese individuals; in a cross-sectional study of 11–15-year-olds in the North West and South West of England, normal-BMI participants scored significantly higher than overweight/obese participants on measures of physical, emotional and social functioning – but not school functioning – even after adjustment for covariates including age, sex, ethnicity and receipt of free school meals, as an indicator of low SES (Boyle, Jones & Walters, 2010). Disability has additionally been implicated in children's wellbeing; early data from the Ontario Child Health Study indicated a relationship between psychosocial difficulties and long-term disability associated with chronic physical health problems (Cadman, Boyle, Szatmari & Offord, 1987), and a more recent article based on longitudinal data from children in England found that those with special educational

needs (SEN) and long-standing limiting illnesses are more likely to experience bullying, which has been found to have detrimental consequences for psychological wellbeing (Chatzitheochari, Parsons & Platt, 2016).

Moving on to academic achievement and cognitive performance, a multitude of variables are associated with mental function, including whether a child has SEN (noted, for example, in relation to performance on the Year 6 SATs; "Special-Needs Pupils 'Struggle'," 2017). As a government report highlights, across the Key Stages girls tend to outperform boys in English and the two sexes perform similarly in mathematics, but far greater predictors of achievement are SES and ethnicity (Department for Education and Skills, 2007); data from 2006 showed the percentage of pupils gaining a top-four grade in five or more GCSEs differed by 28 percentage points between those eligible/ineligible for free school meals (in favour of those ineligible), 70 percentage points between the highest and lowest attaining ethnic groups (although limited data for the lowest attaining group may exaggerate this finding), and only 9 percentage points between boys/girls (in favour of girls). In an attempt to reduce potential objections to the studies and thereby attain an acceptable sample size, the current research did not record individual children's SES or ethnicity. Schools were however chosen from areas of low SES and where possible areas with similar percentages of white British residents to reduce differences between the intervention and control groups. Weight was recorded only to calculate PA intensity from accelerometer data and participants were assured that weight would not be reported upon in the thesis or any research publications as this was an area identified by school and intervention staff to be particularly sensitive in their experiences.

In their review, Castelli et al. (2014) again identified SES as having a direct positive effect on academic achievement – and having a lower BMI was also facilitative – but SES was additionally thought to play a role in the PA–achievement relationship, along with sex, age, home environment, nutritional habits and intellect. To explore age a little further, mental function is of course expected to develop as children mature and learn; however, with the largest effects of PA on mental function having been found for 11–13-year-olds in their own review, Sibley and Etnier (2003) suggested that the wellbeing effects of PA (e.g. anxiety reduction) during this stressful developmental period led to effects for cognitive and academic performance. Hillman et al. (2009)

recognised in addition that differences in participants' motivation for exercise and for academic study might affect the PA–achievement link. Hillman's team had earlier postulated that genetic variability might moderate the effect of exercise/fitness on cognition (see Hillman et al., 2008), but to test this is beyond the scope of most school-based research.

Finally, to summarise variables which might be important in relation to PA, it is a highly consistent finding that girls participate in lower amounts of habitual MVPA than boys (e.g. Health and Social Care Information Centre, 2016). Furthermore, participation declines with age, with daily amounts of MVPA having been found to already be declining for girls and most boys by the age of 7 years in the North East of England (Farooq et al., 2018). Following up on frequent findings that PA levels are lower amongst overweight and/or obese children, an analysis of accelerometer data from 20 studies in 10 countries found that daily total PA differed by weight status from the age of 7, with overweight/obese participants spending less time in PA and MVPA than participants of normal weight (Cooper et al., 2015). Intervention research might therefore expect to find differences in the habitual PA of those of different ages, sexes and weight statuses at baseline.

A less clear picture exists for PA and SES. Data for 2016–2017 show that 10–11-year-olds in the most deprived deciles in England are more likely to be overweight/obese than those in the least deprived deciles (Public Health England, 2018), and as overweight/obese has been linked to lower levels of PA it may be expected that low SES would be associated with low levels of PA. However, although a systematic review of reviews found that this anticipated positive association between PA and SES exists for adolescents, it may not be the case for children aged 12 and under (Sterdt, Liersch & Walter, 2014). Supporting this finding, McLure, Summerbell and Reilly (2009) found no significant association between SES and the percentage of 9–10-year-olds from the North East of England meeting the MVPA guidelines, as assessed via accelerometry, and Love, Adams and van Sluijs (2018) report no differences by SES in the effect of school-based PA interventions on children's accelerometer-assessed MVPA throughout the day. Sterdt et al. surmised that because children's PA is usually informal in nature there is no impact of SES on PA participation, whereas there may be for low-SES adolescents whose opportunities to take part in structured activities

(e.g. sports clubs) are restricted by cost.

Understandably, a seasonal variation effect has been reported for PA participation, with the lowest levels of PA occurring during the winter and the highest during the summer for UK 6–12-year-olds (Rich, Griffiths & Dezateux, 2012). If PA is to be measured as an outcome then it is therefore essential for intervention studies to include a control group with which to compare any changes in the PA of intervention participants over the same period.

Based on even this short discussion it appears prudent for intervention research to record demographic variables – especially participants' age and sex – and to make an attempt to account for these in their analyses.

## 2.4 Stakeholder Perspectives on PSHE and Physical Activity Interventions

When conducting research into the efficacy of interventions, it is useful to explore the views of stakeholders as any outcomes are of course dependent upon participation and there will be little uptake/engagement if an intervention is impractical or otherwise unfavourable to its intended audiences.

Noting the potential for stakeholders to have different priorities for interventions, Morton et al. (2017) consulted three groups for their views on secondary school PA interventions: students aged 13–16 years, education-focused professionals (e.g. teachers, a parent, education-focused academics), and public health professionals (e.g. Local Authority staff, PA/public health-focused academics). Participants were asked to rank nine interventions according to criteria including their cost; short- and long-term feasibility for schools; acceptability for students, teachers and parents; and likely effectiveness for PA, mental health and wellbeing, school behaviour, school enjoyment and academic achievement. Consensus was generally found, with the active lessons intervention receiving the highest ranking from all three groups, effectiveness being rated the most important of the prioritisation criteria and mental health and wellbeing being rated the most important outcome. Although the findings might differ for primary school interventions, particularly in terms of disparities between groups

due to the children being younger, it is interesting that wellbeing ranked so highly; the delivery of a PSHE intervention in part *through* PA, as investigated in the current research, might therefore be popular with stakeholders.

When members of school staff, parents and pupils were asked for feedback on the AFLY5 diet/PA programme, it was identified from interviews and focus groups that children's engagement in the programme was supported by active lessons that promoted an understanding of the importance of the topic and encouraged children to make their own decisions over behaviours, thereby giving them a sense of autonomy (Jago et al., 2015). This is consistent with self-determination theory (Deci & Ryan, 2000), in which intrinsic motivation (taking part in an activity because it is inherently enjoyable or interesting) is supported by feelings of autonomy as well as of relatedness and competence (Ryan & Deci, 2000). It was also felt that the AFLY5 programme would be more exciting for children if they were to receive information from visitors to the school rather than from teachers, suggesting that interventions delivered by staff from football club foundations would be engaging for primary school pupils. Such interventions would have an additional strength over AFLY5 in that despite training, teachers were not confident in delivering the PA component of AFLY5, whereas staff from football club foundations have greater experience in PA facilitation.

As children have been found to be discouraged from PA participation if it takes the form of competitive sports or is highly structured, being motivated instead by experimentation and unusual activities (Allender, Cowburn & Foster, 2006), their engagement in the PA component of intervention sessions might be assisted if the PA aspect is varied, flexible and if it deemphasises competition. Variety in PA was also reported by 11–14-year-olds from London as contributing to their enjoyment of a 12-week community-based weight management programme which contained nutrition and PA components but which differed from school-based interventions in that participants attended in the company of a family member or carer (Watson, Baker & Chadwick, 2016). 'Fun' was a striking theme from participants' accounts of their experiences, and this was associated with active participation in the sessions, which provided greater meaning to the learning, and with taking part in activities with others, harking back to the 'relatedness' aspect of self-determination theory. Having fun appeared not only to be important for children's engagement in the intervention but

also seemed to lead to increased confidence, suggesting a potential role for enjoyment in supporting outcomes.

While school-based interventions are well placed to address many of the barriers to children's PA participation as children are already present and in a safe space (addressing the barriers of cost, transportation and lack of safe outdoor space reported by parents; Bentley et al., 2012), one of the difficulties noted for AFLY5 was that teachers reported a lack of time to deliver the sessions and a pressure to focus on core curriculum subjects (Campbell et al., 2015). The same difficulties may prevent schools from taking up programmes delivered by external providers unless the benefits of these programmes are perceived to outweigh the costs; however, if external providers are hired then there should be greater fidelity of intervention delivery, with Campbell et al. reporting that issues with AFLY5 delivery may have contributed to the lack of effects for children's PA, sedentary time and fruit and vegetable consumption in the effectiveness evaluation, although reductions were found in screen-viewing time and in the consumption of energy drinks and snacks. Similarly, returning to the evaluation of the SEAL programme – another intervention delivered by school staff – it is interesting to note the author's conclusion, based upon stakeholders' accounts, that the effectiveness of programme implementation depended upon factors such as school staff valuing the programme and overcoming barriers including a potential reluctance to teach sensitive PSHE topics (Hallam, 2009). It is likely even if external organisations deliver interventions that such factors will still be at play as school staff are well placed to reinforce programme messages between sessions and following the conclusion of an intervention. Furthermore, SEAL outcomes were highly related to children's pre-intervention wellbeing, which is likely to result from their home as well as school experiences. Interventions may seek to inform parents of programme messages such that they can provide a supportive home environment and, like teachers, reinforce children's learning; however, effects of this might vary as parents were found to support the AFLY5 programme to differing degrees (Jago et al., 2015). All of this points to the importance of positive stakeholder perspectives for positive intervention outcomes, with children being likely to enjoy intervention sessions in which they are actively involved in varied tasks.

# Chapter 3: Methodology

A directional relationship is generally posited between ontology, epistemology, methodology and methods, in that researchers should understand and acknowledge their ontological position, or how they view reality, and their other positions and decisions will follow logically and sequentially from this (Grix, 2002). This chapter follows the same structure to explain the methodological background to the research.

The methods sections in this chapter explain why each method was chosen, with greater detail on the ways in which research tools were employed being provided in the methods sections for the appropriate study or studies.

## 3.1 Ontological and Epistemological Assumptions

Ontological positions range from *naïve realism*, in which it is believed there is an objective reality, through to *relativism*, in which the form and content of reality is seen to be dependent upon the views of an individual or group (Guba & Lincoln, 1994). Epistemological positions are then the ways in which we obtain valid knowledge; as O'Gorman and MacIntosh (2015) explain, these range from *positivism*, in which the focus is on hypothesis testing, the operationalisation of concepts in order to measure them and the generation of causal laws, to *interpretivism*, in which the focus is on developing ideas through induction from the data, looking for in-depth meanings and attempting to understand what is happening. However, in an article advocating a pragmatic approach to social science research methodology, Morgan (2007) discusses ontological and epistemological issues collectively as *metaphysics* and states that a defining feature of pragmatism is what *difference* is made by metaphysical beliefs. The article goes on to express that pragmatism elevates the focus on methodology, as issues related to the research itself are the main concern, and this opens the gate for mixing and combining methods.

The current thesis takes a similarly practical orientation and Biesta's (2010) addition of two further levels above ontology for researchers to consider is seen to be a useful one: the *purpose of the research* here is to *explain*, or to identify causes and

correlations to help change the course of future events (i.e. to measure the outcomes of intervention participation and to investigate stakeholders' views on why interventions are (un)successful in order to inform policy and practice); and the *practical role* of the research is a *cultural* one, in that it provides intervention staff and school staff with different ways of seeing and understanding their interventions and curriculum delivery. Nevertheless, it is recognised that pragmatism – seen by Biesta to be a set of philosophical tools to address problems, rather than a philosophical position in itself – might underestimate the influence of philosophical assumptions on research methods (Maxwell & Mittapalli, 2010). A position of *critical realism* is therefore acknowledged for the current work; a position that has been compared to pragmatism but in which an ontological realism and epistemological constructivism are accepted, meaning it is believed that there is an objective reality but that there can be more than one way of understanding this (see Sayer, 2000). Following the reasoning of Maxwell and Mittapalli, the impact of a position of critical realism for the current research is that it recognises the importance of the processes and context of events and phenomena in explaining causation, indicating the value of quantitative *and* qualitative investigation of the intervention programmes, and that by emphasising such causal processes rather than general laws it allows for explanations of why different individuals or groups might respond differently to the programmes.

## 3.2 Methodology: Mixed Methods Approach

A mixed methods approach is one in which a researcher combines aspects of qualitative and quantitative approaches, for instance data collection, analysis and inference techniques (Johnson, Onwuegbuzie & Turner, 2007). As such, it unites the strengths of a qualitative approach, such as being able to conduct in-depth, open-ended explorations of an issue, with the strengths of a quantitative approach, such as being able to identify patterns and associations and to compare within and between groups (McEvoy & Richards, 2006). Crucially, data must be integrated at some point in the programme of inquiry, the rationale being that neither qualitative nor quantitative methods alone are sufficient to provide a detailed account of a phenomenon (Creswell, Fetters & Ivankova, 2004).

On the basis of the research problem, and consistent with a position of critical realism, a mixed methods approach was adopted for the research programme. As an assessment of the cognition research tool to be used in Studies 2 and 3, Study 1 sits outside of the current discussion; however, by conducting quantitative analyses in relation to potential outcomes of intervention participation (e.g. cognitive performance; Studies 2 and 3) *and* by collecting qualitative data from a range of stakeholder groups regarding their experiences of classroom/PA-format PSHE interventions (Study 4), the researcher was able to arrive at overall conclusions which did not simply reflect the objective but also the *perceived* outcomes of programme participation, as well as the context in and potential mechanisms by which these outcomes appeared to arise. The open-ended nature of the qualitative enquiry allowed the researcher not only to explore whether the stakeholders appreciated that there may be cognition-, academic achievement- and wellbeing-related outcomes of intervention participation as measured in the quantitative studies, but also accommodated the possibility that stakeholders would discuss outcomes which had not been anticipated on the basis of existing literature but which might help inform policy and practice regarding PSHE and PA provision in primary schools.

Creswell (2009) describes that there are four aspects to consider in planning mixed methods research: *timing*, *weighting*, *mixing* and whether a *theoretical perspective* will guide the design. No specific theory guided the current research but there was an action orientation in that the aim of the work was to provide recommendations pertaining to delivery of the interventions, and more broadly to PSHE and PA opportunities in primary schools, with school staff under apparent pressure to prioritise core curriculum subjects in the timetable. Therefore, regarding this action orientation as a theoretical lens, a *concurrent transformative strategy* was adopted, in which equal priority would be given to the quantitative and qualitative studies taking place during the same phase of the research programme (Figure 1.1), and in which the data would be connected by being discussed together in the overall interpretation of the research findings (Creswell, Plano Clark, Gutmann & Hanson, 2003). While some researchers argue that transformative research should meet specific criteria such as referencing a community of concern, presenting background literature on diversity and oppression and being of benefit to the community (Sweetman, Badiee & Creswell, 2010), others recognise it to be political research which makes a commitment to enable change at

some level, whether within a particular organisation or at an international level (Gilbert, 2006). The current research is more consistent with the latter definition. Regardless of the definition employed, however, a concurrent transformative strategy with integration of quantitative and qualitative data in the narrative not only builds a comprehensive picture of the subject of investigation but allows for the identification of any discordance, or inconsistencies in the findings (Fetters, Curry & Creswell, 2013); these inconsistencies being valuable points for consideration when making recommendations for practice and for future research in this field. On the other hand, Creswell et al. noted in 2003 that there was little guidance on using a transformative vision to guide research methods, and a 2019 literature search suggests that this is still the case. Justification for the methods selected in the current research is therefore provided throughout this chapter.

The use of both quantitative and qualitative methods permits methodological triangulation, although the term 'triangulation' might be contested in transformative or political strategies in which "multiple truths co-exist and compete for hegemony" (Gilbert, 2006, p. 215). Two of the three frequently-cited reasons for triangulation described by Risjord, Dunbar and Moloney (2002) nevertheless appear to apply for the current research, with the quantitative and qualitative findings from across the research programme potentially being able to provide *confirmation*, or strong, consistent evidence for the conclusions drawn, and *completeness*, or a richer, more detailed understanding of classroom/PA-format PSHE interventions than would be possible with a single method. The third rationale for triangulation, *abductive inspiration*, is when ideas generated via one method are tested with another, and as such does not apply to a concurrent transformative strategy.

Any account of methodology would not be complete without reference to the quality of the research, or the level of confidence that can be placed in the findings. Again, the terms used to denote this concept differ from research paper to research paper, and especially between quantitative and qualitative articles, but it appears that 'reliability' and 'validity' are favoured in quantitative research and 'rigour' is favoured in qualitative research (e.g. Thomas & Magilvy, 2011). The same terms are therefore applied for the quantitative and qualitative components of the current research

programme, with the exception that when citing a source the term(s) used in that source are used to reflect the language of the author(s).

As Maxwell and Mittapalli (2010) describe, due to its focus on the context and purposes of research, a realist perspective means that validity should be assessed through consideration of the threats to the conclusions drawn in a specific study, as well as on the methods used. Threats to the conclusions of specific studies are discussed in the chapters corresponding to those studies, and the accounts of the methods in the current chapter include quality considerations. However, in the case of mixed methods research there is a further factor in relation to research quality, which is that of *interpretive rigour*, including how well the overall inferences drawn incorporate the inferences from the quantitative and qualitative aspects of the research (Tashakkori & Teddlie, 2008). Onwuegbuzie and Johnson (2006) propose as one of the aspects of *multiple validities legitimation* – in which the legitimation (quality) of the quantitative and qualitative components and of the integration phase are addressed – that the researcher should ask to what extent the overall inferences are greater than inferences stemming from the quantitative and qualitative components separately. This is done in the general discussion (Chapter 9).

## 3.3 Quantitative Approach

Studies 1, 2 and 3 of the thesis each followed a quantitative approach: Study 1 assessed the reliability and validity of a pilot cognitive test battery designed for use in Studies 2 and 3; Study 2 compared changes from pretest in the cognitive performance of participants who had taken part in the physical activity component of an intervention session or in a normal classroom lesson immediately prior to testing; and Study 3 compared the pretest to posttest changes in cognitive performance, academic achievement and wellbeing of participants who had taken part in an intervention with those who had not. In each case, quantitative research was appropriate as this is concerned with hypothesis testing: predictive statements are generated on the basis of theory or existing literature and are then tested, with the results of statistical analyses indicating whether the researcher should retain or reject the null hypothesis (that the difference/relationship being investigated does not exist in the population) on the basis of the probability of the observed outcome occurring in the study if the null hypothesis

were true (Johnson & Christensen, 2008). The researcher can then conclude, for instance, that an experimental manipulation causes an effect or that two variables are related. To use Study 2 as an example, the literature presented in Chapter 2 indicated that a positive effect of PA participation on cognitive performance could be expected, and the hypotheses were written accordingly (i.e. that there would – or, in the case of the null hypothesis, would *not* – be a significantly greater improvement from pretest in the cognitive performance of children who had taken part in a PA session than of children who had taken part in a classroom lesson). Quantitative data relevant to the variables of interest (different aspects of cognition) were then collected, and the results of the statistical analysis conducted on these data indicated that the researcher should retain the null hypothesis.

Study 1 is an example of the literature guiding quantitative research in a slightly different manner to that in Studies 2 and 3, as there have been a great variety of tools used to measure cognitive performance in previous studies, leading the researcher to produce a pilot cognitive test battery that may be used across school-based research in the future. Reliability and validity characteristics of the battery were assessed in Study 1, again through statistical testing.

Consistent with the goal of testing hypotheses, numerous efforts were made to control for confounding variables in the quantitative studies; these can be seen in the relevant methods sections of the thesis but included, for instance, running familiarisation sessions for the cognitive testing such that participants' first recorded results were less likely to be influenced by uncertainty regarding task rules and response formats. Yet, it is never possible to anticipate and control for all of the possible confounding variables in a study, meaning that the effects of the independent variable (IV) may be to some extent obscured by other factors (Ewert & Sibthorp, 2009). Again, such difficulties are described in the relevant methods sections but to give one example, group characteristics might have affected participants' motivation to complete the research activities, with the results of Study 3 therefore reflecting more than simply their participation/non-participation in the intervention. With a vast range of school and non-school factors influencing children's cognitive performance, academic achievement and wellbeing beyond their involvement in the intervention, the findings

of Study 3 were reported as relationships between these constructs and intervention participation rather than as intervention *effects*.

Quantitative research uses larger samples than qualitative research and describes group tendencies; conclusions are drawn from numerical data (e.g. means and standard deviations) indicating what commonly occurs within the group and the amount of variety between the participants (Black, 1999). Although random sampling – one of the assumptions behind an ideal model of generalisation – does not occur in most research as it transpires in reality, quantitative researchers still aim to select a sample representative of the larger population and therefore typically still make statistical generalisations from the participants in a study to the wider population (Polit & Beck, 2010). In the case of the current research, samples were not random because in the interests of statistical power whole classes of children were invited to participate and all of those with completed consent forms did so. However, the samples contained children of both sexes with a range of cognitive (Studies 1–3), academic achievement (Studies 2–3) and wellbeing (Studies 2–3) measurements at baseline, and were thus broadly representative of 9–11-year-old children from schools in areas of low SES in the North East of England; a group from which 39% of children would be anticipated to achieve the expected standard in the Key Stage 2 SATs – compared to 62% of non-disadvantaged children from the same region – based on 2016 data using eligibility for free school meals as the indication of disadvantage (Community Foundation, 2017). That study samples consisted of children with a range of baseline measurements is valuable for intervention staff as it means that the results are likely to generalise to the wider population of children with whom they work, providing them with a picture of the outcomes of participation which they can use internally and potentially share with funding bodies to show the strengths of the programmes and where they might be developed to improve outcomes. Similarly, staff from schools both involved and not involved in the research can use the results to decide whether the programmes – or comparable PSHE and PA opportunities – might be beneficial for their pupils. And finally, researchers considering use of the cognitive test battery designed in Study 1 can be confident that its initial testing was not restricted to children with particular characteristics, which may have limited its applicability for their populations of interest.

Johnson and Onwuegbuzie (2004) provide a comprehensive list of the strengths and limitations of quantitative research. They suggest that quantitative research may have higher credibility with people in power, supporting the inclusion of quantitative research in the current research programme given its aspiration to guide policy and practice. The same authors also state that the results of quantitative research are relatively independent of the researcher; this objectivity likely underpins the credibility issue as audiences are likely to perceive a lesser bias than for qualitative findings generated through the interaction of the researcher with the data. On the other hand, the weaknesses noted in Johnson and Onwuegbuzie's article all centre around the applicability of quantitative research for the research users; for instance, the way in which the research is designed might not reflect different people's understandings of the subject of investigation, and there may be confirmation bias in that the researcher selects the variables to test and could miss any additional phenomena which might be of importance to those looking to make use of the findings, including other researchers. These difficulties are however addressed in the current research programme through the use of a mixed methods approach, with the qualitative study offering the opportunity for participants to supply data beyond the variables investigated in the quantitative studies, and also providing enough depth of information to enable different audiences to consider the delivery and perceived outcomes of classroom/PA-format PSHE interventions as they might occur in their own localities and with their own conception of outcomes (e.g. what constitutes wellbeing).

### *3.3.1 Quantitative Reliability and Validity*

The positivist stance underpinning quantitative research means that the ways in which its rigour is judged differs from that of qualitative research (discussed below), with reliability and validity playing key roles (Bryman, Becker & Sempik, 2008). In relation to measurement, reliability refers to the consistency of measurements and validity to the extent to which a measure captures the intended construct (Carmines & Zeller, 1979). Subtypes of measurement reliability include *test–retest reliability*, in which the same participants complete the same measure on two different occasions to check that the measurements are similar when we would expect them to be (i.e. in the case of stable constructs such as intelligence), and *parallel forms reliability*, in which

measurements are obtained using two different versions of a measure and are expected to be similar if the two versions test the same construct as intended (Furr & Bacharach, 2014). Furr and Bacharach describe that although there are subtypes of measurement validity, at present the essential concept is that of *construct validity*, this term fundamentally expressing measurement validity as it refers to the degree to which a measure reflects the construct it sets out to test.

The reliability and validity of the quantitative measures used in the research programme are detailed within the descriptions of each measure below, these characteristics having played a role in the selection of the tools to be employed. However, the overall *external validity* of the quantitative research – i.e. the extent to which the results can be generalised to other settings and populations – should also be considered. As described above, it was not the goal of Studies 2 and 3 for the results to be generalised in a direct manner, pertaining as they do to participation in a specific intervention, but it is hoped that the findings provide an indication of what could be expected from children's participation in similar PSHE/PA opportunities, especially as the research was conducted in school settings and therefore has high levels of ecological validity. Study 1 details the creation and reliability/validity testing of a cognitive test battery designed for use with 9–11-year-old schoolchildren, and while it is not possible to comment on the generalisability of the results at this early stage due to lack of replication, it is hoped that further studies will find comparable cognitive performance scores in similar samples.

*Internal validity*, as the likelihood in an experiment of drawing correct conclusions about the role of the IV (Levine & Parkinson, 1994), has been considered in the above account of confounding variables. It is also internal validity which is being addressed in the discussion sections of the thesis wherever alternative explanations for results are offered.

### *3.3.2 Quantitative Methods*

#### *3.3.2.1 Cognitive Performance: Cognitive Testing*

While attention research might include observation of on- and off-task behaviour as an indication of sustained attention (e.g. Janssen et al., 2014), cognitive performance is most often measured by asking participants to complete paper- or computer-based

tests. These have been administered both individually and in batteries designed to assess one or more cognitive domains; commonly-used test batteries include the Cognitive Assessment System (Naglieri & Das, 1997) and the Cambridge Neuropsychological Test Battery (Cambridge Cognition Ltd., n.d.). Depending on the study aims, researchers may measure how quickly and/or accurately participants complete the tasks, and sometimes additional variables such as any changes in neural activity whilst doing so. Computer-based tasks are particularly suited to recording response times to individual stimuli but it can be expensive and impractical to conduct computer-based testing in school settings if this requires the transport of computers/tablets for large groups of children.

A great variety of tests have been used by researchers studying cognition. With the long-term goal of providing a tool that can be employed across studies to achieve greater consistency in school-based research, Study 1 constituted an assessment of the reliability and validity of a pilot cognitive test battery designed as part of the research programme. As such, justification for the tests selected and a discussion of the properties of the test battery are presented in full in Chapter 4.

#### *3.3.2.2 Academic Achievement: Teacher Assessment*

In Study 3, academic achievement was measured before and after children's intervention participation, or at corresponding time points for those in the control group. Although teacher-assigned measures of achievement (e.g. grades) may be biased due to teachers' expectations of an intervention having an impact upon children's academic performance (Sallis et al., 1999), educational testing for English and mathematics occurs in UK primary schools only twice: once at the end of Key Stage 1 (pupils aged 6–7 years; Year 2) and once at the end of Key Stage 2 (pupils aged 10–11 years; Year 6). Not only are elements of these assessments still conducted by teachers, taking into account pupils' classwork (Standards and Testing Agency, 2018), but it would be inappropriate to use measures of achievement from time points 4 years apart to represent any changes following a 6-week intervention, with many other variables confounding the picture over such a duration.

An alternative to making use of assessment as it is already occurring in school settings is to ask participants to complete academic test batteries such as the Woodcock-

Johnson Tests of Achievement – Revised, as employed by Best et al. (2011). However, this can be very time-consuming, with each of the Woodcock-Johnson tests taking 5 minutes to complete – a total of 45 minutes if all nine tests are used – and existing assessment measures were felt to provide results of greater relevance for education stakeholders.

Given the drawbacks of alternative methods, the researcher opted to measure academic achievement in Study 3 by recording teacher-assigned measures of achievement at pretest and posttest. This is consistent with the recommendation of Watson et al. (2017) that progress monitoring is used to record academic achievement when the duration of an intervention is less than 1 year. However, as part of the UK government's reforms to the national curriculum in September 2014, the levels that had been used to assess children's attainment and progress at school since 1988 were removed (Department for Education, 2014). Within the requirements that it must enable them to check what pupils have learnt, indicate whether pupils are on track to meet end-of-Key-Stage expectations and allow regular reporting to parents, schools were free to adopt any assessment system in place of levels. Unfortunately, this meant that despite attempts to recruit schools that used the same assessment system, as the recruitment process for Study 3 progressed it became apparent that this would not be possible, with schools across the North East of England using an extensive variety of different systems. Converting the data from different systems into a format allowing for comparison across schools was considered but there was no established method for doing so and it was felt that this might compromise the validity of the data.

Ultimately, the assessment system used by three of the five schools (one intervention school, one control school and one school with both intervention and control children) was selected as the method by which academic achievement would be measured. Unlike the systems used by the remaining two schools, which used descriptors such as 'Year 4 developing' and 'Year 5 secure' to indicate children's academic progress, this quantified achievement by converting into a numerical score teachers' confirmation that a number of 'I can…' statements linked to the curriculum had been achieved by a child. No reliability or validity assessments appear to exist for this system; however, the limitation should be noted that – as with all similar measures –

there is the possibility of inconsistencies within and between teachers' judgements about achievement.

#### *3.3.2.3 Wellbeing: Questionnaire*

One's sense of wellbeing is highly personal and as such unstructured interviews are likely to offer the closest reflection of an individual's unique experiences. However, it was necessary to quantify wellbeing in Study 3 to allow for the planned statistical analyses, and also for the measurement to take place in a whole-class testing situation in order for it to be practicable. The following discussion therefore focuses on quantitative methods suitable for use in this context.

Although instruments designed to assess wellbeing and life satisfaction amongst young people do exist, researchers have not always used these measures. A systematic review of school-based interventions to enhance the emotional and social skills of 6–18-year-olds found that a number of authors had instead used ad hoc measures of emotional and social skills and psychological wellbeing in papers published between 2000 and 2014 (Sancassiani et al., 2015). The reviewers felt this might be due to a lack of validation of instruments as well as poor definitions of the three outcomes. Even those studies employing standard tools had tended to measure a specific characteristic or skill such as resilience rather than overall wellbeing. Particularly problematic for those researching educational interventions is that a number of the surveys available for assessing youth wellbeing – for instance, the youth version of the European Quality of Life 5 Dimension measure (EuroQol Research Foundation, 2017) – centre around clinical health outcomes (e.g. pain/discomfort, anxiety and the ability to participate in activities of daily living), which are unlikely to reflect wellbeing in a useful manner for these researchers and education stakeholders. Yet at the same time as avoiding being too narrow in the conception of wellbeing, researchers must be careful that their chosen surveys are not pitched at a level too broad for assessing changes likely to occur over the intervention period, as may be the case for the Satisfaction with Life Scale adapted for Children (Gadermann, Schonert-Reichl & Zumbo, 2010), which includes items such as, '*In most ways my life is close to the way I would want it to be.*'

Its focus on competencies means that research with an educational orientation tends towards what Waters (2009) referred to as 'instrumental wellbeing' (relating to the

knowledge/skills it is thought important for children to possess, e.g. knowing how to eat healthily), as opposed to 'holistic wellbeing' (how children experience their lives, e.g. feeling valued). The KIDSCREEN-27 health-related quality of life questionnaire for children and adolescents (Ravens-Sieberer et al., 2007; Ravens-Sieberer et al., 2014), was selected for use in Study 3 because it touches upon instrumental *and* holistic wellbeing, with intervention participation potentially operating upon both. There is however possibly a greater emphasis on holistic wellbeing in the questionnaire, for instance with items from the psychological wellbeing dimension assessing subjective wellbeing in a broad sense (e.g. '*Has your life been enjoyable?*'). The inclusion of items pertaining to *perceived* competency (e.g. '*Thinking about the last week, have you got on well at school?*') is valuable because being competent in a particular area can but does not necessarily support a sense of wellbeing (Mashford-Scott et al., 2012); an individual may feel personally dissatisfied with what might objectively be high levels of competency in one or more areas and could therefore experience low levels of subjective wellbeing. Such items were therefore complementary to the measurement of children's academic achievement in Study 3.

As described on the project website (www.kidscreen.org), the KIDSCREEN questionnaire items were arrived at through a three-stage process: i) by conducting a literature review of international and cross-cultural research into health-related quality of life instruments for children and adolescents in order to identify dimensions of quality of life for young people; ii) by consulting a multidisciplinary group of experts from seven European countries for their perspectives on the operationalisation of quality of life in young people; and iii) by running focus groups with children, adolescents and parents across Europe to explore the meaning of wellbeing for these groups and to gain an evaluation of pre-existing quality of life questionnaires for young people. The number of items was reduced first by assessing the items for redundancy and then by running a pilot study in which 1,437 children (8–11 years) and 2,469 adolescents (12–18 years) completed the initial survey, leading to the development of the 52-item KIDSCREEN-52 questionnaire. A further iterative process of item reduction through techniques including exploratory and confirmatory factor analysis, and with expert opinion used for guidance (Robitail et al., 2007), was then used to produce the KIDSCREEN-27: a 27-item, five-factor version of the questionnaire designed to reduce response burden with a minimum of information loss

(Child Public Health, 2011; Ravens-Sieberer et al., 2007). This was another factor contributing to the selection of this tool for use in Study 3, in which children were already being asked to complete a cognitive test battery during the testing sessions and further participant burden was to be avoided.

Lastly, the decision to use the KIDSCREEN-27 was supported by the existence of extensive evidence regarding its psychometric properties. In 2007, two companion papers were published pertaining to the validity of the survey following its completion by 8–18-year-olds ($N$ = 22,827) from 13 European countries including the UK (Ravens-Sieberer et al., 2007; Robitail et al., 2007). The questionnaire demonstrated construct validity by distinguishing between healthy participants and those who were physically or mentally ill, the latter group having significantly lower scores than the former on all five dimensions of wellbeing, as anticipated. Furthermore, an exploratory factor analysis identified that the five-factor structure of the KIDSCREEN-27 explained 56.9% of the variance in the results, a figure comparable to that for similar measures such as the Pediatric Quality of Life Inventory (PedsQL; Varni, Seid & Rode, 1999). KIDSCREEN-27 correlations with scores for other health-related quality of life instruments were to some extent indicative of *convergent* and *discriminant validity*, concepts stating respectively that positive relationships should exist where measures have been designed to assess the same construct (Cramer & Howitt, 2004) and that there should be a lack of undue relationships between similar but distinct constructs (Lewis-Beck, Bryman & Futing Liao, 2004). The Pearson coefficients for 8–11-year-olds with scales from the PedsQL, for example, were found to be moderate ($r$ = .35 to $r$ = .49) where an association was expected, and generally lower ($r$ = .22 to $r$ = .48) where associations were not anticipated. Finally, in relation to reliability, in 11 countries a retest was performed after 2 weeks on random subsamples of participants ($N$ = 559), and intraclass correlation coefficients of between .61 and .74 for the dimensions were calculated. The authors reported these figures as demonstrating acceptable test–retest reliability given the 1-week timeframe of the KIDSCREEN items, suggesting that the survey is suitable for repeated measures testing for pre- to post-intervention changes in wellbeing.

#### *3.3.2.4 Physical Activity: Accelerometry*

Children's physical activity was measured in two components of the research programme: in Study 2, the duration and intensity of pupils' PA was recorded during the intervention session preceding cognitive testing, and in Study 3a participants' pretest and posttest habitual activity was recorded for 9 days.

PA participation has until recently been most frequently assessed using self-report measures. For instance, the Physical Activity Questionnaire for Older Children (Crocker, Bailey, Faulkner, Kowalski & McGrath, 1997) was designed to record the MVPA of 9–15-year-olds and asks respondents to recall from a checklist those activities they have taken part in at different times of the day over the last 7 days, as well as rating the intensity of their activity on a five-point scale. Many self-reports have however been found to overestimate PA (Sallis & Saelens, 2000), possibly as a result of socially desirable responding. Furthermore, their reliance on recall has raised concerns that they are unsuitable for use with children under the age of 10 due to the potential cognitive limitations of young participants (Kohl, Fulton & Caspersen, 2000). To overcome this issue, some studies have used parental reports but these suffer the problem that parents are unable to account for PA undertaken whilst children are at school or otherwise away from their care (e.g. at an activity club). Furthermore, with children's activity often being sporadic it may be difficult to attain a realistic picture of their energy expenditure even when present; Bailey et al. (1995) followed Californian 6–10-year-olds to observe their free-living PA behaviour over a series of 4-hour periods on school days, weekends and holidays and calculated the median duration of their low and medium intensity activities to be 6 seconds, while for high-intensity activities it was just 3 seconds (the minimum that could be identified due to the chosen recording interval for the study). Such short bouts of activity are unlikely to be salient to parents – or school staff if recording in school settings – and it is therefore doubtful that they would be captured via proxy report measures.

PA can alternatively be assessed via observations in which trained observers classify participants' PA by type and intensity in natural settings (e.g. home, school), following an observation system such as the Children's Activity Rating Scale (Puhl, Greaves, Hoyt & Baranowski, 1990). This allows for the calculation of inter-observer reliability between two or more researchers' ratings. Direct observation is however usually

restricted to taking place over limited periods of time (e.g. during PE lessons) due to the impracticalities, investigator fatigue and participant burden associated with prolonged observation, meaning it cannot easily assess habitual activity.

Validated accelerometers go some way to addressing the above difficulties and provide an objective, cost-effective measure of daily PA (Westerterp, 2009). Total daily PA is calculable if an accelerometer is worn from waking until a person goes to bed, although participants are asked to remove the device when bathing or when participating in swimming or combat sports, so activity performed during these times is missed. Accelerometers worn on the waist are, as noted by Yıldırım et al. (2011), also restricted in their ability to measure cycling and arm movements (e.g. carrying objects, lifting weights) because of the limited movement of the torso during these activities. These considerations notwithstanding, accelerometry is a method capable of continuous recording for a week or longer, depending on the researcher's decisions regarding the level of detail of the data to be collected (Chen & Bassett, 2005), yet with the minimum of burden for participants. PA intensity levels are calculable over durations as brief as 1 second, allowing even the sporadic PA of children to be captured. It is therefore no surprise that there has been a rise in the use of accelerometers to record youth PA; in a review, Cain, Sallis, Conway, Van Dyck and Calhoon (2013) observed a more than threefold increase in the number of articles using ActiGraph accelerometers to measure the PA of 6–11-year-olds from 2005–2006 to 2009–2010.

In the present research, ActiGraph triaxial accelerometers (ActiGraph; Pensacola, FL) were used to record children's physical activity. In both Study 2 and Study 3a, accelerometry was appropriate in order to measure children's characteristically short bouts of PA; it was additionally appropriate for Study 3a in order to avoid overestimation of habitual PA and for Study 2 because it would have been impractical for the researcher to observe many participants simultaneously during one of the intervention sessions. Triaxial accelerometers are more suitable than uniaxial accelerometers for predicting energy expenditure when participants engage in a range of different activities as opposed to simply walking (Ojiambo et al., 2012), and were therefore appropriate for measuring the types of PA in which children were anticipated to engage.

Triaxial accelerometers record the frequency and magnitude of participants' vertical, mediolateral and anteroposterior acceleration (Rowlands, 2007); acceleration signals are digitised into 'activity counts' and the number of activity counts occurring over a specified time period (epoch; e.g. 5 seconds, 1 minute) can be used to indicate whether a person was engaging in light, moderate or vigorous activity at a certain point in time by running a prediction equation on the data (Loprinzi & Cardinal, 2011). Agreement is yet to be reached in the interpretation of accelerometer output and a great many thresholds exist for the calculation of activity intensity from raw accelerometer counts, which does of course impact upon the validity of the results when presented as the time spent by participants in each intensity of PA. For instance, two studies of 9–10-year-old children in England published only a year apart employed thresholds of ≥3200 accelerometer counts per minute (cpm) and ≥2000 cpm to define MVPA, this difference undoubtedly contributing to the conclusions that the percentage of those meeting the MVPA guidelines was 7% in the former study (McLure et al., 2009) and 69.1% in the latter (van Sluijs et al., 2008). A review by Reilly et al. (2008) suggested that an MVPA cut-point in the range of 3000–3600 cpm is the most appropriate for children and adolescents, at least when using ActiGraph accelerometers with an epoch of 1 minute, and thus the Puyau Children (Puyau, Adolph, Vohra & Butte, 2002) thresholds were selected for the current research, in which the cut-point for moderate intensity activity is 3200 cpm.

To conclude with a brief discussion of reliability, accelerometry is generally accepted to be a reliable method for recording PA; for instance, a difference of only ±68 cpm was found between outputs when two ActiGraph GT3X+ units were worn by adult participants over 7 days (Aadland & Ylvisåker, 2015). Furthermore, in repeated measures research any potential for lack of interunit reliability can be approached by allocating the same unit to the same participant at each of the recording periods (Rowlands, 2007). Its reliability added to the arguments in favour of the use of accelerometry in Studies 2 and 3a, and this method was therefore employed to record children's PA participation in these studies.

## 3.4 Qualitative Approach

Study 4 set out to develop a picture of primary school PSHE interventions delivered via classroom learning and physical activity from those with experience of such interventions, including what happens and to what extent participants like and value what happens. This would promote an understanding of the interventions as they are delivered in real-world settings and with individuals who may respond to the same intervention activities and learning in a range of different ways. Flick (2014) proposed that the main reason for using qualitative research should be that the research question requires it, and this was certainly the case for Study 4, with a strong emphasis in qualitative research being on the exploration of a particular phenomenon, usually analysed via written data such as transcripts from interviews with individuals with experience of the phenomenon (Gibbs, 2007). By gathering rich data which reveal the complexities of the topic of the research (Marx, 2012), qualitative research is able to provide in-depth insights (Yin, 2016), in this case into participants' views on intervention delivery and outcomes. Qualitative methods might usually be associated with an interpretivist epistemology but, as Tracy (2013) outlines, they have been used to capture realist and causal descriptions of phenomena including why some educational innovations are more successful than others; a very similar objective to that of Study 4.

In the same article as they do for quantitative research, Johnson and Onwuegbuzie (2004) list the strengths and limitations of qualitative research. In addition to its emphasis on understanding personal experiences and accounting for contextual factors as outlined above, one of the strengths of this approach is that it permits researcher responsiveness to any changes that occur during the course of the research, meaning that the direction of a study can be altered as it progresses. This occurred in Study 4, in which participants' interest in the unusual inclusion of PA within a PSHE intervention led to the development of an additional research question specifically concerning the role of PA in the sessions. Such opportunities would be missed in a quantitative approach in which the variables of interest are specified at the beginning of the research. However, and despite the quality safeguards described throughout the thesis, the findings of qualitative research are still at greater risk of being affected by the researcher's personal biases and idiosyncrasies than the more objective results

arising from quantitative research. Furthermore, although it is not the intention of qualitative research to allow for the generalisation of findings to the larger population because the participants in a study are not *selected* to represent that larger population (Yin, 2016), the use of small samples and its context-specific nature does to some extent limit the qualitative approach in that it would be useful if any recommendations from the research could be more widely applied. Following the suggestion of Schofield (2002), detailed accounts of the interventions are provided in the thesis to assist the reader in determining whether the findings are applicable to their own contexts of interest.

### *3.4.1 Qualitative Methods: Semi-Structured Focus Groups/Interviews*

Consistent with a qualitative approach, semi-structured focus groups and interviews were chosen as the methods to be employed in Study 4. The use of a series of questions to define the areas to be explored offered the advantage over unstructured focus groups/interviews of providing some guidance for participants' accounts of their experiences, but the opportunity for more flexible discussion than in structured focus groups/interviews meant that the researcher was able to seek elaboration on participants' responses, resulting in deeper insights (Gill, Stewart, Treasure & Chadwick, 2008).

Focus groups were used for the child participants because the interactions between group members in sharing ideas and in responding to and expanding upon each other's contributions can lead to the generation of insights which may be missed, for example, in one-to-one interviews between the researcher and a single participant (Harding, 2013). Individuals in focus groups might also find they are asked to – or feel they should – explain the reasons behind their views (Oates, 2000), leading to richer, more insightful data for analysis. For these reasons, focus groups would have also been the preferred method of data collection for adult participants, but practicalities concerning recruitment and arranging mutually convenient times for participants meant that it was only possible in one instance, with the researcher meeting two parents together. It was also necessary to interview one of the child participants on a one-to-one basis when another child who had been due to take part in the study was absent on the day of data collection.

Each of the children's focus groups consisted of three to six members in an attempt to avoid participants becoming frustrated at limited opportunities for conveying their views in larger groups (Bloor, Frankland, Thomas & Robson, 2001). It is possible to capture the group effect with as few as three participants (Tracy, 2013); there was however a large degree of interaction in the focus group containing two parents, suggesting that it was fair to consider this case also to possess this key quality of a focus group. Conversely, in some instances the understandable tendency for children to follow turn-taking principles in a school setting, and particularly when a member of school staff was present, meant that at times the focus groups acted more in the manner of group interviews, with limited interactions occurring between participants (Wilkinson, 2016).

Other than lacking in the opportunity for interactions between participants, the one-to-one interviews in Study 4 were very similar to the focus groups, including following the same set of questions (see Chapter 8). In a free-listing task, a similar number of items per transcript was found whether data collection occurred via interview or focus group, while at the same time interviews are less difficult and time-consuming to schedule, conduct, transcribe and analyse (Guest, Namey, Taylor, Eley & McKenna, 2017). This suggests that where interviews rather than focus groups were employed in the current research, the insights may not be as deep as when other participants were present to assist the researcher in probing further, but the range of ideas discussed would be expected to be similar.

When conducting interviews/focus groups, researchers should be aware of the possible influence of status differences between themselves and the participants upon the participants' responses and the establishment of rapport (King & Horrocks, 2010). The researcher presented herself smartly to inspire belief in the worth of the research amongst the adult participants, and therefore encourage engagement in the discussions; however, being aware of the different power dynamic with the children she was careful to interact with these participants in a friendly – yet not patronising – manner to avoid being perceived as intimidating and to avoid the children feeling pressurised to respond to questions. The age difference between the researcher and the children did not appear to be daunting to them, and although the researcher's position as a postgraduate research student had the potential to create a level of educational

divide between herself and some of the adult participants, this did not seem to be the case in practice; conversely, being a student helped to establish rapport because the participants seemed to want to assist in the researcher's studies. This keenness to assist did not appear to lead to fabrication, however, with reports such as those from parents that they knew little of the interventions being indicative of the honesty of their responses. The study may also therefore have avoided the limitation associated with audio recording that participants might not state their true feelings on an issue when being recorded (Polgar & Thomas, 2013), when it was necessary for recordings to be made in order to conduct the analysis.

Field notes providing contextual information were made to assist in interpretation; this was done following the conclusion of the interviews/focus groups in order that notetaking did not disrupt the flow of the discussions (Britten, 1995). In terms of reflexivity – or a researcher's reflection on how their own knowledge, feelings and values might influence the research design and findings (Attia & Edge, 2017) – these notes also made reference to the researcher's thoughts and experiences during data collection, with similar reflections featuring in the notes made during coding. It is the researcher's feeling that the greatest potential for personal impact on the study stems from a desire for it to have practical applications, perhaps most noticeably in terms of the existence of the research question concerning how the interventions can be sustained and developed.

### *3.4.2 Qualitative Analysis: Thematic Analysis*

Qualitative data were analysed in Study 4 through thematic analysis (Braun & Clarke, 2006). Like many forms of qualitative analysis, thematic analysis is a process in which patterns of meaning – or themes – are identified from qualitative data. Braun and Clarke recommend six phases through which this is achieved: i) familiarising oneself with the data by transcribing, reading and re-reading it; ii) generating initial codes by coding aspects of the data and collating the data extracts relating to each code; iii) searching for themes by collating the codes into potential themes; iv) reviewing the themes by checking the data extracts they contain and reworking them if they do not form a coherent pattern, then checking that the themes reflect the overall data set; v) defining and naming themes through creating an account and analysis of the data extracts within them; and vi) producing the research report with reference to the

research questions and existing literature, in which the themes are illustrated through the use of data extracts.

Its simple approach and flexibility (e.g. lack of attachment to a particular theoretical framework) seem to be responsible for the view of some researchers that thematic analysis is a process used as part of a range of qualitative analyses rather than a form of analysis in its own right (see Vaismoradi, Turunen & Bondas, 2013). However, the straightforward focus on coding and theme development was attractive for the current research as it allowed the researcher to explain to intervention and education stakeholders how conclusions and recommendations had been derived from the data in an uncomplicated manner. At the same time, the potential issue of lack of rigour of using an ill-defined mode of analysis was addressed by explicitly outlining in the thesis for the academic reader all of the decisions made in determining the exact form of the analysis to be used (see Chapter 8). Furthermore, in addition to being accessible for lay audiences, thematic analysis was appropriate for the current research in that it can be used to analyse data from heterogeneous samples (Braun, Clarke & Terry, 2015), with data being collected from different groups of stakeholders in Study 4.

A potential area of confusion with this type of analysis is that the term 'thematic analysis' has been applied to different approaches to analysing qualitative data. However, Braun and Clarke's (2006) seminal paper provides a clear definition of their conception of thematic analysis, as outlined above, and it is the definition of these authors and their colleagues that is followed throughout the current thesis. In this approach, the researcher is seen to be active in the research process, with themes being identified as a result of their engagement with the dataset rather than their aim being to uncover themes that already exist within the data (Braun et al., 2015). The familiarisation and coding phases are central to this as they encourage systematic and deep engagement with the data, leading the researcher to develop rich and complex themes (Clarke & Braun, 2013). While the active role of the researcher may be a cause for concern to some readers as it suggests a potential for findings to be biased by the researcher's beliefs, safeguards against this were taken as described in the rigour section below.

### *3.4.3 Qualitative Rigour*

The reliability and validity of qualitative research stems from the investigator's openness and responsiveness to the data and from their implementation of verification processes throughout the course of a study such that any errors can be identified and corrected before they affect the findings (Morse, Barrett, Mayan, Olson & Spiers, 2002). The iterative nature of the analysis was one of the key contributions to the rigour of Study 4 because the researcher reviewed the themes and data extracts multiple times, providing a number of opportunities for them to check that they were not interpreting the data according to their own assumptions. One example of flexibility and responsiveness to the data is the addition of the research question concerning the role of PA in the interventions, which stemmed from participants' interest in this issue. Unfortunately, as in other doctoral studies (e.g. Fereday & Muir-Cochrane, 2006), the processes of data coding and theme identification were undertaken by a single researcher and discussed with supervisors, meaning that opportunities for closer questioning of the interpretations of the lead researcher might have been missed.

Harding (2013) points out that validity can be especially threatened when data are collected via focus groups due to the potential for comments within a discussion to be taken out of context or if the researcher assumes a consensus between participants where this is not the case. However, in many cases the focus group participants took turns to answer the questions, likely due to the school context, and in the resultant 'group interviews' there was a reduced chance of these problems occurring.

Also relevant to the issue of rigour is that an outline of how candidate themes were developed from codes and an account of the final themes/subthemes are offered in the appendices to the thesis, providing transparency as to the researcher's arrival at the findings reported. While themes discussed by just one participant are as valid as those discussed by many more (Veal & Darcy, 2014), and salience to the participant was considered more important than prevalence in identifying themes, prevalence is nevertheless indicated where this was felt to assist in providing a comprehensive account of the data.

The approach taken with regards to saturation – the point at which additional interviews/focus groups cease to provide new information, indicating that there are enough data to address the research questions in adequate depth (Constantinou, Georgiou & Perdikogianni, 2017) – is discussed in Chapter 8.

# Chapter 4: Study 1 – The Creation and Reliability and Validity Testing of CogS: 9–11, a Cognitive Test Battery for Researchers Working with 9–11-year-olds in School Settings

## 4.1 Introduction

As raised in earlier chapters, it is likely that achievement-related outcomes will be among the outcomes of greatest interest to education stakeholders following pupils' participation in school-based interventions of any variety. It has also been demonstrated that academic achievement is related to cognitive performance, with a proposal that cognitive performance supports academic achievement due to the involvement of cognitive functions such as attention in learning (Keeley & Fox, 2009). It therefore follows that investigations of school-based interventions would benefit from the inclusion of cognitive performance as an outcome of interest; however, this has been uncommon for PSHE and PA interventions, and when it has been done methods have unfortunately varied from study to study, making comparisons and conclusions difficult. As a result, the researcher set out to develop a measurement tool for cognitive performance which can be used with whole classes of children over a short duration of time in order to make cognitive testing as acceptable as possible within the school day. The aim of the current study was to assess the reliability and validity of the pilot test battery.

Due to the intention to use the test battery in Study 2 as a measure of cognitive performance following acute PA (children's participation in the PA component of one of the classroom/PA-format sessions of a PSHE intervention), there is a focus on PA–cognition research throughout this chapter.

There has been growing interest in the effects of PA on cognitive function, with researchers recently making moves towards assessing these effects for children and in naturalistic environments such as the school (Daly-Smith et al., 2018). However, the large number of differences in the way studies have been conducted makes it difficult to draw firm conclusions (Watson et al., 2017); even limiting the discussion to investigations of a single bout of activity (acute PA) rather than longer-term

participation (chronic PA), there are differences in factors such as the duration and type of PA (e.g. cognitively engaging games vs. routine exercise), the characteristics of participants (e.g. age, weight status, presence or absence of developmental disorders) and the nature of cognitive testing (e.g. which and how many tests are employed, whether speed or accuracy measures are recorded). Some researchers have measured cognition using full test batteries (e.g. Davis et al., 2007), while others have selected one or more standalone tasks or tasks from test batteries to assess specific aspect(s) of cognition (e.g. Janssen, Chinapaw et al., 2014).

Given the potential for acute PA bouts during the school day to improve children's cognitive performance and by extension their academic performance (Howie & Pate, 2018), it is imperative that researchers begin to work together to replicate findings using comparable methods. Only when researchers and stakeholders such as school staff and educational policymakers can have confidence in conclusions will it be possible to drive forward discussions about the current role of PA – and of other elements of education, such as PSHE opportunities – in the school day and whether any changes are warranted, particularly given the prioritisation often afforded to core curriculum subjects (Bailey, 2017). As a starting point, addressing the measurement of cognitive performance as just one of the areas of inconsistency, the aim of Study 1 was to put forward a battery of cognitive tests which would be appropriate for investigating different aspects of cognition amongst upper-Key Stage 2 children. As throughout the thesis, it is acknowledged that there will always be difficulties in drawing conclusions regarding the effects any IV on specific aspects of cognition due to the interconnected nature of cognitive function; it can be reasoned, for instance, that selective attention requires inhibition to suppress one's attention to task-irrelevant stimuli (Diamond, 2013). However, the creation of the test battery was driven by the need for consistency in methods and it is envisaged that it will evolve to address such difficulties as more data are gathered; at present, it can be considered a pilot instrument.

This chapter introduces Cognition in Schools: 9–11-year-olds (CogS: 9–11), a battery of tests for investigating the processing speed, sustained and selective attention, long-term memory and executive function of 9–11-year-olds in a whole-class testing situation, maximising the number of participants it is possible to test immediately

following their participation in an intervention session. To make it practical for researchers, CogS: 9–11 is paper-based and thus does not require the purchase and transportation of equipment such as laptop computers or tablets. Additionally, it takes no more than 30 minutes to complete in an attempt to make it as unobjectionable as possible to school staff and their pupils, with the additional advantage that this contributes to its suitability for the assessment of post-PA cognition; testing in some studies has not begun until 20–25 minutes post-exercise and yet significant effects have still been recorded (Chen et al., 2014; Hillman et al., 2009).

A total of four testing booklets were created, containing parallel forms of the materials for the cognitive tests and allowing researchers to run a familiarisation session, a baseline testing session, a post-intervention testing session and one additional testing session in their studies. While one of the four testing sessions in this research programme took place *during* the intervention, in the assessment of cognitive performance immediately following PA participation (Study 2), other researchers may find the fourth booklet useful for conducting follow-up testing to assess longer-term intervention outcomes.

In this study, the parallel forms reliability, test–retest reliability and construct validity of the pilot CogS: 9–11 battery were investigated using a sample of children from primary schools in the North East of England. This chapter reports on these psychometric properties of the test battery and outlines the minor modifications made before it was employed in Studies 2 and 3.

## 4.2 Method

### *4.2.1 Selection of Cognitive Tests*

Eight cognitive tests were initially selected for the CogS: 9–11 battery, as described below in the same fixed order in which they were presented in the Study 1 test booklets (an example of which is provided in Appendix A(i)). Each test was given an accessible name for the benefit of the participants. The scoring procedures, design decisions and processes for creating test materials are explained to assist researchers in using and further developing the battery; it should be possible for investigators following this information to create additional CogS: 9–11 booklets for more than four repeated

measures testing sessions, unlike if they were to use purchasable paper-based tasks such as the Sky Search and d2 tests of attention. Although it is not possible to measure participants' speed in responding to individual items due to the paper-based format of CogS: 9–11, scores for most of the tasks (with the exceptions of Memorise! and 3-Back) can be considered to represent a combination of speed and accuracy as the score recorded is for the number of correct responses made within a specified time period.

#### *4.2.1.1 Dot-to-Dot*

The Dot-to-Dot task employs materials based on simple trials of the Connections test (Salthouse et al., 2000). Participants are presented with a grid of numbers from 1 to 49 (Figure 4.1) and have 20 seconds to draw lines between them in ascending order. The total number of correct connections drawn in two trials is recorded (max. 96).


*Figure 4.1. Example stimulus grid for the Dot-to-Dot task*

In this instance, the test is used as a measure of processing speed, although factors such as visual search abilities may contribute to performance. The ability to inhibit motor movements might also play a role on those occasions in which a change of direction is required following a series of linear connections. Like the more well-known Trailmaking test (see Partington & Leiter, 1949), the Connections test usually consists of simple trials with a single sequence of connections (e.g. 1-2-3-etc.) and

complex trials in which making connections requires the retention and updating of both numeric and alphabetic sequences (1-A-2-B-3-C-etc.). Complex trials therefore draw upon executive function to a much greater degree. The current research employed only simple trials to assess processing speed with limited input from working memory, which it can be argued is necessary to some degree for all cognitive tasks.

Unlike the Trailmaking test, researchers can create their own Connections/Dot-to-Dot resources for any number of testing sessions using the free Psychology Experiment Building Language software (http://pebl.sourceforge.net) to randomise the path through the numbers.

#### *4.2.1.2 Match-Up!*

As a digit–symbol coding test (e.g. Wechsler, 1955), Match-Up! asks participants to draw the corresponding symbols for a series of digits by referring to the key at the top of the page. The number of correct symbols drawn in 60 seconds is recorded (max. 90), providing a second measure of processing speed; two measures of processing speed were included in the test battery as this is an aspect of cognition which has received little direct attention in school-based research, and the use of two tasks would provide insight into whether outcomes differed according to the nature of the testing.

The nine symbols are dissimilar characters from the font style 'Symbol', each of which can be drawn without removing the pen from the paper (e.g. ∠ and ∪). They are assigned to different digits in each version of the testing booklet to prevent children from learning digit–symbol pairs over repeated testing sessions. However, some learning is still likely to occur over the course of a trial, meaning that performance might to some extent reflect long-term memory processes (Joy, Kaplan & Fein, 2004), despite the exception to the randomised order of presentation that the same digit is not permitted to appear twice in succession; a measure taken in an attempt to reduce within-trial learning.

#### *4.2.1.3 Find 'M'*

Bearing in mind the difficulties of measuring attention in isolation from other aspects

of cognition – given, for instance, the role of inhibition in helping to ignore distractors (Diamond, 2013), and that the goal and rules of any task must be retained in working memory in order to support successful performance – the Find 'M' task was designed as far as possible to test sustained and selective attention. Participants are asked to search rows of letters in order, circling every 'M' (250 instances) amongst the visually similar distractors 'V', 'W' and 'N' (250 instances of each). A 4-minute time limit is employed to attempt to tap sustained attention without this task lasting for markedly longer than the others in the test battery. Stimuli are displayed in a random order and are centralised so that they do not fall into columns and are thus more difficult to search.

Due to the need to account for both the proportion of hits (p(H) = targets circled/250) and the proportion of false alarms (p(FA) = distractors incorrectly circled/750) in the results, the $d'$ discriminability index (Swets, Tanner & Birdsall, 1961) is calculated for the task by subtracting the inverse $z$-score for p(FA) from the inverse $z$-score for p(H). As in Haatveit et al. (2010), perfect hit rates are adjusted using the formula $1-1/(2n)$ and zero false alarms are adjusted using the formula $1/(2n)$, where $n$ is the number of possible hits (250) and false alarms (750), respectively.

#### *4.2.1.4 Memorise!*

Memorise! is a test of LTM based on the procedure employed by Pesce et al. (2009) in their study of post-PA word recall: 20 items are displayed one by one via a classroom projector for 5 seconds each and there is then a delay of 100 seconds without a distractor task before participants are given 2 minutes to write down in any order all stimuli they can recall. Stimuli in the Memorise! task are however images rather than words as used by Pesce et al., removing the potential effects of reading ability on the results; when recording the number of correct responses (max. 20), misspellings and alternative names for items (e.g. TV/television) are therefore permitted.

Stimuli are taken from the set of 260 black and white line drawings presented by Snodgrass and Vanderwart (1980), which have been standardised on variables such as familiarity and visual complexity that might play a role in memory. Each image is positioned in the centre of the screen against a black background and at a height of just under 60% of the height of the display. To maximise suitability for a 9–11-year-

old audience, only items whose names are acquired before the age of 7 years are used (Morrison, Chappell & Ellis, 1997), and to avoid interference in the subsequent 3-Back test no pictures of animals are included. The pictures for '*gun*' and '*(smoking) pipe*' are also omitted to avoid presenting undesirable stimuli to schoolchildren, as are images known to the research team from previous studies to pose identification difficulties ('*cloud*', '*hair*', '*knife*', '*potato*', '*swing*'). Following these selection criteria 117 drawings remain, which would allow researchers to conduct up to five testing sessions with no repetition of items; along with the stimuli randomised to each of the four booklets in the current research, the unused items which could be presented in an additional testing session are listed in Appendix A(ii).

#### *4.2.1.5 3-Back*

N-back (Kirchner, 1958) is a well-established test of updating in which participants are shown a rapid string of stimuli and are asked to indicate for each stimulus whether or not the same item was shown a specified number of items previously (i.e. three items previously in the 3-back protocol). Testing usually takes place on a computer with button presses indicating 'yes' and 'no' responses and participants' first response being recorded. In this paper-based variation, participants record their answers as ticks and crosses and their score is the total number correct (max. 37). Any altered responses are marked as incorrect as it is impossible to determine which response was made first. It is likely that as well as measuring updating, the task might to some extent reflect inhibition, with inhibition having been found to play a role in both updating and shifting performance (Miyake & Friedman, 2012); in this case, items presented prior to the three to be remembered at any one moment are no longer relevant to task performance, and inhibitory processes may be required to prevent these items from interfering with relevant task information.

In PA research using the N-back task with preadolescent populations, stimuli have included letters (Chen et al., 2014), animals (Jäger et al., 2014) and fruits (Jäger et al., 2015). Study 1 employed 26 landscape animal pictures from the Snodgrass and Vanderwart (1980) set; other animal images were rejected as a result of similarity to other items (e.g. '*tiger*' due to visual similarity with '*lion*') or were reassigned for use in a set of seven demonstration slides due to their portrait orientation, removing orientation as a potential cue in the scored task. The selection of and presentation

sequences for the stimuli are described further in Appendix A(iii).

Pictures are presented at the same size as in the Memorise! task, with the stimulus number also being displayed on the slide to help participants keep track against the response table in their booklets. Similar to Jäger et al. (2015), wherein one third of the 48 stimuli were targets, there are 12 targets among the 37 scored items. Images are presented for 2000 ms (matching the duration of Chen et al., 2014, and only 100 ms longer than Jäger et al., 2014), with an interstimulus interval of 3000 ms (an increase from the 1000 ms and 100 ms used in these computer-based studies due to the need to look away from the screen to respond). The appearance of every image is preceded by 500 ms by a sound to direct participants' attention to the whiteboard.

#### *4.2.1.6 Colours and Shapes*

In PA–cognition research, shifting/cognitive flexibility has most often been tested in a computer-based format, often via an additional block of trials incorporated in the flanker test of inhibition in which cues indicate whether left/right button presses should reflect the direction of the central or flanking figures. However, this test might not discriminate effectively between participants if delivered in a paper-based format due to the slower and less intuitive process of writing/drawing one's responses. On the other hand, the Trailmaking Test (see Partington & Leiter, 1949), a paper-based test of cognitive flexibility employed in PA research by van der Niet et al. (2015), suffers the problem that even if stimuli are presented in a grid like the Connections test, successful performance is likely to involve visual search, updating of the letter/number sequences in working memory, and – as discussed in relation to the Dot-to-Dot test – inhibition, as well as shifting between the number and letter sequences.

The computer-based colour–shape switch task of cognitive flexibility used by Hillman et al. (2014) was adapted such that instead of button presses, participants respond by ticking or crossing beneath printed stimuli. Items have additionally been changed from blue and green to the more visually distinct blue and yellow. The 42 stimuli per block are presented in rows of six, each containing at least one yellow circle, yellow square, blue circle and blue square, with no more than two successive occurrences of the same stimulus.

Each block lasts for 30 seconds. The same stimuli are presented for each block but ticks and crosses are required on the first occasion (colour rule) for yellow and blue shapes, respectively, and on the second occasion (shape rule) for squares and circles, respectively (homogeneous trials). On the third occasion (heterogeneous block), shifting ability was assessed in Study 1 by asking participants to follow the colour rule if a shape had a border and the shape rule if it did not (Figure 4.2), with switch cues being randomly allocated to the shapes. Additional cognitive processes are again likely to support successful performance on shifting tasks (e.g. inhibition of the rule not currently being followed).

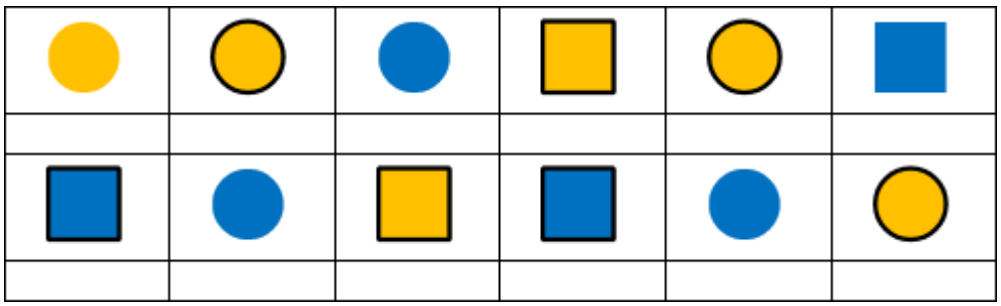


*Figure 4.2. Example stimuli from the heterogeneous trial of the Colours and Shapes task, Study 1*

Performance is recorded as the number of correct answers for heterogeneous trials minus the mean number of correct answers from the two homogeneous blocks; scores are then converted to positive values (max. 42), with higher scores reflecting better performance as in the other tests. Consistent with 3-Back scoring, altered responses are marked as incorrect.

Scores for children who clearly follow one rule in the heterogeneous trials, without attempting to make any switches, are to be discounted from analyses. However, while Diamond (2013) notes that "the stimuli in most task-switching tasks are bivalent" (p. 150), such that a correct response when following one rule would be incorrect if following the alternative rule, the use of only four different stimuli is restrictive in this respect; unfortunately, therefore, as in the colour–shape task described by Miyake and Friedman (2012), stimuli for the current task are not bivalent, and this might make it more difficult to identify when a participant has failed to follow task rules.

#### *4.2.1.7 Which Colour?*

The Stroop test (Stroop, 1935) is possibly the most frequently-used measure of executive function. A number of processes are likely to underpin successful performance but the task is included in CogS: 9–11 as an indicator of inhibition; incongruent stimuli (e.g. 'BLUE' printed in red ink) require participants to inhibit dominant responses to answer with colour *names* when the goal is instead to give the colours in which the names are *printed*.

The main difficulty for CogS: 9–11 was that the Stoop test usually involves giving verbal responses, making it unfeasible in a whole-class testing situation. Furthermore, although Janssen, Chinapaw et al. (2014) report success in asking children to time themselves when completing the Sky Search test, the risk of experimenter error was felt to be too great were a similar approach to be adopted as both speed and accuracy would require recording. In the Which Colour? task, participants are therefore given 30 seconds to tick one coloured box (red, blue, yellow or green) for each of the incongruent colour–word stimuli presented (Figure 4.3), similar to making responses via mouse clicks in some computer-based Stroop variants (e.g. COMPASS, Northumbria University, Newcastle upon Tyne, UK). The number of correct responses is recorded (max. 40); where two responses are given for one stimulus, this is marked as incorrect as inhibition was unsuccessful.


*Figure 4.3. Example stimuli from the Which Colour? task*

Compared to the original task, smaller interference effects have been identified for adults and children in computer-based Stroop tasks, possibly due not only to the different response modality but also to presenting one stimulus at a time rather than a list of stimuli (Penner et al., 2012). With its manual response modality but presentation of all stimuli on a single page, the current task falls somewhere between the two versions.

One of the limitations of the Stroop test is that reading fluency might influence the results. Non-reading variants do exist (see Lagattuta, Sayfan & Monsour, 2011) but conversion to a manual response format would have been difficult without introducing a reading element. Another approach to the task was also considered; however, the potential priming effect of having participants respond to multiple sets of stimuli (for instance, colour words printed in black, neutral stimuli printed in different colours, and finally incongruent colour–word stimuli; e.g. Buck et al., 2008; van der Niet et al., 2015) was felt to outweigh the benefits of this procedure in differentiating between incongruency and reading fluency effects, especially for children of an age at which the names of colours should be familiar enough to elicit the interference effect. Participants are therefore exposed only to incongruent colour–word stimuli in the Which Colour? task.

#### *4.2.1.8 Remembering Backwards!*

Although working memory is thought to support performance in other cognitive tests, it was intended that Studies 2 and 3 would specifically assess children's ability to manipulate information in working memory; this is an area likely to be of interest to education stakeholders as Gathercole, Lamont and Alloway (2006) report that poor working memory skills amongst children have been associated with poor academic progress in literacy and mathematics, with particular difficulties occurring when classroom tasks involve both storage and processing loads.

Remembering Backwards! was a backward span task in which the researcher read out sets of digits and letters for the participants to subsequently write down in reverse order. Digit/letter strings increased in length from three to nine items. However, when the task was run in the first Study 1 familiarisation session it was found to be flawed: asking for written rather than verbal responses due to the whole-class testing situation meant that participants were able to remember the strings in presentation order and simply write them down from right to left, thereby essentially completing a forward span task. The backward and forward variants of the digit and letter string tasks load onto different factors, with the forward tasks apparently tapping less complex cognitive processes not involving transformations (Reynolds, 1997); as it was the manipulation of information that was of particular interest, the Remembering Backwards! task was removed from the test battery for Studies 2 and 3, and was

employed in no further sessions of Study 1.

### *4.2.2 Ethical Approval*

Ethical approval for Study 1 was obtained from the Faculty of Health and Life Sciences Research Ethics Committee at Northumbria University. Permission was obtained from all of the schools involved in the research via email. Participants were provided with age-appropriate participant information sheets and were asked to take home more detailed information for their parents/guardians. This included the researcher's email address to allow them to ask any questions. Children gave written assent for their participation, while parents/guardians provided written consent. At the end of the study, participants were given a verbal debriefing and took away written debriefings for themselves and for their parents/guardians. Examples of consent forms, information sheets and debriefs used in the research programme are provided in Appendices B–F. There was no incentive for participation but parents/guardians who provided their email address were sent a summary of the results (Appendix G).

### *4.2.3 Recruitment*

Convenience sampling was used to recruit participants; eight schools recommended by acquaintances of the researcher were contacted and staff at the four schools from which responses were received were asked to distribute information sheets and consent forms to their Year 5–6 pupils. A total of 222 consent forms were handed out, leading to a sample of 60 children from across the four schools. Characteristics of the participating schools are outlined in Table 4.1.

To reflect the sample anticipated for Studies 2 and 3, efforts were made to contact schools with a similar profile to those usually taking up the intervention to be investigated in these studies, although it was necessary for reasons of sample size to contact schools located across a wider area of the North East of England than that in which the intervention was available. One of the four schools was also potentially in a more affluent area than intervention schools, with its nearest residential postcode being in category 3 (Comfortable Communities) of the Acorn population profile (CACI Ltd., London, UK).

*Table 4.1. Characteristics of schools at the time of their involvement in Study 1*

| School | School type[a] | Number of pupils on roll [a] | Ofsted 'overall effectiveness' rating[a] | Acorn classification profile for school postcode/ nearest residential postcode[b] | 2011 Census characteristics for the area[c] | | |
|---|---|---|---|---|---|---|---|
| | | | | | % households social rented | % White British | % of those aged 16–74 unemployed |
| 1 | Voluntary controlled school | 381 | Good | ***Category 3:* Comfortable communities**<br>*Group I:* Comfortable seniors<br>*Type 30:* Older people, neat and tidy neighbourhoods | 12.0 | 97.1 | 3.2 |
| 2 | Community school | 195 | Good | ***Category 4:* Financially stretched**<br>*Group M:* Striving families<br>*Type 44:* Post-war estates, limited means | 18.1 | 95.3 | 3.7 |
| 3 | Foundation school | 398 | Good | ***Category 5:* Urban adversity**<br>*Group Q:* Difficult circumstances<br>*Type 59:* Deprived areas and high-rise flats | 22.7 | 97.5 | 4.5 |
| 4 | Voluntary controlled school | 268 | Good | ***Category 4:* Financially stretched**<br>*Group L:* Modest means<br>*Type 38:* Semi-skilled workers in traditional neighbourhoods | 45.6 | 96.7 | 8.6 |

[a] *Information from Ofsted (2012–2018)*
[b] *Information from CACI Ltd. (2016–2018)*
[c] *Information from Nomis (2011) local area report*

### *4.2.4 Procedure*

Children took part in three sessions of paper-based cognitive testing (familiarisation, baseline and repeat), each lasting approximately 30 minutes. In all but one instance, the sessions took place exactly 1 week apart; in the remaining instance, repeat testing took place 13 days following baseline testing due to a school residential trip. Due to school timetabling it was not possible to test the children at the same time of day across the four schools but each school was consistent in the time at which testing took place for their pupils: for two schools this was following the children's lunchbreak, for one school it was after morning break and for the final school it was during the first hour of the day.

Children completed a different parallel form of the CogS: 9–11 test battery at each of the three testing sessions, these different versions being identified by the colour of the cover page of the booklet (red, green, blue or yellow). The order of booklet presentation for the four schools is indicated in Table 4.2; however, where participants missed a session, their results were recorded and analysed according to their own individual order of testing, resulting in slight variations to the sample sizes at each test period. For example, at School 1 the booklet presentation order was red, green, yellow; a child who took part on only the researcher's first and third visits to the school would have results for the red booklet at familiarisation (as would their classmates), but their second set of results would be logged as baseline and would reflect completion of the yellow booklet. The order of presentation was determined by the needs of the research: it was necessary for each of the booklets to be used at baseline in order to assess for parallel forms reliability, and for participants to complete three different versions of the booklet across the sessions to avoid duplication. This resulted in a limited number of combinations, the order in Table 4.2 being chosen because none of the booklet versions appeared immediately following the same one on more than one occasion.

*Table 4.2. Order of presentation of research booklets, Study 1*

| | **Familiarisation** | **Baseline** | **Repeat** |
|---|---|---|---|
| **School 1** | Red ($n$ = 14)[a] | Green ($n$ = 14) | Yellow ($n$ = 7) |
| **School 2** | Green ($n$ = 17)[a,b] | Blue ($n$ = 14)[a,b] | Red ($n$ = 13)[b] |
| **School 3** | Yellow ($n$ = 10) | Red ($n$ = 16)[a] | Blue ($n$ = 9) |
| **School 4** | Blue ($n$ = 20) | Yellow ($n$ = 15)[c] | Green ($n$ = 15)[c] |

[a] *One participant from School 2 completed the red rather than green booklet at familiarisation; however, due to the presentation of stimuli on the whiteboard for Memorise! and 3-Back, they completed the green booklet versions of these tasks. The participant is therefore included in the figures for both booklet versions. The baseline figures were affected in the same manner.*

[b] *One participant from School 2 completed only the Dot-to-Dot test from the green booklet on the researcher's first visit to the school, so the figures for this test are n = 18 for the green booklet at familiarisation, n = 15 for the blue booklet at baseline and n = 14 for the red booklet at repeat.*

[c] *One participant from School 4 missed the Match-Up! test at baseline, so the figures for this test are n = 14 for the yellow booklet at baseline and n = 14 for the green booklet at repeat.*

Testing took place in available classrooms at the children's schools. Each test was preceded by a visual demonstration of how to complete it, this being displayed on the whiteboard and narrated by the researcher, with children being invited to ask questions for clarification. The total duration for the testing was approximately 30 minutes each time, including short rests between tests.

### *4.2.5 Data Analysis*

All statistical analyses were performed using IBM SPSS Statistics Version 24.0.0.1 (IBM Corp., Armonk, NY) and a significance level of .05 was employed.

#### *4.2.5.1 Parallel Forms Reliability*

Given that the four different versions of CogS: 9–11 would be used in Studies 2 and 3 at familiarisation, pretest, post-PA/classroom testing and posttest, it was important to establish in Study 1 that performance was assessed equally by each booklet (i.e. that the stimuli in no one booklet made performance easier or more difficult than for the other versions). Parallel forms reliability was assessed at baseline using a 1 × 4 (booklet version) between-groups multivariate analysis of variance (MANOVA), with

scores from each of the tests constituting the seven dependent variables (DVs). Any significant differences would indicate a lack of comparability across the versions of the testing booklet.

Scores for baseline were selected for this analysis because it was anticipated that more data would be available than for repeat. This was borne out following data collection (see Table 4.2).

#### *4.2.5.2 Test–Retest Reliability*

As a repeated measures design was to be used in Studies 2 and 3, it was necessary to check for practice/fatigue effects when the CogS: 9–11 tests were completed 1 week apart, the minimum inter-testing interval planned for the intervention research. Given that missing data were expected due to the nature of the research, which would have limited the data available for analysis via repeated measures MANOVA, paired samples *t*-tests were planned for the assessment of test–retest reliability. The scores obtained by participants at baseline and repeat (regardless of the booklet versions completed due to assuming parallel forms reliability), were entered into the analyses, with any significant differences indicating an improvement or deterioration in performance between testing sessions; over a week-long period and in the absence of some intervention, it was felt that this would be indicative of a practice or fatigue effect. Correlational analyses were also planned, with positive associations anticipated between baseline and repeat scores as the same participant should not vary greatly in their cognitive performance from one session to the next.

#### *4.2.5.3 Construct Validity*

The construct validity of the test battery was assessed by conducting a principal component analysis to examine whether the scores at baseline for tests which were proposed to measure the same constructs loaded onto the same component and equally whether the scores for tests which were proposed to measure different constructs loaded onto different components. An exploratory rather than confirmatory procedure was adopted due to this study constituting the first use of the test battery. It was anticipated that scores for Dot-to-Dot and Match Up! would load onto a component representing processing speed; those for Find ‘M’ would load onto a component representing attention; the number of words remembered in Memorise! would load

onto a component representing LTM; and scores for 3-Back, Colours and Shapes and Which Colour? would load onto a component representing executive function.

## 4.3 Results

### *4.3.1 Participants*

Participant characteristics are presented in Table 4.3. No significant differences were found between schools for percentage of males. However, as some schools were able to accommodate the testing of both Year 5 and Year 6 pupils, while at others testing was possible only for Year 6 pupils, the participants from School 1 were on average younger than those from Schools 2 and 4.

*Table 4.3. Participant characteristics, Study 1*

| | ***n*** | **% males** | **Mean age in years at familiarisation *(SD)*** |
|---|---|---|---|
| **School 1** | 12 | 66.67 | 10.28 *(0.661)*[*] [†] |
| **School 2** | 21 | 47.62 | 11.14 *(0.283)*[*] |
| **School 3** | 9 | 44.44 | 10.81 *(0.687)* |
| **School 4** | 18 | 44.44 | 10.86 *(0.665)* [†] |
| | | $\chi^2(3) = 1.714$, $p = .634$ | $F(3,56) = 5.948$, $p = .001$ |

[*] [†] *Sig. dif. in Tukey post-hoc tests (p = .001 and p = .039, respectively)*

### *4.3.2 Preliminary Data Analysis*

Descriptive statistics for the seven cognitive tests are presented in Table 4.4. The negative skew for 3-Back at baseline and for Dot-to-Dot at repeat indicated possible ceiling effects for these tasks, particularly in the case of 3-Back, in which the negative skew was accompanied by high mean scores. The positive skew for Colours and Shapes at both baseline and repeat indicated a possible floor effect. Grayson (2004) warns that statistical transformations of non-normal data result in a loss of empirical meaning such that the scores in essence reflect a different construct; this would have been particularly problematic for an investigation of the properties of a new cognitive test battery, and transformations were not therefore applied to the data.

*Table 4.4. Descriptive statistics for the dependent measures at baseline and repeat testing, Study 1*

| Task, area of cognition measured (max. possible score) | Baseline | | | | | Repeat | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | ***n*** | **Mean *(SD)*** | **Range** | **Skewness *z*-score** | **Kurtosis *z*-score** | ***n*** | **Mean *(SD)*** | **Range** | **Skewness *z*-score** | **Kurtosis *z*-score** |
| Dot-to-Dot, processing speed (96) | 57 | 58.44 *(12.387)* | 29 to 80 | –0.43 | –0.52 | 45 | 58.16 *(10.449)* | 29 to 73 | –2.49† | 0.91 |
| Match-Up!, processing speed (90) | 57 | 26.86 *(5.965)* | 14 to 40 | –0.24 | –0.98 | 43 | 26.51 *(6.798)* | 11 to 42 | 0.18 | –0.60 |
| Find 'M', attention (6.09) | 57 | 3.39 *(0.473)* | 2.25 to 4.61 | 0.68 | 0.05 | 43 | 3.56 *(0.546)* | 2.75 to 4.73 | 1.47 | –0.93 |
| Memorise!, long-term memory (20) | 57 | 11.23 *(2.659)* | 5 to 16 | –0.71 | –0.45 | 44 | 10.61 *(2.305)* | 6 to 15 | –0.64 | –1.27 |
| 3-Back, executive function: updating (37) | 57 | 31.07 *(4.636)* | 16 to 37 | –3.59† | 2.31† | 43 | 30.35 *(4.082)* | 18 to 37 | –1.19 | 0.99 |
| Colours and Shapes, executive function: shifting (42) | 54 | 16.01 *(8.178)* | 4.5 to 37.5 | 2.46† | 0.38 | 39 | 14.58 *(8.755)* | 2.5 to 38.5 | 3.28† | 1.63 |
| Which Colour?, executive function: inhibition (40) | 57 | 23.33 *(6.561)* | 5 to 37 | –1.38 | 1.00 | 44 | 26.11 *(6.892)* | 7 to 40 | –0.78 | 0.45 |

† *Value outside range –1.96 to +1.96, indicating non-normality at $p \leq .05$*

Pearson/Spearman correlations revealed that at baseline participants' age positively correlated with performance only on the Match-Up! ($r$ = .319, $p$ = .016) and Memorise! ($r$ = .262, $p$ = .049) tasks, and at repeat there was a single significant correlation between age and Which Colour? score ($r$ = .320, $p$ = .034). However, when a correction was applied for multiple correlations by dividing the $\alpha'$-level by the number of tests (Curtin & Schulz, 1998), none remained significant at $p < .004$. Age was not therefore included as a covariate in further analyses.

Male and female performance was compared using independent samples $t$-tests and Mann-Whitney $U$ tests as appropriate for each task. Significant differences were found only for the Find 'M' task at both baseline, $t(55) = -3.485$, $p = .001$, and repeat, $t(41) = -3.476$, $p = .001$, with the mean $d'$ for females exceeding that for males at both time periods (baseline: females: $n = 28$, $M = 3.59$, $SD = 0.386$; males: $n = 29$, $M = 3.19$, $SD = 0.472$; repeat: females: $n = 23$, $M = 3.80$, $SD = 0.486$; males: $n = 20$, $M = 3.28$, $SD = 0.485$). Sex differences are described where applicable in further analyses.

### *4.3.3 Parallel Forms Reliability*

Parallel forms reliability was assessed for seven DVs (baseline test scores) with a 1 × 4 (booklet version) between-groups MANOVA. The number of participants entered into the analysis for each of the booklet versions was: red = 10, green = 14, blue = 11 and yellow = 14. Using Pillai's trace, SPSS reported an observed power of .997.

A significant difference was found in cognitive performance between booklets, $V = .922$, $F(21, 123) = 2.597$, $p = .001$, $\eta_p^2 = .307$, although Box's test indicated a violation of the assumption of homogeneity of covariance matrices, $M = 162.63$, $F(84, 3877.28) = 1.35$, $p = .019$. A nonparametric MANOVA conducted using the procedure described in Finch (2005) was however also significant, and including sex as a covariate did not change the outcomes of the analysis. Univariate analysis of variance tests (ANOVAs) revealed significant differences in scores between booklets for 3-Back, $F(3, 45) = 16.054$, $p < .001$, $\eta_p^2 = .517$, and Colours and Shapes, $F(3, 45) = 3.598$, $p = .021$, $\eta_p^2 = .193$. Tukey *post-hoc* tests indicated significantly poorer mean 3-Back performance for the yellow booklet ($M = 25.64$, $SD = 4.144$) than for each of the other booklets (red: $M = 33.4$, $SD = 1.838$; green: $M = 33.07$, $SD = 4.178$; blue: $M = 33.55$, $SD = 2.659$), all $p < .001$, as well as significantly better Colours and Shapes

performance for the yellow ($M$ = 20.57, $SD$ = 10.166) compared to the red booklet ($M$ = 10.55, $SD$ = 3.745), $p$ = .011.

### *4.3.4 Test–Retest Reliability*

Results of the test–retest reliability testing are presented in Table 4.5. Following the *a priori* assumption of parallel forms reliability, data at baseline and repeat were compared without grouping the data by booklet version. Paired samples *t*-tests were run where the data had demonstrated normality (Table 4.4), and Wilcoxon signed ranks tests where they had not. Performance on the Find 'M' task was found to be significantly better at repeat ($M$ = 3.56, $SD$ = 0.546), than at baseline ($M$ = 3.38, $SD$ = 0.446), as was performance on the Which Colour? task (repeat: $M$ = 26.56, $SD$ = 6.303; baseline: $M$ = 22.65, $SD$ = 5.875). Performance on the Memorise! test was significantly poorer at repeat ($M$ = 10.61, $SD$ = 2.305) than at baseline ($M$ = 11.52, $SD$ = 2.328).

*Table 4.5. Test–retest reliability for scores at baseline and repeat, Study 1*

| | ***N*** | **Wilcoxon signed ranks test/ paired samples *t*-test** | **Spearman/Pearson correlation** |
|---|---|---|---|
| Dot-to-Dot | 45 | $z = -1.233$, $p = .218$ | $r_s = .721$, $p < .001^*$ |
| Match-Up! | 43 | $t(42) = 0.179$, $p = .859$ | $r = .787$, $p < .001^*$ |
| Find 'M' | 43 | $t(42) = -2.984$, $p = .005^*$ | $r = .689$, $p < .001^*$ |
| Memorise! | 44 | $t(43) = 2.705$, $p = .010^*$ | $r = .537$, $p < .001^*$ |
| 3-Back | 43 | $z = -0.499$, $p = .618$ | $r_s = .431$, $p = .004^*$ |
| Colours and Shapes | 37 | $z = -0.932$, $p = .351$ | $r_s = .378$, $p = .021^{**}$ |
| Which Colour? | 43 | $t(42) = -4.880$, $p < .001^*$ | $r = .630$, $p < .001^*$ |

$^* p \leq .01$; $^{**} p \leq .05$

Pearson/Spearman correlations between baseline and repeat data were significant and positive for all tasks (Table 4.5), although the correlation for Colours and Shapes, $r_s$ = .378, $p$ = .021, was not significant when corrected for multiple correlations ($p$ < .007). The remaining coefficients ranged from $r_s$ = .431 for 3-Back to $r$ = .787 for Match-Up!.

### *4.3.5 Construct Validity*

A principal component analysis was conducted to explore the structure of the baseline data. The correlation matrix (Table 4.6) indicated no positive correlations between Colours and Shapes and any of the other tasks, including the remaining two tests of executive function, between which the relationship was small, $r = .266$. All other tasks were positively correlated with all other tasks, $r = .246$ to $r = .527$, with the exception that there was no significant association between Find 'M' and 3-Back. Bartlett's test indicated there were adequate relationships between variables to conduct the analysis, $\chi^2(21) = 77.056$, $p < .001$.

*Table 4.6. Principal component analysis, Study 1: Correlation matrix*

| | **Dot-to-Dot** | **Match-Up!** | **Find 'M'** | **Memorise!** | **3-Back** | **Colours and Shapes** |
|---|---|---|---|---|---|---|
| **Match-Up!** | .492* | | | | | |
| **Find 'M'** | .474* | .246** | | | | |
| **Memorise!** | .486* | .527* | .366* | | | |
| **3-Back** | .291** | .425* | .102 | .345* | | |
| **Colours and Shapes** | –.088 | –.323** | –.125 | –.126 | –.214 | |
| **Which Colour?** | .339* | .432* | .343* | .455* | .266** | –.076 |

** $p \leq .01$; ** $p \leq .05$*

The Kaiser-Meyer-Olkin statistic, *KMO* = 0.774, suggested that the sample size of 49 for the analysis was 'good' (Hutcheson & Sofroniou, 1999), and KMO values for individual items were .587 to .839, where .5 is acceptable (Field, 2009). An oblique promax rotation was employed to allow for correlations between components, with all mental abilities being positively correlated (Reynolds, 1997). Using Kaiser's criterion to extract components with eigenvalues > 1, two components were extracted which together accounted for 58.15% of the variance and were correlated $r = .420$. Unfortunately, 52% of the residuals computed between observed correlations and correlations based on the model had absolute values > .05, raising potential concerns over the model fit.

Component loadings from the structure and pattern matrices are reported in Table 4.7. Applying a cut-off of ≥ 0.4 for reporting loadings (Stevens, 2009), in the pattern matrix four tasks loaded only on component 1 (Dot-to-Dot, Find 'M', Memorise! and Which Colour?) and two loaded only on component 2 (3-Back and Colours and Shapes, the latter loading negatively). Match-Up! loaded on both components, .429 on component 1 and .548 on component 2. In the structure matrix, the tasks loaded on the same components with one exception: Memorise! loaded on both components, .769 and .450, respectively.

*Table 4.7. Principal component analysis, Study 1: Loadings*

| | **Pattern Matrix** | | **Structure Matrix** | |
|---|---|---|---|---|
| **Measure** | **Component 1** | **Component 2** | **Component 1** | **Component 2** |
| Dot-to-Dot | .790* | –.013 | .785* | .319 |
| Match-Up! | .429* | .548* | .659* | .728* |
| Find 'M' | .811* | –.263 | .700* | .078 |
| Memorise! | .705* | .154 | .769* | .450* |
| 3-Back | .113 | .665* | .392 | .713* |
| Colours and Shapes | .276 | –.858* | –.085 | –.742* |
| Which Colour? | .682* | .031 | .695* | .318 |

* *Component loading > 0.4*

## 4.4 Discussion

This article presents a preliminary assessment of CogS: 9–11, a paper-based test battery designed for use in the investigation of 9–11-year-old children's cognitive performance in a classroom setting. Using a sample of children from four primary schools in the North East of England, the parallel forms reliability, test–retest reliability and construct validity of the test battery were explored.

### *4.4.1 Parallel Forms Reliability*

The parallel forms reliability of the four alternate forms of the CogS: 9–11 battery – identified by the colours of the cover pages of the test booklets – demonstrated that

the red, green and blue booklets elicited comparable cognitive performance in all of the tests. Scores for the 3-Back task were however significantly poorer for the yellow booklet than for each of the other booklets, while scores for the Colours and Shapes task were significantly greater for the yellow booklet than for the red booklet. It is therefore recommended that the yellow booklet is reserved for use in familiarisation sessions, in which the apparent difficulty of the yellow version of the 3-Back task and ease of the yellow version of the Colours and Shapes task is of lesser importance than the provision of an opportunity for children to practise the tasks. The red, green and blue booklets would then allow for baseline testing and up to two further testing sessions.

### *4.4.2 Test–Retest Reliability*

Given that CogS: 9–11 was created for use in repeated measures designs, baseline and repeat testing sessions were carried out 1–2 weeks apart to check for practice or fatigue effects which could distort comparisons between pre- and post-intervention performance. On the whole, scores for the two sessions were found to be positively correlated, and there were no significant differences between scores at baseline and repeat for the Dot-to-Dot, Match-Up!, 3-Back and Colours and Shapes tasks, indicating test–retest reliability. Performance on the Memorise! task was found to be poorer at repeat than at baseline, though the researcher noted that this was likely to have been due to the poor on-task behaviour of the largest class when completing the test at the repeat session, and as such this finding requires further investigation.

Conversely, significantly higher scores were found for the Find 'M' and Which Colour? tasks at repeat compared to baseline, suggesting a practice effect. Follow-up analyses for the Which Colour? task revealed that children completed a greater number of items in the repeat session, $t(42) = -4.859$, $p < .001$, but without making significantly more errors, $t(42) = 0.819$, $p = .418$, suggesting an improvement in speed without a loss in accuracy. In the Find 'M' task, they processed a greater number of items (measured as the last target to be circled), $t(42) = -5.485$, $p < .001$, and recorded a greater number of hits, $t(42) = -7.122$, $p < .001$, but also a greater number of false alarms, $t(42) = -2.017$, $p = .050$. For this task, there therefore seemed to be an improvement in speed with a corresponding loss in accuracy which was unfortunately not reflected in the $d'$ discriminability index. There was an element of competition to

children's performance in both tasks, with participants trying to progress further through the activities at baseline than they did at familiarisation and further still at repeat, although this was also true of the Dot-to-Dot task, where no significant difference in baseline vs. repeat performance was observed. It is therefore recommended that a control group is employed in research using the CogS: 9–11 battery such that improvements in performance can be attributed to intervention (non-)participation rather than simply repeat testing.

### *4.4.3 Construct Validity*

The seven CogS: 9–11 tests were chosen to provide data on four broad aspects of cognition: processing speed, sustained and selective attention, LTM and executive function. The construct validity of the battery was explored through principal component analysis, which indicated a two-component solution that was difficult to interpret in respect of the anticipated structure: tasks loading on the first component were thought to assess processing speed (Dot-to-Dot), attention (Find 'M') and the executive function of inhibition (Which Colour?), while the second component appeared to centre around the executive function of updating, with 3-Back loading positively while the Colours and Shapes shifting task loaded negatively. In the structure matrix, two tasks loaded on both components, suggesting that LTM (Memorise!) and processing speed (Match-Up!) played a role in both, though in the pattern matrix Memorise! loaded only on the first component. The similar loading of these two measures is not unexpected given the potential for LTM to support the learning of digit–symbol pairs in the Match-Up! task (Joy et al., 2004), and this element of learning may explain why the two processing speed tasks did not load in the same manner.

Some degree of difficulty in defining components is to be expected given that the different elements of cognition are related (Reynolds, 1997); however, more concerning is that the two-component solution accounted for only 58.15% of the variance and that the residuals between observed correlations and correlations based on the model suggested problems with the model fit. Despite being classified as 'good' based on the Kaiser-Meyer-Olkin measure (Hutcheson & Sofroniou, 1999), the sample size for the analysis of 49 was low for a principal component analysis, meaning that the construct validity results might be best viewed as a pilot analysis with further

investigation required to establish a final model.

Nevertheless, it does seem even from these early findings that the test battery distinguishes between the executive functions of updating, shifting and inhibition. This is in itself useful for those interested in physical activity and cognition, as current evidence suggests that acute PA participation most consistently benefits inhibition (Jäger et al., 2014), and further investigation into this is required before firm conclusions can be drawn. It has been proposed, for example, that inhibition contributes to updating and shifting performance (Miyake & Friedman, 2012); successful shifting performance might rely on inhibition of the rule(s) not currently being followed, and performance on updating tasks is likely to benefit from the inhibition of information falling outside of the specified window for the task (e.g. more than three items of information previously for the 3-Back task). Inhibition is also potentially necessary in other cognitive tasks, for example in preventing the continued drawing of a straight line in the Dot-to-Dot task when the next item in a previously linear series requires a change of direction. Therefore, if PA – or any other intervention – is of benefit to inhibition, it may improve performance on other tasks.

#### *4.4.4 Limitations*

Aside from the sample size, as discussed above, the main limitation of the reliability and validity testing was that all of the participants at a particular school were asked to complete the same version of the CogS: 9–11 battery at each testing session. Despite attempts to select schools with similar characteristics, any differences in performance between booklet versions might therefore reflect between-school effects rather than a lack of equivalence in test materials (Sellström & Bremberg, 2006). It was unfortunately not possible for children to complete different booklet versions at the same testing session due to the stimuli for the Memorise! and 3-Back tasks being displayed to the whole class on the whiteboard, but the issue was partially addressed by logging data on an individual basis: if, for example, a participant missed the baseline session but was present for the repeat session, they would be recorded as having completed the repeat booklet version at baseline. The main result of this was that pupils from a mixture of schools were recorded as having completed the red booklet at baseline, the session upon which the parallel forms reliability testing was based.

In terms of the individual tasks, a probable ceiling effect was identified for 3-Back, with four children at baseline and three at repeat attaining a maximum score. The task was therefore modified before use in Studies 2 and 3, as described at the end of this chapter. There were also indications of possible acceptability concerns for the Colours and Shapes task; of the 57 children at baseline and 44 at repeat who were able to stay for the entire testing session, data for the Colours and Shapes task were available for only 54 and 39, respectively, due to children failing to take part in one or more of the three task components. Other than the two-trial Dot-to-Dot task, however, Colours and Shapes is the only test for which the calculation of a score is dependent on children's completion of multiple measures, and greater amounts of missing data are therefore to be expected. Nevertheless, the task was modified before use in later studies in an attempt to improve its acceptability, as described below.

Due to the numerous processes involved in completing cognitive tasks, for instance the processing of visual stimuli and maintenance of task goals in working memory, it is difficult to claim that any task assesses only the aspect of cognition it is intended to measure. This may be a particular problem when the target measure is one of executive function (Miyake & Friedman, 2012). It was beyond the scope of the current study to tackle this extensive issue but the complication is nevertheless acknowledged. One of the areas in which the contribution of other aspects of cognition was most apparent was for the Memorise! task, which aimed to assess LTM and was designed to minimise the contribution of working memory: 20 items of visual information cannot easily be maintained in working memory due to capacity limitations and the difficulty of rehearsing nonverbal material (Jeneson & Squire, 2012). The majority of the participants did however clearly rehearse the *names* of the items during the 100-second delay.

The only sex difference to be identified occurred for the Find 'M' task, with females outperforming males at both baseline and repeat testing. CogS: 9–11 was primarily designed for repeated measures testing but this issue should be borne in mind by researchers wishing to test for sex differences in children's cognitive performance.

## 4.5 Conclusion and Potential Impact

The CogS: 9–11 test battery shows some promise as a measure of cognitive performance suitable for use with 9–11-year-olds in school settings. The battery takes approximately 30 minutes to complete and permits testing with whole classes of children simultaneously, making it as acceptable as possible to school staff and practical for researchers. Principal component analysis provided early indications that the battery may distinguish between the executive functions of updating, shifting and inhibition, although a larger sample is required to explore this further.

The impetus for the study was that it is often difficult to draw conclusions from across school-based studies into cognitive performance due to the multitude of methods employed. The current research focused on the way in which cognitive performance is measured as just one of the factors that will benefit from standardisation, and it is hoped that the CogS: 9–11 test battery will be useful in assessing the impact of educational interventions on pupils' cognitive performance in future, although at present it should be considered a pilot tool. It is recommended that the yellow version of the test booklet is reserved for use in familiarisation sessions, with the red, green and blue versions demonstrating adequate parallel forms reliability to run baseline testing and up to two further testing sessions. As practice effects appear to occur for the Find 'M' and Which Colour? tasks, it is recommended that a control group is employed such that any improvements in performance can be reasonably attributed to changes in the IV (e.g. intervention participation).

## 4.6 Changes Made to the Test Battery Following Study 1

Before CogS: 9–11 was employed in Studies 2 and 3, two minor modifications were made based on the findings from Study 1. Firstly, due to possible ceiling effects in the 3-Back task, the number of unique stimuli presented to participants was reduced from 26 to 10 (as described in Appendix A(iii)), limiting the potential for novelty to be used as a cue that a 'no' response was required for a stimulus. The same pattern of 'yes' and 'no' responses was however maintained in order not to deviate too dramatically from the version of the task assessed in the reliability and validity study. For the Colours and Shapes task, it was felt that the presence or absence of a border around a shape as a cue to switch between the colour and shape rules added an unnecessary

level of complication, the researcher having observed that children did not respond favourably to the task and the completion rate being lower than for the other tests. As in the 3-Back task, the same pattern of responding was maintained but the cue was modified; similar to the procedure for the shifting task described in Miyake and Friedman (2012), the letter 'C' or 'S' was presented alongside the shape to indicate whether the colour rule or the shape rule should be followed for that item.

An example of the version of the CogS: 9–11 test battery used in Studies 2 and 3, incorporating the above changes, is presented in Appendix H.

# Chapter 5: General Methods – Studies 2 and 3

Studies 2 and 3 were conducted simultaneously using the same sample of participants: Study 2 was an analysis of children's cognitive performance immediately following participation in the PA component of one of the sessions of a classroom/PA-format PSHE intervention or a normal classroom lesson; and Study 3 investigated the relationships between overall intervention participation/non-participation and children's cognitive performance, academic achievement and wellbeing (with a pilot study, Study 3a, analysing the pretest and posttest daily MVPA of a subsample of the participants). In order to avoid repetition, the common features of the studies are reported in this chapter.

## 5.1 Experimental Design

The DVs for Study 3 were cognitive performance (scores on the seven CogS: 9–11 cognitive tasks described in Study 1), academic achievement (class teachers' scores reflecting a child's achievement in reading, writing and mathematics) and wellbeing scores on four dimensions of the KIDSCREEN-27 (physical wellbeing, psychological wellbeing, social support and peers, school environment). The daily physical activity (percentage of time spent in MVPA) of a subgroup of participants was the DV in Study 3a, an additional small-scale pilot study.

Minimising the testing burden for schools and their pupils when no immediate changes could reasonably be expected in teacher-assessed academic achievement (a measure chosen over academic test batteries due to its relevance to stakeholders) or dimensions of wellbeing such as physical wellbeing (which would be anticipated to improve over time), the only posttest DV in Study 2 was cognitive performance, assessed in the same manner as for Study 3. Participants' PA during the PA component of the intervention session was also measured via accelerometry in order to assess associations between acute PA and cognitive performance.

Studies 2 and 3 each took the form of quasi-experiments, in that it was not possible to randomly assign participants to groups; schools arranged for pupils' participation in

the intervention directly with the football club foundation providing it. A pretest–posttest, nonequivalent-group design was employed, in which both groups of participants provided pretest data on the variables of interest, the intervention group then took part in the intervention while the control group continued their usual curriculum, and finally both groups provided posttest data on the same variables as measured at pretest (Reichardt, 2009). The use of a control group guarded against drawing inappropriate conclusions on the basis of the possible practice/fatigue effects noted for the cognitive testing in Study 1 and the natural improvements in academic achievement which would be expected over time. The protocol for the two studies is depicted in Figure 5.1.

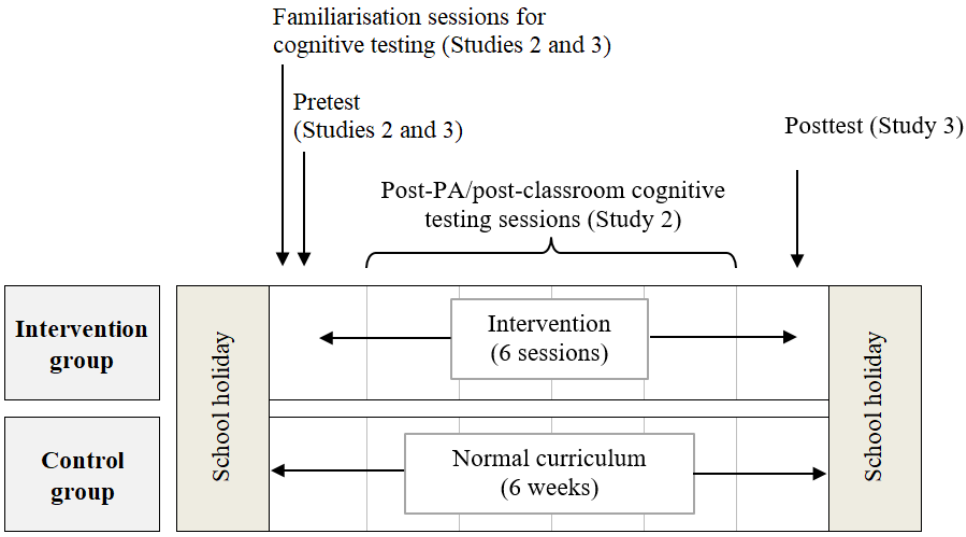



*Figure 5.1. Protocol for Studies 2 and 3*

Both of the studies tested for interaction effects, with greater pretest to posttest improvements being expected for the intervention group than for the control group for each of the DVs. The collection of pretest data also allowed for the identification of any differences between children in the two groups at the beginning of the research, though in order to minimise selection bias control schools were chosen which possessed similar profiles to the intervention schools (see 'recruitment' section). Causality is inferred in Study 2, because the children took part in either PA or a classroom lesson immediately before the final cognitive testing session for this study, making it reasonable to conclude that the condition in which they participated was a fairly direct cause of any differences from pretest cognitive performance between the two groups. However, Black (1999) describes that it can be difficult to identify

meaningful and sensible causal chains in the social sciences and education research because it is carried out in the field, in real live environments or 'open systems', and thus there is a lack of control over other variables which might play a role in causality. For this reason, Study 3 describes the results in terms of *associations* with intervention participation; even if those participating in the intervention experience greater improvements in wellbeing, cognitive performance and academic achievement in comparison with the control group, these outcomes are likely to be contingent on many additional factors and so the research would claim the existence of a *relationship* with intervention participation.

Due to the nature of the studies it was not possible to blind the participants as to whether they were in the intervention or control condition as they were fully aware of whether or not they were participating in the intervention. Neither was it possible to blind the investigator to the conditions because of their role in liaising with the schools and the football club foundation to arrange suitable times for testing around delivery of the intervention sessions. In future, this could be addressed by having other researchers collect the data; however this was not a feasible option for the current PhD programme of research.

## 5.2 Ethical Approval

Ethical approval was obtained for both studies from the Faculty of Health and Life Sciences Research Ethics Committee at Northumbria University. Permission was obtained from all of the schools involved in the research via email. As in Study 1, participants were provided with information sheets for themselves and for their parents/guardians, detailing the research activities of both Study 2 and Study 3 (including Study 3a). Children gave written assent and parents/guardians written consent; with the potentially sensitive nature of taking height and weight measurements for the PA aspect of the studies in mind, the consent form asked for consent to be provided for individual elements of the research (i.e. cognitive testing, academic achievement, wellbeing survey and PA measurement). Participants were given a verbal debriefing at the end of the research and took away written debriefings for themselves and for their parents/guardians.

Examples of consent forms, information sheets and participant debriefings are provided in Appendices B–F. There was no incentive for participation but parents/guardians who provided their email address were sent a summary of the results (Appendix I).

## 5.3 Recruitment

Convenience sampling was used to recruit participants. Firstly, schools in the North East of England whose Year 5 pupils would be taking part in a PSHE intervention with classroom learning and PA components (the first intervention described in section 1.3) were identified through consultation with the football club foundation delivering the intervention. Potential control schools in the same geographical region were then contacted if – like the intervention schools – they had received an overall effectiveness rating of 'good' at the time of their most recent Ofsted inspection and if the school postcode/nearest residential postcode indicated that they were located in areas of similar SES to the intervention schools, using the Acorn population profile as a proxy (as in Thomas & Upton, 2014). It was felt that these factors would be broadly reflective of similar school environments and experiences for the intervention and control participants.

Ultimately, following invitations being sent to 12 schools, 2 intervention schools and 3 control schools were recruited; however, one of the Year 5 classes at one of the intervention schools was not participating in the intervention and so it was possible to recruit 14 additional control children from this intervention school. Characteristics of the participating schools are outlined in Table 5.1.

A total of 219 participants were invited to take part in Studies 2 and 3 (111 from classes taking part in the intervention and 108 from control classes). To minimise objections to the research and maximise recruitment, participants' SES and ethnicity were not recorded, and participants and their parents were informed that weight measurements would be used only to assist in the calculation of PA levels in Studies 2 and 3a and would not feature in the thesis or any publications resulting from it. Figure 5.2 illustrates the flow of participants through the studies.

*Table 5.1. Characteristics of schools at the time of their involvement in Studies 2 and 3*

| School | School type[a] | Number of pupils on roll [a] | Ofsted 'overall effectiveness' rating[a] | Acorn classification profile for school postcode/ nearest residential postcode[b] | 2011 Census characteristics for the area[c] | | |
|---|---|---|---|---|---|---|---|
| | | | | | % households social rented | % White British | % of those aged 16–74 unemployed |
| ***Intervention schools*** | | | | | | | |
| 1 | Academy converter | 370 | Good | ***Category 5:* Urban adversity**<br>*Group P:* Struggling estates<br>*Type 52:* Poorer families, many children, terraced housing | 68.4 | 90.7 | 10.1 |
| 2[d] | Academy converter | 686 | Good | ***Category 5:* Urban adversity**<br>*Group O:* Young hardship<br>*Type 49:* Young families in low cost private flats | 27.7 | 93.7 | 6.3 |
| ***Control schools*** | | | | | | | |
| 3 | Voluntary aided school | 140 | Good | ***Category 3:* Comfortable communities**<br>*Group J:* Starting out<br>*Type 32:* Educated families in terraces, young children | 32.1 | 89.4 | 4.5 |
| 4 | Academy converter | 241 | Good | ***Category 4:* Financially stretched**<br>*Group M:* Striving families<br>*Type 44:* Post-war estates, limited means | 68.4 | 90.7 | 10.1 |
| 5 | Voluntary aided school | 227 | Good | ***Category 5:* Urban adversity**<br>*Group Q:* Difficult circumstances<br>*Type 58:* Singles and young families, some receiving benefits | 52.9 | 77.0 | 12.6 |

[a] *Information from Ofsted (2012–2018)*
[b] *Information from CACI Ltd. (2016–2018)*
[c] *Information from Nomis (2011) local area report*
[d] *Two intervention classes and one control class*

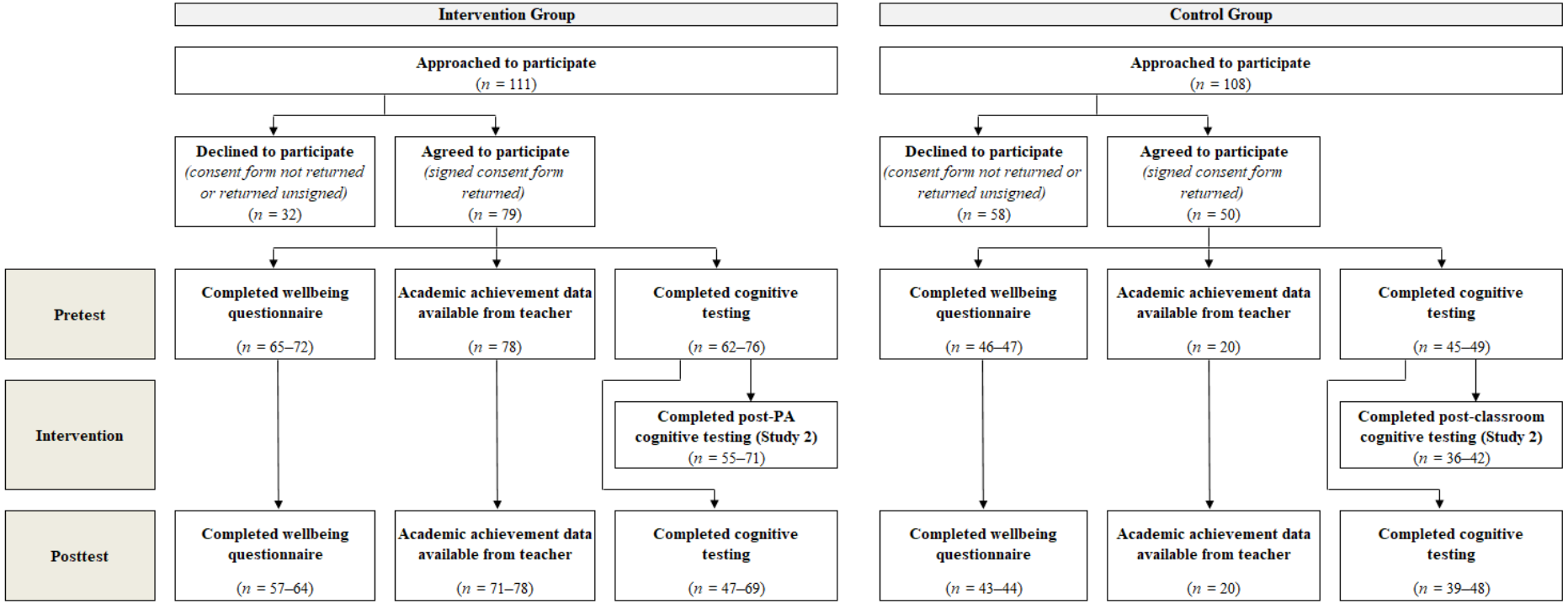



*Figure 5.2. Flow of participants through Studies 2 and 3*

*Note: Ranges of numbers are given for some of the variables because it was possible for a participant to complete some but not all of the cognitive tasks or sections of the wellbeing survey, or for their teacher to provide academic achievement data for only one or two of the three core subjects under investigation.*

## 5.4 Procedure

As Studies 2 and 3 examined the same intervention and used the same participants, the procedures for both studies are presented here. A subsample of the participants also had their pretest and posttest daily PA recorded for Study 3a, but in the interests of clarity the additional procedures for this pilot study are presented in Chapter 7.

As in Study 1, the researcher distributed consent forms and information sheets to the children, who were asked to return the consent forms to their class teacher, signed by themselves and by their parents/guardians, if they wished to participate. Those participating in the studies were introduced to the cognitive tests during a familiarisation session. This was a chance for the researcher to explain each of the tasks and to allow the children through practice trials to become accustomed to what was being asked of them and the ways in which they should make their responses. No data were recorded from familiarisation visits. The yellow version of the CogS: 9–11 test booklet was used in the familiarisation sessions because it had been identified in Study 1 as possessing some potentially more/less difficult versions of the cognitive tasks than the red, green and blue versions of the booklet; these more equivalent versions were reserved for use in the data collection visits.

As illustrated in Figure 5.1, at the pretest visit the researcher measured the children's cognitive performance (for Studies 2 and 3, using the red CogS: 9–11 booklet), recorded their wellbeing (for Study 3) and collected pretest academic achievement data from their teachers (for Study 3). Constituting the posttest data for Study 3, the same measures were taken again following the conclusion of the intervention or after 6 weeks of normal schooling for the control group, with the blue CogS: 9–11 booklet being used for the cognitive testing. In the intervening weeks, children's cognitive performance was recorded using the green CogS: 9–11 booklet immediately following the PA component of one of the intervention sessions or a normal classroom lesson of equivalent duration. This provided the post-PA/post-classroom learning measure of cognitive performance for Study 2. Children's physical activity was additionally recorded during the PA component of the same intervention session. Accelerometers were distributed to participants at the beginning of the session and collected in at the end, with PA calculations being restricted to the time period over which the PA

component had taken place. Participants wore their accelerometers on elastic waistbands, as described in the measurement section below, and anthropometric measurements – also described below – were taken before the PA session or as quickly as possible during the session where necessary to avoid the interruption of schoolwork. For those children participating in Study 3a, the same anthropometric measurements taken to assist in the calculation of daily PA for the pilot study were used in the calculations of PA for Study 2.

In order to prevent undue disruption to children's learning, cognitive performance and wellbeing measurements were taken at the most convenient time in the school day and thus differed between schools. Importantly for a repeated measures design, however, within schools these measurements were whenever possible taken at the same time of day in an attempt to control for confounding effects such as variations in children's fatigue and hunger levels.

Each school visit took approximately 30–40 minutes (cognitive testing: 30 minutes; wellbeing survey: 10 minutes), including short rests between tests. Testing took place in the children's usual classroom or, for smaller groups, in quiet areas such as libraries. The post-PA cognitive testing in Study 2 began upon children's arrival in the testing room immediately following their PA participation, and cognitive testing throughout the two studies followed the same procedure as in Study 1.

## 5.5 Measurements

### *5.5.1 Cognitive Testing (CogS: 9–11 Test Battery)*

Studies 2 and 3 both used the CogS: 9–11 test battery to assess children's cognitive performance; this was described in detail in Chapter 4 but a more concise account is provided here to assist the reader. As noted at the end of Chapter 4, the battery underwent two minor adjustments following Study 1: the number of unique stimuli in the 3-Back test was lowered in order to reduce novelty as a cue for 'no' responses in an attempt to tackle ceiling effects; and in the interests of simplifying the task, the switch cue for Colours and Shapes was changed from the presence/absence of borders around shapes to use of the letters 'C' and 'S'. A summary of the cognitive tests, in the order in which they were presented to participants, is given in Table 5.2.

*Table 5.2. Summary of cognitive tests used in Studies 2 and 3*

| Task name | Proposed to measure | Description | Duration | Scoring |
|---|---|---|---|---|
| 1. Dot-to-Dot | Processing speed | The numbers 1 to 49 are presented in a grid. Participants are asked to draw lines between them in ascending order. | ~1 minute (20 seconds x 2 with a short break) | Total number of correct connections from both trials (max. 96) |
| 2. Match-Up! | Processing speed | Digit–symbol coding; participants are asked to draw corresponding symbols for digits by referring to a key. | 1 minute | Number of correct symbols drawn (max. 90) |
| 3. Find 'M' | Sustained and selective attention | Participants are asked to circle every letter 'M' presented amongst the distractors 'V', 'W' and 'N'. | 4 minutes | *d'*: Inverse *z*-score for proportion of false alarms subtracted from that for proportion of hits[a] |
| 4. Memorise! | Long-term memory | 20 items are displayed for 5 seconds each. There is a delay of 100 seconds (no distractor task), then participants have 120 seconds for recall (in any order). | 5 minutes 20 seconds | Number of items correctly recalled (max. 20); misspellings and alternate names permitted |
| 5. 3-Back | Executive function: Updating | Participants are shown a rapid string of animal pictures and give a tick/cross to indicate for each item whether the same image was shown three items previously. | 3 minutes 20 seconds | Number of correct responses (max. 37) |
| 6. Colours and Shapes | Executive function: Shifting | Participants are given the same stimuli three times. In homogeneous blocks they tick/cross stimuli according to one feature (either colour *or* shape). In the heterogeneous block they shift between colour and shape decisions based on cues ('C' or 'S') for each stimulus. | ~2 minutes (30 seconds x 3 with short breaks) | Mean of correct answers from homogeneous blocks subtracted from score for heterogeneous block; converted to positive scores (max. 42) |
| 7. Which Colour? | Executive function: Inhibition | Stroop task; for each of the incongruent colour–word stimuli (e.g. 'BLUE' printed in red ink), participants tick a coloured box to indicate the colour in which it is printed. | 30 seconds | Number of correct responses (max. 40) |

[a] *Perfect hit rates adjusted using 1−1/(2n); zero false alarms using 1/(2n); n = number of possible hits (250) and false alarms (750), respectively*

### *5.5.2 Academic Achievement (Teacher Report)*

As described in Chapter 3, primary schools in the UK currently use a multitude of different systems to monitor pupils' academic achievement. The system selected for use in Study 3 provides a quantitative measure of achievement; teachers confirm how many *'I can…'* statements linked to the curriculum have been achieved by a pupil in each academic subject and the system converts this information into numerical scores. In a single subject, the expected progress per year is 100 points, resulting in an average of 600 points per subject at the end of Year 5. Scores for reading, writing and mathematics, as core curriculum subjects, were recorded at pretest and posttest for Study 3; school staff provided this information for each of the participating children.

This quantitative assessment system was employed by three of the five schools involved in the study: both of the intervention schools (including the class of control children from School 2), and one of the control schools. Unfortunately, it was not possible to recruit only schools using the same assessment system as there were limited responses from schools specifically invited to participate in the study because they were known to use this assessment method.

### *5.5.3 Wellbeing (KIDSCREEN-27 Questionnaire)*

The KIDSCREEN project (Ravens-Sieberer et al., 2005; The KIDSCREEN Group Europe, 2006) has produced a series of questionnaires into the health-related quality of life of 8–18-year-olds. These surveys see quality of life as encompassing physical, emotional, mental, social and behavioural aspects of wellbeing (Ravens-Sieberer et al., 2014), and were written to reflect quality of life as seen from the child's perspective. The 52-item version provides measures of 10 dimensions of quality of life, the 27-item version encompasses 5 dimensions and the 10-item version produces a single global quality of life measurement (Table 5.3). The 27-item version was selected for use in Study 3 as it addresses aspects of wellbeing anticipated to be influenced by intervention participation and – with an expected completion time of 10–15 minutes – it was practical to administer within a testing session which also contained cognitive testing, helping to keep the overall duration of testing to a minimum to reduce the chances of participant fatigue influencing the results.

*Table 5.3. Dimensions of health-related quality of life assessed by the three versions of the KIDSCREEN questionnaire*

<table>
<tr><th>KIDSCREEN-52</th><th>KIDSCREEN-27</th><th>KIDSCREEN-10</th></tr>
<tr><td>1. Physical wellbeing</td><td>1. Physical wellbeing</td><td rowspan="10">General index of health-related quality of life</td></tr>
<tr><td>2. Psychological wellbeing</td><td rowspan="3">2. Psychological wellbeing</td></tr>
<tr><td>3. Moods and emotions</td></tr>
<tr><td>4. Self-perception</td></tr>
<tr><td>5. Autonomy</td><td rowspan="3">3. Autonomy and parent relation</td></tr>
<tr><td>6. Parent relation and home life</td></tr>
<tr><td>7. Financial resources</td></tr>
<tr><td>8. Peers and social support</td><td>4. Peers and social support</td></tr>
<tr><td>9. School environment</td><td>5. School environment</td></tr>
<tr><td>10. Bullying</td><td></td></tr>
</table>

Not all of the KIDSCREEN-27 dimensions were however assessed in Study 3. While it was reasonable to assume on the basis of past research that participation in a classroom/PA-format PSHE intervention might be associated with changes in a child's physical and psychological wellbeing, their relationships with their friends and their experiences of and behaviours at school, changes were not expected in their financial situation and in their relationships with their parents, so participants were not asked to complete the 'autonomy and parent relation' section of the questionnaire, containing items such as, '*Have your parents had enough time for you?*' and '*Have you had enough money to do the same things as your friends?*'. Furthermore, in a validation study of the KIDSCREEN-27 (Robitail et al., 2007), 'autonomy and parent relation' items had the greatest percentage of missing values, perhaps indicating a greater reluctance to answer these questions. The following caveat is however noted: in their systematic review of the child wellbeing literature, Pollard and Lee (2003) identified five similar domains of wellbeing to those assessed by the KIDSCREEN-27 – cognitive, economic, physical, psychological and social – but cautioned that measuring multiple separate indicators of wellbeing may not measure wellbeing itself due to the potential for important domains to be missed. Excluding a domain suffers the same difficulty but was felt to be appropriate in this instance so as not to overburden the young participants with unnecessary testing.

The four dimensions of wellbeing investigated in Study 3 are described by Ravens-Sieberer et al. (2007) as follows:

- Physical wellbeing: Five items concerning the child's level of physical activity, energy and fitness (e.g. '*Have you felt full of energy?*')
- Psychological wellbeing: Seven items concerning positive emotions, satisfaction with life and feeling emotionally balanced (e.g. '*Have you been in a good mood?*')
- Peers and social support: Four items concerning participants' relationships with other children (e.g. '*Have you spent time with your friends?*')
- School environment: Four items concerning the child's perception of their cognitive abilities, learning and concentration, as well as their feelings about school (e.g. '*Have you been able to pay attention?*')

After three opening demographic questions (sex, age and '*Do you have a long-term disability, illness or medical condition?*'), participants recorded their responses to items on five-point Likert scales referring to frequency ('never' to 'always') or intensity ('not at all' to 'extremely') in relation to the last week. They also provided a single five-point rating of their general health ('poor' to 'excellent').

Feedback received from 9–11-year-olds for a similar questionnaire – an early version of the Middle Years Development Instrument (MDI; Schonert-Reichl et al., 2013) – included that some items (e.g. regarding body weight) might make children "feel bad", but that it was still better to have the opportunity to report on uncomfortable issues than not. Based upon this, the researcher adopted the same approach as taken for later versions of the MDI, which was to emphasise to the participants that their answers were confidential and would help to improve programmes for others of their age. Wille et al. (2010), however, comment on the positive approach of the KIDSCREEN to peer relationships, noting that it asks questions regarding the quality of interaction and perceived support from friends rather than issues such as stigmatisation as in the PedsQL (e.g. '*Other kids do not want to be my friend*').

Total scores for each of the four dimensions of the KIDSCREEN-27 investigated in Study 3 were converted into Rasch scores using the scoring algorithm provided by the

KIDSCREEN group. Rasch scores were then transformed into *t*-values with a mean of 50 and standard deviation of 10 (referring to the mean and standard deviation from a representative sample of the European population, as described in Villalonga-Olives et al., 2010), where a higher score indicates better wellbeing. As in previous studies which have analysed data from the KIDSCREEN-27 through parametric tests (e.g. multivariate analysis of covariance [MANCOVA]: Meade & Dowswell, 2015; ANOVA: Wille et al., 2010), the data were treated as having interval level properties.

### *5.5.4 Physical Activity (Accelerometry)*

As described in the procedure section above, children's physical activity was recorded via accelerometry during the PA component of one of the intervention sessions for Study 2. Accelerometers were also used to record the PA of a subgroup of participants for 9 days at pretest and again at posttest for Study 3a; other than the difference in recording duration, the measurement of PA in the pilot study was conducted in the same manner as for Study 2.

Accelerometers were a mixture of ActiGraph GT3X+ and ActiGraph wGT3X-BT units (ActiGraph, Pensacola, FL), with the two types being distributed across both the intervention and control groups in Study 3a. In order to capture whole body movements they were worn on the right hip, as near as possible to the centre of mass of the body (Godfrey, Conway, Meagher & ÓLaighin, 2008). The units were set to record at 30 Hz in each of the three axes; sampling frequencies other than this default have been found to affect the processing of acceleration data to activity counts (Brønd & Arvidsson, 2016).

Data were downloaded to ActiLife 6.11.9, where they were converted into activity counts at epoch lengths of both 1 second and 60 seconds, the latter being the epoch used in the original validation study for the Puyau Children cut-points which were employed in Studies 2 and 3a to calculate time spent in different intensity levels of activity (Puyau et al., 2002). The definitions for these cut-points in accelerometer counts per minute are: sedentary: 0–799 cpm; light: 800–3199 cpm; moderate: 3200–8199 cpm; vigorous: ≥8200 cpm. Two epoch lengths were used because 1 second epochs were preferred in relation to the aims of the research, allowing the intermittent activity of children to be captured; however, it has been reported that if a researcher

selects a different epoch length to that used in the original study in which the cut-points were validated, this can alter estimates of the time spent by participants in different intensity levels of activity (Banda et al., 2016).

Children's sex, date of birth, height, weight and handedness were entered into the ActiLife software to assist in the calculation of activity intensity levels from raw acceleration signals. Sex and date of birth were recorded via self-report, handedness was assessed by asking the child in which hand they would hold a pen, and anthropometric measurements were taken as outlined below. As described by Freedson, Pober and Janz (2005), age and sex can provide an indication of maturity, with the metabolic cost of movement decreasing as children mature (Malina, Bouchard & Bar-Or, 2004), while height and weight act as proxy measures for stride length and distance of the accelerometer unit from the child's centre of mass, both of which affect the acceleration signal. Handedness allowed the PA calculation to account for the position of the accelerometer on either the dominant or non-dominant side of the body, as all participants were asked to wear their accelerometer over the right hip.

#### *5.5.4.1 Anthropometric Measurements*

Prior to the commencement of the studies, the researcher received training in taking stature measurements from a Level 4 anthropometrist accredited by the International Society for the Advancement of Kinanthropometry. Children's height and weight were recorded whilst they wore their usual school clothes minus shoes; height was recorded in the Frankfort horizontal plane to the nearest 0.1 cm using a portable stadiometer (Seca 213; Seca, Hamburg, Germany) and weight to the nearest 0.5 kg using calibrated scales (Salter; Tonbridge, UK). Each measurement was taken twice and the mean value recorded as the child's height/weight. If the two height measurements differed by >0.4 cm then a third measurement was taken and the median value used (Guinhouya, Lemdani, Vilhelm, Durocher & Hubert, 2009), but for weight the mean value from the two measurements was always used in order to avoid excessive weight testing which may have caused participant distress.

## 5.6 Sample Size Calculation

Although participation in a PSHE intervention with a PA component would be

anticipated to be beneficial for children's wellbeing, the thrust of the thesis was to consider how participation would be beneficial for children's *learning*, as an area of interest to education stakeholders. As it was anticipated that there may be difficulties in recruiting schools using the same assessment system, resulting in fewer participants with academic achievement data, a decision was made to base the sample size calculation upon cognitive performance as a potential outcome, with attention, memory, etc., playing a role in children's classroom learning. This decision was further appropriate in that cognitive performance was measured in both Studies 2 and 3, which shared the same sample of participants, and in that of the constructs under investigation the greatest evidence exists for the effects of PA on cognitive performance, providing a reasonable indication of an anticipated effect size although methods have differed across studies and more school-based research is required. Furthermore, it appears from the literature that PA participation has an effect particularly on executive function, with evidence being more equivocal for other aspects of cognition at the present time.

A meta-analysis of the effects of PA on executive function for participants aged between 6 and 35 years found an overall effect size of $d = 0.52$ for acute PA (Verburgh et al., 2014); on the basis that this meta-analysis was recent, that the overall effect size for acute PA was based on a total of 19 effect sizes (as opposed to just 5 for chronic PA in the same article; $d = 0.14$, non-significant), and that within the studies of acute PA there was no significant difference between the effect sizes for preadolescents ($d = 0.57$, $n = 2$), adolescents ($d = 0.52$, $n = 3$) and young adults ($d = 0.54$, $n = 14$), the overall effect size of $d = 0.52$ was employed for the sample size calculation.

Sample size was calculated via an *a priori* power analysis using G*Power (version 3.1.9.2; Faul, Erdfelder, Lang & Buchner, 2007). Sample size cannot be calculated for a MANCOVA specifically in this programme; however, the power analysis was run for a repeated measures, between factors MANOVA with $\alpha = .05$ and a correlation among repeated measures of .596, the mean of the correlation coefficients for cognitive test scores between baseline and repeat testing in Study 1. This calculation indicated that a total sample size of 78 would be adequate to detect an effect of the anticipated magnitude (power = 80%).

# Chapter 6: Study 2 – The Effects of Acute Physical Activity Participation during Classroom- and Physical Activity-Based Intervention Sessions on Children's Cognitive Performance

## 6.1 Introduction

Research has demonstrated improvements following acute PA participation for academic achievement (e.g. Hillman et al., 2009) and for cognitive performance, including for executive function (e.g. Chen et al., 2014; Jäger et al., 2014), long-term memory (e.g. Etnier et al., 2014; Pesce et al., 2009) and attention (mainly in laboratory studies; Janssen, Toussaint et al., 2014), with research into the effects of acute PA on processing speed for preadolescents being required. Acute PA participation would also be expected to enhance children's mood by raising serotonin levels and providing an opportunity for distraction from worry (Stathopoulou et al. 2006). However, in order to be assessed immediately following physical activity, academic achievement requires measurement via academic test batteries, the results of which are less likely to be meaningful to education stakeholders than those from assessment tools already in place in schools, which tend to reflect a child's mounting competencies in a particular subject and cannot therefore be administered as a post-PA assessment. Furthermore, despite the potential for acute PA to boost participants' mood, improvements in children's wellbeing more broadly were expected to occur over time with, for example, the development of interpersonal skills in relation to social wellbeing (e.g. Bailey et al., 2013) and health benefits in relation to physical wellbeing (e.g. Strong et al., 2005).

Minimising the burden of involvement in the research for schools and their pupils when effects of acute PA could not be as readily anticipated for meaningful measurements of academic achievement and wellbeing as for cognitive performance, Study 2 aimed to assess children's cognitive performance following participation in the PA component of one of the PSHE intervention sessions in comparison with the cognitive performance of children who had taken part in a normal classroom lesson. A time × group interaction was anticipated, in which the PA group would experience significantly greater improvements from pretest than the classroom group. School,

age, sex, and self-reported presence/absence of disability were included as covariates, with the disability variable containing both physical and learning disabilities; variables noted in Chapter 2 to have a potential relationship with children's mental function include age, sex and SEN, along with variables such as SES and weight status which were either not recorded or were not to be published, in both cases in the interests of the study remaining acceptable to participants, parents and schools. The school variable was included as a covariate to account for clustering effects; that is, the potential for participants within a cluster (school) to be more similar than those between clusters.

It was anticipated that results from the study could be used by school staff and education policymakers to assist in decision-making and guidance regarding the time at which PA opportunities – including those within intervention sessions – might take place within the school day. If cognitive performance was found to be enhanced following the PA component of the intervention sessions, for instance, then it would make sense for school staff to arrange for intervention sessions to precede lessons on core curriculum subjects, with cognitive performance theoretically supporting academic achievement due to the involvement of functions such as attention in learning (Keeley & Fox, 2009).

The duration and intensity of PA in which children engaged before cognitive testing was recorded via accelerometry to explore the association between PA and cognitive performance more deeply than simply in terms of participation/non-participation. With previous research having often tested cognition following children's participation specifically in MVPA (e.g. Chen et al., 2014; Hillman et al., 2009), but the current research investigating a naturally-occurring session in which children might engage in different PA intensities for different durations of time, it was anticipated that there would be a positive relationship between post-PA cognitive performance and time spent in MVPA during the PA session, accounting for pretest cognitive performance. The correlational analyses from this study would provide an indication as to whether this is a suitable avenue for further research, for example using multiple regression to predict cognitive performance from different elements of PA participation (e.g. time in MVPA, degree of social engagement, etc.).

Two hypotheses were proposed for Study 2:

1. Participants' cognitive performance – recorded as scores for the CogS: 9–11 test battery – will improve to a significantly greater extent from pretest following participation in an acute bout of PA (PA group) than following a normal classroom lesson (classroom group); and
2. Accounting for prettest scores, there will be significant positive correlations between the time spent by children in MVPA during the PA component of the intervention session and their post-PA cognitive performance scores.

## 6.2 Method

Due to the overlap in methods of Studies 2 and 3, the experimental design, recruitment, procedure, measurements and sample size calculation for Study 2 are provided in Chapter 5.

### *6.2.1 Data Analysis*

IBM SPSS Statistics Version 24.0.0.1 (IBM Corp., Armonk, NY) was used to perform the statistical analyses, for which a significance level of .05 was employed.

A 2 × 2 mixed MANCOVA was planned to test for a time (pretest, post-PA/classroom) × group (PA, classroom) interaction for cognitive performance. There would be seven DVs (scores on each of the CogS: 9–11 tests) and four covariates (school, age, sex and disability).

A series of partial correlations was planned to test for associations between the number of seconds spent in MVPA by children during the PA session and their post-PA performance on each of the seven cognitive tests. These analyses would control for pretest performance on the relevant cognitive test, along with age as another continuous variable of potential importance.

## 6.3 Results

### *6.3.1 Participants*

#### *6.3.1.1 Participants in the Cognitive Performance Analyses*

A total of 115 children provided data for at least one of the cognitive performance

variables. However, 13 of the participants who were taking part in the intervention were excluded from the analyses as they had participated in a classroom rather than PA session immediately before the cognitive testing (e.g. due to injuries, forgetting their PE kits, etc.), and including these children in the classroom group would have introduced a confound due to their status as intervention participants. These exclusions resulted in a sample size of 102 for the cognitive performance analyses: 60 participants in the PA group and 42 in the classroom group.

Comparisons of participants' ages and sexes were carried out by PA/classroom group (Table 6.1). There was no significant difference between groups for percentage of males, but the mean age of participants in the classroom group was significantly greater than the mean age of those in the PA group.

*Table 6.1. Participant characteristics by PA/classroom group, Study 2*

| | ***n*** | **% males** | **Mean age in years at pretest *(SD)*** |
|---|---|---|---|
| **PA group** | 60 | 48.3 | 9.94 *(0.301)* |
| **Classroom group** | 42 | 47.6 | 10.16 *(0.331)* |
| | | $\chi^2(1) = 0.005, p = .943$ | $t(100) = 3.583, p = .001^*$ |

$^* p \leq .001$

*6.3.1.2 Participants with Physical Activity Data*

Physical activity data for 51 children were collected via accelerometry during their participation in the PA component of the intervention sessions: 26 males (12 from School 1, 14 from School 2) and 25 females (13 from School 1, 12 from School 2).

### *6.3.2 Preliminary Data Analysis*

*6.3.2.1 Cognitive Performance Data*

Pretest cognitive performance data for the PA and classroom groups are presented in Table 6.2. A series of independent samples *t*-tests and Mann-Whitney *U* tests were performed to assess whether pretest data differed by group; although seven tests were run, these were not Bonferroni corrected as such a correction was considered to be too

conservative for preliminary difference testing. Posttest means and standard deviations are provided for visual comparison with pretest data.

The only cognitive tests for which significant between-groups differences were found were the Dot-to-Dot and Which Colour? tasks, with the classroom group outperforming the PA group at pretest in both instances.

Although it was not the aim of the research to test for sex differences, it was noted that females performed significantly better than males at pretest on the Match-Up! task (females: $M = 26.81$, $SD = 5.626$; males: $M = 20.98$, $SD = 6.306$; $t(99) = -4.912$, $p < .001$), and on the Find 'M' task (females: $M = 3.37$, $SD = 0.696$; males: $M = 2.95$, $SD = 0.539$; $U = 848.5$, $p = .003$), while males performed better on the Colours and Shapes task (females: $M = 13.86$, $SD = 8.078$; males: $M = 17.89$, $SD = 8.547$; $U = 748.5$, $p = .011$).

*Table 6.2. Descriptive statistics for the dependent measures at pretest, Study 2*

| | PA Group | | | | | Classroom Group | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | ***n*** [a] | **Mean (SD)** [a] | **Range** | **Skew *z*-score** | **Kurtosis *z*-score** | ***n*** [a] | **Mean (SD)** [a] | **Range** | **Skew *z*-score** | **Kurtosis *z*-score** | **Independent samples *t*-test/ Mann-Whitney *U* test** |
| Dot-to-Dot: Processing speed (max. 96) | 58 | 50.55 (12.203) | 23 to 76 | –0.29 | –0.64 | 42 | 60.57 (13.791) | 30 to 96 | 0.95 | 0.43 | $t(98) = 3.836, p < .001^{*}$ |
| | *56* | *53.80 (14.107)* | | | | *42* | *64.76 (16.864)* | | | | |
| Match-Up!: Processing speed (max. 90) | 59 | 23.02 (5.646) | 11 to 33 | –1.01 | –0.95 | 42 | 25.48 (7.610) | 11 to 43 | 0.22 | –0.25 | $t(99) = 1.865, p = .065$ |
| | *58* | *22.43 (6.448)* | | | | *42* | *25.67 (7.056)* | | | | |
| Find 'M': Attention (max. 6.09) | 60 | 3.07 (0.544) | 1.45 to 4.00 | –0.78 | –0.48 | 42 | 3.31 (0.777) | 1.85 to 5.43 | 2.52† | 1.89 | $U = 1075.0, p = .208$ |
| | *60* | *2.86 (0.639)* | | | | *41* | *3.25 (0.927)* | | | | |
| Memorise!: Long-term memory (max. 20) | 60 | 11.00 (3.518) | 4 to 17 | –0.44 | –1.45 | 42 | 9.90 (3.145) | 1 to 18 | –0.11 | 1.92 | $t(100) = –1.615, p = .109$ |
| | *60* | *10.40 (3.147)* | | | | *41* | *10.51 (3.736)* | | | | |
| 3-Back: Updating (max. 37) | 57 | 23.09 (4.227) | 16 to 34 | 0.99 | –0.46 | 38 | 23.39 (4.618) | 15 to 36 | 0.88 | 0.19 | $t(93) = 0.334, p = .739$ |
| | *59* | *26.03 (5.468)* | | | | *37* | *26.16 (5.659)* | | | | |
| Colours and Shapes: Shifting (max. 42) | 53 | 16.77 (9.362) | 1.0 to 39.0 | 1.71 | –0.71 | 40 | 14.64 (7.169) | 3.0 to 39.5 | 2.46† | 2.89† | $U = 946.5, p = .378$ |
| | *54* | *17.10 (8.226)* | | | | *38* | *15.68 (7.739)* | | | | |
| Which Colour?: Inhibition (max. 40) | 57 | 21.51 (6.727) | 9 to 39 | 0.64 | 0.24 | 41 | 24.88 (6.539) | 8 to 39 | –0.37 | 0.63 | $t(96) = 2.474, p = .015^{**}$ |
| | *57* | *22.53 (8.054)* | | | | *40* | *27.08 (6.261)* | | | | |

† *Value outside range –1.96 to +1.96, indicating non-normality at* $p \leq .05$

$^{*}p \leq .01$; $^{**}p \leq .05$

[a] *Post-PA/post-classroom values provided in italics*

#### *6.3.2.2 Physical Activity Data*

Physical activity data were collected from the PA component of four intervention sessions, three of which took place in the school hall ($n$ = 32) and one of which took place outdoors ($n$ = 19). Three of the PA sessions were 35 minutes long; however, one of the indoor sessions was only 15 minutes long due to the impact at the beginning of the session of needing to clear up the school hall following lunch and at the end of the session of the children attending a school assembly.

Paired samples $t$-tests demonstrated that the time spent by participants in sedentary behaviour and in light PA were significantly higher and lower, respectively, when calculated from 1-second compared to 60-second epoch data; however, there was no significant difference for MVPA. As MVPA was the main focus of the investigation, and as calculations based on 1-second epochs would be more sensitive to shorter bouts of activity, especially when analysing PA sessions as short as 15–35 minutes, further analyses were based upon 1-second epoch data.

The mean number of minutes spent in each of the three activity intensities per PA session is shown in Figure 6.1; across the four sessions, participants spent a mean of 64.66% of their time in sedentary behaviour, 15.90% of their time in light PA and 19.44% of their time in MVPA. Bonferroni-corrected independent samples $t$-tests found no significant differences between males and females in percentage of time spent in sedentary behaviour, light PA or MVPA. There were however differences in percentage of time spent in sedentary behaviour and MVPA between indoor and outdoor sessions, with a greater percentage of time spent in sedentary behaviour in the indoor sessions (indoor: $M$ = 70.14%, $SD$ = 12.44%; outdoor: $M$ = 55.42%, $SD$ = 5.50%; $t(46.162) = -5.807$, $p < .001$) and a greater percentage of time spent in MVPA in the outdoor session (indoor: $M$ = 15.21%, $SD$ = 7.61%; outdoor: $M$ = 26.57%, $SD$ = 3.95%; $t(48.374) = 7.007$, $p < .001$).

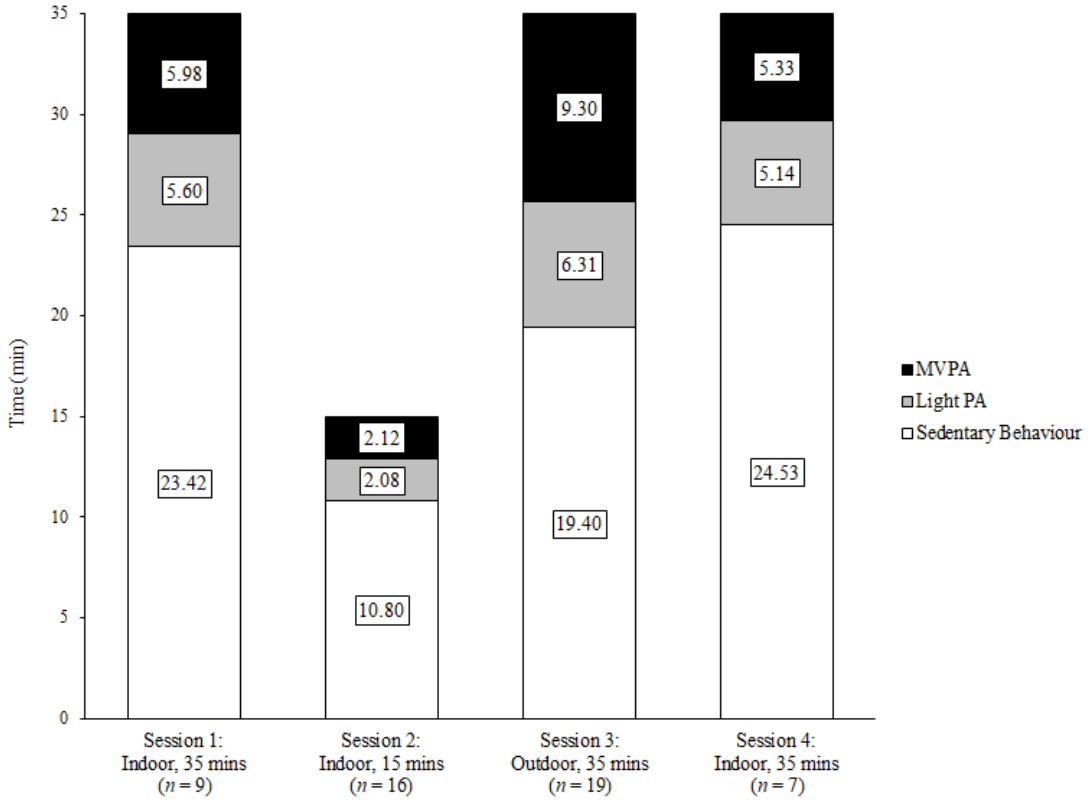



*Figure 6.1. Mean number of minutes spent by participants in sedentary behaviour, light intensity physical activity (light PA) and moderate-to-vigorous intensity physical activity (MVPA) in the physical activity component of the intervention sessions*

### *6.3.3 Post-PA vs. Post-Classroom Cognitive Performance*

A 2 × 2 mixed MANCOVA was used to test for a time × group interaction for cognitive performance. There were seven DVs (scores on the CogS: 9–11 tests) and four covariates (school, age, sex and disability). A total of 37 participants from the PA group and 30 participants from the classroom group were included in the analysis. Using Pillai's trace, SPSS reported an observed power for the time × group interaction of .782. The only significant covariate was sex, $V = .416$, $F(7, 55) = 5.596$, $p < .001$, $\eta_p^2 = .416$, and there was a significant time × school interaction, $V = .416$, $F(7, 55) = 5.587$, $p < .001$, $\eta_p^2 = .416$.

Box's test indicated homogeneity of covariance matrices, $M = 145.983$, $F(105, 12018.465) = 1.065$, $p = .308$, and the MANCOVA found a significant time × group interaction, $V = .222$, $F(7, 55) = 2.239$, $p = .045$, $\eta_p^2 = .222$. Univariate tests revealed a significant interaction only for the Which Colour? test, $F(1, 61) = 10.902$, $p = .002$, $\eta_p^2 = .152$, with the adjusted mean for the classroom group being 24.26 ($SE = 1.349$)

at pretest and 29.54 (*SE* = 1.755) after the classroom lesson (a significant difference from pretest to post-classroom, $p < .032$), whereas the adjusted mean for the PA group was 24.06 (*SE* = 1.159) at pretest and 21.86 (*SE* = 1.508) after the PA session (no significant difference from pretest to post-PA).

### *6.3.4 Partial Correlations between Cognitive Performance and MVPA*

Only one significant correlation existed between the time in seconds spent by participants in MVPA during the PA component of the intervention session and their performance in the post-PA cognitive testing session, with a positive association, $r = .463$, being found for number of words recalled in the Memorise! task (Table 6.3). This correlation remained significant at $p < .007$ (Bonferroni corrected for multiple tests) when controlling for participants' age and pretest task performance, $r = .394$.

*Table 6.3. Partial correlations between time spent in MVPA during the PA component of the intervention session and post-PA cognitive test scores, Study 2*

| | ***n*** | **Correlation with time in MVPA (secs)** | **Partial correlation with time in MVPA (secs)[a]** |
|---|---|---|---|
| Dot-to-Dot | 48 | $r = –.148$, $p = .315$ | $r = –.054$, $p = .724$ |
| Match-Up! | 47 | $r = –.228$, $p = .123$ | $r = –.183$, $p = .230$ |
| Find 'M' | 50 | $r = .171$, $p = .236$ | $r = .249$, $p = .089$ |
| Memorise! | 50 | $r = .463$, $p = .001^*$ | $r = .394$, $p = .006^*$ |
| 3-Back | 48 | $r = –.036$, $p = .809$ | $r = .014$, $p = .928$ |
| Colours and Shapes | 41 | $r = .104$, $p = .520$ | $r = –.023$, $p = .892$ |
| Which Colour? | 46 | $r = .097$, $p = .521$ | $r = .145$, $p = .346$ |

[a] *Controlling for participants' pretest cognitive performance (score on the same cognitive test at pretest) and age*

[*] *Sig. following Bonferroni correction, $p < .007$*

## 6.4 Discussion

Study 2 tested the hypothesis that children's cognitive performance would improve from pretest to a significantly greater extent immediately following participation in the physical activity component of one of the intervention sessions compared to immediately following a normal classroom lesson. Although a mixed MANCOVA identified a significant time × group interaction, this was due to the performance of

the classroom group on the Which Colour? test of inhibition significantly improving from pretest, while the performance of the PA group did not change. A practice effect for the Which Colour? task had been identified in Study 1 so the results for the control group were not unexpected but it is difficult to see why there would be a lack of improvement for the PA group; research generally suggests that acute PA has benefits for executive function (Chen et al., 2014) and in particular for inhibition (Jäger et al., 2014). The analysis was however slightly underpowered as an *a priori* power analysis (Chapter 5) indicated that a total sample of 78 participants (39 per group) would be required to detect an effect of $d = 0.52$ (from Verburgh et al., 2014), but only 30 participants from the classroom group were included in the MANCOVA, along with 37 participants from the PA group. Larger groups would assist in establishing the replicability of the results.

A second hypothesis stated that there would be significant positive correlations between time spent by children in MVPA during the PA component of the intervention session and their post-PA cognitive performance scores, controlling for prettest scores. Such a correlation was identified only for the Memorise! test, indicating a positive relationship between children's MVPA and long-term memory performance. Although causation cannot be claimed, one way in which the relationship can be explained is with reference to the proposal of Pesce et al. (2009) that physiological arousal – which was likely to be greater for those spending more time in MVPA – reduces the need for rehearsal of information by increasing the amount of available resources, thereby facilitating consolidation of the information. In Pesce et al.'s study, the cognitive and social aspects of participation in team games also appeared to support LTM processes, but it is not possible to comment upon this prospect from the current findings because while the activities in the PA sessions were designed to be cognitively and socially engaging, it was beyond the scope of the study to measure these factors as variables for inclusion in the analyses and, as discussed in the limitations section, not all of the children may have experienced the cognitive and social elements of the PA sessions to the same degree.

The identification of a significant relationship between MVPA and LTM is particularly noteworthy given that studies into PA and LTM are limited. Such a finding sets the scene for further research, potentially that in which the link is explored through

multiple regression to consider the contributions of different elements of PA participation such as PA intensity and cognitive and social engagement to the prediction of LTM performance. The lack of associations for MVPA with other aspects of cognitive performance – and of effects for the PA group compared to the classroom group in the MANCOVA – is surprising but when comparing the study with past research it may be that the acute PA sessions did not contain an adequate duration of MVPA for associations/effects to be seen. For example, in the studies of Chen et al. (2014) and Hillman et al. (2009) into executive function, children took part in 30 minutes of moderate intensity PA (60–70% of predicted HRmax) in a school setting and in 20 minutes of moderate intensity PA (60% of estimated HRmax) in a laboratory setting, respectively. Across the four PA sessions in the present research, participants spent a mean of only 5.68 minutes per session (19.44%) in MVPA. In contrast to those in the studies of Chen et al. and Hillman et al., however, these PA sessions were not introduced for the purposes of the research and are therefore more reflective of the sorts of PA opportunities that are provided in schools and that are potentially favoured by policymakers; schools may be unlikely to adopt PA delivery consisting principally of 20–30 minutes of continuous moderate intensity aerobic activity because there are other elements to the inclusion of PA within the school day. The national curriculum for PE includes the objective, for instance, for all pupils to not only be physically active for sustained periods of time but to "develop flexibility, strength, technique, control and balance" (Department for Education, 2015, p. 199), the development of such skills – as well as enjoyment of PA – supporting pupils' long-term PA participation (Hobbs, Daly-Smith, McKenna, Quarmby & Morley, 2018). With a recent study in Essex having found that on average just 9.5% of 8–9-year-olds' time in PE lessons was spent in MVPA (Wood & Hall, 2015), it appears that the intervention sessions might help children to achieve greater durations of MVPA than standard PE lessons; however, it also seems possible despite the other aims of school-based PA participation that greater durations of MVPA can be achieved as large proportions of the sessions were spent in sedentary behaviour.

Only one of the four PA sessions took place outdoors but during this session children spent a significantly greater percentage of time in MVPA than children taking part in indoor sessions, who spent a significantly greater percentage of time in sedentary behaviour. The researcher was present throughout the PA sessions and made notes

regarding the nature of the activities in which children engaged; the amount of sedentary time in the indoor sessions was commensurate with the researcher's observations as indoor sessions tended to include activities in which children waited in turn (e.g. to throw balls through hoops), could be eliminated from games, or cycled through activity stations in teams, one station being an opportunity for seated rest. In the outdoor session, however, they were kept moving for much of the time. It would be inappropriate to generalise on the basis of a single outdoor session that greater time is spent in MVPA in outdoor sessions but it seems likely that the more limited space in indoor sessions is restrictive for PA; this is discussed in Chapter 9 in the context of qualitative findings from Study 4. Time restrictions for the PA sessions were also noted, including the impact on one of the indoor sessions of having to wait for the school hall to be cleaned following lunch and then additionally finishing early for a school assembly; however, the remaining intervention sessions still comprised only 35 minutes each of PA participation due to factors such as accommodating the requests of school staff and allowing time for children to change into their PE kits and to move from their classrooms to the school hall/outside.

### *6.4.1 Limitations*

As noted above, the main limitation of the study was that although 102 participants took part, only 67 of these were included in the MANCOVA due to missing data for some of the variables. Recruitment was unfortunately limited by the number of schools running the intervention and lack of responses from the schools invited to participate, although every effort was made to increase the sample size.

In addition to measuring the duration and intensity of children's PA via accelerometry, it may have been useful to conduct a more formal observation of the PA sessions in order to supplement duration and intensity data with information regarding the cognitive and social aspects of the activities taking place. The researcher made notes on the activities in which children were asked to participate but a team of researchers may have been able to systematically observe each of the participants in order that their degree of cognitive and social engagement could also be assessed; it is possible that a child could engage in high levels of MVPA yet not interact with others or fail to follow instructions such as to move in the opposite direction to that indicated by the commands of the facilitator (a cognitively engaging activity). Social and cognitive

engagement might mediate the effect of acute PA on cognitive performance and future research may therefore wish to account for these variables.

## 6.5 Conclusion and Potential Impact

Children's cognitive performance did not improve to a greater extent from pretest following participation in acute PA during one of the intervention sessions compared to following a normal classroom lesson. There was however a significant correlation between the amount of time spent by participants in MVPA during the PA component of an intervention session and their performance on the Memorise! test, indicating a positive relationship between MVPA duration and LTM. Further research into this relationship is recommended as there are few studies of PA and LTM with preadolescent participants.

Findings regarding the amount of time children spent in sedentary behaviour, light PA and MVPA were fed back to the football club foundation responsible for the intervention in order that they can determine whether to make adjustments to the PA component of the sessions to increase the amount of time for which children achieve moderate or vigorous intensities of PA and/or to decrease pupils' time in sedentary behaviour, particularly for indoor sessions.

The lack of effect of acute PA on cognitive performance means that there appears to be no advantage of school staff arranging for intervention sessions to precede core curriculum subjects in the timetable in order to assist children's learning. While there is also no *detrimental* effect of PA participation on cognitive performance, it is not known whether there are positive or negative effects of PA on other factors of potential importance to learning, such as energy and motivation; further research is therefore required before recommendations can be made as to the optimal scheduling of intervention sessions and of other PA opportunities within the school day.

# Chapter 7: Study 3 – Children's Wellbeing, Cognitive Performance and Academic Achievement Following Participation in a Combined Classroom Learning and Physical Activity Intervention

## 7.1 Introduction

By their very nature, Personal, Social, Health and Economic education programmes are expected to increase the wellbeing of participants. Children would be anticipated to complete a programme with an improved understanding of the particular PSHE topic they have been studying – all of which relate to one or more aspects of wellbeing – and they may additionally acquire or develop skills and behaviours which further contribute to their wellbeing (e.g. psychosocial and physical wellbeing may be boosted by the ability to resist peer pressure and the greater consumption of healthy foods, respectively). Demonstrating, for example, the effects for knowledge of a programme taking a whole-school approach, as opposed to a class-specific curriculum-based programme, intervention children had greater knowledge and understanding of the health benefits of diet and PA than control children following participation in the APPLES intervention designed to reduce risk factors for obesity (Sahota et al., 2001).

What has received lesser research attention, yet is potentially highly persuasive to school staff and education policymakers responsible for decisions regarding curriculum content and time allocations for subjects within the school day, is the potential for improvements also to be seen in pupils' cognitive performance and academic achievement following participation in a PSHE programme; the study of Snyder et al. (2009) of the Positive Action programme, following which improvements were seen in reading and mathematics performance, is one notable exception. The literature presented in Chapter 2, however, illustrates associations between children's wellbeing and academic achievement (see Public Health England, 2014b) and between their cognitive performance and academic achievement (e.g. Evans et al., 2002; Floyd et al., 2003; St Clair-Thompson & Gathercole, 2006); as a result, if an intervention is successful in improving outcomes in one of these areas, then improvements in other areas may also be seen. Furthermore, physical activity has been related to wellbeing (e.g. Ahn & Fedewa, 2011; Janssen & LeBlanc, 2010),

cognitive performance (e.g. Hillman et al., 2014; Sibley & Etnier, 2003; Verburgh et al., 2014) and academic achievement (e.g. Hillman et al., 2009; Singh et al., 2018; Watson et al., 2017), so interventions involving PA participation and/or promoting children's PA participation beyond the intervention sessions would be anticipated to have similar benefits. On this basis, Study 3 aimed to investigate whether there were greater improvements in children's wellbeing, cognitive performance and academic achievement following participation in a 6-week classroom/PA-format PSHE intervention delivered by staff from a local football club foundation (intervention group) compared to 6 weeks of normal schooling (control group).

It is however also noted in Chapter 2 that there are many variables other than intervention participation that might influence children's wellbeing and mental function, including age, sex, physical disabilities, SEN, SES, ethnicity and weight status (e.g. Breslin et al., 2012; Cadman et al., 1987; Department for Education and Skills, 2007; McLellan & Steward, 2015). In the interests of recruitment, participants' SES and ethnicity were not recorded and any weight measurements were to be used only in the calculation of PA intensities. The remaining variables were however included as covariates in the Study 3 analyses, with the covariate 'disability' being a nominal variable taken from the KIDSCREEN-27 survey for which 'yes' responses encompassed both physical and learning disabilities. Nonetheless, as explained in Chapter 5 it is difficult to identify causal chains when research is carried out in open systems in which there is a lack of control over variables (Black, 1999), and the results of the study are therefore described in terms of *associations* between intervention participation, wellbeing and mental function, rather than as intervention participation *causing* changes in wellbeing and mental function.

Three hypotheses were proposed:

1. There will be a significantly greater increase from pretest to posttest in the wellbeing scores (physical wellbeing, psychological wellbeing, wellbeing pertaining to peers and social support, and wellbeing pertaining to the school environment, measured via the KIDSCREEN-27 questionnaire) of intervention participants compared to control participants.
2. There will be a significantly greater increase from pretest to posttest in the cognitive performance (scores for the seven CogS: 9–11 tests) of intervention

participants compared to control participants.

3. There will be a significantly greater increase from pretest to posttest in the academic achievement (reading, writing and mathematics scores, as reported by class teachers) of intervention participants compared to control participants.

## 7.2 Method

Due to the overlap in methods of Studies 2 and 3, the experimental design, recruitment, procedure, measurements and sample size calculation for Study 3 are presented in Chapter 5.

### *7.2.1 Data Analysis*

As in the previous studies, statistical analyses were performed using IBM SPSS Statistics Version 24.0.0.1 (IBM Corp., Armonk, NY) and a significance level of .05 was employed.

To test for time (pretest, posttest) × group (intervention, control) interactions, a total of three 2 × 2 mixed MANCOVAs were planned: one for wellbeing (four DVs), one for cognitive performance (seven DVs) and one for academic achievement (three DVs). Separate analyses were planned because although there were theoretical associations between the DVs it was anticipated that some participants would not possess usable academic achievement data due to different assessment systems operating in different schools, and Study 1 had demonstrated that pupils might choose not to complete some of the cognitive tests; to include all of the variables in a single MANCOVA would therefore have reduced the power of the test due to missing data.

Four covariates were planned for inclusion in each of the MANCOVAs: along with participants' age, sex and disability, school was to be included as a covariate to account for clustering effects as in Study 2. Pupils' school has, for instance, been found to make a significant contribution to the prediction of outcomes such as the social skills and relationships of Key Stage 2 children following their participation in the earlier-referenced SEAL intervention concerning the social and emotional aspects of learning, with the ethos of the schools potentially explaining differences in outcomes (Hallam, 2009).

## 7.3 Results

### *7.3.1 Participants*

The number of participants supplying data for each of the DVs differed as described in the next section, but a total of 128 participants (79 in the intervention group and 49 in the control group) provided data for at least one DV. A comparison of participants' ages and sexes was carried out by intervention/control group membership (Table 7.1), although age data for two of the intervention participants were not available. No significant difference was found for percentage of males. However, as in Study 2, the control group was significantly older than the intervention group.

*Table 7.1. Participant characteristics by intervention/control group, Study 3*

| | **Sex** | | **Age** | |
|---|---|---|---|---|
| | ***n*** | **% males** | ***n*** | **Mean age in years at pretest *(SD)*** |
| **Intervention group** | 79 | 51.9 | 77 | 9.93 *(0.301)* |
| **Control group** | 49 | 46.9 | 49 | 10.17 *(0.341)* |
| | $\chi^2(1) = 0.298, p = .585$ | | $t(124) = 4.244, p < .001^*$ | |

$^* p \leq .001$

### *7.3.2 Preliminary Data Analysis*

Pretest cognitive performance, academic achievement and wellbeing data for the two groups are presented in Table 7.2. As in Study 2, independent samples *t*-tests and Mann-Whitney *U* tests were run to test for differences between the groups for each of the DVs at pretest. For each of the DVs, the figures in Table 7.2 reflect data from *all* of the participants with data for that DV in order to demonstrate the equivalence/non-equivalence of the groups regardless of the number of participants who completed the study; however, the results of between-groups tests did not differ when restricted to participants only with both pretest and posttest data. Posttest means and standard deviations are provided for visual comparison with pretest data.

No significant differences were identified at pretest between the intervention and control groups for any of the four dimensions of wellbeing. However, the control

group outperformed the intervention group on the Dot-to-Dot and Which Colour? tasks ($p \leq .01$), as in Study 2, and additionally – with the slight difference in participants from Study 2 – on the Match-Up! and Find 'M' tasks ($p \leq .05$). They also had significantly higher achievement scores than the intervention group for reading, writing and mathematics ($p \leq .01$).

It was not the aim of the research to test for sex differences but it was noted that females performed significantly better than males at pretest on the Match-Up! task (females: $M = 26.56$, $SD = 5.624$; males: $M = 20.94$, $SD = 6.145$; $t(122) = -5.321$, $p < .001$), on the Find 'M' task (females: $M = 3.39$, $SD = 0.746$; males: $M = 2.95$, $SD = 0.557$; $U = 1292.0$, $p = .001$), and on the Memorise! task (females: $M = 11.19$, $SD = 2.833$; males: $M = 9.89$, $SD = 3.876$; $t(111.717) = -2.143$, $p = .034$). The mean reading achievement scores were also significantly higher for females than for males (females: $M = 525.85$, $SD = 24.192$; males: $M = 505.04$, $SD = 52.648$; $U = 818.0$, $p = .007$), as were the mean writing achievement scores (females: $M = 522.26$, $SD = 27.733$; males: $M = 502.65$, $SD = 46.065$; $U = 771.0$, $p = .002$. Males outperformed females on the 3-Back task (females: $M = 22.27$, $SD = 4.845$; males: $M = 23.86$, $SD = 4.172$; $U = 1297.5$, $p = .033$), and on the Colours and Shapes task (females: $M = 13.93$, $SD = 8.092$; males: $M = 17.74$, $SD = 8.438$; $U = 1039.5$, $p = .007$).

*Table 7.2. Descriptive statistics for the dependent measures at pretest, Study 3*

| | Intervention Group | | | | | Control Group | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | ***n*** [a] | **Mean (SD)** [a] | **Range** | **Skew *z*-score** | **Kurtosis *z*-score** | ***n*** [a] | **Mean (SD)** [a] | **Range** | **Skew *z*-score** | **Kurtosis *z*-score** | **Independent samples *t*-test/Mann-Whitney *U* test** |
| ***Cognitive performance (CogS: 9–11 scores; max. possible score given in brackets)*** | | | | | | | | | | | |
| Dot-to-Dot: Processing speed (96) | 73 | 50.27 (11.923) | 23 to 76 | –0.54 | –0.57 | 49 | 60.12 (14.505) | 30 to 96 | 1.45 | 0.36 | $t(120) = 4.097$, $p < .001^{*}$ |
| | *71* | *57.04 (14.503)* | | | | *47* | *64.96 (15.995)* | | | | |
| Match-Up!: Processing speed (90) | 75 | 22.69 (5.754) | 11 to 34 | –0.57 | –1.26 | 49 | 25.37 (7.294) | 11 to 43 | 0.22 | –0.13 | $t(122) = 2.273$, $p = .025^{**}$ |
| | *69* | *24.62 (7.042)* | | | | *48* | *25.79 (8.437)* | | | | |
| Find 'M': Attention (6.09) | 76 | 3.04 (0.586) | 1.45 to 4.91 | 0.78 | 0.79 | 49 | 3.36 (0.797) | 1.85 to 5.43 | 2.29† | 1.01 | $U = 1449.5$, $p = .037^{**}$ |
| | *70* | *2.76 (0.763)* | | | | *45* | *3.22 (0.911)* | | | | |
| Memorise!: Long-term memory (20) | 75 | 10.73 (3.596) | 1 to 17 | –0.84 | –0.76 | 49 | 10.24 (3.212) | 1 to 18 | –0.21 | 1.27 | $t(122) = -0.771$, $p = .442$ |
| | *71* | *11.14 (3.331)* | | | | *48* | *9.90 (3.453)* | | | | |
| 3-Back: Updating (37) | 71 | 22.75 (4.693) | 4 to 34 | –2.19† | 4.61† | 45 | 23.53 (4.398) | 15 to 36 | 0.76 | 0.29 | $U = 1454.5$, $p = .417$ |
| | *70* | *25.59 (5.358)* | | | | *41* | *27.44 (6.144)* | | | | |
| Colours and Shapes: Shifting (42) | 62 | 16.60 (9.053) | 1.0 to 39.0 | 2.06† | –0.52 | 47 | 14.85 (7.561) | 3.0 to 39.5 | 2.52† | 1.84 | $U = 1326.0$, $p = .423$ |
| | *55* | *16.73 (8.933)* | | | | *41* | *15.80 (6.720)* | | | | |
| Which Colour?: Inhibition (40) | 71 | 20.93 (6.990) | 6 to 39 | 0.43 | –0.21 | 47 | 24.49 (6.626) | 8 to 39 | –0.18 | 0.30 | $t(116) = 2.764$, $p = .007^{*}$ |
| | *64* | *24.48 (8.018)* | | | | *47* | *27.81 (7.739)* | | | | |

† *Value outside range –1.96 to +1.96, indicating non-normality at* $p \leq .05$

$^{*}$ $p \leq .01$; $^{**}$ $p \leq .05$

[a] *Posttest values included in italics*

*Table 7.2 (continued). Descriptive statistics for the dependent measures at pretest, Study 3*

| | Intervention Group | | | | | Control Group | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | ***n*** [a] | **Mean (SD)** [a] | **Range** | **Skew *z*-score** | **Kurtosis *z*-score** | ***n*** [a] | **Mean (SD)** [a] | **Range** | **Skew *z*-score** | **Kurtosis *z*-score** | **Mann-Whitney *U* test** |
| ***Wellbeing (KIDSCREEN-27 t-values; mean = 50, SD = 10)*** | | | | | | | | | | | |
| Physical wellbeing | 72 | 52.77 (10.219) | 28.13 to 73.20 | 0.53 | –0.10 | 47 | 52.06 (11.446) | 25.07 to 73.20 | 0.05 | –0.50 | $U = 1630.5$, $p = .737$ |
| | *66* | *55.01 (12.146)* | | | | *45* | *56.44 (10.970)* | | | | |
| Psychological wellbeing | 72 | 52.70 (12.781) | 13.23 to 73.53 | –1.28 | 0.96 | 47 | 54.31 (11.944) | 33.15 to 73.53 | 0.80 | –1.35 | $U = 1635.5$, $p = .758$ |
| | *65* | *52.04 (12.702)* | | | | *45* | *53.27 (12.320)* | | | | |
| Peers/social support | 66 | 55.89 (11.244) | 23.62 to 66.34 | –2.72† | –0.44 | 47 | 56.93 (13.084) | 11.24 to 66.34 | –4.39† | 3.13† | $U = 1396.0$, $p = .341$ |
| | *65* | *57.35 (10.430)* | | | | *45* | *57.01 (11.536)* | | | | |
| School environment | 65 | 54.32 (12.474) | 16.28 to 71.00 | –1.47 | 0.08 | 46 | 57.91 (12.448) | 27.81 to 71.00 | –2.17† | –0.48 | $U = 1219.0$, $p = .094$ |
| | *66* | *54.62 (13.190)* | | | | *45* | *58.91 (13.169)* | | | | |
| ***Academic achievement (teacher report; pupils expected to score 500 and 600 points per subject at the beginning and end of Year 5, respectively)*** | | | | | | | | | | | |
| Reading | 78 | 507.99 (44.776) | 301 to 547 | –10.16† | 15.51† | 20 | 542.45 (12.194) | 516 to 559 | –1.81 | 0.15 | $U = 199.0$, $p < .001$* |
| | *79* | *543.95 (46.687)* | | | | *20* | *564.70 (6.650)* | | | | |
| Writing | 78 | 506.17 (41.873) | 337 to 547 | –7.92† | 9.50† | 20 | 535.00 (11.792) | 522 to 569 | 3.34† | 3.10† | $U = 391.5$, $p = .001$* |
| | *72* | *538.78 (42.320)* | | | | *20* | *564.80 (9.232)* | | | | |
| Mathematics | 78 | 506.36 (41.114) | 328 to 543 | –8.69† | 11.81† | 20 | 531.00 (7.398) | 515 to 542 | –0.98 | –0.40 | $U = 422.5$, $p = .002$* |
| | *72* | *534.18 (39.547)* | | | | *20* | *551.45 (12.348)* | | | | |

† *Value outside range –1.96 to +1.96, indicating non-normality at* $p \leq .05$
* $p \leq .01$; ** $p \leq .05$
[a] *Posttest values included in italics*

Although the data in Table 7.2 demonstrate some instances of non-normality, Tabachnick and Fidell (2014) advise that when running MANCOVAs with small, unequal samples, the normality of DVs is judged by the researcher based on expectations of a normal distribution in the population. As wellbeing, cognitive performance and academic achievement could all be expected to be normally distributed in the population, this assumption of the test was judged to be met. Where Box's test indicated that the assumption of homogeneity of covariance matrices had not been met for a particular MANCOVA, however, a nonparametric MANCOVA (Finch, 2005) was run to corroborate the results of the parametric test.

### *7.3.3 Intervention Participation and Wellbeing*

A 2 (time) × 2 (group) mixed MANCOVA was conducted, with four DVs (scores for physical wellbeing, psychological wellbeing, peers/social support and school environment) and four covariates (school, sex, age and disability). This MANCOVA included 53 intervention participants and 42 control participants, and SPSS reported an observed power of .214 for the time × group interaction using Pillai's trace. The only significant covariate was school, $V = .129$, $F(4, 86) = 3.175$, $p = .018$, $\eta_p^2 = .129$, and there was a main effect of group, $V = .145$, $F(4, 86) = 3.648$, $p = .009$, $\eta_p^2 = .145$, with the control group having significantly higher scores than the intervention group for all four dimensions of wellbeing (Table 7.3).

*Table 7.3. Follow-up analyses for the main effect of group in the intervention participation and wellbeing MANCOVA, Study 3*

| | **Intervention group (*n* = 53)** | | **Control group (*n* = 42)** | | |
|---|---|---|---|---|---|
| | ***Adjusted mean*[a]** | ***SE*** | ***Adjusted mean*[a]** | ***SE*** | |
| Physical wellbeing | 50.04 | 1.782 | 57.93 | 2.105 | $F(1, 89) = 5.738$, $p = .019^{**}$ $\eta_p^2 = .061$ |
| Psychological wellbeing | 48.60 | 1.848 | 58.22 | 2.183 | $F(1, 89) = 7.939$, $p = .006^{*}$ $\eta_p^2 = .082$ |
| Peers/social support | 53.78 | 1.841 | 60.71 | 2.174 | $F(1, 89) = 4.150$, $p = .045^{**}$ $\eta_p^2 = .045$ |
| School environment | 50.70 | 1.934 | 64.07 | 2.284 | $F(1, 89) = 14.018$, $p < .001^{*}$ $\eta_p^2 = .136$ |

$^{*}p \leq .01$; $^{**}p \leq .05$

[a] *KIDSCREEN-27 t-values (mean = 50, SD = 10)*

Box's test indicated homogeneity of covariance matrices, $M$ = 47.416, $F$(36, 26051.747) = 1.194, $p$ = .197, and the MANCOVA found no significant time × group interaction, $V$ = .031, $F$(4, 86) = 0.685, $p$ = .604, $\eta_p^2$ = .031.

### *7.3.4 Intervention Participation and Cognitive Performance*

A 2 × 2 mixed MANCOVA was also used to test for a time × group interaction for cognitive performance. The analysis included seven DVs (scores for each of the seven cognitive tests) and the same four covariates as for the wellbeing analysis (school, sex, age and disability). Due to missing data for some of the variables, the analysis was conducted with 36 intervention participants and 33 control participants. An observed power of .830 for the time × group interaction was reported by SPSS using Pillai's trace. Significant covariates were sex, $V$ = .324, $F$(7, 57) = 3.909, $p$ = .002, $\eta_p^2$ = .324, and age, $V$ = .219, $F$(7, 57) = 2.283, $p$ = .040, $\eta_p^2$ = .219, and there was a significant time × school interaction, $V$ = .264, $F$(7, 57) = 2.918, $p$ = .011, $\eta_p^2$ = .264.

Box's test again indicated homogeneity of covariance matrices, $M$ = 137.237, $F$(105, 13762.158) = 1.015, $p$ = .440. A significant time × group interaction was identified, $V$ = .233, $F$(7, 57) = 2.468, $p$ = .028, $\eta_p^2$ = .233; univariate tests revealed significance only for the Memorise! test, $F$(1, 63) = 10.453, $p$ = .002, $\eta_p^2$ = .142, with the adjusted mean for the control group being 11.56 ($SE$ = 0.685) at pretest and 9.98 ($SE$ = 0.670) at posttest, while the adjusted mean for the intervention group was 9.96 ($SE$ = 0.644) at pretest and 12.02 ($SE$ = 0.629) at posttest. The change from pretest to posttest was not significant for either group.

### *7.3.5 Intervention Participation and Academic Achievement*

Finally, a third 2 (time) × 2 (group) mixed MANCOVA was used for the analysis of academic achievement data (three DVs: reading, writing and mathematics; four covariates: school, sex, age and disability). A total of 70 intervention and 20 control participants were entered into the MANCOVA. Using Pillai's trace, SPSS reported an observed power of 1 for the time × group interaction. Significant covariates were school, $V$ = .114, $F$(3, 82) = 3.521, $p$ = .019, $\eta_p^2$ = .114, and sex, $V$ = .110, $F$(3, 82) = 3.381, $p$ = .022, $\eta_p^2$ = .110, and there was a time × school interaction, $V$ = .429, $F$(3, 82) = 20.550, $p$ < .001, $\eta_p^2$ = .429. There was a significant main effect of time, $V$ = .145, $F$(3, 82) = 4.626, $p$ = .005, $\eta_p^2$ = .145, with scores for reading, writing and

mathematics all significantly improving from pretest to posttest, $p < .001$.

A significant time × group interaction was found, $V = .631$, $F(3, 82) = 46.813$, $p < .001$, $\eta_p^2 = .631$, although Box's test indicated a violation of the assumption of homogeneity of covariance matrices, $M = 135.429$, $F(21, 4559.041) = 5.657$, $p < .001$. A nonparametric MANCOVA (Finch, 2005) was however also significant. Univariate tests revealed a significant time × group interaction for the reading measure, $F(1, 84) = 127.191$, $p < .001$, $\eta_p^2 = .602$, with the adjusted mean for the control group being 533.08 ($SE = 9.285$) at pretest and 548.95 ($SE = 9.107$) at posttest, while the adjusted mean for the intervention group was 512.59 ($SE = 4.217$) at pretest and 550.96 ($SE = 4.135$) at posttest. The interaction for mathematics was also significant, $F(1, 84) = 6.640$, $p = .012$, $\eta_p^2 = .073$, with the adjusted mean for the control group being 518.19 ($SE = 7.911$) at pretest and 538.50 ($SE = 7.535$) at posttest, and the adjusted mean for the intervention group being 513.02 ($SE = 3.592$) at pretest and 541.96 ($SE = 3.422$) at posttest.

## 7.4 Discussion

Study 3 explored whether there were associations between children's wellbeing, cognitive performance and academic achievement and their participation in a 6-week classroom/PA-format PSHE intervention delivered by staff from a local football club foundation. Results suggested that there was no relationship between intervention participation/non-participation and wellbeing, and the only significant time × group interaction for the cognitive performance analysis was for the Memorise! test, in which from pretest to posttest the mean score for the control group underwent a non-significant decrease and the mean score for the intervention group underwent a non-significant increase. As neither the increase nor decrease alone was significant, it cannot be concluded that intervention participation/non-participation was significantly associated with long-term memory performance.

There did however appear to be a relationship between intervention participation and academic achievement, with a main effect of time yet the adjusted means for the reading and mathematics achievement scores of the intervention group improving to a greater degree than those of the control group from pretest to posttest. This indicates

that intervention participation could contribute – as one of a number of factors operating over the intervention period – to achievement in some of the core subjects for primary school children. However, conclusions should be viewed in the light that there were between-groups differences in reading, writing and mathematics scores at pretest, with the control group scoring more highly on all measures despite 70% of the control participants being from the same school as 36.6% to 42.3% of the intervention participants (this percentage range being due to missing data for some academic subjects). The intervention group therefore had greater scope for improvement, and ideally the research would be replicated with groups which were comparable at pretest to corroborate the present findings.

The academic achievement findings complement those of the Positive Action programme, a school-based social-emotional programme following which intervention schools experienced improvements in pupils' reading and mathematics performance (Snyder et al., 2009). This lends weight to the argument that participation in PSHE programmes is associated with greater academic achievement. Although the current study did not seek to determine the reasons behind any associations, previous research has also suggested a relationship between PA participation and academic achievement (e.g. Watson et al., 2017), and it is possible that children's PA participation within and/or outside of the intervention sessions, as promoted by intervention staff, contributed to the association between intervention participation and academic achievement. This was explored in Study 3a as a pilot study.

At a subject level, the findings from PA–achievement research have been mixed. Hillman et al. (2009) measured children's academic performance following *acute* PA and found significantly better performance after moderate aerobic exercise relative to seated rest for reading comprehension, though not for spelling and arithmetic, assessed using the WRAT. The authors were surprised by the lack of effect for arithmetic, given the computational nature of mathematical problem-solving and the effects they observed for acute PA on cognitive performance, and suggested this may have been due to measurement factors such as lack of sensitivity of the WRAT or because there was a delay between the end of the PA session and mathematics testing; after PA, cognitive testing occurred first, followed by reading, spelling and finally mathematics testing. In contrast, the systematic review of Singh et al. (2018) into PA interventions

(i.e. *chronic* PA) found inconsistent evidence for a beneficial effect on young people's language performance (e.g. literacy, reading), but strong evidence for a beneficial effect on their mathematics performance. The current findings demonstrated improvements in both reading *and* mathematics, which may be due to the inclusion of both PA and PSHE in the intervention. However, Trudeau and Shephard (2008) refer to the role of culture within school sport and to research suggesting that cultural factors might have a greater effect for performance in more subjective subjects like English than in mathematics. It is an interesting possibility for the present results that the larger effect for reading ($\eta_p^2$ = .602) than for mathematics ($\eta_p^2$ = .073) could be partially explained through cultural factors, for instance the status children may perceive they gain through having an involvement with staff from a local football club foundation and therefore associated with their local professional football club. It is however difficult to explain the lack of effect for writing.

It was anticipated that a relationship between intervention participation and academic achievement would also be explicable through an association between intervention participation and children's wellbeing, as wellbeing and academic achievement have been positively associated in previous research (summarised in Public Health England, 2014b). In the absence of an association between intervention participation and wellbeing amongst the current findings, however, it is difficult to argue that wellbeing is one of the mechanisms behind greater academic achievement. While it is possible that wellbeing simply did not improve with intervention participation, it is also possible that the way in which wellbeing was defined and measured within specified dimensions did not capture the sorts of improvements experienced, or that improvements take longer than 6 weeks to occur as children require time to put into place the knowledge and skills they have acquired and developed. Future research might like to study the relationships between intervention participation and wellbeing over longer periods and to employ a measure of life satisfaction in which participants are free to use their own subjective criteria in making their ratings (Gadermann et al., 2010).

An association between intervention participation and cognitive performance was additionally anticipated, given that an association between intervention participation and wellbeing was anticipated and that there is some evidence for an association

between wellbeing and cognitive performance (e.g. Gothe et al., 2012). It is particularly interesting to note the existence of a relationship between intervention participation and academic achievement in the absence of a clear relationship between intervention participation and cognitive performance (and in the absence of an effect of acute PA on cognitive performance in Study 2), given that cognitive functions such as attention are involved in learning and cognitive performance is therefore thought to support academic achievement (Keeley & Fox, 2009). It may therefore be that intervention participation is positively associated with other variables involved in academic achievement, for example motivation (Spinath et al., 2006), though again it is difficult to explain why an association would not be observed for writing achievement.

### *7.4.1 Limitations*

Although efforts were made to recruit as many children as possible, the main limitation of the study was its recruitment of only 128 participants (79 in the intervention group and 49 in the control group). As some of the participants were missing data for some of the variables, this limited the numbers of participants included in the MANCOVAs to 95 for the wellbeing analysis (intervention: 53, control: 42), 69 for the cognitive performance analysis (intervention: 36, control: 33) and 90 for the academic achievement analysis (intervention: 70, control: 20). The sample size specified in Chapter 5 of 78 participants (39 per group) suggests, therefore, that only the wellbeing analysis was adequately powered. The sample size calculation was however based around effect sizes anticipated for Study 2; as Study 3 explored variables over a longer period with greater potential for confounds and therefore reduced effects, this required sample size is more likely to be an underestimation than an overestimation. Ideally, a single MANCOVA containing all three areas of interest would have been run as relationships between the wellbeing, cognitive performance and academic achievement DVs would be expected on the basis of the research presented in the literature review; however, it was anticipated that missing data would be problematic for such an analysis and this was indeed the case: a single MANCOVA would have contained data for just 39 participants (intervention: 27, control: 12).

Intervention research also commonly suffers from a lack of follow-up testing. In this instance a follow-up was not possible due to the timescale of the PhD programme of

research but it would have been valuable to assess the children's wellbeing, cognitive performance and academic achievement again at least one half term (6 weeks) after the conclusion of the intervention to determine whether the observed relationships remained and also whether others had arisen; it is possible that associations between intervention participation and wellbeing, for instance, require time to develop as they may rely on children putting into practice the skills and knowledge they have learnt.

## 7.5 Conclusion and Potential Impact

Further evidence is required from groups which are both larger and equivalent in pretest measurements, but it appears from the results of Study 3 that participation in the 6-week classroom/PA-format PSHE intervention may be associated with greater reading and mathematics achievement for Year 5 children. If these preliminary findings are corroborated with additional data they might help to inform the decisions of school staff and education policymakers in relation to the inclusion of PSHE and PA opportunities within the school timetable, as there are potential benefits for pupils' achievement in two core curriculum subjects and no detrimental effects for their achievement in writing, the other core curriculum subject examined in the research.

## 7.6 Study 3a: Pilot Study of Children's Intervention Participation and Daily Physical Activity

### *7.6.1 Introduction*

The intervention investigated in Study 3 was a programme in which PSHE content was delivered through classroom learning and via physical activity. While the associations of interest were between intervention participation and children's wellbeing, cognitive performance and academic achievement, it was recognised that it would not be possible from the results of Study 3 to determine the mechanisms behind any associations: greater understanding of the PSHE topic, improved skills (e.g. in relating to peers) and increased participation in PA as promoted by intervention staff are just some of the potential reasons for any relationships between intervention participation and the three measured constructs.

With the unusual inclusion of PA in PSHE interventions being an issue central to the thesis, and with one of the aims of the intervention explored in Study 3 being to

promote children's increased PA participation, Study 3a aimed to test whether there was a significantly greater pretest to posttest increase in the daily PA participation of intervention children than of control children as one possible mechanism behind any associations observed in Study 3. Specifically, this pilot study examined time spent by children in MVPA, as it is this intensity of PA in which the UK guidelines state that 5–18-year-olds should engage for at least 60 minutes per day (Department of Health, 2011). Evidence for the effect of PA interventions on PA is mixed but it was hypothesised on the basis of some of the more recent intervention studies (e.g. Breslin et al., 2012; Gorely et al., 2009) that there would be a significantly greater increase from pretest to posttest in the percentage of time spent in MVPA by intervention participants compared to control participants.

### *7.6.2 Method*

Study 3a was a small-scale quasi-experiment which set out to record the prettest and posttest daily MVPA of a subsample of 26 children from Studies 2 and 3. This sample included all 13 of the control group participants who were present at school during the researcher's visit to collect consent forms; for the intervention group, the first 13 children with consent forms were asked to take part.

The accelerometers used to measure children's PA are described in Chapter 5 and further detail on PA measurement is provided in the procedure and data analysis sections below. Sample size was restricted by accelerometer availability but it was nonetheless felt worthwhile to conduct a small-scale investigation comparing the daily MVPA participation of children who had taken part in the intervention with those who had not. This would provide an initial indication as to whether the intervention increased PA participation at the intensity recommended in the UK PA guidelines following the conclusion of the intervention sessions.

#### *7.6.2.1 Procedure*

Participants were asked to wear an accelerometer for all of their waking hours every day for 10 days at pretest and again at posttest, except when bathing/showering or taking part in swimming or combat sports. They were provided with an accelerometer on an elastic waistband and were asked to wear it such that it sat over their right hip. As in Guinhouya, Apété and Hubert (2009) with similarly-aged participants (8–11

years), children and their parents were given written instructions reiterating this information to encourage compliance and a familiarisation period for accelerometer wear was built into the study, with data from the first day of wear being removed from the analysis.

To address any potential for differential recording from device to device, the same accelerometer was allocated to each participant at pretest and posttest, as suggested by Rowlands (2007). Height and weight measurements were recorded on only one occasion before pretest accelerometer wear, such that the calculations of MVPA at pretest and posttest were based upon the same anthropometric data. The researcher took anthropometric measurements in the manner described in Chapter 5 on her visit to the school to collect consent forms.

#### *7.6.2.2 Data Analysis*

Again following the procedure of Guinhouya, Apété and Hubert (2009), time spent in MVPA was calculated over the period 7.00 am to 9.00 pm. Non-wear periods were calculated using the algorithm of Choi, Liu, Matthews and Buchowski (2011), as Choi et al. established that this misclassified significantly fewer periods of non-wear time amongst both adult and youth participants during waking hours than the algorithm of Troiano (2007) upon which it was based (for information on the Troiano algorithm see the ActiGraph website; ActiGraph, 2018). Both the Choi et al. and Troiano algorithms are included within the ActiLife software; although an alternative option is to define a custom non-wear period, the researcher opted to use an established algorithm in the interests of comparability of the results with other research. In an attempt to increase the likelihood that recording was representative of a child's daily MVPA participation and not simply a single day's wear, a minimum number of 2 days of recording was required per participant for their data to be included in the analysis. To enable comparisons between participants who may have worn their accelerometers for different lengths of time over the recording period, MVPA was analysed as a percentage of wear time rather than as the number of seconds/minutes spent by a child in MVPA.

A 2 × 2 mixed analysis of covariance (ANCOVA) was planned to test for a time (pretest, posttest) × group (intervention, control) interaction for percentage of

accelerometer wear time spent in MVPA. As in Study 3, age, sex and disability would be covariates; however, school would not be included as this would overlap completely with group.

### *7.6.3 Results*

#### *7.6.3.1 Participants*

Of the 26 participants, 17 contributed ≥2 days of PA data at prettest and posttest: 10 in the intervention group and 7 in the control group. There were no significant differences in age or percentage of males between the two groups (Table 7.4).

*Table 7.4. Participant characteristics by intervention/control group, Study 3a*

| | ***n*** | **% males** | **Mean age in years at pretest *(SD)*** |
|---|---|---|---|
| **Intervention group** | 10 | 40.0 | 9.93 *(0.328)* |
| **Control group** | 7 | 57.1 | 9.87 *(0.311)* |
| | | $\chi^2(1) = 0.486$, $p = .486$ | $t(15) = -0.406$, $p = .691$ |

#### *7.6.3.2 Preliminary Data Analysis*

Participants' physical activity data at pretest, with MVPA calculated at epoch lengths of 1 second, are presented in Table 7.5. The control group engaged in a significantly greater percentage of MVPA during accelerometer wear time at pretest (5.09%) than the intervention group (3.21%), $U = 11.00$, $p = .019$.

*Table 7.5. Descriptive statistics for physical activity at pretest, Study 3a*

| | **Intervention Group (*n* = 10)** | | | | **Control Group (*n* = 7)** | | | |
|---|---|---|---|---|---|---|---|---|
| | **Mean (SD)** [a] | **Range** | **Skew *z*-score** | **Kurtosis *z*-score** | **Mean (SD)** [a] | **Range** | **Skew *z*-score** | **Kurtosis *z*-score** |
| MVPA[b] | 3.21 (1.159) | 2.31 to 6.18 | 3.14[†] | 3.95[†] | 5.09 (1.357) | 2.41 to 6.47 | –1.75 | 1.54 |
| | *3.60 (1.162)* | | | | *4.52 (2.569)* | | | |

[a] *Posttest values included in italics*
[b] *Percentage of total wear time, calculated at epoch lengths of 1 second*
[†] *Value outside range –1.96 to +1.96, indicating non-normality at p ≤ .05*

Of a maximum possible of 7560 mins, accelerometer wear time at pretest (as identified by the ActiLife programme during the 9 days of recording from 7.00 am until 9.00 pm each day), ranged from 1528 mins to 6784 mins ($M$ = 3829.80, $SD$ = 1549.409) for the intervention group and from 1663 mins to 5987 mins ($M$ = 4018.14, $SD$ = 1580.486) for the control group. Wear time at posttest ranged from 720 mins to 5799 mins ($M$ = 3185.20, $SD$ = 1933.067) for the intervention group and from 287 mins to 4646 mins ($M$ = 2099.29, $SD$ = 1947.899) for the control group. There were no significant differences between mean wear times for the two groups at either pretest or posttest, and no significant difference in the mean wear time of the intervention group between pretest and posttest; however, mean wear time was significantly lower for the control group at posttest compared to pretest, $t(6) = 4.610$, $p = .004$.

Not unexpectedly, Wilcoxon signed ranks tests found that the percentage of accelerometer wear time spent by participants in MVPA at both pretest and posttest was greater when calculated from 1-second compared to 60-second epoch data ($p < .001$). All analyses were therefore conducted using both 1-second and 60-second data. However, use of the two forms of data did not change the outcomes of any of the analyses, which are therefore reported for the 1-second data as this is likely to be more reflective of the intermittent bouts of activity characteristic of children.

#### *7.6.3.3 Children's Intervention Participation and Daily Physical Activity*

A 2 × 2 mixed ANCOVA was employed to test for a time × group interaction for percentage of accelerometer wear time spent in MVPA. The covariates in this analysis were age, sex and disability. With only 10 intervention participants and 7 control participants, SPSS reported an observed power of .057 for the time × group interaction using Pillai's trace. There was a time × age interaction, $V = .304$, $F(1, 12) = 5.237$, $p = .041$, $\eta_p^2 = .304$, and a main effect of time, $V = .294$, $F(1, 12) = 5.002$, $p = .045$, $\eta_p^2 = .294$, with adjusted means indicating that the percentage of time spent in MVPA reduced from 4.12% ($SE$ = 0.318%) to 4.09% ($SE$ = 0.474%) from pretest to posttest.

There was no significant time × group interaction for percentage of accelerometer wear time spent in MVPA, $V = .006$, $F(1, 12) = 0.07$, $p = .796$, $\eta_p^2 = .006$. Box's test indicated a violation of the assumption of homogeneity of covariance matrices, $M$ =

16.856, $F(3, 9273.498) = 4.760$, $p = .003$, and pretest data (Table 7.5) suggested the data were not normally distributed; however, such characteristics of the data were unlikely to improve without the recruitment of a larger sample.

### *7.6.4 Discussion*

No significant time × group interaction was found for percentage of accelerometer wear time spent in MVPA, suggesting that participation in the 6-week PSHE intervention is not related to greater daily MVPA participation following the intervention's conclusion. However, the limited sample size of the pilot study prevents any firm conclusions from being drawn. Unfortunately, because it was not possible to venture as to whether the intervention's promotion of PA participation was successful in increasing children's daily MVPA, it was not possible to comment upon whether this might be one of the mechanisms behind the association observed in Study 3 between intervention participation and greater reading and mathematics achievement.

The main limitation of this pilot study is the sample size; it was possible only to recruit two schools to take part despite others' involvement in the wellbeing, cognitive testing and academic achievement aspects of Study 3. Attempts were made to recruit further schools but these were unfortunately unsuccessful; findings from the research programme were however shared with invited schools to demonstrate the goals and value of the research, which might aid future recruitment efforts. Furthermore, while the pilot study began with 26 participants, data from only 17 were available for the analyses and the control group had a significantly shorter mean accelerometer wear time at posttest than at prettest, indicating possible compliance issues with accelerometer wear. Future research would benefit from larger initial samples in order to increase the amount of data available for analyses following accelerometer non-return/non-wear.

# Chapter 8: Study 4 – The Views of Stakeholders on Combined Classroom Learning and Physical Activity PSHE Interventions for Schoolchildren: A Thematic Analysis

## 8.1 Introduction

Study 4 was conducted concurrently with Studies 2 and 3 and aimed to explore classroom/PA-format PSHE interventions from a qualitative perspective. As described throughout the thesis, it seems to be that core curriculum subjects such as English and mathematics are given priority in the school timetable (Bailey, 2017; Campbell et al., 2015), with time allocated for lessons such as PSHE and PE sometimes suffering as a result. However, not only have improvements been found in the social and emotional skills of young people following their participation in PSHE-type programmes which aim to develop their self-awareness, social awareness and responsible decision-making, but gains in academic achievement have also been demonstrated via increased school grades or scores on standardised achievement tests for reading and mathematics (Durlak et al., 2011). The outcomes of PA participation complement those of PSHE programmes, with improvements having been noted for self-esteem, self-discipline, teamwork/social inclusion, responsibility and assertiveness in addition to physical health (Bailey et al., 2013).

Despite the existing evidence, potentially supported by some of the quantitative results presented earlier in this thesis, it is understandable for core curriculum subjects to take priority in a crowded curriculum, with schools having targets to meet in these subjects (Department for Education, 2018). Education staff might therefore feel more confident in allocating some of the school day to providing opportunities for PSHE/PA with the backing of stakeholders such as parents/guardians. Schools can be of value to such stakeholders as sources of support for children's wellbeing and exercise, for instance with parents of overweight 9–11-year-olds in rural areas of the US reporting that schools would be the best agency to partner with for a weight loss programme (Davis, James, Curtis, Felts & Daley, 2008). However, a more recent qualitative investigation of the AFLY5 intervention in Bristol and North Somerset in England suggested that parents supported this PA and nutrition programme to differing degrees, and it was

not apparent why this was so (Jago et al., 2015). Participants from the same study felt that children engaged in programmes with active lessons that promoted autonomous decision-making; similarly, in a community-based weight management programme for 11–14-year-olds from London, active participation and taking part with others were associated with fun (Watson et al., 2016). Active participation may therefore promote the intervention buy-in of children, another important stakeholder group whose level of engagement is likely to be considered – along with the potential outcomes of any lessons/activities, as supported by this engagement – when making decisions regarding time allocations within the school day.

In light of the value of stakeholder input, Study 4 explored the views of stakeholders on interventions of the type considered throughout the research programme: 6-week PSHE interventions containing both a classroom and a PA component, which were delivered by football club foundations to 9–11-year-olds in primary schools in the North East of England. Contributions from various stakeholders were sought as there is a need for health promotion research to provide an understanding of contextual influences on implementation (MacDonald & Green, 2001), and it was felt that the richest description – and the one that would best capture the aspects that might help inform and improve practice – would be achieved by accessing a range of stakeholder groups. Stakeholders were identified as not only children and parents but also school staff and intervention staff, all four constituting key groups likely to hold an interest in the interventions.

The interventions are described in full in Chapter 1 and are summarised in Table 8.1 to assist the reader. They differed from many of those explored in the health promotion literature to date in that they were provided by facilitators from external organisations; in this case, specifically from football club foundations. Other interventions have often been delivered by researchers and may therefore take place over a period of time limited by the timescale of the research project and/or funding from grant-awarding bodies (Warren et al., 2003). A common alternative is for researchers to train teachers in delivery, but in this case implementation compliance may suffer due to the imposition placed on teachers' already limited planning time (Bartholomew & Jowers, 2011).

It was not the goal of the current study to compare the interventions with other programmes, though it is hoped that the findings can be of use in highlighting potentially effective elements for use in school-based PSHE/PA delivery. The intent was rather to provide a picture of the interventions as seen by the participants; a greater appreciation of what is perceived to be of value to stakeholders might allow education staff to feel more justified in opting for pupils to undertake a programme that detracts from time which could be spent on core curriculum subjects. The study's final four research questions concerned participants' views on: i) the role of PA in the interventions; ii) children's engagement in the sessions; iii) the outcomes of intervention participation and iv) the sustainability of intervention delivery.

Reporting was guided by the consolidated criteria for reporting qualitative research, a 32-item checklist for studies using interviews and focus groups (Tong, Sainsbury & Craig, 2007), with rigour having been previously discussed in Chapter 3.

## 8.2 Method

### *8.2.1 Ethical Approval*

Ethical approval was obtained from the Faculty of Health and Life Sciences Research Ethics Committee at Northumbria University. Permission was obtained from all of the schools involved in the research, preferably by email confirmation before the researcher introduced the study to the children, but in some instances via permission slip (Appendix J) at the introductory visit when arrangements had been made with other members of staff or via telephone.

Participants under the age of 18 gave written assent, with their parents/guardians providing written consent. Before doing so, children were provided with age-appropriate participant information sheets and also received information in a short verbal presentation delivered by the researcher to their school class. As in previous studies, their parents/guardians received more detailed information sheets which included the researcher's email address.

Parents, school staff and intervention staff were similarly provided with information sheets and gave written consent for their participation.

Following the conclusion of the interviews/focus groups, participants were given both verbal and written debriefings. Children received their own written debriefing and one to take home for their parents/guardians. Examples of consent forms, information sheets and debriefs are provided in Appendices B–F.

Participants were not offered an incentive for participation but adult participants and the parents/guardians of child participants had the opportunity to provide their email address to obtain a summary of the results on completion of the study (Appendix K).

### *8.2.2 Interventions*

Data were collected from participants with experience of PSHE interventions which were delivered in primary schools by facilitators from two football club foundations and which shared a number of characteristics, as outlined in Table 8.1. Both interventions 1 and 2 contained multiple programmes within their classroom/PA delivery models, enabling intervention staff to report on the delivery of different PSHE topics, while the remaining participants discussed only those programmes in which they, their children or their classes had taken part. A full account of the interventions is provided in Chapter 1.

*Table 8.1. Characteristics of the interventions discussed by participants in Study 4*

| | ***Intervention duration*** | ***Session duration*** | ***Programmes contained within the intervention*** |
|---|---|---|---|
| **Intervention 1** | | | |
| **Aims:**<br>• To develop children's knowledge and understanding of the PSHE topic covered;<br>• To promote children's increased PA participation and confidence in participating in PA;<br>• *For fitness and nutrition programme:* To improve children's physical fitness. | 6 weeks<br><br>1 session per week | 120 mins:<br>~60 mins classroom learning<br>~60 mins physical activity | • Fitness and nutrition<br>• Discrimination (with sessions on British values, bullying, sexism, racism and disability awareness) |
| **Intervention 2** | | | |
| **Aim:** To challenge the attitudes and perceptions of young people towards the PSHE topic covered.<br>**Benefits proposed by the football club foundation:** Self-esteem, teamwork, communication, conflict resolution, improved behaviour. | 6 weeks<br><br>1 session per week | 60 mins:<br>~30 mins classroom learning<br>~30 mins physical activity | • Drugs education<br>• Racism<br>• Self-esteem |

### *8.2.3 Participants*

It was important to select a sample that would be able to provide a high level of insight into the research questions (Marshall, 1996, p. 523). Schools whose pupils had taken part in different intervention programmes were therefore approached (including one school whose pupils had participated in both the fitness and nutrition and discrimination programmes), providing perspectives on a total of five PSHE topics delivered within the intervention models.

Invitations to participate in the study were extended to 13 schools in the North East of England whose Year 5 and Year 6 pupils (ages 9–11; final two years of primary

school) were taking part in an intervention covering one of the following PSHE topics: discrimination, drugs education, fitness and nutrition, self-esteem or racism. Arrangements were made with four schools; the researcher visited each one to give a short verbal presentation to the classes about the study and to deliver information sheets and consent forms for pupils to take home to their parents, as classroom visits appear to contribute to research participation rates (Blom-Hoffman et al., 2009). A fifth school was later recruited to increase the numbers of school staff taking part in the research. Characteristics of the participating schools are outlined in Table 8.2.

Across the initial four schools, information sheets and consent forms were distributed to a total of 148 pupils, with 27 and 15 valid consent forms being returned for children and parents, respectively. Including those from the fifth school, 9 school staff were invited to participate in person or via email. Nine intervention staff were also invited in this manner. The researcher attempted to make arrangements with all of those interested in participating; ultimately, 25 children (15 females), 5 parents (3 females), 6 members of school staff (all female) and all 9 members of intervention staff (1 female) took part. The majority of the intervention staff were facilitators responsible for the delivery of the programmes, some having additional management responsibilities and one participant having a purely managerial role. Three of the members of school staff were teachers whose classes had participated in the intervention programmes, two were teaching assistants who had been present during the course of the programmes and one was a deputy head teacher who had been involved in the decision for the intervention to take place at their school.

As 24 of the children and 2 of the parents took part in focus groups rather than interviews, a total of 26 transcripts resulted from data collection. Further parents were not sought once the initial five with whom arrangements had been possible had taken part in the study because it was clear that members of this group knew little of the programmes in which their children had been participating. While this in itself was a useful finding – discussed below and communicated to the football club foundations to inform their development of the interventions – further data collection was considered to be unnecessary and unethical and so the line of enquiry with parents was stopped.

*Table 8.2. Characteristics of schools at the time of their involvement in Study 4*

| School | School type[a] | Number of pupils on roll [a] | Ofsted 'overall effectiveness' rating[a] | Acorn classification profile for school postcode/ nearest residential postcode[b] | 2011 Census characteristics for the area[c] | | |
|---|---|---|---|---|---|---|---|
| | | | | | % households social rented | % White British | % of those aged 16–74 unemployed |
| 1 | Voluntary aided school | 375 | Good | ***Category 4:* Financially stretched**<br>*Group L:* Modest means<br>*Type 38:* Semi-skilled workers in traditional neighbourhoods | 13.9 | 90.9 | 4.7 |
| 2 | Academy sponsor led | 206 | Good | ***Category 4:* Financially stretched**<br>*Group N:* Poorer pensioners<br>*Type 45:* Pensioners in social housing, semis and terraces | 20.8 | 96.2 | 4.2 |
| 3 | Community school | 227 | Good | ***Category 5:* Urban adversity**<br>*Group O:* Young hardship<br>*Type 49:* Young families in low cost private flats | 13.9 | 90.9 | 4.7 |
| 4 | Community school | 421 | Good | ***Category 5:* Urban adversity**<br>*Group P:* Struggling estates<br>*Type 56:* Low income large families in social rented semis | 39.0 | 98.0 | 6.8 |
| 5[d] | Academy converter | 370 | Good | ***Category 5:* Urban adversity**<br>*Group P:* Struggling estates<br>*Type 52:* Poorer families, many children, terraced housing | 68.4 | 90.7 | 10.1 |

[a] *Information from Ofsted (2012–2018)*
[b] *Information from CACI Ltd. (2016–2018)*
[c] *Information from Nomis (2011) local area report*
[d] *Only school staff were recruited from this school*

### *8.2.4 Materials*

The researcher conducted all of the focus groups and interviews using lists of pre-prepared open questions and prompts. Although these had been designed to elicit sufficient and pertinent information to address the pre-planned research questions (Dilorio, Hockenberry-Eaton, Maibach & Rivero, 1994), a semi-structured approach was taken such that they were treated as guides, with additional questions being used during data collection to clarify and further explore participants' responses. The order of questions was also flexible to aid the flow of the discussion and put participants at ease.

As recommended by Hennink, Hutter and Bailey (2011), a number of pilot tests were run with people anticipated to closely approximate the participants who would take part in the final research. The pilot tests did not collect data for analysis but allowed the researcher to reflect on whether the questions from the initial guides were comprehensible, structured appropriately and would lead to data relevant to the research questions. Furthermore, they allowed the researcher to practise keeping discussions focused on the research questions (Liamputtong, 2011) whilst allowing enough flexibility for participants to talk through any issues emerging from the conversation. Pilot participants were recruited through their association with a school not involved in the main body of the research. One focus group with parents, one focus group with Year 5 children and two one-to-one interviews with members of school staff were conducted. On the basis of pilot participant feedback and personal reflection, the researcher made minor modifications to the interview/focus group guides before they were used in the final study. For example, for children, a clarifying prompt (*'What do you do in your PE lessons?'*) was added after the question, *'Please can you tell me what you learn in your PE lessons?'* because pilot children appeared to perceive PE as something they *did* rather than as a subject in which they *learnt*.

The final interview/focus group guides are presented in Appendices L(i) to L(iv). Across all of the participant groups, each guide broadly followed the structure put forward by Krueger (1998) for focus groups. There were opening/introductory questions designed to put participants at ease and encourage discussion, then key questions addressing the research questions, and finally ending questions which encouraged participants to state their thoughts on the researcher's summary of the

discussion and to add anything which they felt to be important to the topic but which had not yet been raised. The guides generally covered the same content, simply pitched at different levels for the different participant groups, but as those involved in marketing or choosing to take up the programmes, only intervention and school staff were asked directly about intervention sustainability.

As in Cavanagh and Meinen (2015), a literature review shaped the three pre-planned research questions, with the role of PA research question arising during data collection (see the 'data analysis' section below). Although the content of Chapter 2 will not be repeated here, children's engagement in the sessions was, for example, felt to be important to intervention success by participants in the study of Jago et al. (2015). Findings in relation to children's engagement, intervention outcomes and intervention sustainability were also likely to lead to practical recommendations for future PSHE/PA provision, as one of the aims of the overall research programme. Many of the items from the focus group/interview guides therefore constituted open questions addressing these research questions; others were developed from specific questions asked in previous research, including the question for children, *'Could you please describe the [intervention] programme you've been taking part in? (Prompts: What is it about? What did you do?)'*, which was based on a question used in interviews with UK adolescents following their participation in a weight management programme: *'Could you describe what [programme] is in your own words? (What is it about/for?)'* (Watson et al., 2016). To promote wider discussion through comparison, some of the questions additionally asked participants to consider the usual provision of PSHE in schools and any opportunities for children to be physically active both in and out of school.

### *8.2.5 Procedure*

All data collection was conducted in quiet rooms either on school premises at the conclusion of intervention delivery for children, parents and school staff, or at the workplaces of intervention staff. A member of school staff was allocated to sit in on three of the children's focus groups and in the other four instances staff were in adjoining rooms and/or checked in throughout the process. Although the school setting might have affected participants' behaviour (Gill et al., 2008), for instance causing parents to respond in what they perceived to be an appropriate manner for parents of

schoolchildren, it was felt to be important for the researcher to meet the participants face-to-face at a familiar location to help establish rapport and allow them to feel comfortable in sharing their experiences (DiCicco-Bloom & Crabtree, 2006). The researcher outlined her affiliation with the university but it is likely given the nature of the investigation that some of the participants perceived her to be associated with intervention delivery.

The interviews and focus groups ranged in length from 12 minutes and 23 seconds (School Staff 2) to 52 minutes and 20 seconds (Intervention Staff 1), with the mean length for children being 27 minutes and 18 seconds. Each interview/focus group was audio-recorded and transcribed verbatim as soon as possible afterwards, with the researcher engaging in memo writing immediately following data collection to provide context when transcribing.

To help identify different participants during the transcription of the focus group discussions, children were asked to choose a picture of an animal and to state this animal each time they spoke. Ground rules for the focus groups were also presented before the recording began, including to support the participation of others by not speaking for too long or over the top of another person and to remember that there were no right and wrong answers and that differing opinions were valued and should be put forward if held. In addition, the researcher reminded those taking part in both interviews and focus groups of details from the participant information sheet, including their right to withdraw and that if they did not wish to respond to a question they did not have to do so.

### *8.2.6 Data Analysis*

The applied nature of the research questions meant that the content rather than context of the discussions was the focus for the analysis; to draw on the distinction offered by Morgan (2010), *what* was being said was of greater importance than *how* the discussion unfolded, so the focus group and interview transcripts were analysed in an identical manner. As described in Chapter 3, the decision to follow the six phases of thematic analysis proposed by Braun and Clarke (2006) was made on the basis that this process is reasonably accessible to non-researchers and would enable stakeholders to understand how the researcher arrived at conclusions and recommendations, again

consistent with the applied nature of the research. The analysis was conducted within a realist/essentialist paradigm, with themes being identified at a manifest level from the explicit reports of participants (Joffe, 2012). The research questions relating to engagement, outcomes and sustainability were determined prior to data collection; however, the inductive approach adopted for the analysis, coupled with the aim to provide a description of the entire data set, resulted in the evolution of an additional research question concerning the role of PA in the programmes, a topic of interest to the participants.

Transcripts were imported into QSR NVivo 10 (Copyright© QSR International Pty Ltd., Melbourne, Australia) for coding. The initial coding process resulted in a total of 86 codes (Appendix M(i)), though at this stage these were separated into those relating to the interventions and those relating to children's wider PA participation. As the aim of the research was to explore the interventions, albeit in a manner informed by participants' thoughts on wider PA and PSHE provision, the data extracts pertaining to non-intervention provision were assigned a different colour in NVivo and then moved into the same codes as the programme-related extracts (e.g. *'Autonomy – PA'* and *'Autonomy – Programme'* became *'Autonomy'*). Differential colouring assisted in the analysis by highlighting which extracts related to the programmes and which related to PA and PSHE more broadly. Combining the two and revisiting the codes to develop a coding framework resulted in a total of 63 remaining codes (Appendix M(ii)). These codes were arranged into initial thematic maps (Appendix M(iii)), with a small number of additional headings being introduced for the purposes of sorting codes into themes: *'Facilitators to Programme Engagement'* and *'Barriers to Programme Engagement'* for the engagement research question, and *'Psychosocial Wellbeing'* for the outcomes research question.

A thorough, iterative process of refining the themes was then carried out by reviewing the data extracts assigned to each one, using the criteria of internal homogeneity and external heterogeneity for categories (Patton, 2002). The validity of the resultant themes was assessed by re-reading the transcripts to establish that the themes accurately represented the data set; as anticipated, during this phase additional data extracts were coded (Braun & Clarke, 2006). An in-depth account of each theme was then written, including the main ideas it encompassed, comparisons and contrasts with

other themes and how it provided insight into the research question(s) (Appendix M(iv)). This was reviewed and agreed by the principal supervisor. Final thematic maps for each of the research questions are displayed in the findings, and direct quotes are provided to illustrate participants' experiences and to substantiate the final themes (Bloomberg & Volpe, 2012).

#### *8.2.6.1 Saturation*

Saturation of themes was approached using the Comparative Method for Themes Saturation (Constantinou et al., 2017). The themes identified in each of the 26 interviews/focus groups were compared four times: firstly in the order in which the interviews/focus groups were conducted, then in reverse order, and finally in two orders determined by random number generation. Each time, the themes shared with previous interviews/focus groups were noted, as were any new themes (Appendix M(v)). From the four comparisons, the maximum number of interviews/focus groups after which no new themes were found was five for the role of PA research question, nine for the engagement research question, seven for the outcomes research question and three for the sustainability research question, indicating saturation of themes for all four research questions.

Guest, Bunce and Johnson (2006) found that new themes emerged infrequently after 12 interviews but suggested that this might differ for heterogeneous groups. Although that did not appear to be the case in this instance, it should be noted that not all of the participant groups touched upon all of the themes; for example, children did not discuss confidence/self-esteem as an intervention outcome. In the majority of cases, however, themes contained data extracts from participants from each of the stakeholder groups.

## 8.3 Findings

For clarity of reporting, the research questions are presented below as a series of headings beneath which their corresponding themes are discussed. The research questions are however best viewed in relation to one another, for instance with outcomes being reliant upon participants' engagement in an intervention. These links are explored further in the discussion section.

To maintain confidentiality, participants are identified following quotes using only an indicator of their participant group (C: child, IS: intervention staff, P: parent, SS: school staff) and the number of their transcript within that group. Where it is not apparent from the quote or surrounding text, the intervention/programme (or basis for comparison with these) upon which they were commenting is also specified in order to provide context.

### *8.3.1 Research Question 1: The Role of Physical Activity*

This research question emerged from participants' discussion of the two components of the intervention sessions. It was common for children to have taken part in PSHE sessions or PA sessions delivered by external providers at school but participants reported that sessions consisting of classroom-based content *and* active games were unfamiliar yet valued: 'It's a really good balance' (P3, self-esteem programme). Three themes were identified to explain the positive perception of PA in the intervention: i) suitability for a range of children, ii) rest and reward, and iii) reinforcement (Figure 8.1).

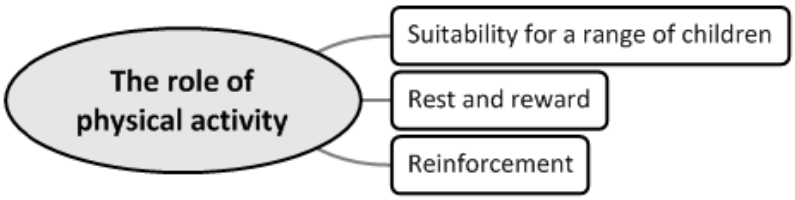



*Figure 8.1. Final thematic map for research question 1: The role of physical activity in the interventions*

#### *8.3.1.1 Theme 1: Suitability for a Range of Children*

Firstly, it was felt that the inclusion of PA and classroom work made the sessions appealing to a range of children: 'some people… sometimes enjoy, like, inside the classroom with [facilitator] as he makes it fun… And then quite a lot of the people, like, aim to be good at sport and they really enjoy the little games' (C6, self-esteem programme). The two components also provided different modes of learning:

> there's some children who don't always just engage with classroom activities and, you know, may struggle more with writing or… So, it gives them… an option of a different means to learn, as well. So, you're doing one aspect…

> with classroom-based work: questioning… speaking and listening skills, reading… and then the writing… But then it's giving everybody that option to have another means of learning, as well. (IS3, intervention 2)

#### *8.3.1.2 Theme 2: Rest and Reward*

Secondly, when questioned about PE at school, children revealed that they tended to see PE lessons as an opportunity for a break from more academic schoolwork: 'it's not freedom but it's, like, not sitting there in your chair all day… writing out something or doing your times tables' (C6). There were fewer comments on the PA component of the intervention sessions providing a break from wider schoolwork, with most of the data extracts comparing the PA and classroom components of the sessions themselves; however, intervention PA appeared to be viewed in a similar manner to PE because as one child described, even when a pupil did not like a particular game, 'most of the time they just… try their best anyway, because they know it's better than doing some lessons in school [laughs] and they don't wanna, kind of, ruin it for people who are enjoying it' (C5, self-esteem programme). The classroom activities were also apparently perceived as a break from more academic subjects, though not to the same extent as the PA: 'it wasn't boring work when you did it… you just filled in bits: "Why not?" and "Why?" and, like, "Where would the, like, side-effect damage?" and just… it wasn't hard work?' (C2, drugs education programme).

There was a link between the idea of PA as a break from other subjects and the previous 'suitability for a range of children' theme in that the PA component of the interventions might be particularly suitable for children 'that maybe aren't naturally gifted at [core curriculum subjects] and they love, like, PE… it's really good to incorporate as many opportunities for those, as well, so they feel like they're… striving and doing really well… as well, too?' (SS3, intervention 1).

*Within* the intervention sessions, the PA component was often perceived by the children as a break from and/or positive reinforcement for participation in the classroom component, thereby possibly supporting their engagement in the sessions: 'you felt like you've done your work and, like, now's the time to just have some fun outside. And it felt like a reward for being in the classroom' (C1, drugs education programme). At the same time, one of the school staff indicated that the PA might act

as negative reinforcement by helping to 'release… some of that tension' (SS1) resulting from the issues covered on the racism programme.

There was a sense amongst intervention and school staff that the PA component might be *presented* as an incentive to encourage children's engagement in the classroom – for instance, facilitators might 'say, "Oh, well, once we get this done, we'll be able to go outside and play some games,"' (IS5, intervention 1) – but there were no examples of children being excluded from PA participation due to lack of engagement in the classroom activities.

#### *8.3.1.3 Theme 3: Reinforcement*

Finally, as intended, PA was reported to be a useful conduit via which intervention staff could reinforce PSHE messages, for instance:

> for classes which are quite well-behaved and not a lot is said within the classroom, when it comes to the PE side they tend to open up more. And then you may get one or two things which are said… generally in the heat of the moment, which are a little bit unkind… but… you relate it back to what was spoken about in the classroom. You know, "Do you know by saying that… you could be affecting their self-esteem?" (IS1, intervention 2)

School staff and children generally understood the link between the PA and classroom components of the sessions, for example: 'when we played last week's game… that linked with how to make choices for yourself, like, 'cause… after every, like, five minutes you could swap teams or you could stay on the one you were already on?' (C5, self-esteem programme); 'it was the sexism yesterday. But then they were saying… sometimes you'll have, like, an all-girls team and an all-boys team, and we were mixing them yesterday. So you had the girls *and* the boys' (SS5, discrimination programme). However, in some instances the relationship appeared to require clarification – 'some weeks it's linked and then others it's, like, not really got anything to do with it' (C5, self-esteem programme) – and some topics lent themselves to being delivered via PA more readily than others:

> if you're doing… heart rate, you could quite easily test that. So, before they go out, you get them to test their heart rate, and then once we are out, after we've done a little bit of exercise, I measure their heart rate again. But some of them

are, obviously, with regards to food labelling… I think it would be nigh on impossible (IS5, fitness and nutrition programme)

### *8.3.2 Research Question 2: Engagement*

Four themes pertaining to children's degree of engagement in the sessions were identified and are presented below from most to least prevalent: i) children's enjoyment, ii) delivery by a non-teacher, iii) association with football club, and iv) children's personal circumstances and characteristics (Figure 8.2).

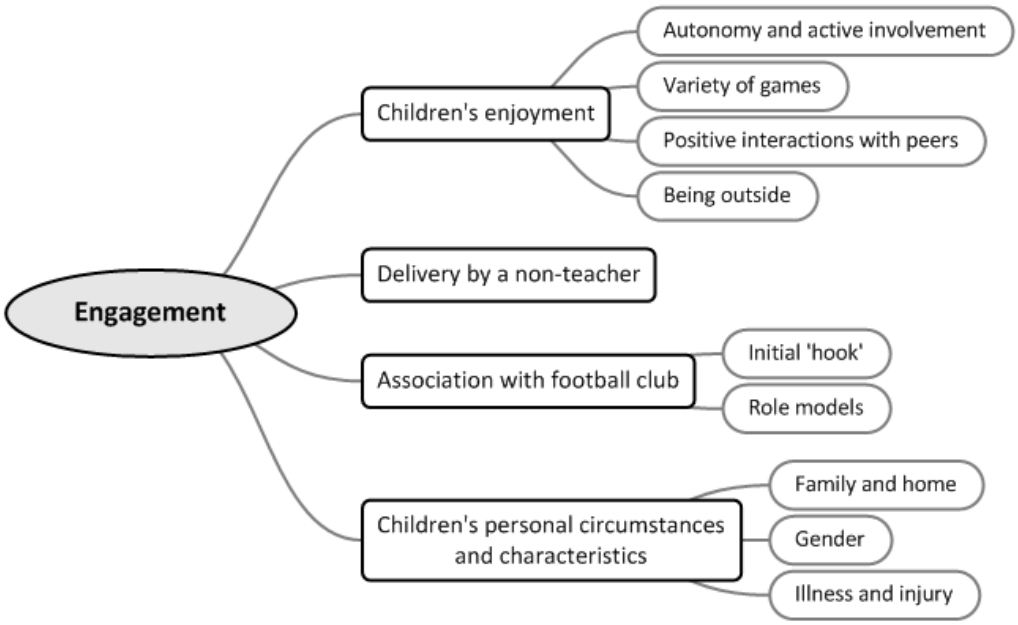



*Figure 8.2. Final thematic map for research question 2: Children's engagement in the intervention sessions*

#### *8.3.2.1 Theme 1: Children's Enjoyment*

Children's engagement in the sessions was predominantly led by their enjoyment, and enjoyment was commented upon by members of all of the stakeholder groups: 'overall it was just really fun. We did loads of fun things in the classroom and out there, as well' (C4, drugs education programme); 'She loves it… She comes in and she's buzzing when she's had it' (P3, self-esteem programme); 'I think the children really seem… they really enjoy it. This morning they were going, "Are the boys coming in? Are [football club] coming in to see us?" So, you know… they *are* interested and they want to learn' (SS3, intervention 1);

> a lot of the schools we go into [for fitness and nutrition programme]… they book them in for [discrimination programme]. So… two or three years later down the line, you go into the school again, you're doing [discrimination programme] with them and they talk about… how good [fitness and nutrition programme] was and how they loved it and stuff. (IS8)

Enjoyment was by far the most prevalent theme for the engagement research question, with children particularly enjoying the PA component: 'outside in the… last little fifteen minutes or so, they love the exercise out in the yard' (SS2, drugs education programme). They also enjoyed the classroom activities, especially when these were novel: 'I wasn't in for that one [building tetrahedrons in teams], but then [the children] came [to me] and they were showing us everything they'd done, and they were talking about it' (SS5, discrimination programme); 'I put on the [alcohol simulation] goggles, and I was like a zombie, basically. So, I was… trying to fit them on and I had to sit on a chair. I nearly missed it. … It was really good' (C2, drugs education programme).

Intervention staff recognised enjoyment to be an important aspect of the courses – 'We try and make it as enjoyable as possible' (IS2, intervention 2) – and even the role of their *own* enjoyment was noted to contribute to children's engagement:

> I know I enjoy teaching it… I know from my previous jobs and stuff that if I'm not enjoying what I'm doing, the kids aren't going to enjoy it, but if I'm going in there and loving it and… I'm engaged and I actually want to teach it to the kids… it's only going to get them on board. (IS8, intervention 1)

Enjoyment of the PA component – and by extension engagement in it – was however in a small number of cases noted to be dependent upon the appeal of PA in general, or of specific games, to specific individuals:

> I think most people get involved… just sometimes… people in the class don't, and… the only time, really, people don't get involved is mainly when… they don't like the sport too much and they're, kind of, not really happy with what the game is? (C5, self-esteem programme)

Intervention staff were aware of this issue, and where pupils were not enjoying the PA they discussed other ways in which engagement in the sessions might be encouraged,

touching upon some of the enjoyment subthemes (e.g. finding an alternative role for a child during a particular task; see 'autonomy and active involvement'). The four subthemes represent specific factors which were identified to support children's enjoyment: the autonomy and active involvement they experienced throughout the interventions, the variety of games on offer in the PA component of the courses, the positive interactions they had with their peers during the sessions, and being outside for the PA aspect when possible. These factors are outlined below.

*Subtheme 1: Autonomy and active involvement*

Intervention staff were clear that children's engagement should be encouraged but voluntary, and that to 'force them' (IS1) to participate would not work: 'at the end of the day it is their choice, you know. … saying… "You must play. Sir or miss has said you must join in," … it's counterproductive. They're not going to do it' (IS1, intervention 2). Although they reported that it was rare for children not to engage in the PA, they would often talk on a one-to-one basis with those for whom this was the case, promoting a sense of autonomy and helping them to enjoy and engage in the sessions: '"Listen, what do you want to play?" Give the responsibility to them. And then they can say, "Oh, well, I loved the game that we played one week," so you do that, and then suddenly they're involved' (IS7, intervention 1). The same member of staff explained how a similar approach worked for those not engaging in the classroom component of the sessions:

> when you give a child your attention… and… you help them, they can recognise that and they, kind of, appreciate that, quite often. … they see it as, like, "Wow. Somebody's actually going out of their way to help me, rather than tell me off." (IS7, intervention 1)

Finding an alternative role for a child was another way in which they could engage in both aspects of the sessions:

> [For the PA component] we give them different roles: be a referee… get them to set out pitches, they've still got to walk around the court or the hall and set up stuff with us, so they're still active rather than sat down… And then we try and get them into games when they want to join in. … [For the classroom component] there's always something they can do… be it hand out books, hand

> out resources and stuff for us. Get them on board first, then get them to join in. (IS9, intervention 1)

Children's active involvement was viewed particularly favourably for their engagement in the classroom component of the sessions: 'I think you need… the practical aspects… exactly like [in the intervention]. Kind of, classroom-based, but lots of activity, lots of involvement of the children, like letting them almost lead it into, kind of, getting them to be engaged' (SS4, discrimination programme). The tasks in the classroom component were designed to actively involve the children because it was recognised that this made them enjoyable:

> we try and make it as enjoyable for the children as possible by making games based around it and making them as active as possible, and interactive. It's not a case of sitting them down and saying, 'Right, this is what it means.' … It's about getting them up on their feet and moving around… and talking, and discussing… and making it fun for them. … because that's what kids want, you know; they want to be listened to rather than talked at. (IS2, discussing the development of another intervention based on experiences of and feedback on intervention 2)

*Subtheme 2: Variety of games*

In a similar but distinct vein, intervention staff described that they facilitated a variety of games in the PA component of the programmes: 'we do try to… vary our games and activities to meet all standards, abilities, children's needs, interests' (IS9, fitness and nutrition programme). Children's enjoyment appeared to be enhanced by this variety: 'it's always really fun 'cause you're never doing the same thing in two weeks' (C6, self-esteem programme). As well as providing a range of games to appeal to different children, variety involved making modifications to existing sports:

> we play a mix of… football in various ways. … rather than, you know, one pitch, two goals, "There, you go and play," you know, there are different ways you can tweak football. … and games like handball… that is closely related to netball… so for those who really engage in netball and have, you know, that sport as… a favourite… they'll buy into that game quite… a lot. (IS1, intervention 2)

Both of the programmes in intervention 1 aimed to develop children's knowledge and

understanding of the PSHE topic being delivered, but the fitness and nutrition programme aimed also to improve children's physical fitness. Due to their slightly different goals, there was a difference in the types of activities included within the PA component of the two programmes. There was still, however, variety in both:

> [In the fitness and nutrition programme] throughout the weeks we just do lots of games based round balance, movement, coordination, with a build-up that hopefully in week six by doing that… their scores [on the walking and balance tests]… do rise. … [Discrimination programme]: a little bit different… there's not a specific focus in the practical sessions. … we just use football as, like, a tool… to get them involved in sport and activity. Again… linking teamwork into it as well. … one of the weeks we… talk about blind football and then we go outside in the practical and… the kids have a go at it… I also do a little game where… the kids aren't allowed to speak. … And they've got to try and organise theirselves into – in a team – [order by] height… and then… birth month… so it's quite a good little challenge for them. (IS8)

Underscoring its importance, variety was also frequently mentioned in relation to non-intervention PA, in which participants reported that children enjoyed taking on new challenges and developing competencies through ongoing learning, with different children potentially having different preferences and 'hidden talents' (C1) that they may find through variety in PA participation.

*Subtheme 3: Positive interactions with peers*

Another common finding in relation to non-intervention PA was that children often enjoyed participating with their friends. While working with friends might also have an influence on their enjoyment of the intervention sessions: 'it's, like, really good because sometimes, like, you'll sit with your friends and have a laugh and, like, talk about different ways to bond' (C6, self-esteem programme), children seemed to appreciate positive interactions with *any* peers, and when asked about making changes to the interventions two of the groups suggested working with a wider variety of classmates:

> you could maybe, like, do it so it's more in group work? 'Cause sometimes it's, kind of, just, like, you can choose whatever you want, but sometimes it's good if they choose the teams for you, 'cause then you get to work with other people. (C5, self-esteem programme)

Intervention staff were additionally mindful of the potential for *negative* interactions with peers to detract from enjoyment of and engagement in the sessions: 'they might have had a bad day at school? And they don't want to be with certain friends, so you put them on other teams. Just simple things like that' (IS8, intervention 1). On the other hand, children were reported to enjoy supporting others in non-intervention PA: 'Now he's in Year 6, he's encouraging all the Year 1s and the Year 2s' (P1), and intervention staff used this inclination to promote the engagement of other pupils in the programmes: '"your mate over there… There's something up, will you just have a chat with him?"' (IS1, intervention 2).

*Subtheme 4: Being outside*

Presented as the final subtheme due to the difficulties over controlling this factor rather than due to its prevalence in the transcripts, being outside for the PA component of the sessions supported children's enjoyment 'because it's a bigger space than the hall. The hall's quite a tight squeeze for, like, all the class' (C5, self-esteem programme). Children spoke of PE lessons in the school hall being problematic for a number of reasons, including that: 'it's a bit slippy' (C2); in the afternoon 'people have just had their lunch and sometimes there's the odd bit of food on the ground' (C2); and 'if you get hot… the room's hot, as well, so you don't really cool down as much, but when you're outside it's cool, so you get cooled down, so… you have… more energy' (C3). However, it was not always possible for the PA component of the interventions to take place outside due to weather conditions and rotas for school facilities. As well as meaning that the above problems for PE lessons then applied also for the programmes, being inside limited the range of games the intervention staff were able to facilitate, particularly affecting the amount of PA in which the children would engage:

> The main hall might not be big enough. And again, you've got to really simplify a session. You can't do many games where you're running about. It's more like team games. … I go back to that thing before: you don't want kids being in queues all the time. Sometimes it's out of your hands and you've got to do little games like that because you haven't got the facilities. (IS8, intervention 1)

> the school hall might not be available… so you're outside, and that's fine when the weather's fine. If it's bad, then… you're back in… the classroom. There's one or two little fun games you can do there which are not really PE, you know, games… but they are fun. (IS1, intervention 2)

#### *8.3.2.2 Theme 2: Delivery by a Non-Teacher*

The status of intervention staff as visitors to the school was another factor perceived as contributing to children's engagement, with many participants noting that 'if there's other people coming in, the children see it as a treat… and something special' (SS1, any external provision) and that when 'they know somebody else is coming in, it's like, "Yes!" They all get excited' (P3, any external provision). This was partly due to the novelty of the session content: 'Normally different people… They normally go over different things' (C4). However, intervention staff also appreciated that their status as non-teachers allowed them to deliver the programmes in an informal manner, creating a different environment to that of a normal classroom lesson: 'linking it into what we do, but… in less of a structured way than a teacher would have to do in a formal organisation… so, in that respect it's a lot more, kind of, laid back' (IS2, intervention 2). Moreover, the characteristics and abilities of the delivery staff were highly valued by children and school staff: 'he's really, like, funny and he's fun' (C7, racism programme); 'I think the lads who've been in have been fantastic. 'Cause they're not the easiest of kids to work with, and they've just shown so much patience getting to know them' (SS5, fitness and nutrition and discrimination programmes); 'I think they've… like, made a relationship? Like, they've… found a bond, and I know some of the [facilitators]… have remembered some of [the children's] names and stuff, which makes them feel important, which is obviously lovely' (SS4, fitness and nutrition and discrimination programmes).

Intervention staff were aware of their part in promoting engagement: 'probably the first five minutes of you walking into the classroom, you've got to be able to switch on… to what they want for them to be… listening and engaged' (IS5, intervention 1). They also felt that being male played an additional role:

> a lot of our delivery staff are men. And when you go into primary schools, you get quite a lot of children that… interact differently with men. They've got female teachers… and potentially not a male role model in their life. And quite often I've seen children react completely differently to me because I'm a man. Erm, that might be positively, and that might be negatively, really! [laughs] … depends on the individual. (IS7, intervention 1)

Intervention outcomes were tied to this theme in a number of the transcripts because

‘if it was [teacher], it wouldn’t really feel different to any other lesson, so you wouldn’t really take it in as much’ (C1, drugs education programme), and because having a range of people delivering sessions in their own styles might strike a chord with different individuals, meaning that ‘you see different results from children that you might not otherwise have seen’ (IS2, intervention 2). However, while one of the parents in the focus group initially said that ‘they probably would take a little bit more in off somebody coming in the school, I think’ they immediately went on to say, ‘Even a teacher, I would’ve said, as well’ (P3, any external provision). The other parent then described that messages at their children’s school were delivered by external providers *and* school staff: ‘I know the school *do* – even though they’ve got, like, police coming in… – the school do reinforce it. … [Teacher] does talk to them about it… [Head teacher] does. Assemblies where she’ll tell them about it, as well’ (P3, any external provision). Intervention staff similarly commented on the effects of working with school staff for children’s engagement:

> You’ll get some teachers that will be there as your assistant. So, they understand the children because they work with them constantly, so they understand the individual needs of each child, so they can go and encourage and support those… children with their learning and with the taking part, which is great. … some of the teachers’ll join in, as well, and they’ll be playing tag as fast as all the kids, which is fantastic. And then you’ve got other ones that see it as PPA [Planning, Preparation and Assessment] time, so we’ll come in, and suddenly, “There’s the keys to my classroom. Off you go.” … which is a shame. (IS7, intervention 1)

> When you get a teacher who joins in, it’s like a positive role model for the kids and they think, “Well… if miss is doing it, and she’s listening… then I’ll do it.” … and then you get others that’ll have a teacher and… they’re talking to another adult, and it’s just, like… well, if they’re talking over the top of me, then the kids’ll just think that they can talk over the top of me, so… yeah, it’s all down to the teacher, as well, and the staff. (IS6, intervention 1)

#### *8.3.2.3 Theme 3: Association with Football Club*

One of the introductory questions in the interviews with members of intervention staff was: *‘What involvement is there in [intervention] from the football club?’*. This was intended only to elicit background information on the programmes and by its nature was not asked of the other participant groups. However, both in response to this question and at other times in their interviews intervention staff discussed the effects

of an association with a football club on children's engagement in the programmes. Other participant groups did contribute to the theme, as demonstrated via the quotes below, but to a lesser extent than the intervention staff potentially because they were not specifically signposted to think about the relationship between the programmes and the football clubs.

Adding to their status as school visitors, intervention staff perceived that their associations with football clubs had a positive influence on children's engagement. For instance, the associations helped to build a rapport: 'the kids will ask questions… "Do you get to see the players?" and "Do you go to games?"… and you strike up a conversation… You form that relationship… that bond. Which helps with the engagement, for some' (IS1, intervention 2). Being associated with a football club was perceived to be especially effective in engaging children who might be less inclined to participate in other school lessons 'because they've got an interest in football' (IS1, intervention 2):

> It's all around the brand… It's… an easy… door into… with some kids, especially the disengaged kids that we… work with… quite a lot of the time… It's just a… good talking point to start with, if nothing else. … It's something as simple as they say… "Who's seen the score?"… whereas if you weren't from [football club] you'd have to find some common ground straight away, but obviously you walk in with the tracksuit on, it's a great barrier broke, straight away. (IS5, intervention 1)

> I think the people [that designed the intervention] knew… how powerful the brand of the football was, and… how much kids bought into it… so, what they thought was, "Right, if we can use the power of the badge, the power of the football, that's… a great way of engaging with… young people… at primary level." … rather than… someone going in with… a shirt and tie on in a classroom setting, going, "Right, do this," or, "Don't do that," they just thought it was… more of an informal, engaging way to… hook the kids in, and then pass on the messages. (IS4, intervention 2)

On the other hand, one child and their parent both noted that although the child had enjoyed the programme, they were 'quite disappointed because not very much of it was football!' (C1, drugs education programme). This is a potential drawback of an association with a football club for children's engagement in the interventions, but one of which intervention staff were very aware:

> the first lesson it's something I would always say… it's not going to be all football. It's just going to be fun games. …there'll be someone rubbing their hands, going, "I can't wait for this," 'cause they love football. But there'll be one or two sitting there thinking, "Ooh, I'm not sure about this." They don't know what to expect… Are they going to have to score goals? …But we just, sort of, relax them and say, "Look, they're… just fun. Don't worry about it." Everyone buys into it. (IS4, intervention 2)

Similarly, there were potential barriers to engagement associated with the particular football team being represented: 'we would never really approach schools on that side of… the border because it just wouldn't work. If I go into the middle of [city] and say, "Who wants to listen to me?", nobody's gonna' (IS7, intervention 1). Other facilitators found that pupils who supported other clubs still engaged 'because [the people in the workbooks] are footballers and if they've got an interest in the sport… they are still recognised and they know their names' (IS1, intervention 2).

Although funding had an impact on availability, rewards linked to the football clubs had at times been available to promote engagement, for example: 'little collectable cards… with different players on… each player would give a different message, and it was just an incentive… If they'd done something particularly well in the lesson, the staff would then give those out' (IS3, intervention 2). Player visits were also possible but infrequent, and these had a pronounced impact on engagement when they occurred: 'the players have got really busy schedules… if we're able to get them then they… can come… and join in with the kids… you're not gonna lose a kid when there's a professional footballer standing in front of them' (IS8, intervention 1). However, there were two main ways in which an association with a football club was felt to promote engagement in the day-to-day running of the programmes: by acting as a 'hook' to trigger children's immediate interest in the interventions, and because it meant that programme facilitators were seen as role models by the pupils. These subthemes are discussed below.

*Subtheme 1: Initial 'hook'*

One member of intervention staff described the association with the football club as the initial 'hook' (IS4, intervention 2) for the children, and school staff agreed: 'I think

with it being an outside agency that's come in, the children… have an interest initially because of the fact it's someone different. But then they see the [football club] badges, which *really* gets them going' (SS5, fitness and nutrition and discrimination programmes).

It was clear that children responded positively to the football club brands: 'even if they're not that PE-orientated… once they… see the badge and [facilitator]… they tend to… buy into it a little bit more. … the participation's there. And then, once that starts… it seems to kind of steamroll' (IS1, intervention 2). Course content continued to be linked to football throughout the programmes – '[we] use the football club and footballers as a case study to try and deliver the messages of… discrimination to children' (IS7, discrimination programme) – but it was the children's immediate interest upon learning that they would be working with the football club foundations that featured most prominently in the transcripts. The facilitator who used the term 'hook' felt that:

> football in the North East particularly… it's a huge sport. … Everyone's got an attachment to it. … even maybe boys and girls who don't like football… we used to give out football cards with players on, and… because they recognise the brand, and how powerful it is, they still want to be associated with it because… their dad might, or their gran, or… someone in their family, generally, would probably have an affinity to the club… so even though they might not personally like the sport… they're quite proud they've got the [football club] badge, or they've got a player [card]. Er, like, I'm not a particularly huge car fan, but if someone came to me from Ferrari, you think, "Ooh." It's… like, a prestige thing, isn't it? … They want to be associated with success… so, to have that contact, they like it. (IS4, intervention 2)

*Subtheme 2: Role models*

Intervention staff noted their status as 'role models' in that pupils would 'see the badge, the tracksuit, and… they'll really engage because of that' (IS1, intervention 2). Again, this may be particularly so for those pupils who are usually less engaged:

> The fact that it's people from [football club] coming, who are fit and healthy and promoting it, and that they've got the skills… It's just fact that they look up to people from [football club]. If they come in here, young lads come in here, wearing a [football club] jacket and top, especially the more difficult boys look up to them and will listen. They've got that respect straight away. (SS6,

fitness and nutrition and discrimination programmes)

Although they did not comment on the intervention staff directly, children and parents valued other physical activity facilitators at school as role models: 'I think it's really good because… [facilitator]… was a professional gymnast, so… it feels like they're role models to you' (C1); 'I just think it's good that they have… something to look up to. And it might be just that person's… aspiration to be like [facilitator]… and to get fitter' (P3).

A further way in which role models encouraged children's engagement in the interventions was through references being made to professional footballers in the course content and materials. Children were reported to respond well to this: 'the workbooks that we have, they're all [football club] embossed, so you've got players on, so [the children are] excited by that, and… "Oh, well… I must follow their… pattern"' (IS4, intervention 2).

*8.3.2.4 Theme 4: Children's Personal Circumstances and Characteristics*

To conclude the findings pertaining to the engagement research question, a number of individual circumstances and characteristics were noted by participants to have a possible bearing on children's degree of engagement in the sessions. For instance, as noted under the 'children's enjoyment' theme, some children had more of a natural inclination towards PA participation. In addition, children were recognised to have different learning styles and ability levels; however, intervention staff reported modifying their materials and delivery to account for such variables:

> We've got resources that are sometimes quite maths-based, so we'll look at… food labelling and we use a little chart – like a traffic light chart – to understand what fats and sugars are in certain foods. And that can be quite difficult for children that struggle with numeracy… so, again we just adapt it and make it a little bit easier, or even just explain it a little bit more than what we would with a higher ability class. (IS7, fitness and nutrition programme)

It was clear from the transcripts that in the vast majority of cases children engaged well with the programmes. Although some were noted not to be as engaged as others, this did not seem to be specific to the interventions:

> [one of our classmates] doesn't really get involved, but, like, he doesn't really get involved in anything because he's a bit… shy and he doesn't interact with that many people but his teachers? And… he doesn't, like, really interact with it the most. But I think he's just the only one in the class, but… the rest of us do. (C5, self-esteem programme)

Three factors constituting personal circumstances and characteristics which might affect children's level of engagement in the programmes were particularly prevalent across the data set. These are presented below as the following subthemes: i) family and home, ii) gender, and iii) illness and injury.

*Subtheme 1: Family and home*

Intervention staff described that both of the interventions aspired to engender positive behaviours beyond the duration of the programmes. It was apparent from participants' reports that such long-term behaviour change would be to an extent dependent upon the support received by children from their families, and in particular from their parents. As can be seen from the below account, the 'family and home' subtheme is strongly related to the outcomes research question. It is however presented here because the engagement research question was concerned with the *how* of the interventions (i.e. the mechanisms by which the programmes led to success or otherwise), while the outcomes research question addressed the *what* of the interventions (i.e. the benefits or otherwise of taking part). The 'family and home' subtheme therefore represents the support from family members and the home environment which is likely to influence children's buy-in to the programmes. It is presented as a subtheme of the 'children's personal circumstances and characteristics' theme because it is reasonable to expect differences between children in the level of support received.

The contribution of parents – and others with whom children came into contact outside of school – to children's behaviours and choices was well recognised by the adult participants: 'Children might not understand what [racism and bullying] are. So… might be making the wrong choices, not knowing what they're doing… by making comments that they see their parents making, or so on. They just think it's the norm' (IS9, discrimination programme);

> I think the schools play a big part [in promoting healthy behaviour and positive choices, including being active], but I also think that we need to recognise the importance that the parents play on it. … we do have [the children] for a considerable amount of the time – and therefore that's why we play an important role – but if they're not getting that at home, as well, it's, sort of, trying to undo all of that when they get to school. And it's really hard work. (SS1, the role of primary schools in promoting positive choices)

Every week, the fitness and nutrition programme asked children to set themselves two goals to complete before the next session: a fitness goal and a food goal. Their ability to participate in this aspect of the programme might have been to some degree reliant upon their individual home environments because, for instance: 'food-wise, what children get put in front of them… from home is, I suppose, from the adults, really. From the parents. I suppose they can have a say in what they like and what they don't want' (IS9, intervention 1). When children were asked about their typical PA participation, PA outside of school generally occurred with or was promoted by their families: 'Nearly every day after school, me and my dad and brother and sister go to the park and start running round the field' (C1); '[I got into] running, swimming, biking and triathlon [because] …my dad… does triathlon' (C2).

The main finding regarding family and home was however that none of the parents in the study – all of whom had been interviewed in relation to intervention 2 – reported knowing much about the programmes in which their children were participating. There was no direct communication with parents regarding either of the interventions, and parents' knowledge of the programmes was therefore reliant upon their children telling them what they had been doing at school, but unfortunately: 'he hasn't really told us much about it at all, to be honest' (P1, drugs education programme); 'She's never mentioned it' (P4, racism programme); 'She's told us a little bit about it… what was it? Something about choices, and things like that? … But it's like, she'll be talking to us but then she'll go off on a rant about something else' (P3, self-esteem programme). As they did not know what their children had been doing, parents had been unable to encourage their involvement in the sessions and reinforce the messages being taught. Suggestions were made for the inclusion of 'anything within the… programme where you could, say, do some activities at home with… your parents so we… understand a little bit more' (P1, drugs education programme), which would help to support long-

term outcomes: 'And then we can, sort of, get involved and keep it going once they… or, if they've got a website… Just something… some information where we can keep it going for a little bit longer' (P2, self-esteem programme). It was even suggested that as well as eliciting the encouragement of healthy behaviours *from* families, introducing activities to complete at home would be encouraging *for* families:

> maybe having some activities where they can do it with their family and encourage families to become more active. I know as a family that's where we sometimes fall down. With… both being at work all week or whatever, the last thing you want to do is go for a walk or whatever, but I think if it was because it was part of the school and then [daughter] had to, sort of, write about what she did on her walk, or… some explanation. As a family we'd probably then go out of our way to do it? Because it was to support [daughter]… at school. (P2, self-esteem programme)

Some of the members of intervention staff – including intervention staff responsible for intervention 1 – reported that they were looking into communicating with parents in future:

> we did discuss… do parents really know what their kids are doing when they're doing [fitness and nutrition programme], or do they just know that [football club foundation] is coming in? So… we're, kind of, in the stages of… getting parents more involved… in handing out, like, resource packs and stuff so that the kids can go home and say, "Look, this is what we're doing with [football club foundation]," … In the next… couple of terms, parents are going to be a lot more aware of what [fitness and nutrition programme] is … hopefully… it's going to have an impact on the parents… "[I should] give me kid… a healthier packed lunch and they probably need to be doing a little bit of more exercise." … So, just little things like that. The books are there, and the things they get to take away, hopefully mam and dad are seeing them and it's encouraging them to… give their kids a healthier… lifestyle. (IS8)

*Subtheme 2: Gender*

Some of the school staff and parents felt that gender played a role in children's PA preferences – 'Obviously there's certain PE lessons that appeal more to the boys or to the girls, and vice-versa' (SS1) – although the children tended to draw less of a distinction: '[in PE] we've been doing tag rugby… and… before hockey, we were playing… gymnastics. … we've been doing dancing… handball and football, and stuff? And… it's really fun. Like, boys and girls both like doing it' (C5). There was

however agreement that in general girls did not enjoy football as much as boys and that this was a potential barrier in relation to their engagement in the PA aspect of the sessions: 'the girls were saying, "Oh, I don't want to do football! I don't want to do football!"' (SS3, discrimination programme). Accordingly, as described under the 'association with football club' theme, facilitators were careful to inform the children at the beginning of the programmes that the PA component of the sessions would consist of a variety of games.

No sex differences in relation to the classroom component of the interventions were noted, and one of the school staff who had been involved in an unrelated project on delivering the curriculum through football had not found this approach to be detrimental to girls' engagement: 'even some of the girls who aren't into it can actually access it. And they like it' (SS6).

*Subtheme 3: Illness and injury*

In a small number of cases, children's illnesses or injuries were cited as having an impact upon their ability to take part in physical activity. If they were unable to participate in the PA component of the interventions they could observe their classmates so they were 'still hearing the messages' (IS3, intervention 2) or, as described under the 'autonomy and active involvement' subtheme of the 'children's enjoyment' theme, they might be asked to take on another role in order to remain actively engaged:

> We had a little girl who'd hurt her wrist? So they'd given her a whiteboard and a pen and said, "You're the tactical… whatever," and… "You're going to look for this and you're going to look for that. You're like my right-hand man." … and at the end of it they were saying… "What did you see?" So… for all she couldn't do the physical part of it, they still involved her. (SS5, discrimination programme)

Children were also caught up on missed content from the classroom component of the sessions if they were absent from school, supporting their engagement in later learning:

> I was off for one session but they filled us in, like, a lot… because we were

doing… your brain, your heart… I didn't know about most of the stuff, so… [facilitator] just filled us in on all of them, so I knew what to do. (C2, drugs education programme)

### *8.3.3 Research Question 3: Outcomes*

The thematic map for the outcomes research question is presented in Figure 8.3. A number of benefits of intervention participation for children were identified, and these were broadly categorised as pertaining to their wellbeing and personal development (theme 1). Although the outcomes of increased PA participation – both during the intervention sessions and encouraged as part of a healthy lifestyle – could additionally be considered to relate to children's wellbeing and personal development (e.g. improved physical wellbeing), the outcomes of increased PA are presented under a separate theme (theme 2) because participants tended to readily appreciate the outcomes of non-intervention PA participation but reported PA-related outcomes less frequently when reflecting on the interventions and in particular the programmes pertaining to PSHE topics other than fitness and nutrition. Moving beyond the outcomes for children, participants also discussed the benefits of the interventions for teacher development (theme 3).

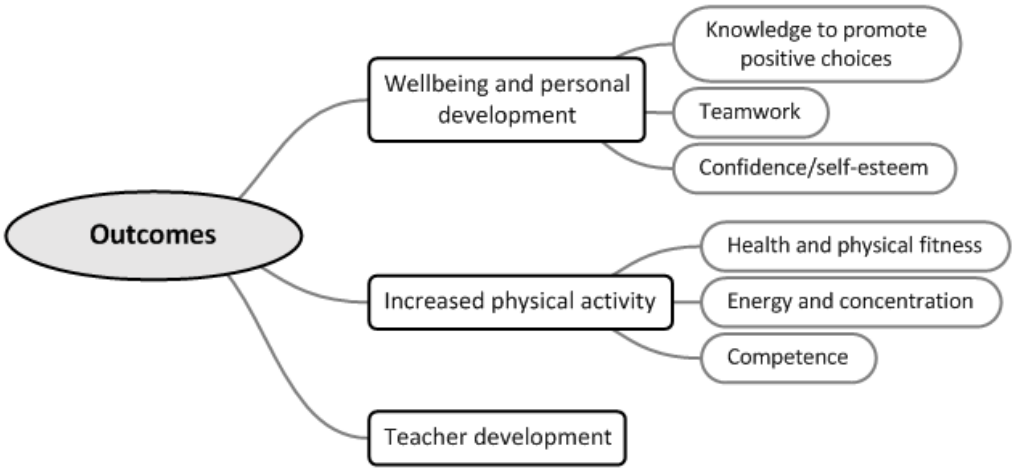



*Figure 8.3. Final thematic map for research question 3: Intervention outcomes*

#### *8.3.3.1 Theme 1: Wellbeing and Personal Development*

Participants were very positive about the interventions and felt that one of the outcomes of children's participation was 'Enjoyment. Yeah. Overall enjoyment' (IS1,

intervention 2); 'honestly… everyone's… I don't know, they just… they seem *happier*?' (SS2, drugs education programme).

There was a pervasive sense amongst the adults of the programmes being 'really good' (SS5, discrimination and fitness and nutrition programmes) for the children, with some of the participants specifying benefits for 'mental health… physical health… emotional health' (SS6, discrimination and fitness and nutrition programmes) and that 'it's a good way to… teach them that… they're going to be good at some things, but not everything, but… they're still good to some degree, and to support each other to do that' (P2, self-esteem programme). One of the members of school staff also noted that the programmes had supported the efforts of school staff in 'keeping [the children] positive… I think this has really, really helped a lot' (SS5, discrimination and fitness and nutrition programmes). Changes in the pupils were noted by school and intervention staff to occur over the course of the programmes: 'week one and two, you might get nothing, but then, as they get to know you… week three, four and five, six… they come on loads' (IS2, intervention 2).

In particular, three outcomes relating to children's wellbeing and personal development were identified from the transcripts. These are presented below as the following subthemes: i) knowledge to promote positive choices, ii) teamwork, and iii) confidence/self-esteem.

*Subtheme 1: Knowledge to promote positive choices*

There can be little doubt that the participants felt that both of the interventions successfully developed children's knowledge and understanding of the PSHE topics covered, with all of the transcripts bar three (two for school staff and one for children) touching upon this as an outcome. Intervention staff reported on the findings from the questionnaires children were asked to complete in the first and final sessions of the programmes, which provided a demonstration of their knowledge: 'overall… the figures [at the end of the intervention]… are fairly high. Generally it's over 90% in each class' (IS1, intervention 2);

> definitely kids get out of it… a lot more knowledge on what they should and shouldn't be eating. And… we know that, because when we do the quizzes in

> week six and we compare the scores [with the scores from week one]… they're getting a lot more answers correct (IS8, fitness and nutrition programme)

Children's accounts indicated possible differences between programmes in the amount or type of knowledge acquired, or at least in the degree to which they could express what they had learnt. For instance, while children who had taken part in the self-esteem programme were able to report that they had learnt 'how your… self-esteem can go up and how it can go down' (C6) and that 'we all have good days and off days and in-the-middle days' (C5), subject knowledge was especially evident for those who had taken part in the drugs education programme. These children were able to list many facts about the types and effects of drugs and demonstrated an understanding of how drug use can begin: 'I've learnt… which [drugs] are allowed, like medicine and tablets, and which… aren't, like cocaine and weed' (C4);

> in the [work]book… it said that there was people that were curious or they were just bored and they'd tried alcohol… or they tried drugs. If you try them… your personality could change… and then you could get addicted to it and it could just change, like, your lifestyle. Your career. (C3)

It was envisaged that knowledge gained from the interventions would help children in practical ways, such as by encouraging healthy eating and providing them with the skills to resist peer pressure and to raise their own/others' self-esteem. There were some limited examples of knowledge having been applied over the duration of the programmes, for instance in relation to self-esteem: '[her brother]'ll do something, and she's like, "You're doing really good, there!"' (P3). Children did report that they had learnt how to make positive choices by following courses of action recommended by intervention staff but also by considering the consequences of their actions: 'we've learnt… if someone's trying to make you do something, if you don't want to do it then you have to stick with what you want to do and say no' (C5, self-esteem programme). Largely, however, adults felt that the practical outcomes of any knowledge acquired were difficult to measure because they might not take effect until later in life – perhaps at secondary school – or when faced with specific situations (e.g. peer pressure, being offered drugs). They might even be demonstrated through a *lack* of a behaviour (e.g. bullying, racism), which it would be difficult to determine might otherwise have

occurred: ‘it’s hard to tell because by me telling a certain individual that it’s really important to encourage and support people… that could have stopped them from potentially bullying, maybe, someone… a week later’ (IS4, intervention 2).

To complete the account of this subtheme, there was a single instance in which programme content had at least initially been thought to trigger a negative outcome for a child, but this was quickly addressed by intervention staff revisiting the programme messages to try to ensure that appropriate knowledge was taken away:

> we’ve had a school in the past who’s approached us after our… [fitness and nutrition programme] and said, “One of the kids isn’t eating because they think it’s bad for them.” It wasn’t that, at all. It didn’t turn out to be like that, it turned out to be various other issues. But we instantly said, “Right, we’ll come back in, and we’ll say, “…Diet *is* eating food. So, you have to eat food.”” … and we went in there, reinforced it, and the child was fine in the end. … it didn’t escalate into anything bad and, as I say, it was probably down to numerous different factors. (IS7)

*Subtheme 2: Teamwork*

The second most prevalent subtheme relating to wellbeing and personal development was that of teamwork. While three of the school staff and one parent noted that PE and out-of-school PA participation provided the opportunity for children to learn about teamwork, there was a much stronger sense that the interventions promoted this, including from the children themselves: ‘[the facilitator says it’s] just about having fun and working together as a team’ (C7, racism programme);

> we don’t normally communicate in PE. PE, it’s more like – well, we do – it’s, like, more of teams, but it wasn’t really *teamwork*… Like, we had small teams every now and then but it was more, like, for ourselves than, like, communicating. (C4, contrasting PE with the drugs education programme)

Both interventions aimed to incorporate teamwork into the PA component of the sessions: ‘The games are really… all about teamwork… getting everyone together, whether they’re in small teams or one big team, to work together and help each other’ (IS1, intervention 2); ‘it does really help kids grow in confidence to work with other kids, and teamwork and stuff like that, doing practical sessions’ (IS8, intervention 1).

Although there was a greater emphasis on teamwork in the PA aspect of the sessions, positive peer relationships were additionally promoted in the classroom and then reinforced through the PA:

> Really goes well with… being in the classroom, because… they do some partner work, but then when they go outside it's all about… talking about peer pressure, and maybe they're not in a team with some of their friends? And it's getting along and how to, like, play and interact with… doesn't matter who it is. (SS2, drugs education programme)

Despite the perception that children had learnt about communication and cooperation through participating in the programmes, few examples of observed teamwork were offered. It did however appear in some cases that the programmes had fostered positive interactions between pupils. For instance, one of the intervention staff reported that:

> by the end of… the course everyone's, sort of, in harmony and they're all supporting each other. … it was lovely to see, 'cause you could see it first-hand… you can see it developing as the weeks go by. … I used to get feedback… from the teachers… And again, off the top of me head… – it was all positive – but it was… a mixed bag, really, that they could see… the peer support in their lessons had improved. It had spilled over into the classrooms… afterwards. (IS4, intervention 2)

*Subtheme 3: Confidence/self-esteem*

Across the data set, self-esteem was in all but one instance mentioned in the context of – and in the same sentence as – confidence, so in order to reflect the data no academic distinction is drawn between the two constructs in the findings.

Two of the intervention 2 facilitators had notably strong feelings about the role of the intervention in developing children's confidence/self-esteem: 'the most benefits I would say was probably… self-esteem, and confidence building, and just having that peer support where they're all, sort of… helping each other out' (IS4, intervention 2). IS2 directly referenced two of the factors explored under the engagement research question as mechanisms through which confidence was boosted: enjoyment and autonomy and active involvement through 'giving them that little bit of a different role [in the PA component] and… essentially putting your faith in them… being able to do

something that little bit different' (IS2, intervention 2). One of the intervention 1 facilitators also reported on confidence as an outcome in the PA aspect of the sessions, seemingly due to pupils' increased exposure to activities:

> with it being just a mixed class of ability, a lot of the kids haven't played football before and aren't that confident in playing team sports. So by playing football, playing other little games and team games, they grow a lot more confidence. (IS8, intervention 1)

Although none of the children reported feeling more confident, five of the six school staff identified increased confidence/self-esteem as an outcome and some provided examples of changes in pupils' behaviour within the intervention sessions: 'I think they're asking more questions. Confidence, I think' (SS2, drugs education programme); 'over the weeks they've relaxed… even the quiet ones'll put their hand up and have a go. And they're not afraid that they get something wrong. … and… they're putting their effort in outside [in the PA component]' (SS5, discrimination programme). Positive reinforcement was cited as contributing to pupils' increased self-esteem: 'my boys are quite competitive with… football… So… the skills when the boys… get the praise for that, I think that boosts them, as well. So, self-esteem's massive. Like, giving them… the positive attitude' (SS4, discrimination and fitness and nutrition programmes). As with IS8 above, familiarity through exposure was offered by SS3 as another reason for improved confidence levels, though with perhaps limited transferability beyond the intervention sessions:

> confidence, as well, I think. … a couple of my girls in my class… wouldn't want to take part in PE… and always didn't think they were very good at it – I mean, and they've still got that a little bit within them – but now when they know it's *this* session, anyway, they're happy to get changed and happy to go out 'cause I think… maybe they know what they're expecting. They're comfortable, maybe, with… the lads now, as well, with it being the same people, over and over. … on Monday we had, like, a spontaneous basketball session with [the children], and a couple of them… we could see they… didn't want to do it, still? So, it's still in there slightly but… I don't know whether it's just routine that they're familiar with, but [the intervention staff]… haven't had any issues with… those couple of girls today, getting ready. They've just gone straight out. (SS3, discrimination and fitness and nutrition programmes)

Finally, one of the parents had observed an increase in confidence in their child, and

both they and one of the intervention staff went on to contemplate the consequences of increased confidence for classroom behaviour:

> I have noticed that she's… probably is a little bit more confident… Her maths isn't that good… but she's been going to booster class, as well, and she… has the confidence in herself, now, with her maths. And maybe it is linked to these classes about her esteem and looking at, "You might not be the best at it, but you're good at this part of it"? That might be linking together. …She's, sort of, trying harder. (P2, self-esteem programme)

> if you've got a child who's confident, they're more likely to achieve? Because they're more likely to put themselves out there a little bit, put their hand up and answer a question. They're more likely to try new things, and… that, for me, is massive. If you've got a child who isn't confident enough to… put themselves out there and… answer questions, and they don't want the attention, they stress out in exams, it's all about just giving them the confidence to try, really, and that's a big deal. (IS2, intervention 2)

#### *8.3.3.2 Theme 2: Increased Physical Activity*

Although the interventions were delivered with complementary content in the classroom and PA aspects of the sessions, some of the outcomes of children's involvement were noticeably attributed to participation in the PA component. PA-related outcomes were more prominent in accounts pertaining to the fitness and nutrition programme, which – along with the discrimination programme within the same intervention model – explicitly aimed to improve children's physical fitness and to promote children's increased PA participation and confidence in participating in PA. However, across the data set it was not uncommon for participants to overlook PA-related outcomes of the interventions while at the same time readily appreciating the outcomes of PA participation more broadly. For these reasons, 'increased physical activity' is presented as its own theme within the outcomes research question, although it should not be viewed in isolation from the 'wellbeing and personal development' theme, especially as the health benefits of increased PA contribute to a child's physical wellbeing.

Intervention staff for the fitness and nutrition programme reported that being more active was 'the main outcome. … we like to think that the kids are active or… even if it's thinking about being active… that might be an outcome for one of [them]' (IS5);

‘from [the walking and balance tests in the final intervention session] they show improvements that they’ve increased their fitness levels and activity levels, so it’s doing its job’ (IS9). Alongside food goals, children were asked to set themselves goals to increase their PA outside of the intervention sessions: ‘we start them off slowly… it might just be something as simple as one lap of the playground at break time, run as fast as you can. Week two, you might increase it and do three laps’ (IS8). This input was appreciated by school staff and appeared to have made a difference to children’s PA participation:

> I think Year 5’s such a huge role, where the kids are starting to get… the high school hormones of where they’re going to stop doing it. … and I think if you start educating them early enough how important it is… that’s got to be… a good head start. (SS4, fitness and nutrition and discrimination programmes);

> the girls especially… they’ve started doing different things, and they’re joining in more on a playtime, as well. Where they would tend to be in their little huddles, they’re joining in with different things. And, you know, they’ll be picking up a skipping rope, or you can see them picking up the basketballs and things. So, they are joining in a lot more. (SS5, fitness and nutrition and discrimination programmes)

To a lesser degree, some of the participants involved in programmes with a focus on topics other than fitness and nutrition noted, ‘We got exercise!’ (C1, drugs education programme) and that PA participation was promoted through the programmes: ‘[facilitator] says that you have to be more active, to do more things and to realise what’s good or bad for you’ (C2, drugs education programme). Children had been introduced to ‘new games you can play… with your friends when you’re out on the street… that, like, only use a couple of cones or a ball. … so… it’s not complicated. You don’t need loads of equipment’ (C6, self-esteem programme). While the child who reported this had attempted to play these games but had been unsuccessful due to poor weather, one of the parents did identify increased PA as an outcome of the self-esteem programme:

> I think it’s better for them [than usual school PSHE and PE provision]. I know it’s encouraging [daughter] more, in that she wanted to go out and do more. Like, more sporty stuff. ‘Cause she’s not normally sporty. She hates it! I mean, she would hate walking; where now… she’ll say to us, “Howay, let’s go and take the dog out for an hour.” (P3)

Three main consequences of participation in PA during the sessions and/or greater overall PA participation, as promoted by the interventions, were identified. These are described below as the following subthemes: i) health and physical fitness, ii) energy and concentration, and iii) competence.

*Subtheme 1: Health and physical fitness*

Of the parents and school staff consulted about the programmes concerning PSHE topics other than fitness and nutrition, only one of the parents noted the potential benefits to physical health of intervention participation. Following an account from a parent of an increase in their daughter's PA levels (presented under the main 'increased physical activity' theme above), the other parent in the focus group linked increased PA to health benefits: 'I just think it's a good success story, from what I've just heard, there. You know, and… if it's gonna get children playing sports, getting more healthier, it's gotta be a massive positive, hasn't it?' (P3, self-esteem programme). It is noteworthy that this was the only recognition of the health-related outcomes of intervention 2 and that it came from a parent involved in the running of a sports club, while on the other hand the health and fitness benefits of non-intervention PA participation were well recognised: 'they obviously get fitter and respect themselves more' (P4);

> I think [school PA provision] is part of a wider… I can't say "issue", because [for my child] the physical side of things isn't an issue because he possibly couldn't do any more… but obviously… I think obesity and overweight… (P1)

Many more children than adults talked about health and fitness in relation to intervention 2, for instance: 'you get to keep fit and healthy when you do the physical activity' (C5, self-esteem programme); 'inside, it teaches you how you could stay, like, healthy, but then outside you *are* staying healthy, so that's, kind of, the relationship' (C3, drugs education programme). Like adults, children readily recognised that PA participation had benefits for physical health and fitness, and one group even suggested changing the self-esteem programme to 'maybe do a bit more about keeping healthy and fitter… other than just self-esteem' (C5).

Understandably, given the aims of its programmes, physical health outcomes were

more frequently noted by school staff with experience of intervention 1 than by those with experience of intervention 2. The programmes were valued for addressing health-related issues: 'in terms of the physical fitness we've found especially in girls we've got a rise in obesity. … which is where [football club foundation] fit in brilliantly, because they're very active' (SS6). School staff also reflected that they had a role to play in reinforcing messages during the course of the intervention and following its conclusion, and an example was given of how there had been post-intervention benefits for a pupil who had taken part in the fitness and nutrition programme earlier in the school year, supported by input from school staff:

> we've got one in particular… she struggled with her confidence and she was also struggling with her weight? … And we talked to her about the things that, like, the lads had said are good to eat. … And we've spoken about the exercise things. And she actually came in the other day and we said, "You need a new jumper 'cause that one's too big." So, you can actually see that she *has* taken it in, but her confidence has soared, as well. (SS5)

*Subtheme 2: Energy and concentration*

It was only intervention and school staff with experience of intervention 1 that mentioned the potential for the PA aspect of the sessions to motivate or tire children for any learning activities that followed. A handful of participants did however refer to these effects for non-intervention PA participation: '[PE] helps you be, like, motivated for the rest of the day and if it's on a morning… you feel a bit more awake and things. [laughs] And you're a bit more focused in your lessons' (C5); 'they're all quite energetic when they go out [for morning playtime] and then tired when they come back in' (SS2). It is interesting to note that one member of school staff with experience of both of the intervention 1 programmes felt particularly strongly that, 'Once they've got rid of that energy, they can focus' (SS6), while at the same time intervention staff for both of the interventions reported a preference amongst schools for programmes to be delivered in the afternoon.

In cases in which it was necessary to deliver the PA aspect of the sessions first (e.g. when two classes took part in an intervention simultaneously and changed over between the classroom and PA components halfway through a session), intervention staff saw advantages and drawbacks for the classroom aspect: 'that can work quite

well ‘cause… the kids burn off steam for the first hour and then you can actually get them to listen for the second hour’ (IS7, intervention 1); ‘I suppose if they do the games… in the first part, and they’re tired, and a bit hot and sweaty, lose concentration, they might not gain the knowledge they should be. Flip side’ (IS9, intervention 1). Tying in with reinforcement as one of the roles of PA in the programmes, one of the members of school staff whose pupils were participating in the PA aspect of the sessions before the classroom aspect reported that:

> I think it’s good ‘cause… they have the engagement physically, and then… when they come back in they can almost see the impact of… what that has done for them… And… whether it be true or not that their… brain be more in gear when… they participate in physical activity… they seem to be listening. I think maybe just ‘cause they maybe want a rest after they’ve done that, so now they’re just happy to sit down and they’re ready to learn. (SS3, discrimination programme)

*Subtheme 3: Competence*

Across the entire data set, an increase in movement-related competence was explicitly identified as an outcome of participation in the PA aspect of the interventions in only a single transcript. This belonged to a focus group with children who had been participating in the drugs education programme: ‘You… learn how to, like, move,’ and ‘you learn how to improve on your reaction skills. Like, on the first week… [the facilitator] shouted out something or… did actions which… made you improve on the reaction skills’ (C3). Despite a low level of prevalence within the data, physical competence was felt to be an important outcome to present here for discussion as it is clear from the children’s account that the facilitator was promoting it as an outcome yet it was not recognised to the same degree as other outcomes by stakeholders including intervention staff themselves. The development of physical skills – in some cases including an understanding of making movements – was however appreciated as an outcome of PA participation outside of the interventions: ‘we learnt… where you go like that [mimes a chest pass] and where you have to go like that to catch it [mimes an overhead catch with one hand] so it’s not too big of a hold’ (C2, school PE provision); ‘she can tell you… the different muscle groups that she’s using for different activities’ (P2, school PE provision); ‘[my football club] taught me really good stuff and… I’m really good at football, now’ (C1).

#### *8.3.3.3 Theme 3: Teacher Development*

In addition to the above intervention outcomes for children, there were outcomes for school staff in that they had the chance to observe the delivery of the sessions and to learn from the methods employed by intervention staff. The foundation behind intervention 1 was beginning to seek to promote teacher development through the courses they offered, and their discrimination and fitness and nutrition programmes were recognised by school staff as an opportunity for continuing professional development (CPD): 'it's quite nice because… it supports the teachers… like [teacher]… I mean, that's supported *her* in developing *her* role, and she's learnt skills through it that she'll then carry on in the classroom and in her lessons' (SS6); 'for my own CPD, as well… if you're going to be taught by the best for football, then get them in, I think, so… we can all learn together' (SS3). Intervention 2 was felt also to have benefits for teacher development (e.g. learning new games to play with pupils), though from the prevalence and content of comments it was seemingly less frequently recognised than intervention 1 as an opportunity for CPD. Nevertheless, during their interview one of the members of school staff considered using the classroom/PA format in future teaching:

> I suppose thinking about it now, the idea of mixing in the two activities is something that I perhaps… if I knew I was having to do something in PSHE that was quite… hard-hitting… then maybe planning some sort of activity after that would be quite a good idea… to break it down. So, I think, yeah, I would consider that. (SS1, racism programme)

There was an inclination for teachers to be interested especially in the PA component of the intervention sessions for CPD opportunities. Data extracts from the 'delivery by a non-teacher' theme from the engagement research question acknowledged that having external providers deliver PE was 'really handy because not every teacher has… a background in sport. I know I personally don't. … I teach my… PE lessons but I can't say I'm an expert' (SS1). Intervention staff were however specialised in this area: 'our strengths… as opposed to [teaching staff]… would be the practical' (IS6, intervention 1). One of the intervention staff described that:

> I know a lot of teachers that deliver PE and they're not very comfortable with it. … the PE side of things is… kind of rushed with a lot of teachers… a

> [Postgraduate Certificate in Education], which lasted a year [contained] one afternoon covering PE. … so a lot of teachers, you know, they don't go in with that confidence of being able to deliver a physical activity session when they've been given so little training on it. (IS2)

### *8.3.4 Research Question 4: Sustainability*

Two main themes linked to sustainability were identified: i) funding, with appropriate income/covering of costs being necessary to ensure the continued running of the interventions, and ii) school awareness and acceptance of interventions to support their ongoing uptake by primary schools (Figure 8.4).

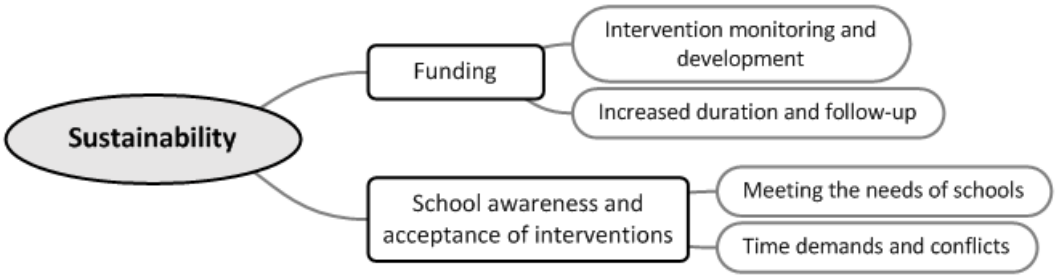



*Figure 8.4. Final thematic map for research question 4: Sustainability of intervention delivery*

#### *8.3.4.1 Theme 1: Funding*

The question of the sustainability of the interventions essentially came down to whether or not they would remain financially viable. Intervention staff involved in intervention 2 explained that the sustainability of their programmes was largely dependent upon continued funding from the local council. Although schools were able to purchase the programmes, receiving one for free removed cost as a possible barrier to uptake. Intervention staff involved in intervention 1 described that schools would usually access the fitness and nutrition and discrimination programmes by buying a package offering PE provision for the whole academic year with the 'bolt-on' (IS5) of the intervention programmes and after-school PE-related CPD sessions for school staff. Alternatively, schools could purchase the individual intervention programmes independently of the PE provision at any time throughout the year. The majority of any additional funding again came from the local council, with some further funding having been received from football- and health-related organisations. Two of the

intervention 1 staff recognised cost as a potential barrier for schools, but a third noted that the PE and sport premium for primary schools had recently been doubled (Department for Education, 2017), which one of the school staff felt meant that 'for this year, anyway, there's no reason why schools can't… choose to – and they should be – bringing outside providers in' (SS3).

Funding sometimes had an impact on programme content. For example, when an organisation concerned with heart health had provided some funding for the fitness and nutrition programme, the course had been adapted to include 'a little bit about the heart and having healthy hearts… so the design is based around… things that we feel's important and… avenues that we have to go down because of the needs of the school or… funders' (IS7). However, continued funding was uncertain:

> we don't know what's going to happen with funding in the future. Whether the council's going to have the same kind of money that they did before… whether [a particular topic is] big on the current government's agenda or not. … it's very difficult. So that's why we're now developing these new programmes. So hopefully… next academic year, if it does get cut – the funding for [intervention 2] – we can say, "Right, we now do this, and this is big on the government's agenda. This is how we can… support the schools and support the children… and meet the government's agenda." But you're, kind of, constantly battling… with regards to… what people want, and who wants what. … It's very difficult. (IS2)

As indicated in this quotation, one of the ways in which the football club foundations sought to maintain funding was through ongoing monitoring and development of the interventions. Funding did however limit the duration of the interventions, which were often noted by participants to be rather short. These issues are described further in the subthemes below.

*Subtheme 1: Intervention monitoring and development*

Both of the interventions had regular review processes in which feedback from stakeholders – including those delivering the sessions – was used to 'try and adjust lessons based on what the children want and what the children need' (IS2, intervention 2). This might simply be changing tasks and content that pupils found difficult to understand, making the interventions more favourable to the organisations funding

them/schools buying them; 'just little tweaks. Just, as I say, so we… can stay on track and we're always refreshing it and it will not become as stale and just always improving' (IS8, fitness and nutrition programme).

The interventions also both made use of programme-specific questionnaires during their first and final sessions in order to assess improvements in children's knowledge, with additional walking and balance tests in intervention 1 to assess improvements in their fitness. As well as assisting in making adjustments to the intervention content and delivery where appropriate, intervention staff appreciated the role of measuring outcomes in monitoring the success of the programmes and in attracting continued funding: 'we'll contact [the teachers] for… quotes, for example, for the termly reports [for the funder], and… they'll send us… the real-life examples of how [a pupil] was before, and how [they are] now performing in schools' (IS3, intervention 2);

> if we just did [fitness and nutrition programme] for six weeks and there was no monitoring and evaluating at the end, and no outcomes… the schools might turn round and say, "Well, what was the point in [fitness and nutrition programme]?" But when we're giving them hard information; evidence… that, "Look… seventy percent of the kids have increased their knowledge of healthy eating. Ninety-five percent of the kids have increased their physical activity scores," schools are going to take note and go, "Well, [fitness and nutrition programme]'s working." (IS8)

However, as described in relation to the outcomes research question, one of the main goals of the interventions was to promote positive choices, and this was a difficult outcome to measure due to its lifelong nature and possible dependence upon encountering specific situations (e.g. being offered drugs). Intervention staff reported they had 'never done any studies… to look at long-term impacts' (IS3, intervention 2).

One of the ways in which the foundation responsible for intervention 2 was planning for the future was through the development of additional programmes. Intervention staff had identified that 'at the minute there's a big focus by the government on British values… So… We're adding to [the intervention]' (IS2). The foundation responsible for intervention 1 was beginning to promote their programmes as part of an overall package of programmes they would run in a school over the course of an academic

year. Both courses of action were focused on the marketability/funding potential of the interventions.

*Subtheme 2: Increased duration and follow-up*

A highly prevalent issue, discussed by all of the stakeholder groups, was that of the limited duration of the interventions, and in the case of intervention 2 – with 30 minutes of classroom learning and 30 minutes of PA – its sessions: 'six weeks is not an awful lot of time, is it?' (P3, self-esteem programme); 'I think the kids would get more out of it if they could divulge loads… more questions… And having a bit of time to just say, "Oh, I don't really understand that. I'm going to, maybe, ask that question"' (SS2, drugs education programme). While one of the intervention 2 staff suggested that sessions of any longer than 75 minutes – a 15-minute increase on the current duration – might result in poorer engagement when catering for the attention spans of some pupils, they did feel that over the course of a 10- or 12-week programme 'you would see that journey and that impact a little bit more, I would think' (IS1).

Bringing together the issues of long-term outcome monitoring and limited programme duration, some of the parents, school staff and intervention staff discussed introducing follow-up sessions:

> maybe even going back at the end of the next term… and saying… "Remember when we did that? How do you feel about that now? Have you made any changes?"… and just following it up a little bit. Mainly to, kind of, get more feedback from them, 'cause the feedback you get at the end of the course is more, kind of, a reaction whilst you're there. Whereas if you give them that extra half term, it would be a bit of reflection: "What have I actually taken from this? How much of a difference have I seen in myself?" (IS2, intervention 2)

One of the school staff felt that if intervention staff were to follow up with the children, not only would this allow the impact of the programmes to be measured but it might in itself *contribute* to their impact because 'it isn't just how they see themselves but, I don't know, the thought of [football club] tracking them… Bigger impact. … And just them knowing. You know, that they've got somebody' (SS6, intervention 1). With the transition to secondary school being mentioned by a number of participants as an important issue for pupils in upper primary school, the same member of school staff

and one of the parents suggested that follow-up sessions could take place at secondary school to 'see how they're doing… – 'cause it's going to be a big step for them, going to the comprehensive, anyway – and see how… they're coping with it, there' (P3, self-esteem programme).

Despite this apparent demand, there was an obstacle to running longer programmes in that 'everything we do's subject to funding' (IS7, intervention 1). Even follow-up sessions could be problematic: 'We used to do revisits in schools, which is something… we're gonna try and start again this year, but it's all to do with staffing and whether we've got time to do it' (IS6, intervention 1). The promotion of long-term outcomes might however be possible without the need to seek additional funding or to increase the cost of the interventions; although there were no direct follow-on courses for children to pursue after participating in the interventions, intervention staff reported that their foundations ran 'lots of different activities… we try and signpost children and families onto' (IS9, intervention 1). Children were therefore able to maintain a relationship with the foundations – though possibly not the same members of delivery staff – if they were able to take up these opportunities. Additionally, if their families were to become involved in programmes which invited children and adults to participate together, then family members would be able to reinforce programme messages at home and help to support long-term outcomes, for instance by preparing healthier meals. The teacher development outcomes might also in essence extend the programmes because 'if teachers are getting that knowledge of what we can provide in terms of games, then there's no reason why children should be dropping their activity levels' (IS9, intervention 1), and 'teachers do comment on how… "Since your lesson last week, we've discussed… self-esteem again. We've looked at different examples of peer pressure. We've watched this video… which showed… a good example." So, yeah, they do reinforce it' (IS1).

#### *8.3.4.2 Theme 2: School Awareness and Acceptance of Interventions*

Ultimately, members of school staff decide whether or not to buy a programme or to accept a funded programme for their pupils. Fundamentally, therefore, intervention uptake – and by extension the continuation of the interventions as a result of adequate demand – relies upon school staff having an awareness of the programmes available to them and an appreciation of their value for the school and its pupils. This awareness

and appreciation was felt to be supported by a prior involvement with the football club foundations, if not direct experience of the programmes themselves; when asked why they chose for their pupils to take part in the fitness and nutrition programme, one of the school staff said: 'because in the past when we've done [it], the children have absolutely loved it' (SS6). Two of the intervention 2 staff felt there might be a misperception of the programmes amongst schools without such prior experience, and in this manner an association with a football club might present a barrier to uptake:

> one school in particular… we struggled… to get access to, and it was through… a teacher who had worked previously at a different school… we managed to get access. …the school had no experience with us… and I think initially they thought, "Well, you know, they must just do football coaching." (IS1)

Another member of intervention staff (IS7) also noted as a potential barrier to uptake that schools might have already bought into sport packages with other organisations, including neighbouring football club foundations. On the other hand, with many of the school staff – and one of the parents in particular – speaking highly of their schools' promotion of healthy and safe behaviours including sport and PA, a culture supportive of these elements of children's education might have played a positive role in the decisions of school staff to take up the interventions. The foundations attempted to increase the acceptability of the programmes to schools by covering content that met their needs, although time demands were an often-cited difficulty for the accommodation of the programmes in school timetables. These issues are described in the subthemes below.

*Subtheme 1: Meeting the needs of schools*

Intervention staff reported that one of the selling points of the programmes for schools was that 'they map to… the national curriculum, in the PSHE section' (IS1, intervention 2), meaning that they were able to help schools meet the guidance for the learning they would be anticipated to provide for their pupils, including academy schools which are not bound by the national curriculum but are required to provide a "balanced and broadly based curriculum" (Academies Act 2010, s.1). In some instances, the PA component of the interventions was in addition counted by schools towards children's weekly PE allocation. The fitness and nutrition programme was in

particular noted not only to cover PSHE content but also tied in with the curriculum for science and PE: 'we talk about the digestive system, which is a big part of the science curriculum. We talk about where energy comes from, which again is part of the science curriculum' (IS7); 'Our games, we try to keep it similar to the PE curriculum so they're learning what they should be learning, rather than go in and play six weeks of football' (IS9).

School staff agreed that the interventions met their needs and were suitable in the current educational context: 'from what I've seen it's covered issues that it needs to cover in an appropriate way' (SS1, racism programme); 'PE has suddenly become huge… I think the government's finally said, "Right, we really need to push to get people fit, or at least just healthy"' (SS6). At the same time, one of the intervention staff highlighted the importance of achieving a balance between meeting the needs of the schools and engaging the children:

> if you go too far one way or the other, if you design a course that's perfect for schools, and they say, "Oh, yeah, brilliant! It ticks all these boxes for Ofsted," you might not get the engagement from the children, whereas if you go the other way and say, "Right, we're going to go in, we're going to engage these kids, [laughs] and we're going to do games the whole time," then the school's not going to be on board with it. So, for me, it would be finding that balance of doing the right amount of educational work linked to the curriculum in a way that's engaging to the children. (IS2, intervention 2)

Intervention staff described the range of programmes contained within intervention 2 as a strength because this allowed school staff to select programmes addressing any issues their pupils were directly experiencing, thereby meeting the needs of schools beyond those of delivering the curriculum. Similarly, there was enough flexibility within each of the interventions to cater for requests concerning the needs of specific groups; for example: 'there was a few incidents… of bullying within the class, and [the school staff] said, "Can you try and focus around that subject?"… I used a few snippets from [the bullying] workbook and brought it into the self-esteem course' (IS1, intervention 2).

*Subtheme 2: Time demands and conflicts*

Although the interventions were felt to be 'really good because… we don't get the

chance to divulge into all the different topics that [facilitator] can… There's just not enough hours in the day' (SS2), time was more frequently identified as a barrier to intervention uptake: 'schools quite often don't want to give up mornings because they're doing their numeracy and literacy. So… they'll want an afternoon, and that's the only barrier, really… they've got to give up… the two hours a week' (IS6, fitness and nutrition programme). Delivery to Year 6 classes in the half-term preceding their SATs examinations was noted to be especially unlikely due to school time being focused on preparation for these examinations: 'I know some schools at this point in the year, they stop the Year 6s going to do sports events and other things' (SS6); however, in 'the last half term of summer… they've done their SATs and they've got nothing on, particularly… They're not gonna start anything else. So, that's already… really heavily booked' (IS6, fitness and nutrition programme). While such accounts indicated that some schools prioritised core curriculum subjects, it was clear from across the interviews/focus groups that PSHE and PA opportunities were valued. One of the parents suggested that *greater* school time should be allocated to PA: 'I definitely think one… hour per week [of PE] is not enough. … They might do [some PA] every day… but I think they should do a little bit more of it' (P1).

With school staff reporting that it was difficult 'trying to fit everything in' (SS4) during the school day, intervention staff made the duration of both the classroom and PA components of the intervention sessions as flexible as possible to address this potential barrier to uptake. It was however not always possible to ensure that the scheduling of the sessions did not conflict with other school activities:

> [fitness and nutrition programme] generally is… two hours. And there's times, as I say: kids getting changed, that knocks fifteen minutes off… mornings, sometimes you're booked in nine to twelve but from nine to quarter to ten you're doing… the classroom side of things and then they've got a half an hour break… They've got to do reading, so kids are, like, popping in and out. … It can't be helped. … You've got to give what the school wants, but at the same time it needs to be appropriate so that the kids are getting something out of it, so it's not being rushed. (IS8)

> It's obviously got positives and negatives with it being, like, a structured day a week, but… when we've had trips and things, it's meant… [one of the two classes] had to miss out because you can't shift things around, sometimes… It's not really a negative, it's just something that comes with having things booked in… weekly… It's not always convenient… in this sort of

environment, in a school where things are changing all the time. (SS3, intervention 1)

## 8.4 Discussion

This study provided insights into PSHE interventions delivered via classroom learning and PA participation from the perspectives of primary school children, parents, school staff and intervention staff. The interventions were viewed very favourably across all of the stakeholder groups: the classroom and PA components of the sessions were felt to work well together, the children were reported to be highly engaged in the learning activities and there were perceived benefits of intervention participation for pupils' psychosocial and physical wellbeing. While the sustainability of intervention 2 was heavily dependent upon council funding, both of the interventions met the needs of schools well and uptake of the programmes was limited mainly by time demands within the school day. At the same time, there were requests from parents and school staff for longer programmes or follow-up sessions, indicating again that the interventions were valued by stakeholders and that there was a marketplace for them. In the face of pressure to prioritise core curriculum subjects (Bailey, 2017; Campbell et al., 2015), education staff may find the evidence of support from parents and children for the inclusion of PSHE and PA opportunities within the school day to be useful in justifying the timetabling of these activities.

In the interests of quality, qualitative researchers should comment upon the generalisability of their findings (McKenna & Mutrie, 2003). While it is hoped that the current findings are of broad use in guiding school delivery of PSHE and PA opportunities, for instance by identifying which elements were successful in engaging the children, it should be borne in mind that the data were collected in relation to two specific primary school interventions run by football club foundations in the North East of England. Extrapolations beyond this geographical location, to audiences outside of the age bracket of 9–11 years and to interventions run by teachers or external providers from non-football-related organisations may not be appropriate. Nevertheless, several of the findings were also touched upon by pupils, parents and school staff in the AFLY5 RCT process evaluation, including that: there is a perceived positive impact of autonomy on children's engagement; primary school teachers might not be confident in delivering PE lessons; it can be difficult to run PA sessions due to

timetabling restrictions for facilities such as school halls; engagement with parents would be likely to contribute to intervention success due to the continued promotion of programme messages at home; and it was exciting for children to have information delivered to them by a visitor to the school (Jago et al., 2015).

Before discussing the four research questions, it is interesting to note that 53 good practice characteristics of interventions and policies regarding diet, PA and sedentary behaviours have been identified (Horodyska et al., 2015). Although the interventions explored in the current study were not all focused on nutrition and PA, they did possess similar aims pertaining to the promotion of positive behaviours. The content of the interviews and focus groups suggested, however, that they did not meet all of the characteristics. For instance, while ongoing monitoring of delivery was taking place, there was no family involvement in the programmes, theory had not been applied in the development of the interventions, and there had been no investigation into whether outcomes were sustainable. Participants noted the value of family involvement and the assessment of long-term effects, and these considerations are discussed below. In relation to theory, the evidence is mixed as to whether public health and behaviour change interventions explicitly based on theory are more effective, and findings might depend on the measure of effectiveness employed, whether an appropriate theory is chosen and how well theory is applied (Davis, Campbell, Hildon, Hobbs & Michie, 2015). In the case of the current interventions, several behaviour change techniques were used, including the following from a widely-cited taxonomy of techniques to help people change their PA and healthy eating behaviours (Michie et al., 2011): providing information on the consequences of behaviours (e.g. taking drugs), goal setting (e.g. fitness and food goals) and general communication skills training (e.g. teamwork). Moving forward, formalising the use of behaviour change techniques by choosing an appropriate theory to encompass them and to guide the inclusion of additional techniques might make interventions more attractive to schools and funders.

For clarity of reporting, the remainder of the discussion addresses each of the four research questions in turn. However, links are drawn between the research questions to provide a comprehensive, holistic account; for instance, one of the perceived *roles of PA* in the sessions was that it provided a reward for children's *engagement* during the classroom component, and the *outcomes* of intervention participation are likely in

turn to be influenced by children's degree of engagement.

### *8.4.1 The Role of Physical Activity*

The role of physical activity in the interventions was explored in response to participants' interest in the unusual format of the sessions: classroom learning followed by physically active games. Participants from all stakeholder groups identified that PA played a role in children's engagement by appealing to those who may not have invested in a purely classroom-based programme but were enthused by the games, though the reverse possibility was also recognised. Engagement was thought to be further promoted via children's perception of the PA as a reward for participating in the classroom activities, and one member of school staff suggested that PA participation possibly provided relief following classroom study of demanding PSHE topics. PA might therefore have stimulated engagement through both positive and negative reinforcement, providing a reward for children's work and an escape from any discomfort and thereby encouraging their continued positive involvement in the sessions (O'Donohue & Ferguson, 2001).

PA was thought to also support intervention outcomes, with intervention staff recognising that the different components of the sessions might meet different children's preferred styles of learning (Department for Education and Skills, 2004), although experimental evidence for an interaction between learning styles and instructional methods for educational outcomes is limited (Pashler, McDaniel, Rohrer & Bjork, 2008). However, PA was not used simply to reiterate messages; taking part in the games encouraged children to 'open up more' (IS1), allowing them to experience behaviours they had discussed in the classroom (Kolb, 2015) and put their learning into practice. In a small number of cases the children had unfortunately failed to appreciate the link between the classroom and PA components of the sessions but further investigation (e.g. observation of delivery) would be required to discern the reasons for this and how it could be addressed.

### *8.4.2 Engagement*

Consistent with the above discussion on the role of PA in supporting engagement, the leading factor behind children's engagement in the intervention sessions appeared to be their enjoyment, and in particular their enjoyment of the PA component. Although

the analysis was not guided by any specific framework, reasons for children's enjoyment seemed to broadly map onto self-determination theory (Deci & Ryan, 2000), as they did in Watson et al.'s (2016) study of a weight management programme, in which 'fun' was a highly prevalent theme. Self-determination theory proposes that intrinsic motivation is supported by environments stimulating feelings of autonomy, relatedness and competence (Ryan & Deci, 2000). Intervention staff reported making efforts to promote autonomy and relatedness by encouraging children's sense of ownership over the games and peer support throughout the programmes, while children further touched upon relatedness in noting that they liked the intervention staff and that in the team games they enjoyed working with others. Children and intervention staff also referred to the variety of games as a feature of the programmes which was apparently successful in making them appealing for different children; however, variety was more frequently mentioned in relation to non-intervention PA, where it was linked with taking on new challenges and different children excelling in different activities. It is possible that including more PA-based challenges and opportunities for skill development would better address the competence aspect of self-determination theory and improve enjoyment even further; however, there were few concerns over children's engagement levels and negotiating access to suitable indoor facilities in the event of poor weather would be likely to have a greater impact on enjoyment.

Closely related to one another were the themes of 'delivery by a non-teacher' and 'association with football club'. The association of the interventions with football clubs was felt by intervention staff to promote children's engagement in the sessions by being an early source of excitement and by giving delivery staff a platform for the development of a rapport with the pupils. This may be difficult for other external intervention organisations to mirror. Nevertheless, receiving information from any visitors to the school was felt to be exciting for pupils; Jago et al. (2015) proposed that it was "desirable for both child engagement and role modelling" (p. 7). The status of delivery staff as role models through children's familiarity with the football clubs also made them potentially more persuasive at changing attitudes and behaviour (Hogg & Vaughan, 2002), strengthening intervention outcomes. It was however felt that school staff had a part to play as role models in addition; if they were to join in with activities during the intervention sessions they would be modelling desirable behaviour and

encouraging the engagement of their pupils in the activities via imitation (Bandura, 1977). A possible barrier to engagement was recognised for children who do not enjoy football in that they might anticipate the PA component being football-centric, but this misperception was addressed early in the courses.

Relatedly, gender was one of a small number of variables identified at the level of the child as having a possible impact on their engagement, with participants – mainly school staff – describing that girls were potentially less interested in football than boys. However, intervention staff were aware of this – along with illness/injury as another possible barrier to engagement – and worked to involve the children in the sessions. Undoubtedly the factor from the 'children's personal circumstances and characteristics' theme with the greatest potential for development, therefore, concerned the family/home experiences of the children. A key modification to the interventions advocated by participants, and one which would likely support children's engagement *and* intervention outcomes, was the addition of parental involvement. Parents knew little of the programmes and could not therefore express an interest in this aspect of their children's education, such interest having been related to the value placed on learning by a secondary school sample (Harris & Goodall, 2008). Neither could parents reinforce the programme messages, despite participants recognising the role of the home environment in promoting healthy behaviours and evidence existing for parents' influence on, for example, children's self-esteem (Kernis, Brown & Brody, 2000) and intention to smoke/initiation of smoking in adolescence (Jackson & Dickinson, 2003, 2006). Suggestions were made for the introduction of homework activities for children to complete with their parents as a method of communicating programme content; this approach, along with sending home newsletters and invitations to school assemblies, has been used by a number of successful PA interventions for 4–10-year-olds, though it was unclear from study results whether the involvement of the parents contributed to programme success (Brunton et al., 2005).

### *8.4.3 Outcomes*

Participants from all of the stakeholder groups suggested that children's participation in the interventions was beneficial in terms of their wellbeing and personal development, especially in relation to their knowledge and understanding of the PSHE

topics studied. The main difficulty lies in assessing whether an increase in knowledge translates to children making positive choices later in life as the interventions intended; knowledge has been associated with positive choices regarding food for this age group (Kandiah & Jones, 2002), and the interventions do appear to provide learners with knowledge and skills to assist in making safe and informed decisions (Department for Education, 2013), but the accounts in this study were speculative about long-term effects because no follow-ups have been conducted.

In addition to increased knowledge, there were felt to be benefits of intervention participation for children's confidence/self-esteem. Blascovich and Tomaka (1991) describe that self-esteem is the extent to which a person values or approves of themselves, whereas self-confidence is a narrower construct in that it refers to how capable an individual perceives themselves to be in specific situations (e.g. speaking with people, taking part in athletic activities, academic learning), though a general confidence level is also acknowledged. It is easy to see why participants referred to confidence and self-esteem together, and to draw a distinction between the two would not be as appropriate as simply acknowledging their view that the interventions helped children to perceive and value themselves more positively. Adult participants suggested that children's increased confidence/self-esteem was underpinned by a number of factors including an improved understanding of how to cope with everyday issues, being entrusted with responsibilities to help others in the programme sessions and experiencing increased peer support (with the interventions encouraging teamwork, especially through the PA component). These factors have been found to promote self-esteem and a sense of being needed in youth/young adult populations (Danish, Fazio, Nellen & Owens, 2002; Steinhardt & Dolbier, 2008; Wilkinson, 2004). In this way, improvements in knowledge and in teamwork/peer support might contribute to confidence/self-esteem outcomes, which were in turn speculated by adult participants to be beneficial for academic achievement on the basis that children were more likely to 'put up their hand and have a go' (SS5). Exposure to and therefore increased familiarity with activities such as the games in the PA component of the sessions was also cited as a contributing factor to what appeared to be self-confidence specifically, as the effects were apparently restricted to the intervention sessions.

Important as they are, other than when the programme topic was fitness and nutrition

the above gains might for parents and school staff have overshadowed potential outcomes of intervention participation stemming specifically from the PA component of the sessions. Although the PA component might complement the outcomes expected from a classroom-based PSHE intervention, with PA participation having been found to enhance characteristics and skills such as self-esteem, self-discipline and teamwork (Bailey et al., 2013), opportunities to highlight PA-specific benefits to parents and school staff are potentially being missed. Especially when run in addition to – rather than in place of – PE lessons, the interventions may assist children in meeting the UK PA guidelines (Department of Health and Social Care, 2011) through the opportunity for PA participation within intervention sessions and the encouragement of PA participation outside of the sessions. This in turn could improve children's health (e.g. Janssen & LeBlanc, 2010). Children themselves did note the benefits of intervention participation for their physical health and in one case even requested to 'maybe do a bit more about keeping healthy and fitter' (C5, self-esteem programme).

Some of the school staff, intervention staff and children noted the potential effects of PA participation during the school day of increasing children's focus/motivation or alternatively of reducing their energy for any subsequent schoolwork. Investigations of the effects of school-time PA – and of PSHE – on children's post-session energy levels (and specifically the *type* of energy, i.e. beneficial or detrimental to learning) would be valuable to complement the preliminary findings regarding academic achievement from Study 3 and the findings from previous research that participation in PA interventions (e.g. Watson et al., 2017) and social and emotional learning programmes (e.g. Durlak et al., 2011) might support academic achievement.

Frequently overlooked as an outcome of intervention PA participation, although intervention staff did appear to attempt to promote physical skills, was an improvement in children's movement-related competence. In a longitudinal study conducted in Australia, the proficiency of 7–11-year-old children in object control (kicking, catching, throwing) was shown to account for some of the variance in daily MVPA in adolescence (Barnett, van Beurden, Morgan, Brooks & Beard, 2009), suggesting that the development of physical competence during childhood might assist in the long-term adoption of positive PA behaviours, in line with intervention aims.

More might therefore be made of physical competence as an intervention outcome, helping to better inform stakeholders and contributing to intervention marketing and sustainability.

The outcomes research question was anticipated to identify what *children* took away from their participation in the interventions; however, there were sufficient references to teacher development in the transcripts for this to be identified as an additional outcome. Evidence from this and other studies (e.g. Jago et al., 2015) suggests that primary school teachers might lack in confidence in delivering PE lessons, but their observation of intervention sessions might provide them with ideas to improve their practice in this subject area, thereby enhancing the experience of school PA for pupils in their current and future classes.

### *8.4.4 Sustainability*

The sustainability research question was driven by the tendency in the literature for school-based interventions to have been delivered by researchers or for researchers to have trained teachers in their delivery. The former approach suffers the drawback that the intervention will be rolled out only in a limited number of schools and over a limited timeframe (Warren et al., 2003), as determined by the scope of the research project, and the latter approach is problematic in that teachers might deviate from or abandon the intended delivery plan if, for instance, it places additional demands upon their time (Bartholomew & Jowers, 2011; Campbell et al., 2015). The interventions investigated here, on the other hand, had the potential for greater longevity and delivery of the full complement of sessions in the manner intended because they were delivered by the staff of football club foundations whose job it was to facilitate these and other PA- and education-related courses for members of their local communities. It was however important to gather participants' insights into whether intervention delivery was likely to continue, and why this might or might not be the case, in order to consider the overall potential scope for intervention outcomes.

Understandably, funding was by far the most prevalent theme in relation to intervention sustainability: without adequate funding, the interventions would be unable to run. As well as being available for purchase by schools – though cost was a potential barrier to uptake – some of the programmes were dependent upon or

supplemented by funding from sources such as local councils. This cannot however always be guaranteed due to fluctuations in the money available to councils (see Bounds, 2017). At the time of the interviews, intervention staff were confident of obtaining continued funding for the programmes as they addressed topics which were not only of relevance in the current curriculum but ones which pupils might be experiencing (e.g. racism), making the programmes valuable to schools and their stakeholders.

In addition to cost, lack of awareness of the interventions and misconceptions that their PA component would be football-based were acknowledged as further potential barriers to school uptake. Both of these issues might be addressed through promotion of the interventions, though this may be limited by funding. A much greater difficulty was accommodating the intervention sessions in a busy school timetable, and it is here that the impact of the priority given to core curriculum subjects (Bailey, 2017) becomes evident. Education staff should draw confidence from the current findings in relation to their inclusion of PSHE and PA opportunities within the school day, as these lessons/activities were valued by parents and enjoyed by children, as well as being perceived by all stakeholder groups to be beneficial for children. At the same time, academic achievement was mentioned by rather few of the participants as an outcome of intervention participation, potentially indicating a lack of awareness of the positive relationships between wellbeing and academic achievement (e.g. Durlak et al., 2011) and between PA and academic achievement (e.g. Watson et al., 2017). As school staff are more likely to welcome changes which address learning and teaching problems they are experiencing (Terhart, 2013), such as helping their pupils to meet specified attainment levels in core subjects, efforts to raise awareness of these relationships might assist in the implementation of any changes in practice with regards PSHE and PA provision.

In terms of future developments, the major suggestion from participants was for the duration of the programmes to be increased or for follow-up sessions to be added. One member of school staff felt that being tracked by the football club foundation would result in better outcomes for the children, a notion consistent with the 'observer effect', in which the behaviour of a research participant is affected by the presence of an observer and their interpretation of this presence (Sykes, 1978). Dependent upon

pupils' individual interpretations there may therefore be facilitative effects of intervention staff revisiting them, and there is little reason to doubt that revisits would be perceived positively given children's enjoyment of the programmes. The costs of any additional sessions must however be considered in any interventions adopting this approach, and there are feasibility difficulties for the idea of follow-up sessions taking place at secondary school due to secondary school classes containing pupils from various primary schools who might have completed different programmes or have not experienced a programme at all. A similar approach might therefore be adopted to that proposed for the maintenance of healthy activities following a UK weight management programme: participants could engage in ongoing group activities they had identified as 'fun' without having to repeat didactic elements of the course (Watson et al., 2016). In this case, school staff could run follow-up PA sessions to remind pupils of programme messages. Similarly, the involvement of parents in the interventions might assist in the reinforcement of messages and desirable behaviours, as discussed under the 'engagement' research question.

### *8.4.5 Limitations*

While one of the strengths of the research is its inclusion of a range of stakeholders, helping to construct a picture of the interventions from the viewpoints of a number of groups with an interest in them, the responses of intervention staff are likely to incline towards a positive portrayal of the interventions due to the participants' employment by the football club foundations. There is also likely to be some level of socially desirable reporting from all groups given the topic matter of preventive health behaviour (e.g. Kristiansen & Harding, 1984), with participants not wishing to be negatively evaluated if they were to criticise an attempt to improve children's wellbeing.

While the coding framework applied well across the two interventions and the findings were broadly similar between them, both of the interventions contained multiple programmes addressing different PSHE topics. The diversity of courses investigated may mean that the current findings offer a breadth rather than a depth of insight, especially in relation to intervention outcomes which would be expected to differ according to course content. This was borne out in that participants appeared to have a greater appreciation of increased PA and its benefits for physical health as outcomes

from the fitness and nutrition programme.

From a methods-related standpoint, the children's focus groups did not always generate discussion and some therefore effectively operated as group interviews. This was felt to be due to the school setting and associated conventions of turn-taking. Although the aim of the research to explore stakeholders' views on the interventions was still met, debate might have led to additional insights and enriched the analysis.

## 8.5 Conclusion and Potential Impact

In summary, there was a high level of engagement from primary school children in the intervention sessions: they enjoyed the programmes, were excited to work with visitors to the school and in particular those associated with local football clubs, and there were few barriers to them joining in with programme activities. They were felt to benefit from intervention participation in relation to their wellbeing and personal development (e.g. improved knowledge, greater confidence/self-esteem), though the physical health benefits and other outcomes specifically of PA participation were not well recognised for some of the programmes. Furthermore, outcomes were not always noticeable during the course of the 6-week programmes and longer-term investigations are recommended, with findings from these being useful in the guidance of policy and practice pertaining to school-based PSHE and PA opportunities. Both engagement and outcomes may be further supported by the involvement of parents in the interventions, and a cost-effective way to do this might be to add homework activities for children to complete with their families.

It is hoped that the study feedback provided to the football club foundations will enable them to make further improvements for children's experience of and outcomes from participation in their school-based interventions. More broadly, the tendency noted in the literature for core curriculum subjects to be given priority in school timetables lent weight to an examination of opinions on the value of activities which might be at risk of being displaced in the school day. Education staff and policymakers may find the accounts of parents and children to be useful support for the continued provision of school-based PSHE and PA.

A distinctive feature of the interventions was their communication of PSHE messages through a combination of classroom learning and active games. The inclusion of PA was felt to engage a wider range of children than classroom learning alone, programme messages were reinforced through experiential learning (Kolb, 2015), and the games provided relief from potentially difficult programme topics and other forms of schoolwork. Schools may wish to emulate the classroom/PA format of the sessions to attempt to reap the same benefits for other lessons. It is however possible that the unusual format of the intervention sessions was one of the key ingredients in their success and if this approach becomes the norm rather than the exception then some of the impact may be lost, although the novelty of delivery by a visitor associated with a local football club would remain.

# Chapter 9: General Discussion

The aim of this PhD programme of research was to examine PSHE interventions delivered to 9–11-year-olds in primary schools in the North East of England through a combination of classroom learning and physical activity. The goal of PSHE is to provide children with the skills and knowledge for making safe and informed decisions (Department for Education, 2013), while PA participation has benefits for physical health (Strong et al., 2005) and for social skills and emotional regulation (Bailey et al., 2013), meaning that a positive association would be anticipated between pupils' participation in such interventions and their wellbeing; the term 'association' being used as causation cannot confidently be established due to the multitude of other factors operating upon participants over the same period. Recognising the priority often given in the school timetable to core subjects such as reading, writing and mathematics as a result of the value placed upon these subjects by educational stakeholders (Bailey, 2017), the research also set out to assess whether intervention participation might be positively associated with children's cognitive performance and academic achievement. Education staff might more readily accommodate PSHE/PA interventions – and other PSHE and PA opportunities – in the school day if the findings were able to address concerns over participation having a detrimental impact on pupils' achievement by reducing the time available for the study of core subjects.

It is anticipated that findings from the research programme will in the long term be added to those of further studies into school-based PSHE and PA delivery, building an evidence base to guide policy and practice in relation to provision of these opportunities in primary school settings. The literature reviewed in Chapter 2 indicated the existence of positive relationships between the wellbeing, PA participation, cognitive performance and academic achievement of young people, suggesting that intervention participation might reasonably be expected to be associated with higher levels of cognitive performance and school achievement. It is not however common for studies into school-based PSHE or PA interventions to consider mental function (cognitive performance and academic achievement) amongst their outcomes (Campbell et al., 2015; White, 2017), which is where this thesis makes its contribution

to the research literature.

The qualitative arm of the research (Study 4) explored the views of children, parents, school staff and intervention staff on classroom/PA-format PSHE interventions, addressing research questions pertaining to the role of PA in the programmes, children's level of engagement in the sessions, the perceived outcomes of intervention participation and factors influencing the sustainability of future delivery. Findings in these areas complement the quantitative findings of Study 3, in which cognitive performance, academic achievement and wellbeing were measured before and after children's intervention participation, and of Study 2, in which the immediate effect on cognitive performance of participation in the PA component of one of the intervention sessions was assessed. As described in Chapter 3, the philosophical position of critical realism underpinned the research; this is a position similar to pragmatism in which methodology is driven by the needs of the research, allowing for the mixing of methods. It also tied in with the applied orientation of the research programme, which aimed to provide findings that were of use in helping to change the course of future events (Biesta, 2010) and that recognised the importance of context (Maxwell & Mittapalli, 2010); together, the quantitative and qualitative findings would allow the researcher to make recommendations for future school PSHE/PA delivery which were based not only on objective results that might have credibility with people in power (e.g. funders; Johnson & Onwuegbuzie, 2004), but which also accounted for context, making the recommendations feasible and acceptable to stakeholders (e.g. by accounting for barriers to implementation/sustainability). This chapter brings together the findings from the studies in the interests of reaching a set of overall conclusions and making such recommendations.

The literature review also revealed that for the research into post-intervention cognitive performance that does exist, researchers have employed an array of different methods, with variations between studies in factors including intervention content and duration, participant characteristics and tools for measuring outcomes. To begin to address this issue, Study 1 aimed to pilot a cognitive test battery suitable for use in a school-based, whole-class testing situation in order to provide researchers with an instrument which can be used across studies, allowing for the comparison of results. While this is a new tool and conclusions should therefore be viewed as preliminary, it

is hoped that with further use the CogS: 9–11 test battery will be refined and will help to provide some consistency in research from which recommendations for education staff can be made, particularly in relation to the inclusion of PA within the school day as the test battery was designed with post-PA testing in mind.

## 9.1 Summary of the Findings

Findings from across the programme of research provide an original contribution to research as they present a picture of the efficacy of school-based PSHE/PA interventions with an emphasis on cognitive performance and academic achievement; variables likely to be of interest to education stakeholders but which are unfortunately measured less frequently in studies of school interventions than other anticipated outcomes such as improved knowledge or increased PA. PA in particular was explored both as a potential mechanism for any relationships between intervention participation and children's wellbeing, cognitive performance and academic achievement and also as an unusual way of allowing children to experience concepts introduced in the classroom (e.g. making use of compliments in team games following discussion of how this might help to raise self-esteem).

Study 1 constituted an assessment of the reliability and validity of Cognition in Schools: 9–11-year-olds (CogS: 9–11), a cognitive test battery designed to investigate the processing speed, sustained and selective attention, long-term memory and executive function of 9–11-year-olds in whole-class testing situations. Parallel forms reliability testing suggested that the red, green and blue versions of the booklet elicited comparable cognitive performance, and on the basis of these results the researcher recommended that the yellow version is reserved for use in familiarisation sessions. In relation to test–retest reliability, practice effects were observed for the Find 'M' task of attention and for the Which Colour? task of inhibition, while there was a decline in children's performance on the Memorise! task of LTM, all of which emphasises the need for a control group in intervention research employing the test battery. Finally, principal component analysis was used in the assessment of construct validity and there were early indications that CogS: 9–11 may distinguish between the executive functions of updating, shifting and inhibition. It is hoped that future research

will further test this, employing a larger sample of participants from the target age group.

It was surprising in Study 2 – a quantitative analysis of children's cognitive performance immediately following participation in PA compared to a standard classroom lesson – that only one time × group interaction was found, and that this was attributable to the significant improvement from pretest in the performance of the classroom group on the Which Colour? task of inhibition, while the performance of the PA group did not change over time for this task. More consistent with the hypotheses, a positive correlation was found between the time spent by children in MVPA during the PA session and their performance on the Memorise! test of LTM. A greater mean percentage of time in MVPA and a lower mean percentage of time in sedentary behaviour were also recorded for the outdoor PA session than for the three indoor PA sessions after which cognitive testing took place, a pattern that would benefit from further investigation.

In Study 3, although no firm associations were established between intervention participation and children's wellbeing or cognitive performance, quantitative analyses found a greater improvement from pretest to posttest in the reading and mathematics achievement of intervention children compared to control children. The intervention group did however have greater scope for improvement as their pretest achievement scores were lower than those for the control group, meaning that this finding should be viewed with caution and that it would benefit from replication. Unfortunately, the sample size in Study 3a was too small to conclude whether intervention participation was associated with children spending greater percentages of the day in moderate-to-vigorous intensity physical activity at posttest.

The findings from Study 4 – a qualitative investigation of PSHE interventions adopting the classroom/PA format – provide further insight into interventions of the type explored in Studies 2 and 3. These interventions were already running in school settings, rather than being introduced for the purposes of the research, and were delivered by football club foundations rather than by researchers or teachers trained in intervention delivery, as is often the case in intervention research. There was agreement amongst children, parents, school staff and intervention staff that the

inclusion of PA in the programmes was valuable because classroom learning and learning through PA were formats which suited the needs and preferences of different children. Furthermore, PA provided a sense of rest and reward following the classroom element, and intervention messages were able to be reinforced through PA participation as intended (e.g. by allowing children the opportunity to choose a team and not to be swayed by peers). Children appeared to engage in the intervention sessions because they enjoyed them (especially the PA and interactive classroom activities), because they found it novel that the sessions were delivered by visitors to the school, and because they were excited that intervention staff were from foundations linked to local professional football clubs. Engagement was however to some extent affected by children's personal circumstances and characteristics such as home life and in some cases illness/injury. When it came to outcomes, pupils were widely perceived to benefit from programme participation in terms of their psychosocial wellbeing and personal development, acquiring knowledge which it was believed would help them to make positive choices throughout their lives, although it was not possible for participants to have observed/experienced long-term outcomes at the point at which data were collected. Adult participants did however feel that pupils grew in confidence during the course of the programmes and were more willing over time to attempt activities in the classroom and PA components of the sessions or to ask questions. The benefits of increased PA for children's physical health were also discussed, particularly when the programme topic was fitness and nutrition, and teachers noted that observing PA delivery by intervention staff was useful for their own CPD. Finally, the sustainability of interventions was seen to be reliant upon ongoing funding (e.g. from councils as well as through purchase by schools), and upon interventions continuing to meet the needs of schools by covering content relevant to the school curriculum and by sessions fitting in around other demands in the school timetable. One of the most popular requests for development was however for interventions to be longer or to include follow-up sessions in order to help support pupil outcomes.

## 9.2 Further Discussion on Study 1

Before the findings of the intervention-related studies are explored in the next section, the findings of Study 1 are discussed here separately as this study concerned the

development of a measurement instrument rather than intervention efficacy. The cognition-related findings of Studies 2 and 3 should however be viewed in light of the use of this newly-developed instrument.

One of the recurring arguments throughout the thesis is that there is a need for greater consistency in the methods employed by researchers investigating school-based interventions. Only when studies begin to use the same measurement tools, for instance, can well-founded conclusions regarding the efficacy of PSHE and/or PA interventions be drawn, and research can then go on to explore whether variations in the characteristics of interventions (e.g. content, duration, classroom/PA delivery format) and in the populations of children taking part (e.g. age, SES) have an influence upon outcomes.

The CogS: 9–11 test battery was introduced in Study 1 as a pilot measurement tool that might in the long term assist in achieving consistency in cognitive testing occurring in schools. The battery constitutes a freely-available set of tasks which can be used for repeated measures testing and which, being paper-based, does not require the transportation of expensive equipment such as laptop computers. Furthermore, as testing takes approximately 30 minutes, the battery appears to be suitable for capturing post-PA effects on executive function, such effects having been found even when testing has only *begun* 25 minutes following PA (e.g. Chen et al., 2014; Hillman et al., 2009), though the possibility of an inverted 'U' relationship between the time elapsed following PA and children's cognitive performance should be explored.

It must be emphasised that the CogS: 9–11 battery was designed to test the efficacy of interventions and not to measure children's cognitive performance per se. As a result, the tasks might not measure aspects of cognitive function in their purest forms where there were concerns over practicalities and/or over the acceptability of the tasks for the intended audience; for instance, the tests of executive function are not necessarily novel in content and form, which Bull and Scerif (2001) discuss as being characteristic of a true measure of executive function, because novelty is difficult to achieve to the same degree across repeated measures testing sessions and is likely to make the assessment more frustrating for young participants. It is also acknowledged that the scoring of the test battery is labour intensive from a researcher's perspective and

modifications to improve this aspect of its use are welcomed to refine it moving forward.

Following Study 1, two minor modifications were made to the test battery before its use in Studies 2 and 3: the number of unique stimuli presented in the 3-Back task of updating was reduced in order to limit the use of novelty as a cue for 'no' responses, thereby addressing the potential ceiling effect observed for the task; and the presentation format of the switch cues in the Colours and Shapes shifting task was changed to reduce the complexity of the task and make it more acceptable to participants. Unfortunately, a similar percentage of participants completed the Colours and Shapes task at pretest in Studies 2 and 3 (85%) as at baseline in Study 1 (90%), suggesting that the demands of the task rather than of its presentation format constitute the difficulty. However, with a maximum possible score of 37, the mean scores for 3-Back at pretest in Study 3 (intervention group: $M = 22.75$, $SD = 4.693$; control group: $M = 23.53$, $SD = 4.398$) were much less suggestive of a ceiling effect than the mean score at baseline in Study 1 ($M = 31.07$, $SD = 4.636$). Furthermore, none of the participants achieved a maximum 3-Back score at pretest in Studies 2 and 3 – there was only one score of 37 across the two studies, achieved by a participant at posttest in Study 3 – whereas four participants achieved a maximum score at baseline in Study 1, as did three at the repeat testing session. It therefore appears that the modification made to the 3-Back task was successful in reducing ceiling effects.

Study 1 constituted a pilot investigation of the CogS: 9–11 test battery; with assessment of its construct validity being especially limited by the sample size, further research into this element is warranted. In putting forward the battery, the study does however offer a practical solution to the oft-cited issue of lack of consistency in school-based intervention research, at the very least drawing attention to a potential way in which this problem might be addressed.

## 9.3 Further Discussion on Studies 2, 3, 3a and 4

This section brings together the findings from the four intervention-related studies reported in the thesis (including the pilot study, Study 3a), both in order to present a cohesive summary of the findings from across the programme of research and also in

the interests of quality, with Onwuegbuzie and Johnson (2006) proposing that as part of multiple validities legitimation in mixed methods research the researcher should consider the extent to which overall inferences are greater than the inferences derived from the qualitative and quantitative components alone. The below discussion demonstrates quality in this respect as it is clear that the quantitative results and the qualitative findings deliver very different parts of the story of the interventions, and the overall inferences are able to bring together the two aspects in a way that means they inform one another and provide greater depth and meaning to the findings.

One of the thrusts of the thesis was to provide an account of classroom/PA-format PSHE interventions which places the interventions in context and considers how they are delivered and received by those involved in them, as it is only by doing so that appropriate recommendations can be made (Castelli et al., 2014). The qualitative data collected in Study 4 indicated, for instance, that events such as school trips or mentoring sessions for individual pupils sometimes occurred at times conflicting with intervention sessions. This suggests that the inflexibility of session timings to accommodate school events poses a potential difficulty for intervention delivery and may be an area for the football club foundations and schools to negotiate. It is known for school staff to report lack of time in relation to intervention timetabling (e.g. Campbell et al., 2015), and the results of Study 2 support participants' reports from Study 4 that there were practicalities to consider in the timetabling of sessions, including the availability of appropriate school facilities in the event of poor weather. In Study 2 the researcher observed, for example, that one of the indoor PA sessions was limited in duration by other activities taking place in the school hall; furthermore, the mean percentages of sedentary behaviour and MVPA taking place in indoor sessions were significantly higher and lower, respectively, than that in the outdoor session, providing quantitative evidence in support of participants' views in Study 4 that indoor facilities limited interventions' PA offer due to space restrictions. With intervention staff describing their aims to keep children active throughout the PA sessions, the findings of Study 2 might help to guide conversations with school staff when making arrangements for intervention sessions.

The qualitative data clearly demonstrate that the interventions are well received by children and that they are valued by school staff, with parents also viewing them

positively although knowledge of the interventions was limited within this group. Even in the absence of clear associations being identified in Study 3 between children's intervention participation and their wellbeing and cognitive performance, therefore, the sessions may be worthwhile in the eyes of stakeholders as pupils were reported to enjoy them and were felt to benefit from increased knowledge about PSHE topics and the opportunity for PA participation. Without the insights from Study 4 it would be easy to focus only on the academic achievement findings of Study 3, but there may be additional benefits of intervention participation not recognised in the quantitative research, for instance in relation to increased confidence/self-esteem. The children themselves may not have appreciated this as an outcome but it was noted by adult participants during their interviews/focus groups and was felt to increase children's willingness to participate in the PA component of the sessions, potentially helping them towards reaching the UK PA guidelines which are seemingly met by less than 50% of this population (Health and Social Care Information Centre, 2015). Confidence/self-esteem was also proposed by a small number of adult participants to contribute to children's academic performance by virtue of them being more willing to attempt activities in class. This perception is reminiscent of findings from the pilot of the SEAL programme, in which school staff reported at the end of the school year that pupils had better motivation and persistence when it came to classroom activities and that their better behaviour allowed staff to spend more time with pupils who needed help, although they were unfortunately uncertain as to whether there had been any positive effects of the programme on children's standards of learning (Hallam, 2009). School and intervention staff in Study 4 alluded to similar changes in behaviour occurring over the course of just a 6-week programme, for instance in relation to peer support in the classroom and in the development of a positive mindset. It is possible that these changes supported the greater improvements in reading and mathematics achievement observed for the intervention group in Study 3 (though these results require replication), with motivation for instance having been found to add to the prediction of English and mathematics achievement beyond general mental ability for 9-year-old pupils (Spinath et al., 2006).

Beyond a small number of references to confidence/self-esteem and the possible effects of post-PA energy/fatigue, participants in Study 4 did not generally, however, discuss academic achievement as an outcome of intervention participation. This

suggests a lack of awareness of the relationships between children's wellbeing and PA participation with school achievement (e.g. Durlak et al., 2011; Watson et al., 2017). If they can be replicated, the greater improvements in reading and mathematics for the intervention group than for the control group in Study 3 are therefore an important contribution not just to the research literature but to stakeholders' understanding of educational interventions and in particular those with a PA component. As suggested in Chapter 7, it may even be that the sport-related nature of the interventions can explain the larger effect size for reading achievement because cultural factors in school sport have been theorised to have a greater effect for performance in subjective subjects such as English (Trudeau & Shephard, 2008), and the Study 4 findings indicate that the interventions being linked with local football clubs might contribute to children's engagement, with one of the members of intervention staff discussing specifically that pupils recognise the prestige of the football club brand and that this encourages their buy-in to the programmes because they wish to be associated with success (i.e. an increase in social status). It is interesting also from the perspective of awareness of outcomes for learning that a positive association was identified in Study 2 between time spent by children in MVPA during the PA sessions and their LTM performance; if causation were to be established then school staff might choose to schedule intervention sessions immediately prior to core curriculum subjects to assist in children's retention of taught material.

In considering the results of Studies 2 and 3 together, there are the beginnings of an intriguing finding for LTM. Study 3 found an interaction effect in that the control group underwent a non-significant decline in LTM performance from pretest to posttest, while the intervention group underwent a non-significant improvement; this on its own was not pursued as a finding of great interest in that study because the prediction was for there to be a greater increase in cognitive performance for the intervention group than for the control group, yet a significant increase from pretest for the intervention group was not identified. In Study 2, however, a positive relationship was found between time spent in MVPA during the PA session and LTM performance in the post-PA cognitive testing session. Furthermore, a decline in performance was observed between baseline and repeat testing for the Memorise! test when the test–retest properties of the CogS: 9–11 battery were assessed in Study 1, this having been attributed by the researcher to participants' poor on-task behaviour

during the repeat testing session. Further research is therefore recommended to discern whether PA (and particularly MVPA) participation has at the very least a 'protective' effect against declines in performance on and/or motivation for the Memorise! task. Studies may also benefit from considering the role of elements of PA participation other than intensity in any effects, for example by including variables such as social and cognitive engagement in regression analyses predicting LTM performance.

It is recommended that further LTM tasks are additionally included in any future research as the 100-second delay in the Memorise! task between the presentation and recall periods did not contain a distractor task (consistent with the procedure of Pesce et al., 2009), and it is likely that children rehearsed the names of the images during this time. Results from the Memorise! task therefore potentially reflect a combination of LTM and short-term/working memory performance, as well as drawing upon additional aspects of cognition such as attention, visual processing and the inhibition of task-irrelevant information (e.g. distractions in the classroom setting in which testing takes place). The attempt to capture results specific to particular forms of memory should however be considered in the context of the research; if the aim is to reflect children's retention of the items presented in an emulation to some degree of their learning of information at school, then the important factor is the amount of information recalled. Indeed, some theorists propose that short-term memory should not be viewed as a storage system separate from and preceding LTM but as the set of items from LTM that are currently active (Shiffrin & Schneider, 1977). In this case, the images shown during the presentation phase of the Memorise! task would temporarily activate relevant nodes in the brain and long-term memories would be formed not through the transfer of information to a long-term store but through the formation/strengthening of connections between active nodes. This notion is potentially consistent with the proposal of Pesce et al. that physiological arousal facilitates the consolidation of information (the strengthening of a memory trace, or connections between neurons) by increasing the amount of available resources, thereby reducing the need for rehearsal. Preventing rehearsal with a distractor task would not only allow exploration of this possibility but might more closely reflect school learning as it is not often that pupils are asked to recall information presented to them without some sort of intervening activity in the school day or even across the school year.

In Studies 2 and 3a, acute and chronic PA respectively were explored as potential mechanisms for intervention outcomes, Study 2 specifically investigating the effects of acute PA on cognitive performance, which is thought to support academic achievement (see Chapter 2). Results from both studies were however inconclusive, with the only significant time × group interaction being for inhibition in Study 2 and this interaction being driven by an improvement from pretest performance for children who had taken part in a classroom session immediately prior to cognitive testing, while there was no change from pretest for those who had taken part in PA. Unfortunately, as Study 3 was a quasi-experiment exploring intervention delivery/non-delivery as it was naturally occurring in primary schools, there are many possibilities other than PA participation – or other elements of intervention content – as to the variables that might underlie the academic achievement results. For example, the control group took part in 6 weeks of normal curriculum delivery, leaving open the possibility that the greater improvement in reading and mathematics achievement recorded for the intervention group resulted from attention shown by the intervention staff. In support of this proposal, one of the themes identified in Study 4 was that the status of intervention staff as visitors to the school contributed to children's engagement because the children saw having visitors as a treat, as well as it being an opportunity for them to learn something which was often new and delivered in a less formal manner than other school lessons. It may therefore be the case that external delivery staff are the mechanism behind intervention outcomes, and a suggestion is made for how to discern between this and other mechanisms in the 'directions for future research' section later in the chapter.

As a final issue of interest, in their review of the effects of PA interventions on the cognitive and academic performance of young people, Singh et al. (2018) noted that overweight children may experience greater benefits. Although it was not possible in the current programme of research to publish data regarding children's weight status due to schools' concerns that doing so would negatively affect the number of parents consenting to their children's participation, qualitative data again provide some degree of insight into weight status as a potential moderator; it was apparent from the reports received from staff at one of the schools that one of their overweight pupils had not only experienced weight loss but was perceived to have developed greater confidence

since participating in the fitness and nutrition programme. School staff had reinforced messages from the intervention, highlighting that support received outside of the programme sessions may also play a role, but it is noteworthy that some of the adult participants related pupils' confidence to their academic achievement and that independent of this school staff acknowledged increased post-intervention confidence for an overweight pupil. Future research may wish to investigate weight loss and improved confidence as variables which might contribute to the possible greater effects for academic achievement of PA participation for overweight children, and to explore whether these variables are also relevant for other groups.

## 9.4 Strengths and Limitations of the Research

One of the strengths of the research programme is that it set out to investigate existing intervention delivery in schools and to reflect outcomes as they occur in real-world educational settings, as few studies in this area have done (Hillman, 2014). Future school-based research is also encouraged with the production of the CogS: 9–11 test battery. Conducting the research in school settings also has its logistical challenges, however, as it is difficult to discern whether intervention participation, other potentially changing variables at the time of the investigation (e.g. curriculum topics), or a combination of both are responsible for any outcomes. This is why in Study 3 the results were presented in terms of associations between the variables of interest and intervention participation rather than as intervention *effects*. Furthermore, it is possible in intervention research that teachers' expectations of positive outcomes might change their behaviour towards the children and contribute to any outcomes occurring; while it could be argued that in this case outcomes are still attributable to the intervention and the process by which they arise is unimportant (Ericsson, 2008), it cannot be stated that teachers – and intervention delivery staff – would behave in the same way were the outcomes not being recorded for a research study. Similarly, as described in Chapter 5, it was not possible to blind the investigator to whether schools/classes belonged to the intervention or control group; having a research team in which one researcher makes arrangements with school/intervention staff for testing visits and another collects the data without knowledge of the hypotheses would help to address this limitation in future studies.

The strengths and limitations of a mixed methods design are discussed in Chapter 3. At the end of the research programme the value of this design for an investigation of school-based interventions can be seen, with qualitative and quantitative data providing complementary findings as discussed above. The quantitative studies also allow for a degree of generalisation of results, though the comparability of the current interventions to those to which generalisations are to be made should be borne in mind, for instance in terms of their content, duration and format (e.g. classroom-based, PA-based or both). The qualitative findings provide an indication of children's level of engagement, offering another basis for comparison with other interventions. Generalisations to other populations are not however recommended as results might differ, for instance, for populations of different ages and socioeconomic statuses to those in the current research.

In terms of recruitment, it was difficult to recruit schools who could accommodate the research activities in their timetables, and within schools it was then difficult to recruit participants due to lack of parental response to information sheets and consent forms sent home with children. This had implications for study sample sizes and the power of the statistical analyses, and further research is therefore required. Another factor limiting power in Studies 2 and 3 was the lack of complete data for some of the participants, which meant that from samples of 102 and 128 participants, respectively, only 67 were included in the Study 2 MANCOVA and only 69–95 were included in the Study 3 MANCOVAs. While probable attrition was factored into recruitment efforts, the likelihood of missing data is another variable to be considered now that the percentages of children fully completing the cognitive test battery can be established from the studies included in this thesis.

Although it was disappointing in Study 4 to stop recruiting parents, it was felt that this was the only ethical course of action as it quickly became apparent that parents were not well informed about the interventions and further interviews were therefore unnecessary. Saturation was however achieved and it was clear that there was a large degree of agreement across the stakeholder groups regarding the themes, so the decision to halt recruitment was not felt to affect the findings and parents' lack of knowledge was noted as an important finding in itself for the development of the interventions.

## 9.5 Directions for Future Research

The quantitative results from the current research programme are an interesting starting point for research into the cognitive performance, academic achievement and wellbeing of children following participation in PSHE/PA interventions. Were this work to be continued, future studies would benefit from taking the form of cluster randomised controlled trials. This would provide greater confidence that results were due to intervention participation/non-participation and not differences between schools that choose to take part/not take part in interventions. Furthermore, as raised earlier in the chapter, participants in Study 4 identified that intervention delivery by a visitor to the school contributed to children's engagement in intervention sessions, and as noted in Fisher et al. (2011) the increased attention shown to intervention participants compared to the control group might be responsible for any effects, rather than the intervention itself and in this case the unusual combination of classroom learning and PA in particular. To discern the impact on intervention outcomes of delivery by visitors and of the inclusion of PA in intervention sessions, future research might ideally employ an intervention group and a control group taking part in their normal school curriculum, as in the present research, but with additional groups of participants that would, for instance, take part in just the classroom activity aspect of the intervention, as delivered by the same members of intervention staff, or that would take part in the full classroom/PA-format intervention but delivered by their usual classroom teacher. Employing larger numbers of participants would also allow researchers to conduct subgroup analyses testing whether different groups of participants experienced different degrees of change in pretest to posttest measurements (e.g. males/females, high/low achieving pupils, pupils of different weight statuses).

As discussed in Chapter 7, it would be valuable to collect data at follow-up periods in addition to immediately post-intervention in order to assess the longevity of effects. It is even possible that some effects (e.g. for wellbeing) might develop between the posttest and follow-up testing periods as skills acquired through intervention participation may require practice. Qualitative data gathered at follow-up periods would offer insight into children's use of knowledge gained from interventions when

faced with making choices (e.g. regarding peer pressure, PA participation); due to the timescale of the research programme, participants in Study 4 were only able to speculate on children's long-term use of knowledge, so this would be a valuable contribution to the current findings.

As reported earlier in the thesis, academic achievement is a measure not always included in research into wellbeing and PA interventions; going forward, it is recommended that this measure is included where possible as educational outcomes are of great importance to research users such as those responsible for setting the school curriculum and timetables (Campbell et al., 2015; Langford et al., 2014). Future research may well additionally need to build from the findings of the current work, in which academic achievement was recorded from teacher reports, towards the inclusion of a measure of examination-based academic achievement. This would help to address the issue of collecting comparable data across schools with the removal of national curriculum levels (Department for Education, 2014), and stakeholders are likely to be responsive to such data as primary schools are under pressure to place favourably in performance tables based upon pupils' results in external examinations as well as upon teacher assessments (Department for Education, 2018). However, careful consideration of this matter is required as it can be difficult to select a measure of achievement suitable for the assessment of short-term interventions, as discussed in Chapter 3.

## 9.6 Conclusion and Recommendations

This thesis provides an original contribution to the research literature as it presents a comprehensive account of primary school interventions that deliver PSHE messages through a combination of classroom learning and physical activity, with a focus on cognitive performance and academic achievement as potential intervention outcomes. The programme of research enhances our knowledge by indicating that intervention participation is positively associated with children's achievement in reading and mathematics (Study 3), though further research is required to corroborate these preliminary findings and to explore the possible mechanisms behind them. Nonetheless, the classroom/PA format of the intervention sessions was found to be an approach to the delivery of a broad range of PSHE topics – including discrimination,

self-esteem, drugs education and fitness and nutrition – that is popular with and valued by stakeholders (Study 4). In addition, an association was identified between the time spent by children in moderate-to-vigorous intensity physical activity during the PA component of intervention sessions and their long-term memory performance immediately post-PA (Study 2), providing an interesting avenue for further research to explore the reasons behind the relationship and, if it is a *causal* relationship, whether acute bouts of MVPA during the school day can be used to enhance children's learning.

There are strong practical applications of the research, with school staff being able to make decisions regarding their uptake of interventions or similar PSHE/PA programmes based upon both the quantitative and qualitative findings. The football club foundations responsible for intervention design and delivery are similarly anticipated to use both sets of findings to enhance their provision. When combined with further research into other forms of PSHE and PA delivery, it is envisaged that the current findings can contribute to informing educational policy concerning the inclusion of PSHE and PA opportunities within the school day. The main recommendations at this stage are however for intervention staff to promote the interventions with reference to the finding that intervention participation at the very least does not appear to be detrimental to children's academic achievement in core subjects; to work to increase the time spent by pupils in MVPA during PA sessions; and to consider whether parents can be informed of intervention messages and whether intervention duration can be increased or follow-up sessions introduced to support pupil outcomes. Returning to the good practice characteristics of PA/diet interventions (Horodyska et al., 2015), the identification of a theory of behaviour change to encompass programmes' existing behaviour change techniques and to guide the inclusion of additional techniques might be a longer-term project, with this being of benefit in informing facilitators' efforts to encourage children's participation in at least 60 minutes of MVPA per day.

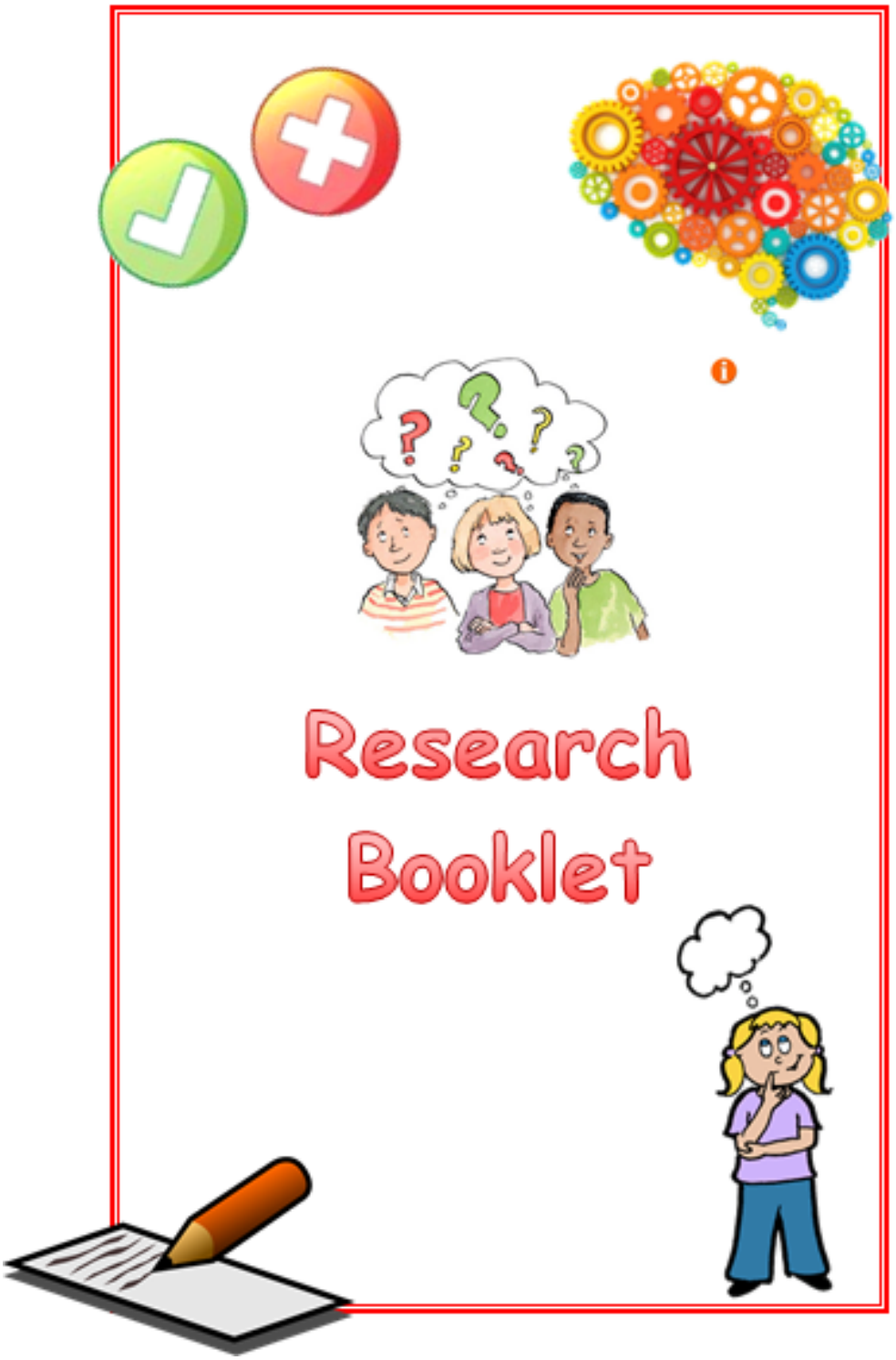
At present, the pressures upon school staff for their pupils to achieve in core curriculum subjects means that other subjects are at risk of receiving lesser attention in the school timetable. Research into PSHE and PA opportunities is therefore highly relevant at the current time, particularly research that measures the associations

between children's participation in PSHE and PA opportunities and their academic achievement in core subjects. The thesis is also timely from the perspective that there is growing interest in the study of PA and mental function in school settings; a suggestion is therefore presented for a cognitive test battery that might be used to achieve consistency in school-based PA–cognition research, and in school-based intervention research more broadly (Study 1). It is hoped that future research into children's mental function is able to not only use and refine this battery but to identify the mechanisms behind the associations between PSHE/PA intervention participation and pupils' achievement in reading and mathematics if these results are found to be replicable.

# Appendices

## Appendix A(i): Initial Version of the CogS: 9–11 Cognitive Test Battery, as used in Study 1 (Example: Red Booklet)

Date of Birth: ___/___/___ Male / Female



## Dot-to-Dot 1

When the timer starts you have 20 seconds to connect as many of the numbers **in order** as you can, by drawing lines from one circle to the next. Good luck! ☺

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | 3 | 4 | 25 | 26 | 28 | 29 |
| 2 | 6 | 5 | 23 | 24 | 27 | 30 |
| 10 | 7 | 8 | 21 | 22 | 32 | 31 |
| 11 | 9 | 19 | 20 | 33 | 42 | 44 |
| 12 | 18 | 35 | 34 | 41 | 43 | 45 |
| 13 | 17 | 36 | 38 | 40 | 47 | 46 |
| 14 | 15 | 16 | 37 | 39 | 48 | 49 |

## Dot-to-Dot 2

When the timer starts you have 20 seconds to connect as many of the numbers **in order** as you can, by drawing lines from one circle to the next. Good luck! ☺

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 12 | 13 | 14 | 15 |
| 6 | 5 | 4 | 11 | 18 | 17 | 16 |
| 7 | 8 | 10 | 19 | 39 | 40 | 42 |
| 22 | 9 | 20 | 38 | 37 | 41 | 43 |
| 23 | 21 | 27 | 34 | 35 | 36 | 44 |
| 24 | 26 | 28 | 31 | 33 | 45 | 48 |
| 25 | 29 | 30 | 32 | 46 | 47 | 49 |

Page 2

## Match-Up!

The numbers 1-9 have been matched up with these pictures:

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|
| ∧ | ⌋ | – | ⊃ | ⟨ | / | ∪ | > | ∠ |

The numbers below are missing their pictures. When the timer starts you have 60 seconds to fill in as many of the boxes with the right ones as you can!

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 6 | 5 | 6 | 4 | 7 | 8 | 3 | 9 | 2 | 8 |
| 9 | 1 | 6 | 5 | 8 | 4 | 5 | 3 | 7 | 1 |
| 3 | 2 | 8 | 3 | 4 | 8 | 2 | 1 | 5 | 9 |
| 1 | 6 | 4 | 2 | 9 | 6 | 8 | 3 | 1 | 6 |
| 1 | 9 | 2 | 1 | 3 | 9 | 6 | 9 | 8 | 3 |
| 8 | 6 | 7 | 4 | 6 | 8 | 7 | 6 | 7 | 1 |
| 7 | 4 | 9 | 6 | 2 | 8 | 5 | 3 | 5 | 9 |
| 8 | 2 | 7 | 9 | 6 | 4 | 5 | 8 | 2 | 4 |
| 1 | 6 | 5 | 8 | 1 | 7 | 6 | 7 | 1 | 5 |

## Find 'M'

When the timer starts you have four minutes to go through the big jumble of letters below, **row by row**. Please circle every letter '**M**' that you see, but none of the other letters!

NVNNWMVMVMVVVNWMMNNNNMNMMWNVVMVMMNWM
VWWWNNNMWMMMNNWNNVMWVWMWNWVVNVNVWW
MWWWWWVMNNVVMVNMMNMWMWWNNWVMNMNNNV
WWVWWWNMMWNNMMWMWWNNVVMVWVWNVWWNM
VWVVWNWWWVWVNVNVNVWMVNMWWMMMNNWVMNM
MNMNNVWMWMMMMMWVMWVWWVMNNVMWVMNMVMV
VNMWNNWMVWWVNNWVMMMNWWNNMNNNNMWNWN
NVNVMNMVVVNVMVWVNWVWMNMMVMWNMVMWWWW
MMMNWMNVMVWMWMVMMNMVNVNVWNWNMMNVVVW
VMWVMMVMVNVWVWMWWMVWWVNMWNWMWMNVNW
VNNNMVMMVMNNWWMWVNVWMVNWVVVVWVWNMVWV
NMMNNNMMVMNWMWNWNWMNNWNVVNVWNNNMMMV
VWMMWNVWNNVVNMWVWNWVNNNNWWWWVVVMWW
VWNMMWMNWVMMNMVNMWMNMMWMMWWMNVVMW
WMWWVVVWMMVWNNVWMNMNVWMMNWVVWMWMMV
MWWNVNMWWWNVVMVWWWNMWVNVMMWMNWMMN
MNVNNVNMWVVNMVNNVMNMVWMWMVWWWMVNNMNN
VVMMNVVMVWWVVVNNWMVMMNWMMWWVVVVMVVWN
WVVMVWVWWMWMNVWNVNNMNVNVNMVNWMWNNNW
WNVNMMWWMNMMMWVVVWMMVVVNMNMVMMVWVMW
VNVMVNVWNNNNWWVMVWNMWMMVVMNVMMMWMMW
WWMMVMNNNWWWVMWVWMMNVVMNWMMNNNNMWV
WWVNWVVWNVVMWNWMMWMNWWWWVWVWNMMMNV
WMVVVVNWVNVMNMVNWNVVVMVVWVMMVNVWWMWMN
NNVWWMNVNNVMVMVVMVMNMNMWVNMMWWMNMVNN
NWMMWNMVNNVMVVNVVMWVWVMNMWWWVNNNNWV
WNMMNWNWNNVWNVVVWVVVNVWWNNWMWVVWNNW
VNVVMNNWMNNNVMWWVWNNWNWNNVMWWVNNWV
VNVNVWMNVWWNWNNMWWMNMWMWWVM

## Memorise!

Please write down the names of as many of the items as you can remember from the pictures you were shown. Don't worry, they **don't have to be in the same order** they were shown! ☺

| | |
|---|---|
| 1. | |
| 2. | |
| 3. | |
| 4. | |
| 5. | |
| 6. | |
| 7. | |
| 8. | |
| 9. | |
| 10. | |
| 11. | |
| 12. | |
| 13. | |
| 14. | |
| 15. | |
| 16. | |
| 17. | |
| 18. | |
| 19. | |
| 20. | |

## 3-Back

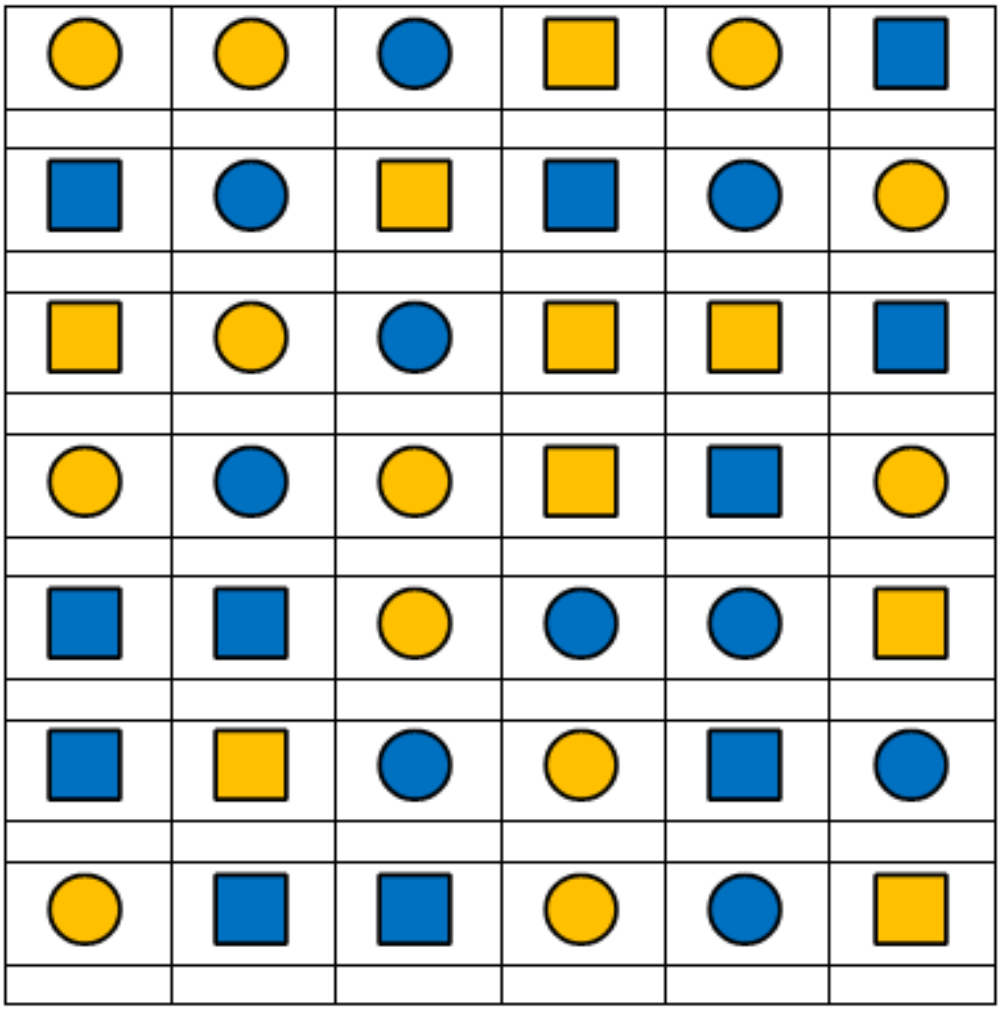
For each of the animals shown on the screen, please put a tick if it **matches** the animal shown **three** pictures before it or a cross if it **doesn't match** the animal shown **three** pictures before it.

| | ✓ or × | | ✓ or × |
|---|---|---|---|
| 1. | | 21. | |
| 2. | | 22. | |
| 3. | | 23. | |
| 4. | | 24. | |
| 5. | | 25. | |
| 6. | | 26. | |
| 7. | | 27. | |
| 8. | | 28. | |
| 9. | | 29. | |
| 10. | | 30. | |
| 11. | | 31. | |
| 12. | | 32. | |
| 13. | | 33. | |
| 14. | | 34. | |
| 15. | | 35. | |
| 16. | | 36. | |
| 17. | | 37. | |
| 18. | | 38. | |
| 19. | | 39. | |
| 20. | | 40. | |

## Colours and Shapes: Part 1

When the timer starts you will have 30 seconds to go through each picture below **in order**. Please put a: **tick** ✓ below **yellow shapes**

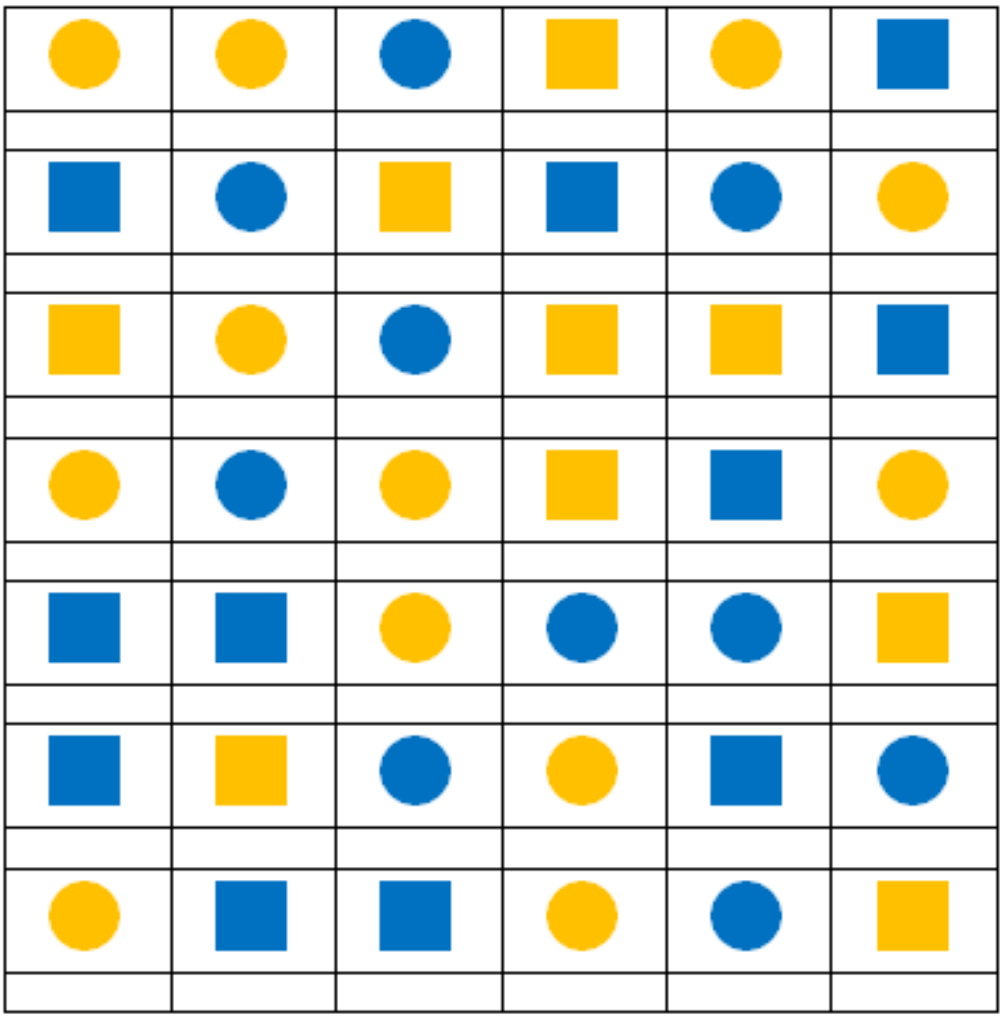
**cross** × below **blue shapes**



## Colours and Shapes: Part 2

When the timer starts you will have 30 seconds to go through each picture below **in order**. Please put a: **tick** ✓ below **squares**

**cross** × below **circles**

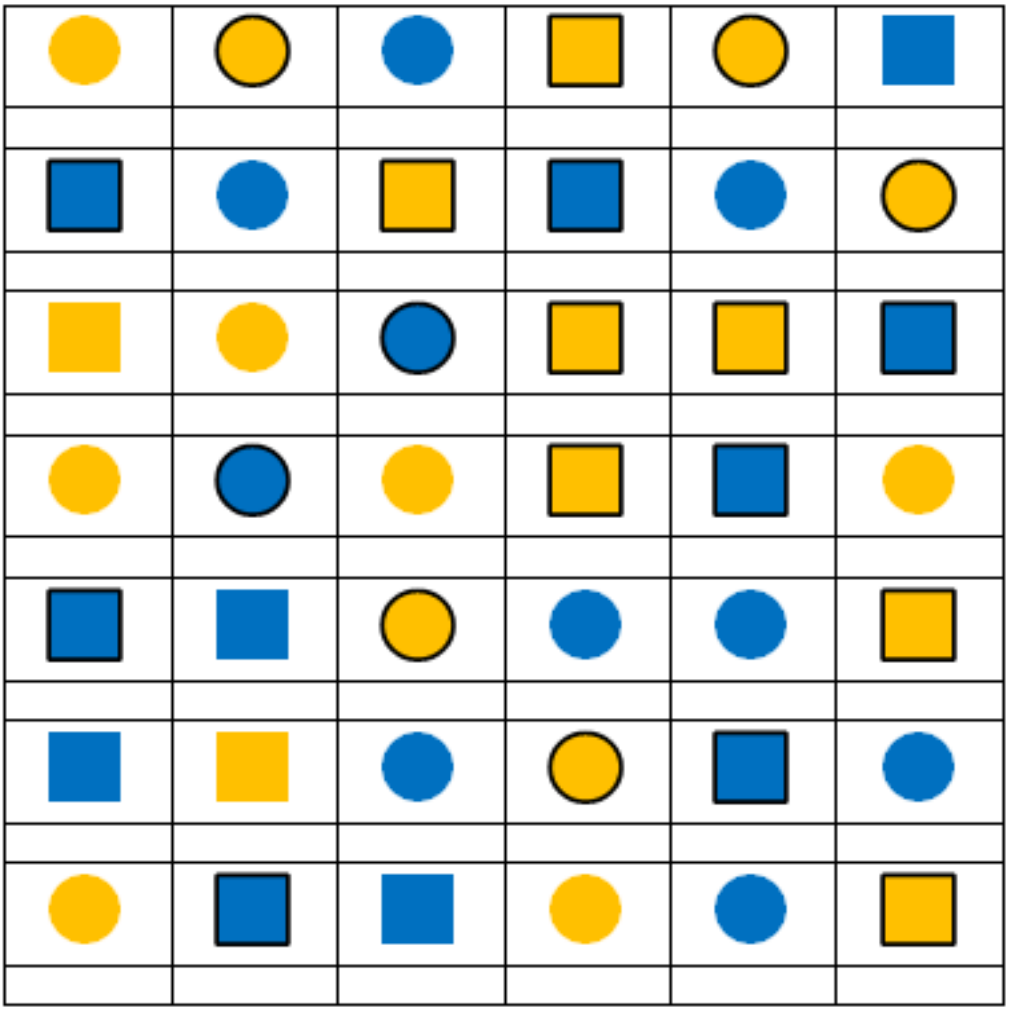


## Colours and Shapes: Part 3

When the timer starts you will have 30 seconds to go through each picture below **in order**.

If the shape has a **border**, please put a: **tick** ✓ below **yellow shapes**
**cross** × below **blue shapes**

If the shape has **no border**, please put a: **tick** ✓ below **squares**
**cross** × below **circles**



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## Which Colour?

This activity can be a little bit tricky! When the timer starts you will have 30 seconds to go through the words below. For each one, please **tick the coloured box that matches the colour the word is printed in** (not what it says)! For example, for 'BLUE' you would tick the ■.

| | | | | |
|---|---|---|---|---|
| RED | RED | BLUE | YELLOW | RED |
| YELLOW | BLUE | GREEN | YELLOW | YELLOW |
| GREEN | BLUE | GREEN | RED | RED |
| RED | YELLOW | RED | YELLOW | YELLOW |
| RED | RED | YELLOW | YELLOW | BLUE |
| GREEN | GREEN | RED | BLUE | GREEN |
| YELLOW | RED | GREEN | GREEN | BLUE |
| GREEN | GREEN | RED | GREEN | YELLOW |

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## Remembering Backwards!

For each of the sets of numbers read out to you, please write it **backwards** in the boxes below!

For instance, if the numbers read out were "**9… 2… 7**", you would write down **729**.

| | | | |
|---|---|---|---|
| 1. | | 2. | |
| 3. | | 4. | |
| 5. | | 6. | |
| 7. | | 8. | |
| 9. | | 10. | |
| 11. | | 12. | |
| 13. | | 14. | |

Now, let's try the same thing for letters! For instance, if the letters read out are "**I… B… G**", you would write down **GBI**.

| | | | |
|---|---|---|---|
| 1. | | 2. | |
| 3. | | 4. | |
| 5. | | 6. | |
| 7. | | 8. | |
| 9. | | 10. | |
| 11. | | 12. | |
| 13. | | 14. | |

## Appendix A(ii): Stimuli for the CogS: 9–11 Memorise! Task, as used in Studies 1–3 (All Booklet Versions)

The 117 available stimuli from the Snodgrass and Vanderwart (1980) set (for which the characteristics and selection process are described in Chapter 4) were randomly sorted into sets of 20 items. Of these, only the first four sets were used in the Memorise! task, with items being displayed to participants in the order in which they are presented below.

| | |
|---|---|
| **Set 1: Red Booklet**<br>sandwich, finger, bike (*bicycle*), balloon, screwdriver, iron, windmill, lemon, saw, television, candle, comb, hat, tie, crown, aeroplane (*airplane*), bus, trumpet, sock, bell | **Set 2: Green Booklet**<br>piano, ring, clown, table, sun, wheel, ball, watch, scissors, spoon, carrot, ladder, cherry, apple, jacket, flower, eye, helicopter, church, glasses |
| **Set 3: Blue Booklet**<br>grapes, screw, umbrella, tomato, bowl, toaster, kite, drum, bow (ribbon), axe, chain, cap, coat, lips, pen, bread, leg, window, hand, ruler | **Set 4: Yellow Booklet**<br>bed, nail (tool), mountain, stool, motorbike (*motorcycle*), basket, box, cup, star, flag, belt, car, pineapple, cake, whistle, mushroom, banana, guitar, skirt, leaf |
| **Stimuli not used**<br>pumpkin, fork, necklace, hammer, pencil, paintbrush, arm, violin, tree, glass, strawberry, glove, vase, envelope, book, chair, onion, brush, clock, lettuce, button, fence, foot, bottle, orange, boot, key, barrel, door, moon, nose, pear, heart, lamp, snowman, suitcase, telephone | |

## Appendix A(iii): Stimuli for the CogS: 9–11 3-Back Task, as used in Studies 1–3 (All Booklet Versions)

The animal stimuli from the Snodgrass and Vanderwart (1980) set are as follows:

1. Ant
2. Bear
3. Bee
4. Butterfly
5. Camel
6. Cat
7. Caterpillar
8. Cow
9. Dog
10. Donkey
11. Elephant
12. Fish
13. Fly
14. Fox
15. Giraffe
16. Goat
17. Gorilla
18. Horse
19. Kangaroo
20. Leopard
21. Lion
22. Monkey
23. Mouse
24. Owl
25. Penguin
26. Pig
27. Rabbit
28. Sheep
29. Snail
30. Snake
31. Spider
32. Squirrel
33. Swan
34. Tiger
35. Zebra

From these stimuli, the following items were removed:

- Ant and bee, due to semantic similarity with fly;
- Gorilla, due to semantic similarity with monkey;
- Leopard and tiger, due to visual similarity with lion;
- Cat, giraffe, owl and penguin, due to their portrait orientation (all of the remaining stimuli were presented in landscape orientation). To avoid their orientation being a visual cue, the portrait stimuli were used for the demonstration slides.

A total of 26 animal stimuli remained for use in the 3-Back task, as follows:

1. Bear
2. Butterfly
3. Camel
4. Fly
5. Caterpillar
6. Cow
7. Dog
8. Elephant
9. Fish
10. Fox
11. Spider
12. Horse
13. Kangaroo
14. Lion
15. Monkey
16. Mouse
17. Donkey
18. Goat
19. Pig
20. Rabbit
21. Sheep
22. Snail
23. Snake
24. Squirrel
25. Swan
26. Zebra

For Study 1, stimuli were arranged into the sequences shown below, where greyed out cells indicate that no response was required for a stimulus and green cells indicate that a tick was the correct response. For all remaining stimuli, a cross was the correct response.

| Red Booklet | Green Booklet | Blue Booklet | Yellow Booklet |
|---|---|---|---|
| 1. Monkey | 1. Cow | 1. Fly | 1. Caterpillar |
| 2. Rabbit | 2. Monkey | 2. Camel | 2. Mouse |
| 3. Fish | 3. Sheep | 3. Swan | 3. Cow |
| 4. Dog | 4. Spider | 4. Kangaroo | 4. Squirrel |
| 5. Zebra | 5. Monkey | 5. Camel | 5. Mouse |
| 6. Spider | 6. Fish | 6. Cow | 6. Pig |
| 7. Dog | 7. Spider | 7. Spider | 7. Squirrel |
| 8. Donkey | 8. Goat | 8. Fox | 8. Fox |
| 9. Sheep | 9. Squirrel | 9. Cow | 9. Pig |
| 10. Monkey | 10. Horse | 10. Spider | 10. Cow |
| 11. Cow | 11. Pig | 11. Camel | 11. Fox |
| 12. Butterfly | 12. Mouse | 12. Rabbit | 12. Snail |
| 13. Caterpillar | 13. Bear | 13. Horse | 13. Horse |
| 14. Bear | 14. Pig | 14. Camel | 14. Bear |
| 15. Butterfly | 15. Zebra | 15. Caterpillar | 15. Pig |
| 16. Caterpillar | 16. Bear | 16. Mouse | 16. Cow |
| 17. Bear | 17. Elephant | 17. Goat | 17. Bear |
| 18. Lion | 18. Zebra | 18. Elephant | 18. Pig |
| 19. Spider | 19. Fox | 19. Mouse | 19. Monkey |
| 20. Monkey | 20. Donkey | 20. Goat | 20. Zebra |
| 21. Rabbit | 21. Snail | 21. Elephant | 21. Fly |
| 22. Fly | 22. Fox | 22. Zebra | 22. Monkey |
| 23. Fox | 23. Donkey | 23. Kangaroo | 23. Zebra |
| 24. Mouse | 24. Snail | 24. Monkey | 24. Sheep |
| 25. Fly | 25. Snake | 25. Dog | 25. Butterfly |
| 26. Fox | 26. Mouse | 26. Snail | 26. Monkey |
| 27. Mouse | 27. Horse | 27. Snake | 27. Bear |
| 28. Swan | 28. Snake | 28. Dog | 28. Monkey |
| 29. Mouse | 29. Bear | 29. Snail | 29. Monkey |
| 30. Camel | 30. Goat | 30. Pig | 30. Bear |
| 31. Swan | 31. Caterpillar | 31. Squirrel | 31. Monkey |
| 32. Mouse | 32. Bear | 32. Fish | 32. Cow |
| 33. Camel | 33. Spider | 33. Pig | 33. Snail |
| 34. Monkey | 34. Caterpillar | 34. Squirrel | 34. Dog |
| 35. Pig | 35. Butterfly | 35. Fish | 35. Fish |
| 36. Goat | 36. Spider | 36. Monkey | 36. Snake |
| 37. Camel | 37. Dog | 37. Caterpillar | 37. Lion |
| 38. Rabbit | 38. Goat | 38. Horse | 38. Elephant |
| 39. Goat | 39. Elephant | 39. Butterfly | 39. Snake |
| 40. Camel | 40. Camel | 40. Swan | 40. Fish |

To increase the difficulty of the task following a potential ceiling effect in Study 1, the number of unique stimuli was reduced from 26 to 10 by random number selection to limit novelty as a cue for 'no' responses. The 10 remaining stimuli were:

1. Mouse
2. Caterpillar
3. Donkey
4. Horse
5. Rabbit
6. Elephant
7. Fly
8. Bear
9. Fox
10. Sheep

Each of the remaining stimuli was assigned to represent two or three of the previous 26 stimuli, those representing two stimuli being chosen by random number selection:

- Mouse took the place of bear, butterfly and camel;
- Caterpillar took the place of fly, caterpillar and cow;
- Donkey took the place of dog and elephant;
- Horse took the place of fish, fox and spider;
- Rabbit took the place of horse and kangaroo;
- Elephant took the place of lion, monkey and mouse;
- Fly took the place of donkey and goat;
- Bear took the place of pig, rabbit and sheep;
- Fox took the place of snail and snake;
- Sheep took the place of squirrel, swan and zebra.

The stimuli were then put back into the same sequences as in Study 1. For the most part, no changes were required to keep the sequences of 'yes' and 'no' responses the same, but items were replaced using random numbering where necessary. The stimuli as presented in Studies 2 and 3 are shown on the next page.

| Red Booklet | Green Booklet | Blue Booklet | Yellow Booklet |
|---|---|---|---|
| 1. Elephant | 1. Caterpillar | 1. Caterpillar | 1. Caterpillar |
| 2. Bear | 2. Elephant | 2. Mouse | 2. Elephant |
| 3. Horse | 3. Bear | 3. Sheep | 3. Caterpillar |
| 4. Donkey | 4. Horse | 4. Rabbit | 4. Sheep |
| 5. Sheep | 5. Elephant | 5. Mouse | 5. Elephant |
| 6. Elephant | 6. Horse | 6. Caterpillar | 6. Bear |
| 7. Donkey | 7. Horse | 7. Horse | 7. Sheep |
| 8. Fly | 8. Fly | 8. Horse | 8. Horse |
| 9. Bear | 9. Sheep | 9. Caterpillar | 9. Bear |
| 10. Elephant | 10. Rabbit | 10. Horse | 10. Caterpillar |
| 11. Caterpillar | 11. Bear | 11. Mouse | 11. Horse |
| 12. Mouse | 12. Elephant | 12. Bear | 12. Fox |
| 13. Caterpillar | 13. Mouse | 13. Rabbit | 13. Rabbit |
| 14. Mouse | 14. Bear | 14. Mouse | 14. Mouse |
| 15. Mouse | 15. Sheep | 15. Caterpillar | 15. Bear |
| 16. Caterpillar | 16. Mouse | 16. Elephant | 16. Caterpillar |
| 17. Mouse | 17. Donkey | 17. Fly | 17. Mouse |
| 18. Elephant | 18. Sheep | 18. Donkey | 18. Bear |
| 19. Horse | 19. Horse | 19. Elephant | 19. Elephant |
| 20. Elephant | 20. Fly | 20. Fly | 20. Sheep |
| 21. Bear | 21. Fox | 21. Donkey | 21. Caterpillar |
| 22. Caterpillar | 22. Horse | 22. Sheep | 22. Elephant |
| 23. Horse | 23. Fly | 23. Rabbit | 23. Sheep |
| 24. Elephant | 24. Fox | 24. Elephant | 24. Bear |
| 25. Caterpillar | 25. Fox | 25. Donkey | 25. Mouse |
| 26. Horse | 26. Elephant | 26. Fox | 26. Elephant |
| 27. Elephant | 27. Rabbit | 27. Fox | 27. Mouse |
| 28. Sheep | 28. Fox | 28. Donkey | 28. Elephant |
| 29. Elephant | 29. Mouse | 29. Fox | 29. Elephant |
| 30. Mouse | 30. Fly | 30. Bear | 30. Mouse |
| 31. Sheep | 31. Caterpillar | 31. Sheep | 31. Elephant |
| 32. Elephant | 32. Mouse | 32. Horse | 32. Caterpillar |
| 33. Mouse | 33. Horse | 33. Bear | 33. Fox |
| 34. Elephant | 34. Caterpillar | 34. Sheep | 34. Donkey |
| 35. Bear | 35. Sheep | 35. Horse | 35. Horse |
| 36. Fly | 36. Horse | 36. Elephant | 36. Caterpillar |
| 37. Mouse | 37. Donkey | 37. Caterpillar | 37. Elephant |
| 38. Sheep | 38. Fly | 38. Rabbit | 38. Donkey |
| 39. Fly | 39. Donkey | 39. Mouse | 39. Caterpillar |
| 40. Mouse | 40. Mouse | 40. Sheep | 40. Horse |

## Appendix B: Example Consent Form (Study 4, Child Participants)

northumbria UNIVERSITY NEWCASTLE
Faculty of Health & Life Sciences

**Project Title:** An examination of the impact and sustainability of school-based physical activity interventions on long-term behaviour change.

**Principal Investigator:** Nicola McCullogh

**CONSENT FORM FOR CHILDREN'S PARTICIPATION**
**(SIDE ONE OF TWO)**

*Please tick where applicable*

| | |
|---|---|
| My child and I have carefully read and understood the Participant Information Sheets. | ☐ |
| My child and I have had an opportunity to ask questions and discuss this study either by email or face-to-face, and have received satisfactory answers if we have asked questions. | ☐ |
| My child and I understand that my child is free to withdraw from the study at any time, without having to give a reason for withdrawing, and without prejudice. | ☐ |
| My child and I agree for my child to take part in this study. | ☐ |

My child and I hereby confirm that we give consent for the following recordings to be made:

| Recording | Purpose |
|---|---|
| Audio recording of focus group discussion | The audio file will be used for the purposes of transcribing and analysing the focus group discussion. |

***Please tick the box to indicate your consent for this recording to be made:*** ☐

**Clause A:** My child and I understand that the recording(s) may also be used for teaching/research purposes and may be presented to students/researchers in an educational/research context. My child's name or other personal information will never be associated with the recording(s).

***Please tick the box to indicate your consent to Clause A:*** ☐

**Clause B:** My child and I understand that the recording(s) may be published in an appropriate journal/textbook or on an appropriate Northumbria University webpage, **which would automatically mean that the recordings would potentially be available worldwide**. My child's name or other personal information will never be associated with the recording(s). My child and I understand that we have the right to withdraw consent at any time prior to publication, but that once the recording(s) are in the public domain there may be no opportunity for the effective withdrawal of consent.

***Please tick the box to indicate your consent to Clause B:*** ☐

I would like to receive feedback on the overall results of this study. ☐

*(Feedback will be sent to the email address provided on Side 2 of this form.)*

**PLEASE TURN OVER**

**CONSENT FORM FOR CHILDREN'S PARTICIPATION**
**(SIDE TWO OF TWO)**

| Participant code: |
|---|
| |

Child's name (IN BLOCK LETTERS): .....

Signature of parent/guardian: ..... Date: .....

Email address of parent/guardian (to receive information on the dates and times of the focus groups and also to receive feedback on the overall results of the study if this box has been ticked on Side 1 of the consent form):

.....

Signature of participant (child): .....

Signature of researcher: ..... Date: .....

(NAME IN BLOCK LETTERS): .....

**Appendix C: Example Information Sheet for Children (Study 1)**

northumbria UNIVERSITY NEWCASTLE

**I'm trying to find out…**
…whether a set of activities I will be using soon with other children measure what they are supposed to measure!

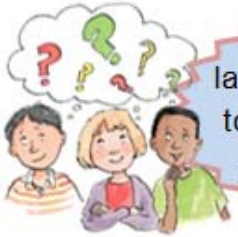
**I'd like to ask you…**
…to complete a booklet of activities which are like little games, measuring things like how well you can remember pictures you have been shown.

# Nicola's Study

*Please ask if there is anything you don't understand.*

The activities are all timed, should take about half an hour and will be done in your normal classroom during school time.


**Please remember…**
…if you don't like an activity you don't have to do it, or you can have a go and then stop if you don't want to do it anymore ☺



I'll come back a week later, and then the week after that, to ask you to do the same sort of activities again and check that they still work!

**If you want to take part in the research, please sign the consent form with your parents/guardians and hand it in to your teacher in the envelope by [DATE].**

*Please remember you can change your mind about taking part at any time. Just ask your parents/guardians to email me.*

**Researcher's name:** Nicola McCullogh

## Appendix D: Example Information Sheet for Parents/Guardians (Studies 2 and 3, Intervention Group)

northumbria UNIVERSITY NEWCASTLE
Faculty of Health & Life Sciences

**Study Title:** An examination of the impact and sustainability of school-based physical activity interventions on long-term behaviour change and school functioning.

**Researcher:** Nicola McCullogh

Participant code:

# Information Sheet for Parents/Guardians

Dear parent/guardian, you might recall the information about my study sent out last week. I would now like to invite your child to take part in the study and enclose a consent form for you to complete if you are happy for them to take part.

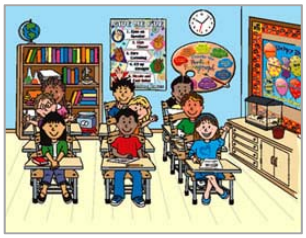
***If you consent to your child's participation in the study once you have read this leaflet, please complete the consent form and ask your child to hand it in to their teacher by [DATE]. Thank you!***

Please find below details on why the study is being carried out and what it will involve. If you have any questions please email me (nicola.mccullogh@northumbria.ac.uk).

**What is the purpose of the study?**

I am conducting this study as part of my PhD in Sport, Exercise and Rehabilitation at Northumbria University, in collaboration with [redacted].

The aim of the study is to investigate the associations between primary school children's participation in healthy lifestyle programmes and their physical activity levels, wellbeing and performance at school. Your child's school has arranged for their class to take part in the '[redacted]' healthy lifestyle programme delivered by [redacted] and I would like to measure the children's activity levels, self-reported wellbeing, mental skills (e.g. attention, memory) and academic achievement before and after the programme to assess the relationships between these measures. Results will be compared with data from a control group to see whether participation in the programme makes a difference over and above other factors (e.g. weather conditions influencing physical activity levels).



**Why has my child been invited to take part?**

Because their class will be participating in the [redacted] programme during the course of the current academic year.

**Does my child have to take part?**

No. It is up to you and your child together whether they take part in the study. If you decide that they will take part, please remember that they can stop being involved in the study whenever you or they choose, without having to tell me why. You are completely free to decide whether or not your child will take part, or for them to take part and then leave the study before the end.

**What will happen if my child takes part?**

Once you and your child have read this information sheet (and asked any questions you may have about the research by emailing me at


nicola.mccullogh@northumbria.ac.uk), if you decide that your child will be participating in the research then ***please sign the consent form and hand it in to your child's class teacher by [date]***. I will pick up consent forms from the teacher and only collect data from children with completed consent forms. There are four aspects to the study and you can consent to your child participating in some aspects but not others by ticking the appropriate boxes on the consent form.

Mental skills: Before and after they take part in the [redacted] programme, plus once immediately following one of the [redacted] sessions, I will ask the children to complete a series of activities in a booklet to measure their mental skills. These activities will be almost like games and will allow me to look at factors such as their memory and attention which might relate to their academic work. To familiarise the children with the activities I will ask them to complete the booklet for practice at a separate session before the [redacted] programme begins.

Wellbeing: Before and after they take part in the [redacted] programme, I will ask the children to complete a survey on their wellbeing (specifically: physical wellbeing; psychological wellbeing; social and peer support; and experiences at school). This should take no longer than 15 minutes. To familiarise the children with the survey I will ask them to complete it for practice at a separate session before the [redacted] programme begins.

School performance: Before and after they take part in the [redacted] programme, I will collect children's assessment levels for Reading, Writing and Maths from their teacher.

Physical activity: To record their physical activity I will ask your child to wear an activity tracker (pictured) on a belt (provided) for two seven-day periods[1]: once before and once after they take part in the [redacted] programme. This small device sits on the right hip and will need to be worn at all times from when they get up to when they go to bed, except when showering/bathing or taking part in swimming or combat sports (e.g. karate).

[1] In practice, most of the children chose to wear the accelerometers for an additional two days as the researcher collected them in after a weekend.

Children will also be asked to wear an activity tracker to record how active they are in one of the [redacted] sessions.

*Setting up the activity trackers:* To set up the activity trackers for each child I will need to measure their height and weight before the first time they wear one. These measurements will only be used to calculate activity levels and will NOT feature in the report, nor will they be made available to anyone other than the research team. They will be taken with children wearing their usual school clothes apart from their shoes.

Children's date of birth, sex and handedness will also be recorded to help set up the activity trackers and to report on things like the average age of the participants and the numbers of males/females in the study, but individual children will not be identified in the report.

**Will my child's taking part in this study be kept confidential and anonymous?**

Yes. Every child will be allocated a participant code so that they are not identifiable to anyone beyond the research team and average scores across a group of participants will be given in the write-up, rather than reporting on each individual child.

Your child's name will not appear in any reports, documents (e.g. science journal publications) or research conference presentations resulting from this study, and the consent form you have been asked to sign will be stored separately from any other data. All data will be stored in accordance with University guidelines and the Data Protection Act (1998). The only exception to the confidentiality of the data collected will be if the research team feels that you, your child or others may be harmed if information is not shared.

I will provide you with a general summary of the findings from the study via email if you indicate you would like this by ticking the appropriate box on the consent form.

**What are the possible benefits and disadvantages of taking part?**

By taking part in the study your child will be providing valuable information which it is hoped can be used to make recommendations for the future running of health programmes.

As part of the study they will be asked to complete a short questionnaire on their wellbeing, and there is a possibility of this causing upset if, for instance, they are dissatisfied with their relationships with others (example question: 'Have you been able to rely on your friends?') or will be affected by reflecting on their lives ('Has your life been enjoyable?').

These issues have been considered in the risk assessment for the research, submitted as part of the ethics proposal (see below).

**Who has reviewed this study?**

The Faculty of Health and Life Sciences Research Ethics Committee at Northumbria University has reviewed the study in order to safeguard your child's interests, and has granted approval for me to conduct the study.

**Contact for further information:**

**Researcher email: nicola.mccullogh@northumbria.ac.uk**
**Supervisor email: spencer.boyle@northumbria.ac.uk**

If you require independent information or advice about the project, please contact Dr Mick Wilkinson, the Ethics Coordinator for the Department of Sport, Exercise and Rehabilitation at Northumbria University, stating the title of the research ("An examination of the impact and sustainability of school-based physical activity interventions on long-term behaviour change and school functioning") and the name of the researcher (Nicola McCullogh). Dr Wilkinson can be contacted at: mic.wilkinson@northumbria.ac.uk

## Appendix E: Example Debrief for Parents/Guardians (Studies 2 and 3, Intervention Group)

Northumbria University NEWCASTLE

Faculty of Health & Life Sciences

Participant code:

# DEBRIEF FOR PARENTS/GUARDIANS

**Name of Researcher:** Nicola McCullogh

**Name of Supervisor:** Dr Spencer E. Boyle

**Project Title:** An examination of the impact and sustainability of school-based physical activity interventions on long-term behaviour change and school functioning.

**1. What was the purpose of the project?**

Primary schools often take part in programmes to promote healthy lifestyles and positive choices for their pupils, including teaching them about the importance of being physically active. Your child has recently taken part in a healthy lifestyle/positive choices programme at school. As part of the research project they were asked to complete questionnaires on their feelings of wellbeing (physical wellbeing; psychological wellbeing; social and peer support; and experiences at school), took part in activities measuring their mental skills (e.g. attention, memory), and had their achievement in reading, writing and maths recorded from their teacher. This will allow for the investigation of the relationships between these measures, as well as physical activity levels, before and after taking part in the programme.

Of particular interest in the research project is whether children's mental performance improved immediately after physical activity, so one set of activities measuring mental skills took place after a physical activity session or a classroom session for comparison. This is a relatively new area of research but it has been suggested that there are short-term benefits of physical activity for some aspects of thinking (e.g. attention). If similar results are found for this study then recommendations will be made about including opportunities for physical activity during the school day to support children's learning.

One of the other aims of the project was to assess whether healthy lifestyle/positive choices programmes have an impact on children's physical activity levels by comparing the daily activity levels of some of the children before and after taking part in the programme. Activity levels were measured by asking some of the children to wear an activity tracker. A control group of children from schools/classes not taking part in healthy lifestyle/positive choices programmes will be used for comparison during the analysis because it is possible that physical activity levels change over time due to other factors (e.g. weather conditions), so the data collected from children in the control group will be used to account for this in the results.

**2. How will I find out about the results?**

If you provided an email address on the consent form then you will be emailed a general summary of the results from this study once the data analysis is complete. It is anticipated that this will be in September 2018. You may also email the researcher at nicola.mccullogh@northumbria.ac.uk to receive a summary of the results.

**3. If I change my mind and wish to withdraw the information my child has provided, how do I do this?**

If you decide for any reason that you do not wish your child's data to be included in the analysis, please let the researcher know as soon as possible using the contact details below and stating the participant code at the top of this debrief sheet. Your withdrawal will be completely without prejudice and the researcher will destroy all of the information provided by your child. Please contact the researcher within four weeks of your child's participation; it may not be possible to withdraw their data after this point as the analysis may have been conducted, although their information will have been anonymised as described in the participant information sheet so they will not be identifiable in any way.

The researcher can be contacted at nicola.mccullogh@northumbria.ac.uk. Her supervisor, Dr Spencer E. Boyle, can be contacted at spencer.boyle@northumbria.ac.uk.

The data collected in this study may also be published in scientific journals or presented at conferences. Information and data gathered during this research study will only be available to the research team identified in the information sheet. Should the research be presented or published in any form, all data will be anonymous (i.e. your child's personal information or data will not be identifiable).

All information and data gathered during this research will be stored in line with the Data Protection Act and will be destroyed 6 months following the conclusion of the study. If the research is published in a scientific journal it may be kept for longer before being destroyed. During that time the data may be used by members of the research team only for purposes appropriate to the research question, but at no point will your child's personal information or data be revealed. Insurance companies and employers will not be given any individual's personal information, nor any data provided by them, and nor will we allow access to the police, security services, social services, relatives or lawyers, unless forced to do so by the courts.

If you wish to receive feedback about the findings of this research study then please contact the researcher at **nicola.mccullogh@northumbria.ac.uk**

This study and its protocol have received full ethical approval from Faculty of Health and Life Sciences Research Ethics Committee. If you require confirmation of this, or if you have any concerns or worries concerning this research, or if you wish to register a complaint, please contact the Chair of this Committee (Dr Nick Neave: nick.neave@northumbria.ac.uk), stating the title of the research project ("An examination of the impact and sustainability of school-based physical activity interventions on long-term behaviour change and school functioning") and the name of the researcher (Nicola McCullogh).

## Appendix F: Example Debrief for Children (Studies 2 and 3, Control Group)

Northumbria University NEWCASTLE

**What was the research about?**

Your results will be compared with results from children who took part in healthy lifestyle sessions at school because the aim of the research is to see if healthy lifestyle sessions have any effect on children being active, their happiness and how well they do on the booklet activities and in reading, writing and maths.

If the findings seem to show that the healthy lifestyle sessions are good for children then more schools might want to run similar sessions to help their pupils be healthy and happy and do well at school.

**Thank you for taking part in my study!**

**If you change your mind and don't want your information to be used for the study, please tell your parents/guardians so they can email me.** Please tell them as soon as you can because I'm going to start writing up the findings in the next four weeks and it might be hard to take your information out after that. You don't need to tell anyone why you don't want your information to be used.

When all of the schools have taken part in this study I'll put all of the information together and write up what was found (without using people's names). I should be able to do this by September 2018. If your parents/guardians ticked one of the boxes on the consent form I'll send them a summary of the results that they can share with you.

**Researcher's name:** Nicola McCullogh

# Appendix G: Study 1 – Summary of Results for Participants and Schools

northumbria UNIVERSITY NEWCASTLE

## Study Feedback for Participants and Schools

**Study Title:** Establishing the reliability and validity of cognitive tests for use in physical activity research.

**Researcher:** Nicola McCullogh
nicola.mccullogh@northumbria.ac.uk

**Supervisor:** Dr Spencer E. Boyle
spencer.boyle@northumbria.ac.uk

**What Did the Study Involve?**

Groups of children were asked to complete a research booklet at school on three occasions, each approximately a week apart. The activities in the booklet are described in the table below. The aim of the study was to see if the activities tested what they aimed to test and if they were suitable for use with Key Stage 2 children in upcoming research into the effects of physical activity on children's mental skills.

The main findings across all of the children from all of the schools were as follows:

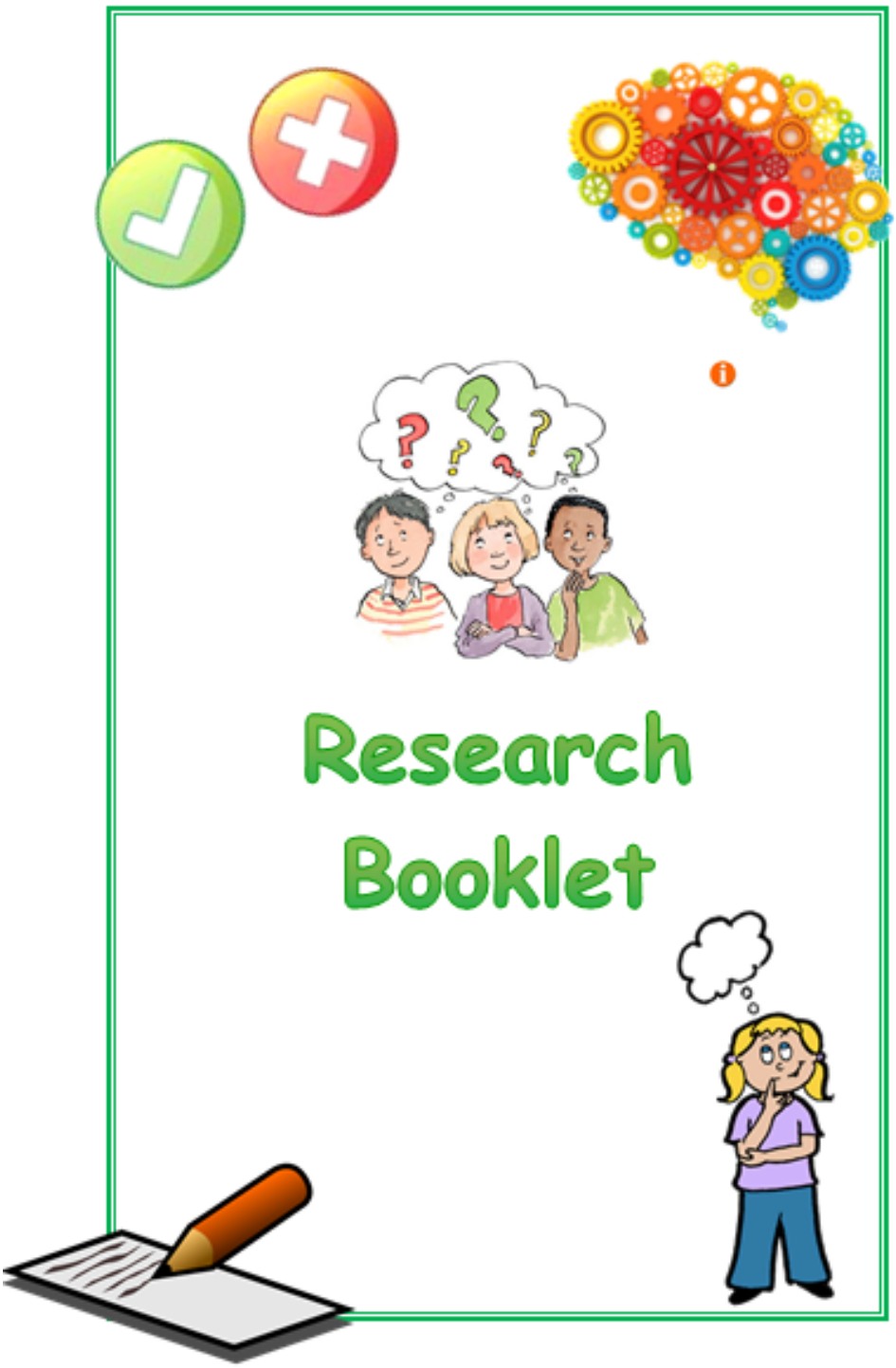
| Activity | Max. Possible Score | Average Score, Visit 1 | Average Score, Visit 2 | Average Score, Visit 3 |
|---|---|---|---|---|
| ***Dot-To-Dot***<br>*Join as many circles as possible in number order. The activity is completed twice, with a time limit of 20 seconds each time, and is designed to test how quickly participants process information.* | 96 | 48.9 | 58.4 | 58.2 |
| ***Match-Up!***<br>*Draw the corresponding symbols for as many numbers as possible in 60 seconds using the key provided. Designed to test information processing speed.* | 90 | 22.2 | 26.9 | 26.5 |
| ***Find 'M'***<br>*Circle as many letter 'M's as possible in 4 minutes from a page full of 'M's, 'N's, 'V's and 'W's. Designed to test attention.* | 1000 | 556.5 | 663.8 | 749.5 |
| ***Memorise!***<br>*After a 100-second break, write down all of the items remembered from the series of pictures previously shown. Designed to test long-term memory.* | 20 | 10.7 | 11.2 | 10.6 |
| ***3-Back***<br>*For each of the animals shown in sequence, indicate whether it matches or does not match the one shown three before it. Designed to test keeping information up to date in short-term memory.* | 37 | 30.6 | 31.1 | 30.4 |
| ***Colours and Shapes***<br>*Alternate between task 1: ticking yellow shapes and crossing blue ones, and task 2: ticking squares and crossing circles. Designed to test how well participants can switch between rules.* | 42 | 16.5 | 16.0 | 14.6 |
| ***Which Colour?***<br>*Words such as BLUE are shown. Indicate for as many words as possible in 30 seconds the colour of the ink, not the word itself. Designed to test how well participants can prevent themselves from making instinctive responses.* | 40 | 18.6 | 23.3 | 26.1 |
| ***Remembering Backwards!***<br>*Write down the numbers and letters read out by the researcher in reverse order. Designed to test working with information in short-term memory.* | This activity was only run with one group of pupils on one occasion before the decision was made to remove it from the research booklet. | | | |

***I hope you enjoyed taking part in the study – thank you for your participation!***

If you require independent information or advice about the project, please contact Dr Mick Wilkinson, the Ethics Coordinator for the Department of Sport, Exercise and Rehabilitation at Northumbria University. Dr Wilkinson can be contacted at: mic.wilkinson@northumbria.ac.uk

**Appendix H: Final Version of the CogS: 9–11 Cognitive Test Battery, as used in Studies 2 and 3 (Example: Green Booklet)**

Date of Birth: ___/___/___ Male / Female



## Dot-to-Dot 1

When the timer starts you have 20 seconds to connect as many of the numbers **in order** as you can, by drawing lines from one circle to the next. Good luck! ☺

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | 5 | 6 | 30 | 31 | 35 | 36 |
| 2 | 4 | 7 | 29 | 32 | 34 | 37 |
| 3 | 8 | 9 | 25 | 28 | 33 | 38 |
| 11 | 10 | 24 | 26 | 27 | 40 | 39 |
| 13 | 12 | 23 | 22 | 43 | 42 | 41 |
| 14 | 17 | 19 | 21 | 44 | 46 | 47 |
| 15 | 16 | 18 | 20 | 45 | 48 | 49 |

Page 1

## Dot-to-Dot 2

When the timer starts you have 20 seconds to connect as many of the numbers **in order** as you can, by drawing lines from one circle to the next. Good luck! ☺

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | 3 | 4 | 7 | 8 | 35 | 36 |
| 2 | 5 | 6 | 10 | 9 | 34 | 37 |
| 17 | 16 | 13 | 12 | 11 | 33 | 38 |
| 18 | 20 | 15 | 14 | 32 | 39 | 41 |
| 19 | 22 | 21 | 29 | 31 | 40 | 42 |
| 23 | 25 | 28 | 30 | 45 | 44 | 43 |
| 24 | 26 | 27 | 46 | 47 | 48 | 49 |

## Match-Up!

The numbers 1-9 have been matched up with these pictures:

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|
| / | \ | ∪ | ⌋ | ∠ | ⊃ | ∧ | > | – |

The numbers below are missing their pictures. When the timer starts you have 60 seconds to fill in as many of the boxes with the right ones as you can!

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 7 | 9 | 1 | 4 | 8 | 5 | 6 | 7 | 6 | 3 |
| 1 | 8 | 5 | 1 | 5 | 3 | 8 | 1 | 4 | 8 |
| 7 | 2 | 3 | 8 | 7 | 9 | 6 | 9 | 5 | 4 |
| 7 | 5 | 7 | 1 | 7 | 4 | 7 | 6 | 2 | 9 |
| 5 | 9 | 3 | 4 | 8 | 7 | 4 | 7 | 5 | 9 |
| 3 | 6 | 8 | 2 | 9 | 8 | 5 | 1 | 8 | 3 |
| 2 | 3 | 7 | 1 | 8 | 6 | 9 | 6 | 1 | 6 |
| 7 | 8 | 3 | 9 | 6 | 1 | 3 | 9 | 1 | 8 |
| 1 | 9 | 7 | 8 | 9 | 2 | 3 | 5 | 9 | 8 |

## Find 'M'

When the timer starts you have four minutes to go through the big jumble of letters below, **row by row**. Please circle every letter '**M**' that you see, but none of the other letters!

NMWWVWNMMWVWNMWNWVVNNWWNWNMWVWMNW
WVNVNWVWMNWWWNNMMWMMMNMVVWNMWMWVMV
WMMWWVMWVMVWVWWVWMNNVVNVNWNMWMMWM
MWVVVWWNMNNNNVWNMNNWMNMMNNVNVVNVVWVN
WWMMWWMNVMVMNMNMNNWNMVNNNVMVWWNNWVV
MMWWNVVMNVMWNNMWMVWWVVMWNNVMVMNNMWM
WVVMNNVNWVVNWNMMWVNWVNWWMMWMWMNNNM
WWVMVMNVNWMVVMNNWMVWMWVNMMNVVMWVVMW
NNNVMWNNVMVMWNWWMMMNNNMWWVVNVWMWVNV
WMVMNMNWWVVWNVVNMNMVWVVVNNWVWWNMMMN
NWWMWMMNVWMNMMVVVMNNVVWWNNVWNNMNVMW
MNMMVNVMVVVNNNVVMMMVNVMMNVNMVNMWMWVMN
MMWMNWNWVWNWVMNMMVWWVWWVWMWWMVNWM
VWWVMNNVNNVMVNVMWNVNMMNWVVNNMNVMNMNV
WVMMNMMVVMVWMWVMMVNNMMVWWMVMNMWVNWV
VVWVMNMWNVMMWVVVNVMWMNVWWMWWVNNNNNN
NNVMVWNMVVVVNWNNWWVNWVWVNNWWNMMNVMW
NWVVVMVWNWWMMNWVMNNNVVNMVMVMMMWNVVVV
WMMMWVWVWMWVWWNWMMWWNNNMNNMWWWNN
WNVVMMMMNMNMWWMNWVMMMWNNWWNNMVMWM
WVNVVNWWMMMNMWWWWNWMWNVMNNVWVNMVVM
MMNNNNNVWNMNMNVVWWVVMWWMWVVNWNVNVWNV
VNVWWVMMVWMWMMNMMWMVWMMWVMWNVMMWVV
NMMVNMWMWVNVVWNMWMWVVVWWVNMWMNWWNM
WMVWMWNWVVNNWNNVMMNMWWMVVVWWMVNVMM
WVVMWNWMVNWNNNNWMVVWMWNWNNVWWNWWNN
NMMWVVMWMWVMNNWMNVVNVVMVNNVVWWVNWWW
MVVVNWNVNVVWNNNMMVMNWWWNMMMNMVVWNMVM
VWMWNVWNNWNWWVVWWMVMMVMVVVNVW

Page 4

## Memorise!

Please write down the names of as many of the items as you can remember from the pictures you were shown. Don't worry, they **don't have to be in the same order** they were shown! ☺

| | |
|---|---|
| 1. | |
| 2. | |
| 3. | |
| 4. | |
| 5. | |
| 6. | |
| 7. | |
| 8. | |
| 9. | |
| 10. | |
| 11. | |
| 12. | |
| 13. | |
| 14. | |
| 15. | |
| 16. | |
| 17. | |
| 18. | |
| 19. | |
| 20. | |

## 3-Back

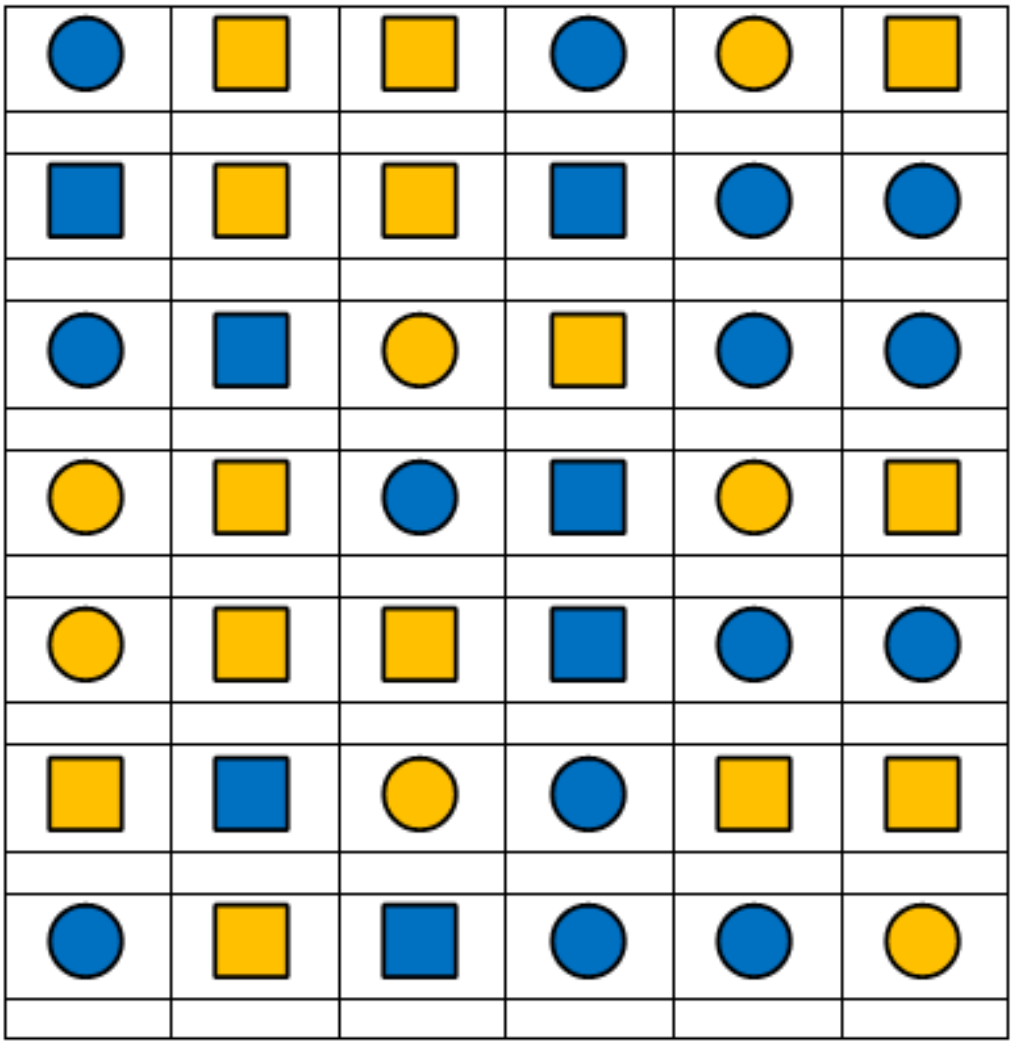
For each of the animals shown on the screen, please put a tick if it **matches** the animal shown **three** pictures before it or a cross if it **doesn't match** the animal shown **three** pictures before it.

| | ✓ or × | | ✓ or × |
|---|---|---|---|
| 1. | | 21. | |
| 2. | | 22. | |
| 3. | | 23. | |
| 4. | | 24. | |
| 5. | | 25. | |
| 6. | | 26. | |
| 7. | | 27. | |
| 8. | | 28. | |
| 9. | | 29. | |
| 10. | | 30. | |
| 11. | | 31. | |
| 12. | | 32. | |
| 13. | | 33. | |
| 14. | | 34. | |
| 15. | | 35. | |
| 16. | | 36. | |
| 17. | | 37. | |
| 18. | | 38. | |
| 19. | | 39. | |
| 20. | | 40. | |

## Colours and Shapes: Part 1 - Colours

When the timer starts you will have 30 seconds to go through each picture below **in order**. Please put a: **tick** ✓ below **yellow** shapes

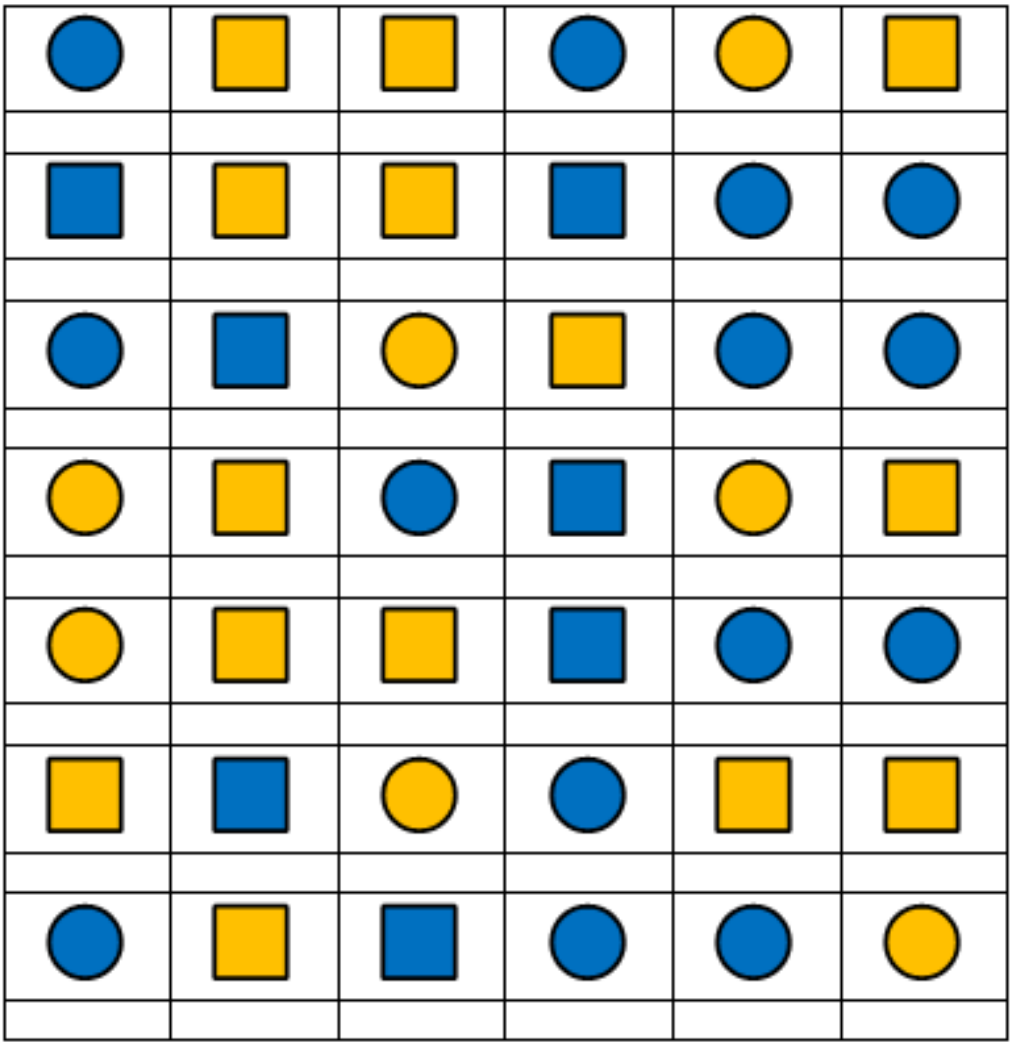
**cross** × below **blue** shapes



## Colours and Shapes: Part 2 - Shapes

When the timer starts you will have 30 seconds to go through each picture below **in order**. Please put a: **tick** ✓ below **squares**

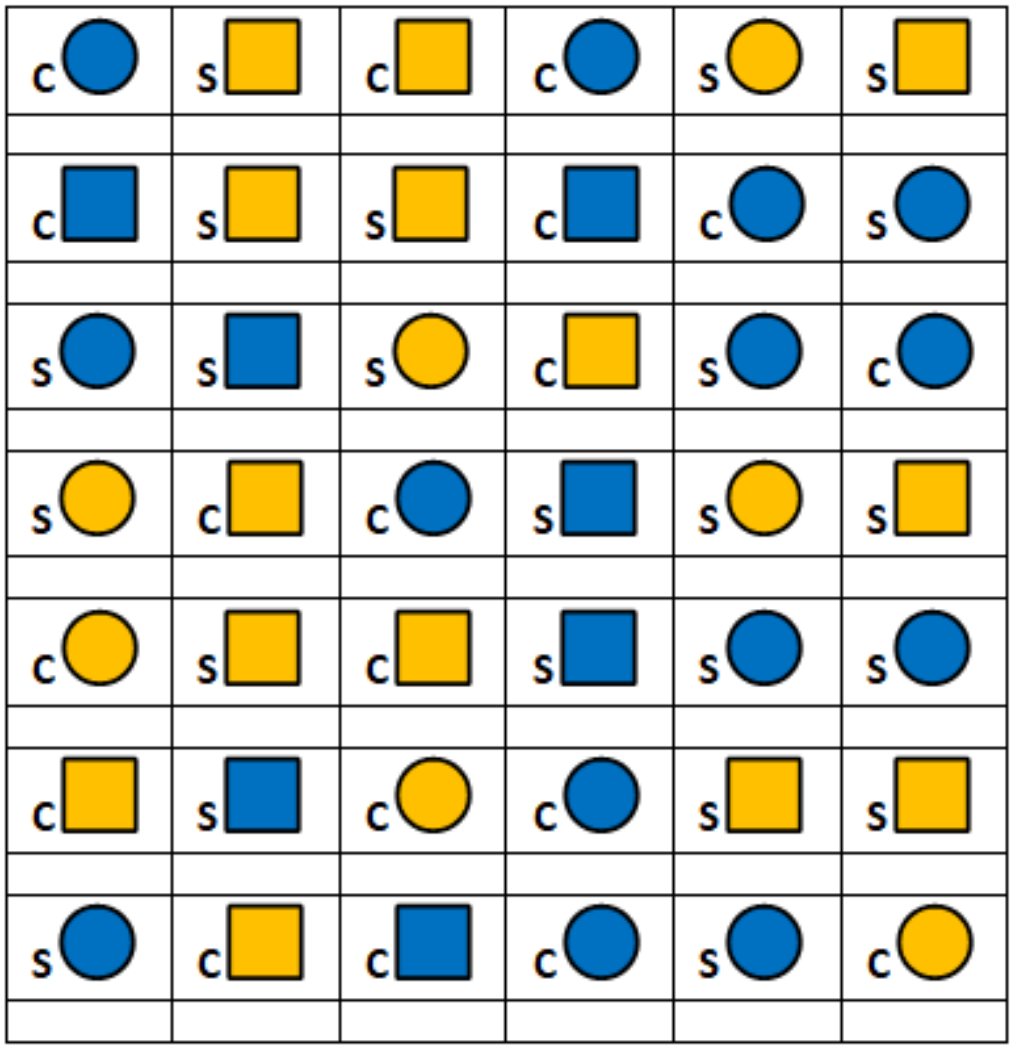
**cross** × below **circles**



## Colours and Shapes: Part 3 – Both!

When the timer starts you will have 30 seconds to go through each picture below **in order**.

| | |
|---|---|
| If the shape has a '**C**' before it, please follow the 'colour' rule:<br>**tick** ✓ below **yellow** shapes<br>**cross** × below **blue** shapes | If the shape has an '**S**' before it, please follow the 'shape' rule:<br>**tick** ✓ below **squares**<br>**cross** × below **circles** |

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## Which Colour?

This activity can be a little bit tricky! When the timer starts you will have 30 seconds to go through the words below. For each one, please **tick the coloured box that matches the colour the word is printed in** (not what it says)! For example, for 'BLUE' you would tick the ■.

| | | | | |
|---|---|---|---|---|
| RED | YELLOW | BLUE | RED | YELLOW |
| BLUE | YELLOW | GREEN | GREEN | YELLOW |
| BLUE | RED | GREEN | BLUE | GREEN |
| BLUE | RED | GREEN | RED | YELLOW |
| GREEN | BLUE | YELLOW | YELLOW | BLUE |
| RED | YELLOW | RED | GREEN | BLUE |
| YELLOW | BLUE | GREEN | GREEN | GREEN |
| YELLOW | RED | GREEN | BLUE | YELLOW |

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# Appendix I: Studies 2–3 – Summary of Results for Participants and Schools

Northumbria University NEWCASTLE

## Study Feedback for Participants and Schools

**Study Title:** An examination of the impact and sustainability of school-based physical activity interventions on long-term behaviour change and school functioning.

**Researcher:** Nicola McCullogh
nicola.mccullogh@northumbria.ac.uk

**Supervisor:** Dr Spencer E. Boyle
spencer.boyle@northumbria.ac.uk

### What Did the Study Involve?

The study aimed to test whether participation in a 'positive choices' programme at school had benefits for children's **wellbeing**, **mental skills** and **academic achievement**. The programme sessions were half in the classroom and half physically active games.

Children were asked to take part in a survey about their wellbeing and completed activities to measure their mental skills (e.g. attention, memory) before taking part in the programme and again at the end. Their achievement in reading, writing and maths was also recorded from their teacher before and after the programme. The control group were children from schools not taking part in the programme, who were asked to do the same things for comparison as there might be natural changes in wellbeing, etc. over time.

Children were also asked to take part in the mental skills activities straight after the games part of one of the programme sessions – or after a normal classroom lesson for the control group – to see if there was an immediate benefit of physical activity for mental skills. The children's physical activity was measured using an activity tracker during the games sessions to see how active they were.

### Academic Achievement

- At the end of the study, the reading and maths achievement of children who had taken part in the programme had improved to a greater extent than the achievement of children who hadn't taken part in the programme.
- It is possible that this is partly due to differences in the way different schools measured achievement because the control group had higher achievement before the study began, so further research is needed before firm conclusions can be drawn about whether participation in the programme has benefits for children's academic achievement.

### Wellbeing and Mental Skills

- There was no effect of the programme on children's wellbeing compared to the control group. Wellbeing was measured using a short survey about children's physical wellbeing, psychological wellbeing, social and peer support and experiences at school.
- There was no effect of the programme on children's mental skills compared to the control group at the end of the study.
- There did not seem to be an immediate effect of participation in the games part of the programme sessions on children's mental skills but there was a positive relationship between how long they spent in moderate-to-vigorous intensity physical activity during the games and their performance on the memory test.

### Physical Activity

- Some of the children were asked to wear an activity tracker to measure their daily activity before the programme started and again after it ended (or at equivalent times for the control group).
- Moderate-to-vigorous intensity physical activity (MVPA) was the focus of this part of the study because the current government guidelines are for children to take part in at least 60 minutes of MVPA per day.
- There was no difference in the amount of time spent taking part in MVPA by children in the two groups at the end of the programme. However, the number of children involved in this part of the study was rather low and more participants are needed to draw firm conclusions.

***I hope you enjoyed taking part in the study – thank you for your participation!***

If you require independent information or advice about the project, please contact Dr Mick Wilkinson, the Ethics Coordinator for the Department of Sport, Exercise and Rehabilitation at Northumbria University. Dr Wilkinson can be contacted at: mic.wilkinson@northumbria.ac.uk

## Appendix J: School Permission Slip

**Study Title:** An examination of the impact and sustainability of school-based physical activity interventions on long-term behaviour change and school functioning. (Qual)

**Researcher:** Nicola McCullogh

I _____ (name), _____ (job title) at _____ (school), confirm that Nicola McCullogh has permission to conduct the above research at the school as part of her PhD.

I understand that the pupils and their parents will be asked to give their assent/informed consent before the focus groups/interviews take place and that neither the participants nor the school will be named in any reports/publications resulting from the research.

I understand that this project has received all necessary safety and ethical approvals necessary for it to be undertaken according to practices set down in the Northumbria University Research Ethics and Governance Handbook.

Signed: _____ Date: _____

# Appendix K: Study 4 – Summary of Results for Participants and Schools

Northumbria University NEWCASTLE

## Study Feedback for Participants and Schools

**Study Title:** An examination of the impact and sustainability of school-based physical activity interventions on long-term behaviour change and school functioning.

**Researcher:** Nicola McCullogh
nicola.mccullogh@northumbria.ac.uk

**Supervisor:** Dr Spencer E. Boyle
spencer.boyle@northumbria.ac.uk

### What Did the Study Involve?

Interviews and focus groups were run with children, parents, school staff and football foundation staff about programmes that teach children 'positive choices' topics (e.g. discrimination), where the first part of each session takes place in the classroom and the second consists of physically active games. The common themes identified from the interviews/focus groups were:

### Children's Engagement in Programme Sessions

- Central to children's engagement in the sessions was that they very much **enjoyed** the programmes, particularly the physically active games and interactive classroom tasks. Very few children did not get involved in the sessions.
- Some of the key factors contributing to enjoyment were the **variety** of games, taking part with **friends**, the **interactive** nature of the sessions and being **outside** when the weather allowed!
- Children, parents and school staff all commented on the value of having **different people visit schools** to deliver sessions on a range of topics.
- Programme staff felt that their **association with a football club** promoted children's engagement in the sessions.
- The main barrier to programme participation was **time**, with schools having many demands to meet and some children being involved in activities taking place at the same time as the programme sessions.
- Parents felt they could better support children's engagement if they had more information on programmes, for instance via **homework activities**.

### The Role of Physical Activity

- Participants felt it was valuable for the classroom session to be followed by active games because the two halves of the session **suited different children**.
- The games were often seen as a **reward**.
- Children, school staff and programme staff felt that the games helped to **reinforce the 'positive choices' messages**. Messages for some topics were easier to reinforce through games than those for other topics.

### Outcomes

- There was an overall feeling that positive choices programmes were good for children's **wellbeing**, and children felt better equipped to **make positive choices** later in life.
- Children and adults also noted that programmes helped with **teamwork skills**, and adults had noticed improvements in children's **confidence**.
- The inclusion of games was felt to be good for children's **health and fitness**.
- School staff benefitted from observing the games part of the sessions for their own **development**.

### Future Developments

- School and programme staff felt that programmes were **well suited to the needs of schools**.
- Participants suggested **increasing the duration of courses/sessions**, or adding a **follow-up session**, to allow more time to monitor children's learning.

***I hope you enjoyed taking part in the study – thank you for your participation!***

If you require independent information or advice about the project, please contact Dr Mick Wilkinson, the Ethics Coordinator for the Department of Sport, Exercise and Rehabilitation at Northumbria University. Dr Wilkinson can be contacted at: mic.wilkinson@northumbria.ac.uk

## Appendix L(i): Study 4 – Focus Group Guide for Children

**Introduction**

- *Introduce myself;*
- *Remind participants of information from the participant information sheet (e.g. right to withdraw/not to respond to questions);*
- *Remind participants that their data will be kept confidential (unless there is a potential for harm or if parents request it) and that it would be appreciated if participants kept each other's data confidential, too;*
- *Answer any questions;*
- *Outline ground rules for the focus group:*
    - *Speak clearly;*
    - *Remember there are no right or wrong answers;*
    - *Support the participation of others by not speaking for too long or over the top of another person;*
    - *Remember that differing opinions are valued and if one is held then it should be put forward.*

**Introductory Question**

1. We're going to be talking today about physical activity. Please could you tell me what you think we mean when we say 'physical activity'?

**Key Questions**

2. *[Link the opening to this question to the answers provided for the previous question.]* If we think about physical activity as being any sort of movement like running or jumping, games, sports and exercise, then what sort of physical activity, if any, do you do?

    *[For those who take part in physical activity:]*

    2.1. Who do you take part in physical activity with?

    2.2. How often do you do *[name of activity]*, and for how long each time?

    2.3. Is that at school, after school or at the weekend?

    2.4. How did you first get into it?

    *[For the whole group:]*

    2.5. How much physical activity do you think you should do in a day? *(Tell them the recommendations on this for their age.)*

3. Now we're going to talk about things you do at school. Please can you tell me what you learn in your PE lessons? *(Prompt: What do you do in your PE lessons?)*

    3.1. What do you think about PE at school?

    3.2. What do you feel you get out of doing PE at school?

4. Please can you tell me what you learn in your PSHE lessons? *[Prompt: These are lessons about being healthy and staying safe, and things like how to get on with others and feel good about yourself.]*
    4.1. What do you think about PSHE at school?
    4.2. What do you feel you get out of doing PSHE at school?
5. Could you please describe the [intervention] programme you've been taking part in? *(Prompts: What is it about? What did you do?)*
    5.1. What do you think about the programme?
    5.2. How does it compare with normal school PE and PSHE? *(Prompts: How is it similar/different?)*
    5.3. Looking back on the programme, what do you feel you got out of taking part in it? *(Prompt for before/after comparisons.)*
    5.4. Do you think you'll stay *[state outcomes given by participants in response to the previous item]* now the programme is over? Why?
    5.5. Is there anything anyone can do to help you to stay *[state outcomes given by participants]*?
    5.6. What do you think about having the classroom lesson *and* physical activity in the [intervention] sessions?
6. Other than the [intervention] programme, have you ever had anyone from outside of the school come in and do PE or PSHE with you?
    6.1. What did you think about this?
7. What do you think would be the best 'positive choices' programme possible, in terms of what you would get out of it and how it would get everyone involved?
8. Is there anything or anyone that encourages you to be more active or stops you from being active at school? *(Prompt: This could be at any time in the day, like break time, lunchtime and at before and after school clubs, as well as in PE.)*

**Ending Questions**

- *Provide a summary of what has been discussed.*

9. Is that a good summary of what we've talked about?
10. Is there anything we haven't covered today that you think is important when we're talking about [intervention] and how to encourage pupils to be active at school?

**Conclusion**

- *Thank the participants for their time;*
- *Answer any questions they may have;*
- *Provide them with written debriefs for themselves and for their parents.*

## Appendix L(ii): Study 4 – Interview/Focus Group Guide for Parents/Guardians

**Introduction**

- *Introduce myself;*
- *Remind participants of information from the participant information sheet (e.g. confidentiality, right to withdraw/not to respond to questions);*
- *Answer any questions.*

*Where run as a focus group, additionally:*

- *Remind participants that it would be appreciated if they kept each other's data confidential;*
- *Outline ground rules for the focus group as in Appendix L(i).*

**Introductory Question**

1. Starting off nice and broad: What role, if any, do you think primary schools have to play in promoting healthy behaviour and happy lifestyles for children, including them being physically active? *(Prompt: Does your child take part in physical activity outside of school?)*

**Key Questions**

2. What can you tell me about the opportunities for your child to be physically active at school, and what are your thoughts on this? *(Prompts: How often do they take part in physical activity (e.g. PE, break time, before/after school, during other lessons)? What do they learn? Do they enjoy it?)*
3. What types of things would you like your child to be taught in PE? *(Prompt 'why?' if explanations are not given.)*
4. How much physical activity do you think a child should do in a day?
    - 4.1. Are you aware of the government guidelines on this? *(Explain the guidelines if participants are not aware of them.)*
    - 4.2. Have you heard of the term 'physical literacy', and if so what do you understand to be meant by this? *(Explain physical literacy if participants have not heard of it.)*
5. What can you tell me about the school's current PSHE *[Personal, Social, Health and Economic education]* programme, and what are your thoughts on this? *(Prompts: What do your children learn? How often do they have PSHE/healthy lifestyle lessons?)*
6. What types of things would you like your child to be taught in PSHE? *(Prompt 'why?')*

7. Are you aware of any organisations that provide healthy lifestyle information and physical activity opportunities for children, either in or out of school? *(Prompt: For example, council programmes, local sports clubs?)*
    7.1 What are your experiences of and thoughts on these programmes/sessions?
    7.2 Is there anything that stops your child from taking part in programmes like this?
8. Thinking about the [intervention] programme your child's class has recently been involved in, has your child spoken to you about the programme, and if so what have they said?
9. What do you feel your child has taken away from the programme? *(Prompt: Do you think there have been any negative outcomes from it?)*
10. Do you expect this/these outcomes to continue now that the programme is over, and if so, for how long would you expect it/them to last?
    10.1. Is there anything you can think of that could be done to help this/these outcomes continue?
11. *[Give a description of the intervention programme.]* What are your thoughts on the programme?
    11.1. How do you think it compares to the school's usual PE/PSHE programme?
    11.2. What are your views on including both classroom-based learning and physical activity in the [intervention] sessions?
12. What do you think would make for the best 'positive choices' programme possible, both in terms of outcomes and also in terms of engaging and motivating the children taking part? *(Prompt 'why?' if explanations are not given.)*
    12.1. Is there anything you think anyone can do to help?

**Ending Questions**

- *Provide a summary of what has been discussed.*

13. Is that a reasonable summary of what we've talked about today?
14. Is there anything we haven't covered that you think is relevant to a discussion on the topics of [intervention] and providing opportunities for children to be active at school and what they get from this?

**Conclusion**

- *Thank the participant for their time;*
- *Answer any questions they may have;*
- *Provide them with a written debrief.*

## Appendix L(iii): Study 4 – Interview Guide for School Staff

**Introduction**

- *Introduce myself;*
- *Remind participant of information from the participant information sheet (e.g. confidentiality, right to withdraw/not to respond to questions);*
- *Answer any questions.*

**Opening Question**

1. How long have you worked in a primary school setting and could you please give a description of your role?

**Introductory Question**

2. Starting off nice and broad: What role, if any, do you think primary schools have to play in promoting healthy behaviour and happy lifestyles for children, including them being physically active?

**Key Questions**

3. What can you tell me about the opportunities for children to be physically active at your school, and what are your thoughts on this? *(Prompts: How often do they take part in physical activity (e.g. PE, break time, before/after school, during other lessons)? What do they learn? Do they enjoy it?)*
4. What types of things do you think should be covered in PE and PSHE lessons?
   *(Prompt 'why?' if explanations are not given; PSHE can be 'healthy lifestyle' lessons.)*
5. How confident do you feel in delivering PE and PSHE lessons?
   5.1. Is there anything you think would make you feel more confident about delivering these lessons?
6. How much physical activity do you think children should do in a day?
   6.1. Are you aware of the government guidelines on this?
   *(Explain the guidelines if the participant is not aware of them.)*
   6.2. Have you heard of the term 'physical literacy', and if so what do you understand to be meant by this?
   *(Explain physical literacy if the participant has not heard of it.)*
7. Why did you choose (or support the decision) for your school to be involved in the [intervention] programme? *(Prompt: How does it compare to usual school PE/PSHE?)*
8. Did you observe the programme sessions?
   8.1. Looking back on the programme, what are your thoughts on it?

8.2. What are your views on including both classroom-based learning and physical activity in the programme sessions?
8.3. Would you consider organising for the programme to run again in the future, and why/why not?

9. What do you feel the pupils have taken away from the programme?
   9.1. Do you think *[name outcomes provided in answer to Question 9]* will continue now that the programme is over?
      9.1.1. For how long would you expect it/them to last?
   9.2. Is there anything you can think of that could be done to help it/them continue?
10. Have you or the school taken anything away from the programme?
11. Do you find there are any barriers to running programmes like this in primary schools?
12. Do you see the provision of programmes like this as being sustainable for primary schools, and why/why not?
13. Before [intervention], had your school ever approached or been approached by an external organisation who would deliver a PSHE and/or PE programme or session for you? *(If yes, follow up with questions on who the organisation was, the content of the programme/session, when and for how long it was to be delivered and whether the participant or another member of school staff would have a role in the programme/session.)*
   13.1. What are your experiences of and thoughts on these programmes/sessions?
   13.2. What influenced your decision (not) to take part?
14. What do you think would make for the best 'positive choices' programme possible, both in terms of outcomes and also in terms of engaging and motivating the children taking part? *(Prompt 'why?' if explanations are not given.)*
   14.1. Is there anything you think anyone can do to help?

**Ending Questions**

- *Provide a summary of what has been discussed.*

15. Is that a reasonable summary of what we've talked about today?
16. Is there anything we haven't covered that you think is relevant to a discussion on the topics of [intervention] and providing opportunities for children to be active at school and what they get from this?

**Conclusion**

- *Thank the participant for their time;*
- *Answer any questions they may have;*
- *Provide them with a written debrief.*

## Appendix L(iv): Study 4 – Interview Guide for Intervention Staff

**Introduction**

- *Introduce myself;*
- *Remind participant of information from the participant information sheet (e.g. confidentiality, right to withdraw/not to respond to questions);*
- *Answer any questions.*

**Opening Question**

1. How long have you worked at [intervention organisation] or in other similar roles, and could you please give a short description of your job?

**Introductory Questions**

2. I'm interested in the design and delivery of [intervention] in particular. Please could you describe the intervention?
3. What involvement is there in [intervention] from the football club?
4. How is the intervention similar to and how is it different from school PE and PSHE/healthy lifestyle lessons?
    - 4.1. What are your views on including both classroom-based learning and physical activity in the [intervention] sessions?
5. Do you know how the intervention was designed, in terms of who put together its content and structure and what these decisions were based on?
6. Do you know if the content or structure of the intervention has ever changed, and if so, why were changes made?

**Key Questions**

7. What do you feel children take away from [intervention]?
   *(Prompt for the participant's thoughts on both aspects of the sessions if they only discuss one: Do you feel they take anything away from the classroom learning/physical activity aspect of the sessions?)*
    - 7.1. Is there anything you feel schools or any other parties take away from the intervention?
8. What impact do you feel the intervention has over the short and long term?
    - 8.1. Do you think there is anything that can be done to support *[name the outcomes mentioned in response to the previous question]* over the long term?
    - 8.2. Are there any programmes for children to transition onto after completing [intervention], or recommendations for them to follow up on?

9. Do you/your staff find that some children, teachers or schools buy into [intervention] more or less than others, and if so is there anything that distinguishes them?
10. Do you/your staff ever need to modify the intervention for different audiences, and can you give any examples of having done this?
    10.1. What strategies do you/your staff employ if there are difficulties in engaging the children?
11. Do you find there are any barriers to running [intervention]? What are these and is there any way you think they could be overcome?
12. Based on your experiences of [intervention] and any similar programmes you have been involved with, what do you think would make for the best 'positive choices' programme possible, both in terms of outcomes and also in terms of engaging and motivating the children taking part?
    *(Prompt 'why?' if explanations are not given for answers.)*
13. Do you see the provision of primary school programmes like [intervention] as being sustainable, and why/why not?
    13.1. What is the role of funding in sustaining the intervention?

**Ending Questions**

- *Provide a summary of what has been discussed.*

14. Do you think that is a reasonable summary of what we've talked about today?
15. Is there anything we haven't covered that you think is relevant to a discussion about [intervention] and other similar programmes, particularly in relation to the physical activity component of the intervention?

**Conclusion**

- *Thank the participant for their time;*
- *Answer any questions they may have;*
- *Provide them with a written debrief.*

## Appendix M(i): Study 4 – List of Initial Codes

1. Academic achievement – PA
2. Academic achievement – Programme
3. Association with football club – Programme
4. Attention to and involvement of children – Programme
5. Autonomy – PA
6. Awareness and perception of programme
7. Behaviour change (unspecified) or beneficial – Programme
8. Boredom – PA
9. Boredom – Programme
10. Break from schoolwork – PA
11. Break from schoolwork – Programme
12. Challenge and competition – PA
13. Challenge and competition – Programme
14. Characteristics of facilitators – PA
15. Characteristics of facilitators – Programme
16. Competence as a barrier – PA
17. Competence as a barrier – Programme
18. Competence as an outcome – PA
19. Competence as an outcome – Programme
20. Confidence – PA
21. Confidence – Programme
22. Dislike of PA, PE or games
23. Drop out, unspecified reason – PA
24. Effort – PA
25. Energy – PA
26. Enjoyment – PA
27. Enjoyment – Programme
28. Flexibility of delivery – Programme
29. Forced participation – Programme
30. Funding – PA
31. Funding – Programme
32. Gender – PA
33. Health and physical fitness – PA
34. Health and physical fitness – Programme
35. Illness and injury – PA
36. Illness and injury – Programme
37. Increased PA – Programme
38. Involvement of facilitators – Programme
39. Involvement of family – PA
40. Involvement of friends – PA
41. Involvement of parents – Programme
42. Involvement of teachers – PA

43. Involvement of teachers – Programme
44. Knowledge (applied) – Programme
45. Knowledge (factual) – Programme
46. Knowledge (games) – Programme
47. Knowledge (unspecified) – Programme
48. Measurement of outcomes – Programme
49. Needs of schools (curriculum) – Programme
50. Needs of schools (targeting) – Programme
51. No change in behaviour – Programme
52. Nutrition
53. Opportunities through sport – PA
54. Outside – PA
55. PA and PSHE (balance) – Programme
56. PA and PSHE (PA as a reward) – Programme
57. PA and PSHE (reinforcement of messages) – Programme
58. PA and PSHE (suitability for different children) – Programme
59. Positive – Programme
60. Post-course support and follow-up – Programme
61. Programme development
62. Programme duration
63. PSHE in schools
64. Rewards – Programme
65. Role models – PA
66. Role models – Programme
67. Rules – PA and Programme
68. School culture – PA
69. School facilities – PA
70. School facilities – Programme
71. School time – PA
72. Sedentary activities
73. Someone coming in – PA and Programme
74. Support and encouragement – PA
75. Teacher development – Programme
76. Teamwork – PA
77. Teamwork – Programme
78. Time barriers – Programme
79. Transition to secondary school – Programme
80. Unique – Programme
81. Variety – PA
82. Variety (games) – Programme
83. Variety (topics) – Programme
84. Weather – PA
85. Weather – Programme
86. Workload – Programme

## Appendix M(ii): Study 4 – Coding Framework

The initial codes (Appendix M(i)) were reviewed to produce a final coding framework. During this process it became clear that some of the codes did not pertain to any of the research questions and as a result the following codes were removed:

- 'Drop out, unspecified reason – PA', 'Opportunities through sport' and 'Sedentary activities': Data extracts were removed from the data set as they did not relate to intervention participation.
- 'Positive – Programme': A single data extract relating to writing positive answers in the intervention workbook was removed from the data set.
- 'PSHE in schools': Data extracts were recoded as 'Needs of schools (curriculum) – Programme' or 'Post-course support and follow-up – Programme' or were otherwise removed from the data set.

Codes with '– PA' and '– Programme' suffixes were merged as described in section 8.2.6 of the thesis. The suffix '(games)' was retained when 'Variety – PA' and 'Variety (games) – Programme' were merged, in order to distinguish 'Variety (games)' from 'Variety (topics)'. The final coding framework is shown on the following page.

**Final Coding Framework**

1. Academic achievement
2. Association with football club
3. Attention to and involvement of children
4. Autonomy
5. Awareness and perception of programme
6. Behaviour change (unspecified) or beneficial
7. Boredom
8. Break from schoolwork
9. Challenge and competition
10. Characteristics of facilitators
11. Competence as a barrier
12. Competence as an outcome
13. Confidence
14. Dislike of PA, PE or games
15. Effort
16. Energy
17. Enjoyment
18. Flexibility of delivery
19. Forced participation
20. Funding
21. Gender
22. Health and physical fitness
23. Illness and injury
24. Increased PA
25. Involvement of facilitators
26. Involvement of family
27. Involvement of friends
28. Involvement of parents
29. Involvement of teachers
30. Knowledge (applied)
31. Knowledge (factual)
32. Knowledge (games)
33. Knowledge (unspecified)
34. Measurement of outcomes
35. Needs of schools (curriculum)
36. Needs of schools (targeting)
37. No change in behaviour
38. Nutrition
39. Outside
40. PA and PSHE (balance)
41. PA and PSHE (PA as a reward)
42. PA and PSHE (reinforcement of messages)
43. PA and PSHE (suitability for different children)
44. Post-course support and follow-up
45. Programme development
46. Programme duration
47. Rewards
48. Role models
49. Rules
50. School culture
51. School facilities
52. School time
53. Someone coming in
54. Support and encouragement
55. Teacher development
56. Teamwork
57. Time barriers
58. Transition to secondary school
59. Unique
60. Variety (games)
61. Variety (topics)
62. Weather
63. Workload

## Appendix M(iii): Study 4 – Development of Initial Thematic Maps

***Development of initial thematic map for research question 1: The role of physical activity in the interventions***

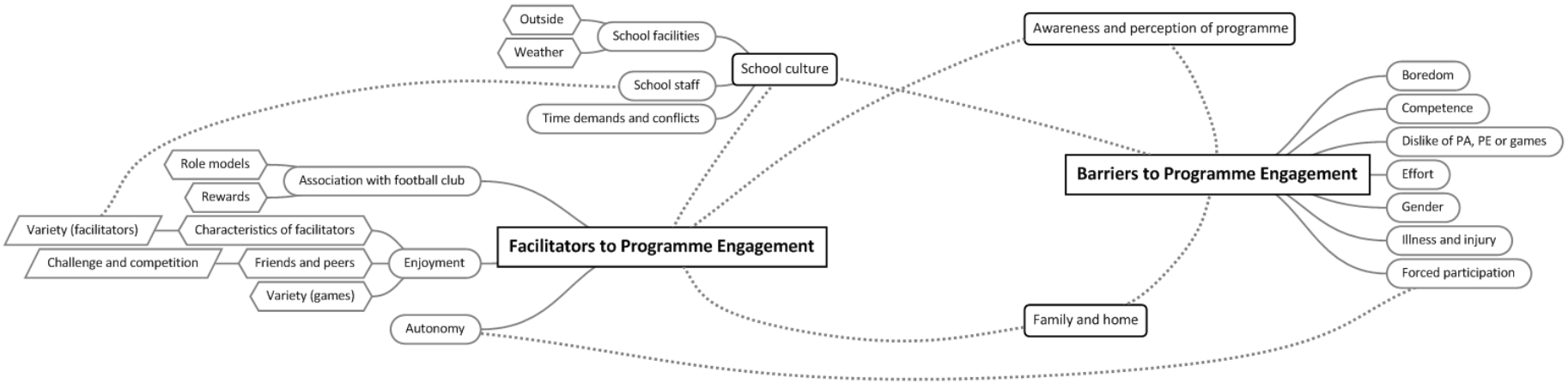
| *Relevant codes from coding framework* | *Changes made* | *Candidate themes/subthemes* |
|---|---|---|
| 1. PA and PSHE (balance)<br>2. Break from schoolwork<br>3. PA and PSHE (PA as a reward)<br>4. PA and PSHE (reinforcement of messages)<br>5. PA and PSHE (suitability for different children) | • Codes beginning 'PA and PSHE' renamed now that a research question addressing the role of physical activity in the interventions had been introduced. | 1. Allocations of session time for PA and PSHE<br>2. Break from schoolwork<br>3. PA as a reward following PSHE<br>4. PA to reinforce PSHE messages<br>5. Suitability of PA and PSHE for different children |

***Development of initial thematic map for research question 2: Children's engagement in the intervention sessions***

| ***Relevant codes from coding framework*** | ***Changes made*** | ***Candidate themes/subthemes*** |
|---|---|---|
| 1. Association with football club<br>2. Attention to and involvement of children<br>3. Autonomy<br>4. Awareness and perception of programme<br>5. Boredom<br>6. Challenge and competition<br>7. Characteristics of facilitators<br>8. Involvement of facilitators<br>9. Competence as a barrier<br>10. Dislike of PA, PE or games<br>11. Effort<br>12. Enjoyment<br>13. Involvement of family<br>14. Involvement of parents<br>15. Support and encouragement<br>16. Forced participation<br>17. Involvement of friends<br>18. Gender<br>19. Illness and injury<br>20. Outside<br>21. Rewards<br>22. Role models<br>23. School culture | • 'Attention to and involvement of children' merged with 'Autonomy' due to similarity in scope.<br>• 'Involvement of facilitators' merged with 'Characteristics of facilitators' due to similarity in scope.<br>• 'Competence as a barrier' renamed 'Competence' now that there was no need to distinguish it from 'Competence as an outcome' from the outcomes research question.<br>• 'Involvement of' removed from the beginning of codes relating to family, friends, parents and teachers for simplicity. 'Teachers' changed to 'school staff', 'family' and 'parents' changed to 'family and home' (codes merged) and 'friends' changed to 'friends and peers' for more accurate descriptors. Data extracts from 'Support and encouragement' moved into the appropriate candidate themes to show the source(s) of support and encouragement. | 1. Association with football club<br>2. Autonomy<br>3. Awareness and perception of programme<br>4. Boredom<br>5. Challenge and competition<br>6. Characteristics of facilitators<br>7. Competence<br>8. Dislike of PA, PE or games<br>9. Effort<br>10. Enjoyment<br>11. Family and home<br>12. Forced participation<br>13. Friends and peers<br>14. Gender<br>15. Illness and injury<br>16. Outside<br>17. Rewards<br>18. Role models<br>19. School culture<br>20. School facilities<br>21. School staff |

***Development of initial thematic map for research question 2 (continued): Children's engagement in the intervention sessions***

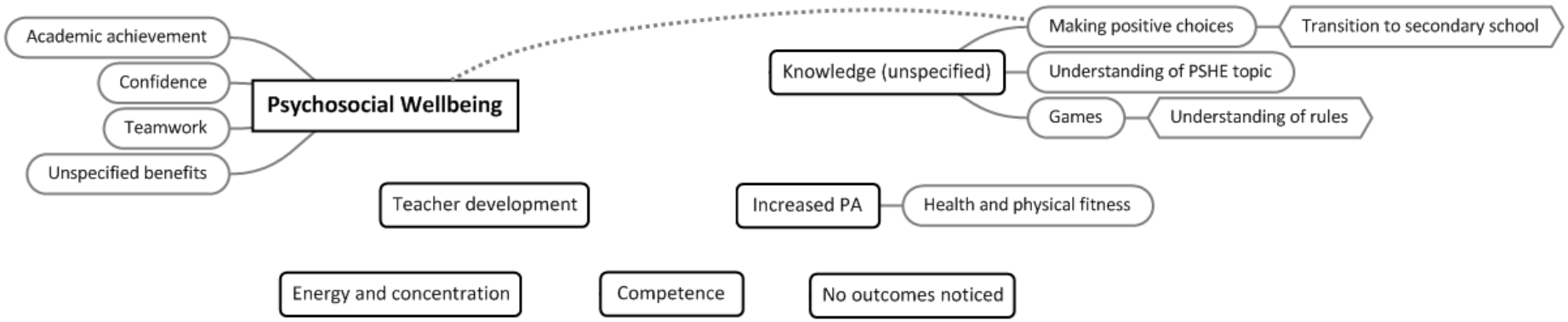
| ***Relevant codes from coding framework*** | ***Changes made*** | ***Candidate themes/subthemes*** |
|---|---|---|
| 24. School facilities<br>25. Involvement of teachers<br>26. School time<br>27. Time barriers<br>28. Workload<br>29. Someone coming in<br>30. Variety (games)<br>31. Weather | • 'School time', 'Time barriers' and 'Workload' merged due to similarity in scope and renamed 'Time demands and conflicts'.<br>• 'Someone coming in' renamed 'Variety (facilitators)' as a more specific descriptor. | 22. Time demands and conflicts<br>23. Variety (facilitators)<br>24. Variety (games)<br>25. Weather |



***Development of initial thematic map for research question 3: Intervention outcomes***

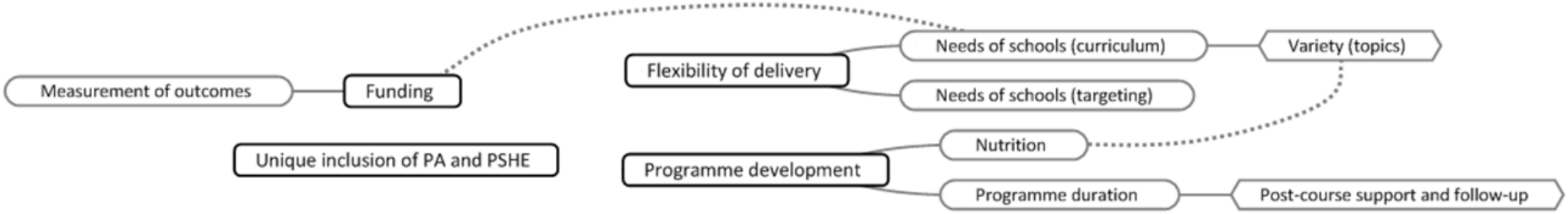
| ***Relevant codes from coding framework*** | ***Changes made*** | ***Candidate themes/subthemes*** |
|---|---|---|
| 1. Academic achievement<br>2. Competence as an outcome<br>3. Confidence<br>4. Energy<br>5. Knowledge (games)<br>6. Health and physical fitness<br>7. Increased PA<br>8. Knowledge (unspecified)<br>9. Knowledge (applied)<br>10. No change in behaviour<br>11. Teacher development<br>12. Teamwork<br>13. Transition to secondary school<br>14. Knowledge (factual)<br>15. Rules<br>16. Behaviour change (unspecified) or beneficial | • 'Competence as an outcome' renamed 'Competence' now that there was no need to distinguish it from 'Competence as a barrier' from the engagement research question.<br>• 'Energy' renamed 'Energy and concentration' as a more accurate descriptor.<br>• Codes beginning 'Knowledge' renamed to better distinguish between these. 'Knowledge (games)' became 'Games'; children learn new games through participation. 'Knowledge (applied)' became 'Making positive choices'; children make positive choices based on knowledge acquired. 'Knowledge (factual)' became 'Understanding of PSHE topic'; children acquire facts, e.g. the names of drugs. 'Knowledge (unspecified)' retained.<br>• 'No change in behaviour' renamed 'No outcomes noticed' as a more accurate descriptor.<br>• 'Rules' renamed 'Understanding of rules' as a more informative descriptor.<br>• 'Behaviour change (unspecified) or beneficial' renamed 'Unspecified benefits' to reflect that the programme was felt to have positive outcomes but these were not named by the participant. | 1. Academic achievement<br>2. Competence<br>3. Confidence<br>4. Energy and concentration<br>5. Games<br>6. Health and physical fitness<br>7. Increased PA<br>8. Knowledge (unspecified)<br>9. Making positive choices<br>10. No outcomes noticed<br>11. Teacher development<br>12. Teamwork<br>13. Transition to secondary school<br>14. Understanding of PSHE topic<br>15. Understanding of rules<br>16. Unspecified benefits |

***Development of initial thematic map for research question 3 (continued): Intervention outcomes***



***Development of initial thematic map for research question 4: Sustainability of intervention delivery***

| ***Relevant codes from coding framework*** | ***Changes made*** | ***Candidate themes/subthemes*** |
|---|---|---|
| 1. Flexibility of delivery<br>2. Funding<br>3. Measurement of outcomes<br>4. Needs of schools (curriculum)<br>5. Needs of schools (targeting)<br>6. Nutrition<br>7. Post-course support and follow-up<br>8. Programme development<br>9. Programme duration<br>10. Unique<br>11. Variety (topics) | • 'Unique' renamed as 'Unique inclusion of PA and PSHE' as a more informative descriptor. | 1. Flexibility of delivery<br>2. Funding<br>3. Measurement of outcomes<br>4. Needs of schools (curriculum)<br>5. Needs of schools (targeting)<br>6. Nutrition<br>7. Post-course support and follow-up<br>8. Programme development<br>9. Programme duration<br>10. Unique inclusion of PA and PSHE<br>11. Variety (topics) |



## Appendix M(iv): Study 4 – Analysis Trail: Theme Summary Tables

***Theme summary table for research question 1: The role of physical activity in the interventions***

| Theme Name | Scope and Content of Theme | How the Theme Fits into the Broader Overall 'Story' in relation to the Research Question(s) |
|---|---|---|
| **1. Suitability for a range of children** | Some children learn from or enjoy the classroom component more than the PA component of the sessions, while for others the opposite is true. | The inclusion of PA in the sessions gives children an opportunity to learn in a different way to traditional classroom learning. *Variety* is therefore important.<br><br>Some of the children wished for there to be greater time for the PA aspect of the sessions but this was to some extent dependent on *time demands* and the *needs of the school*. |
| **2. Rest and reward** | It was generally felt that the classroom component of the sessions was less onerous than other forms of work at school and gave children a break from more traditional classroom lessons; however, like PE lessons, it was the PA component that was felt to provide a greater break, and children perceived the PA to be a reward for their work in the classroom. As identified by the member of school staff who had observed the Year 5 racism programme, PA might also provide children with a release following work on difficult topics. | In past iterations of one of the interventions, PA had been used as a reward following the classroom component. PA is still perceived as a reward by some of the children, suggesting it can be appealing while still functioning as a method for *reinforcing* the intervention messages. |
| **3. Reinforcement** | Intervention staff reported on how they used the PA to help reinforce messages from the classroom component of the sessions, sometimes in response to behaviours which arose during the games. School staff and children generally felt the way in which the PA was used to reinforce messages about the PSHE topics, teamwork and communication was clear; however, it seemed to be easier to draw a link between the two components of the sessions in some programmes (e.g. self-esteem) than in others (e.g. drugs education). | PA is not only enjoyable for children but is a useful tool to bring out behaviours in them that allow for application of *knowledge*.<br><br>Children who cannot participate in the PA due to *illness or injury* can still experience reinforcement through observation.<br><br>*Active involvement* in classroom activities (e.g. completing tasks whilst wearing beer goggles) is another way in which messages are reinforced. |

***Theme summary table for research question 2: Children's engagement in the intervention sessions***

| **Theme Name** *(subthemes)* | **Scope and Content of Theme** | **How the Theme Fits into the Broader Overall 'Story' in relation to the Research Question(s)** |
|---|---|---|
| **1. Children's enjoyment** | Children very clearly enjoyed the programmes, and in particular the PA component, though they also enjoyed the interactive classroom activities. Enjoyment was a highly prevalent theme throughout the data set.<br><br>Children and parents also reported that children tended to enjoy non-intervention PA and PE. | One of the aims intervention staff reported having was to make the programmes fun, enjoyment being a driving force for engagement. A number of factors seemed to contribute to children's enjoyment of the programmes, as described under the subthemes below. |
| *1.1. Autonomy and active involvement* | Intervention staff spoke about not forcing children to participate – particularly in the PA component of the sessions – but of encouraging them by talking with them and giving them roles such as to support other children. They also spoke of allowing the children ownership over the games and of making the tasks in the classroom component of the sessions as interactive as possible (e.g. moving around the classroom and communicating with others). | One child suggested adding to the programmes a vote on the game to be played from the *variety of games* on offer, because sometimes some of the children did not enjoy a particular game. This would give the children even greater ownership over the PA aspect of the interventions. |
| *1.2. Variety of games* | Children, parents and some of the school staff described that in children's general PA participation and in PE lessons they took part in a variety of activities. Intervention staff described that they delivered a variety of games in the PA component of the programmes, including variations to existing sports such as football. Variety was felt to be important in intervention and non-intervention PA because different children enjoyed different activities, because it introduced them to new activities which they might then take up, and because they enjoyed trying new things. | Intervention staff informed pupils from the beginning of the programmes that the PA component would include a variety of games so that they knew what to expect, and particularly so that they did not anticipate that they would be playing football every week due to the *association with a football club*. |
| *1.3. Positive interactions with peers* | It was common for children to participate in PA with their friends, and this was reported to be fun. Similarly, children valued the social aspects of the programmes, including the opportunity to work and play with classmates with whom they would not usually interact. | Parents reported that their children tended to support peers and younger children in their PA participation. Similarly, intervention staff described encouraging pupils to support one another throughout the programmes, as described under the '*autonomy and active involvement*' subtheme. |

***Theme summary table for research question 2 (continued): Children's engagement in the intervention sessions***

| **Theme Name** *(subthemes)* | **Scope and Content of Theme** | **How the Theme Fits into the Broader Overall 'Story' in relation to the Research Question(s)** |
|---|---|---|
| *1.4. Being outside* | Children frequently mentioned being outside as a positive feature of PA participation and enjoyed being outside for the PA component of the programmes. They reported that taking part in PA indoors was less enjoyable, largely due to space restrictions. | Engagement might be enhanced if the PA component of the programmes could be run outside; however, poor weather and the *timetabling conflicts* associated with the use of school facilities often prevent this. Some of the children discussed having enjoyed PA participation in inclement weather but it was generally appreciated that PA would take place indoors during the winter months and in the case of rain. |
| **2. Delivery by a non-teacher** | It was reported by all participant groups that children liked having external providers deliver the interventions and other PA/PSHE sessions due to factors such as the informal nature of their interactions with facilitators, the fact that facilitators were delivering different content to that of their other lessons and simply because it was nice to be taught by someone new and to build relationships with them over the course of the interventions. Two of the parents did however feel that external providers coming into school was no better or worse than delivery by school staff.<br><br>Being an external provider also meant that the class teacher tended to be available to assist, which was useful to encourage children's engagement in the sessions. | Participants described that facilitators delivered the sessions in an engaging, informal manner for the children while still *meeting the needs of schools*.<br><br>Intervention staff outlined how their delivery might differ from that of school staff, particularly in relation to confidence in delivering PA sessions, drawing a link between this theme and the '*teacher development*' theme.<br><br>Facilitators' *association with a football club* was noted to contribute to children's early engagement with them. |
| **3. Association with football club** | Intervention staff described how an association with a football club was valuable in promoting children's engagement, particularly by allowing facilitators to quickly develop a rapport with the children.<br><br>A drawback was that the association tended to create an expectation that the programmes would be football-orientated, with some children disliking football. Facilitators attempted to address this misconception at the start of the courses to promote engagement. | Sometimes football-related rewards were offered in relation to intervention participation, for instance collectable cards and match tickets, but *funding* was often a limiting factor.<br><br>Girls were noted to be more disinclined than boys towards what they perceived to be a football-orientated intervention, linking this theme to the '*gender*' subtheme of the '*children's personal circumstances and characteristics*' theme. |
| *3.1. Initial 'hook'* | Intervention and school staff explained how an association with the football club acted as an initial "hook" to promote children's interest and engagement in the programmes. | Children liked working with *non-teachers* and this appeared to be especially so with the added hook of the association with a football club. |

***Theme summary table for research question 2 (continued): Children's engagement in the intervention sessions***

| **Theme Name** *(subthemes)* | **Scope and Content of Theme** | **How the Theme Fits into the Broader Overall 'Story' in relation to the Research Question(s)** |
|---|---|---|
| *3.2. Role models* | Intervention staff – and some school staff – explained how the association of the programmes with football clubs often inspires the children to engage with the sessions because they see both the facilitators and footballers used in the programme materials as role models. | Children did not explicitly identify intervention staff as role models but did enjoy working with them, as described under the '*delivery by a non-teacher*' theme. Two groups of children and one of the parents did however speak about role models in relation to children's non-intervention PA participation. |
| **4. Children's personal circumstances and characteristics** | It was recognised that there would be differences in the level of engagement in the intervention sessions from child to child. Parents and children spoke on a number of occasions about children differing in terms of their inclination towards sports and PA, which would potentially affect their engagement in the PA component of the programmes. | Learning difficulties were mentioned as one of the factors potentially affecting engagement in the intervention sessions but intervention staff were able to adapt their delivery when working with children of different ability levels, helping the interventions to *meet the needs of schools*.<br><br>Further personal circumstances and characteristics which might affect engagement are outlined in the subthemes below. |
| *4.1. Family and home* | The role of home support for positive behaviours including PA was noted by three of the groups of parents, one of the members of school staff and two of the intervention staff. Outside of school, a good deal of the children reported taking part in PA with family members, particularly their parents. On the other hand, when members of school staff were asked about the role of schools in promoting healthy lifestyles, they discussed how it was appropriate for schools to do this because in deprived areas children's families might not. The home environment was therefore recognised to facilitate children's positive behaviours to different extents.<br><br>None of the parents reported knowing much about the interventions and an interest was expressed in knowing more so that they could help to reinforce the messages for their children. Some of the intervention staff also commented upon the value of this. | Children's engagement could potentially be increased by informing their parents of programme aims and content so that they could discuss PSHE topics with their children and encourage active participation in the sessions. Two sets of parents suggested that information could be communicated via activities the children could be asked to do at home, and one of the children suggested adding physical exercises to do at home, linking this theme with the '*increased physical activity*' theme. |

***Theme summary table for research question 2 (continued): Children's engagement in the intervention sessions***

| **Theme Name** *(subthemes)* | **Scope and Content of Theme** | **How the Theme Fits into the Broader Overall 'Story' in relation to the Research Question(s)** |
|---|---|---|
| *4.2. Gender* | Some of the school staff and parents felt that gender played a role in children's PA preferences, indicating a potential barrier to engagement, but there was less of a distinction drawn between the sexes by the children themselves. | There was general agreement that girls did not enjoy football as much as boys and that this was a potential barrier for them in relation to the PA aspect of the intervention sessions. However, as covered under the '*association with football club*' theme, facilitators were careful to inform the children that intervention PA would consist of a variety of games. |
| *4.3. Illness and injury* | Some of the parents and children noted illness and injury as barriers to general PA participation. While this was therefore a potential barrier to engagement in the PA aspect of the interventions, intervention staff involved the children in the PA component of the sessions in other ways. Children also appeared to be caught up on missed content if they were absent for any of the intervention sessions. | If unable to take part in the PA component of the interventions/one of the sessions, children were still invited to take part in other ways, as covered under the '*autonomy and active involvement*' theme, or to watch in order to reinforce the programme messages through vicarious learning. |

***Theme summary table for research question 3: Intervention outcomes***

| **Theme Name** *(subthemes)* | **Scope and Content of Theme** | **How the Theme Fits into the Broader Overall 'Story' in relation to the Research Question(s)** |
|---|---|---|
| **1. Wellbeing and personal development** | One of the school staff and four of the intervention staff commented on enjoyment and the children seeming happier as a result of participating in the interventions. There was a pervasive sense of the programmes being generally 'good' for the children. | Wellbeing and personal development outcomes were felt to support the *sustainability* of the programmes. Specific outcomes are described in the subthemes below. |
| *1.1. Knowledge to promote positive choices* | Intervention staff described that one of the main aims of the programmes was to provide children with an understanding of the PSHE topic. They felt on the basis of pre- and post-course questionnaires and teacher feedback that this aim was being met, and children's focus groups supported that they had acquired knowledge of the topics they had studied (e.g. what is meant by 'self-esteem'). This was particularly evident for those who had taken part in the drugs programme, who listed many facts about the types and effects of drugs and demonstrated an understanding of why drug use can begin.<br><br>In addition to providing children with a theoretical understanding of the subject matter, it was envisaged that the programmes would help them in practical ways, such as giving them the skills to raise their self-esteem and to resist peer pressure. There were some examples of this having happened during the course of the programmes; in other cases, the children outlined what courses of action they had been advised to take if faced with specific situations in the future, and one group in particular talked about the sorts of consequences they had considered in relation to making certain choices. | Adults often felt that the practical effects of the interventions were difficult to *monitor* because they might not take effect until later in life or when faced with specific situations (e.g. peer pressure, being offered drugs), or might even be demonstrated through a lack of a behaviour (e.g. racism), which it would be difficult to determine might otherwise have occurred. Also pertaining to *intervention monitoring*, when asked to discuss what an ideal programme might look like, children suggested ways in which their understanding could be assessed and reinforced, indicating that the acquisition of knowledge is an important outcome for them.<br><br>The intervention staff for the drugs, self-esteem and racism programmes reported that these programmes were particularly funded for upper Key Stage 2 children to help ease their transition to secondary school, when they might face increased peer pressure and potentially encounter issues such as drugs and alcohol. One parent and one group of children also commented on the benefits of the drugs education and self-esteem programmes in relation to dealing with peer pressure in the transition to secondary school. One of the facilitators for the nutrition and fitness programme and two of the school staff associated with this programme also mentioned the transition to secondary school, indicating that it is an important consideration for upper Key Stage 2 children. A *follow-up* session at secondary school was one of the suggestions participants offered for development of the interventions. |

***Theme summary table for research question 3 (continued): Intervention outcomes***

| **Theme Name** *(subthemes)* | **Scope and Content of Theme** | **How the Theme Fits into the Broader Overall 'Story' in relation to the Research Question(s)** |
|---|---|---|
| *1.2. Teamwork* | PE and other opportunities for PA were noted by three members of school staff and one parent to provide the chance for children to learn about teamwork. However, learning about teamwork and communication was mentioned as an outcome promoted by the interventions specifically on several occasions, particularly in relation to the PA component of the sessions but also the classroom component. | Although observable outcomes were not commonly reported to have occurred over the short timescale of the interventions (though there was a feeling that the interventions would benefit children over the long term), one of the intervention staff reported both witnessing and having received feedback from teachers that peer support in their lessons had improved over the course of the programmes. |
| *1.3. Confidence/ self-esteem* | One of the facilitators noted that one of the aims of intervention 2 was to develop children's confidence. Improved confidence through intervention participation had been observed by most of the school staff and three of the intervention staff, though was not mentioned by children themselves. One parent had also noticed an improvement in their child's confidence through their PA participation outside of the programmes.<br><br>Self-esteem was in all but one instance mentioned in the context of – and in the same sentence as – confidence, so in order to reflect the data no academic distinction is drawn between the two constructs. | Two of the intervention staff and one parent noted how increased confidence either had been or would be of benefit to children beyond the programmes, in terms of greater willingness to try at school, leading to improvements in achievement. This is one way in which the interventions might *meet the needs of schools*. |
| **2. Increased physical activity** | The fitness and nutrition programme had a specific aim for children to be active during the sessions, and also between sessions by setting fitness goals. Even in the programmes not specifically focused on increasing children's PA, one parent had noted their child was engaging in more PA following the programme, and one group of children reported they had been encouraged to be more active, with a further group indicating they were more active during the school day due to participation in the sessions. | One group of children suggested the addition to the drugs education programme of PA exercises for them to complete at home, which would potentially also improve the communication of intervention messages with children's *families*.<br><br>Like PE lessons, being involved in the programmes introduced children to games they might not previously have encountered and that they could play again outside of the sessions. This is similar to teachers learning new activities for use with their classes, as described under the *teacher development* theme. |

***Theme summary table for research question 3 (continued): Intervention outcomes***

| **Theme Name** *(subthemes)* | **Scope and Content of Theme** | **How the Theme Fits into the Broader Overall 'Story' in relation to the Research Question(s)** |
|---|---|---|
| *2.1. Health and physical fitness* | A number of participants referred to the health benefits of being active during the intervention sessions, and in one case as a result of an increase in overall PA which was thought to stem from intervention participation. However, for the adults with experience of programmes other than the fitness and nutrition programme, health and physical fitness tended to be emphasised to a lesser degree than other potential intervention outcomes. On the other hand, the health benefits of other sources of PA for children, including PE lessons, were widely discussed. | The aim of the fitness and nutrition programme for children to be *more active* was in order to improve their health (e.g. tackling obesity) and physical fitness.<br><br>One group of children who had taken part in the self-esteem programme suggested they would like a greater focus on health and fitness in the sessions. This is one way in which the programmes other than the fitness and nutrition programme could be *developed*. |
| *2.2. Energy and concentration* | Engaging in non-intervention PA was noted by children and one member of school staff to motivate pupils for school activities that followed. However, the reverse was also noted by another member of school staff and one group of children, with PA participation sometimes leading to tiredness. Although the interventions were designed to have the children complete the classroom component of the sessions before the PA component, two of the intervention staff on the fitness and nutrition programme noted there were similar advantages and disadvantages for children's engagement with the classroom component when they were asked to deliver the PA component first. | The energising/tiring effects of PA were discussed mainly in relation to non-intervention PA, with participants leaning towards the effects being positive rather than negative. If energising effects occur following participation in the PA aspect of the interventions then to make the most of these effects for learning the programmes should be delivered in the morning; however, this was noted to be a difficulty in relation to the *time demands* upon schools. |
| *2.3. Competence* | Physical competence was a prevalent theme when discussing what is learnt in PE lessons, including developing an understanding of moving the body. Competence was noted to lead to a range of achievements and opportunities for children, suggesting that it is an outcome of value to participants. Only one transcript (for a focus group of children who had participated in the drugs education programme) referred to learning to move and improving on one's reaction skills as outcomes of intervention PA. | Similar to *energy and concentration*, the development of competence was discussed mainly in relation to non-intervention PA participation. It may be that following *intervention monitoring* to assess these potential outcomes, any positive effects can be included in the marketing of the interventions to contribute to their *sustainability*.<br><br>Fitness is a multidimensional construct: while the *physical fitness* subtheme pertains to health-related physical fitness (body composition, cardiovascular fitness, flexibility, muscular endurance and strength), the competence subtheme pertains to skill-related physical fitness (agility, balance, coordination, power, speed and reaction time; Corbin, Pangrazi & Franks, 2000). |

***Theme summary table for research question 3 (continued): Intervention outcomes***

| **Theme Name** *(subthemes)* | **Scope and Content of Theme** | **How the Theme Fits into the Broader Overall 'Story' in relation to the Research Question(s)** |
|---|---|---|
| **3. Teacher development** | The organisation offering the fitness and nutrition programme asked teachers to be present during the sessions, the aims of this policy being so that they could support the children and additionally learn how to improve their own PE delivery. Teacher development was also supported through the offer of twilight sessions. Although it was not an explicit aim of the other intervention, intervention staff involved in these programmes felt that teachers were able to pick up games for use in their PE lessons, as one of the groups of children mentioned had been the case from other external providers. School staff with experience of each of the interventions described how the sessions had been of benefit to their development, again largely in terms of being introduced to activities they could use with their classes. | Some of the intervention and school staff noted that teachers vary in the level of confidence they have in teaching PE, whereas the intervention staff felt they were specialists in this area, highlighting one of the advantages of *delivery by a non-teacher.* |

***Theme summary table for research question 4: Sustainability of intervention delivery***

| **Theme Name** *(subthemes)* | **Scope and Content of Theme** | **How the Theme Fits into the Broader Overall 'Story' in relation to the Research Question(s)** |
|---|---|---|
| **1. Funding** | The facilitators for one of the interventions explained that it is funded by the local council and provided for free to the schools, which is likely to play a role in sustainability because while schools can also buy the programme they are more liable to participate – demonstrating demand for the intervention – if it is provided for free. Funding was also recognised to play a role in the sustainability of the other intervention, for which schools would pay, because cost was a potential barrier to uptake. The recent increase in funding for school sports was however noted as a facilitator. | Some of the intervention staff discussed that funding can be dependent upon programmes covering specified topics. As the funded topics may change over time, this might endanger the interventions unless continual *monitoring and development* is undertaken to keep abreast of current trends. |
| *1.1. Intervention monitoring and development* | Intervention staff described that there are review processes for the interventions and that adjustments are made to the programmes where this is felt to be appropriate. They appreciated the role of measuring outcomes in relation to attracting funding, making adjustments to the programmes and monitoring intervention success, but discussed that it is difficult to measure long-term outcomes. There are currently pre- and post-course questionnaires for both interventions, fitness tests for one of the interventions and a teacher evaluation form for the other, the teacher evaluation feeding into the termly and annual reports written for the funders. Some of the children suggested adding games and quizzes which would provide additional informal assessment of the knowledge they had acquired. | Intervention staff described that they were looking into changing or adding to their provision to continue to meet the *needs of schools* and *funding* criteria. |
| *1.2. Increased duration and follow-up* | Participants from all groups referred to the short duration of intervention 2 and/or its sessions, with one member of school staff reporting that it was difficult for children to ask questions during the course and one member of intervention staff reporting that it could be difficult to address any issues they identified in a class.<br><br>Some of the school staff and intervention staff associated with both interventions – as well as parents whose children were participating in intervention 2 – discussed having a follow-up session to check back in with the children and assess their progress since completing the course. | The provision of longer duration interventions/follow-up sessions was noted to be dependent upon *funding* and working around the barrier of *time demands and conflicts* for school and intervention staff. However, participants felt that there was a role for teachers and *family* in supporting outcomes beyond the duration of the interventions by reinforcing programme messages. Parents are not currently involved in either of the interventions and this is a potential way in which the interventions could be *developed*. |

***Theme summary table for research question 4 (continued): Sustainability of intervention delivery***

| **Theme Name** *(subthemes)* | **Scope and Content of Theme** | **How the Theme Fits into the Broader Overall 'Story' in relation to the Research Question(s)** |
|---|---|---|
| **2. School awareness and acceptance of interventions** | Many of the school staff and parents spoke of their schools' promotion of healthy and safe behaviours, including sport and PA, and parents were also positive about members of school staff. Such school cultures might have played a role in decisions to take up the programmes.<br><br>Schools' decisions to take part in programmes also relied upon an awareness of the existence of the programmes, often supported by prior involvement with the organisations responsible for running them. The possibility that schools were taking part in interventions provided by other organisations was noted by one member of intervention staff. | The first step to children's *engagement* in an intervention is their school selecting it for them to take part in. The unusual inclusion of *both classroom and PA components* appeared to make the programmes popular with school staff and pupils. This might be a selling point for the programmes to support their continued delivery.<br><br>Two of the facilitators felt that there was a perception amongst some schools who had not been involved in their intervention that it would be purely football coaching, and in this way an *association with a football club* might be a barrier to uptake. |
| *2.1. Meeting the needs of schools* | Intervention staff referred to the programmes meeting the national curriculum requirement for schools to provide their pupils with PSHE whilst also being delivered in an engaging manner for the children. The fitness and nutrition programme was noted to additionally count towards schools' PE provision, and had been designed to include aspects of the science curriculum. Children confirmed that the programmes were consistent with other PSHE-related messages they had been given in school; parents agreed but were less informed about school PSHE provision.<br><br>Having a range of programmes and being able to make these available to pupils of different abilities made the interventions flexible, and it was noted that schools could make specific requests for topics or other adaptations. | School staff were happy that the interventions covered topics of use to them, suggesting that the content was appropriate for their market audience and that the programmes would be taken up by schools, although intervention staff were aware of the need for continued *monitoring and development* of the interventions to continue to meet school needs.<br><br>One of the intervention staff noted that there were potentially better *outcomes* if the programmes were chosen to address specific issues within a class. |
| *2.2. Time demands and conflicts* | Intervention and school staff discussed the difficulties of accommodating the programmes into busy school timetables. Even though the interventions were valued, literacy and maths tended to take priority, particularly in the mornings, and there were reports of a reduction in PE lessons at the time of year during which the children were preparing to sit their SATs examinations. School trips and activities such as choir sometimes clashed with intervention sessions. | In some instances, the PA component of the programmes was counted by school staff towards children's weekly PE participation; this replacement of an existing activity meaning a lesser demand being placed upon school time and indicating that the interventions did *meet the needs of schools* in relation to PE provision. It was also possible for intervention staff to adapt the duration of the sessions, helping to make the interventions more *acceptable to schools* as they could be accommodated within busy timetables. |

## Appendix M(v): Study 4 – Themes Saturation

***Themes saturation worktable for research question 1: The role of physical activity in the interventions, with interviews/focus groups arranged in the order in which they were conducted***

| Interview/ focus group | Number of themes | Number of shared themes with previous interviews/ focus groups | Number of new themes per interview/ focus group | Total number of themes | Percentage of saturated terrain per interview/ focus group |
|---|---|---|---|---|---|
| **1** | 3 | | | 3 | 100.00 |
| **2** | 2 | 2 | 0 | 3 | 66.67 |
| **3** | 0 | 0 | 0 | 3 | 0.00 |
| **4** | 2 | 2 | 0 | 3 | 66.67 |
| **5** | 2 | 2 | 0 | 3 | 66.67 |
| **6** | 2 | 2 | 0 | 3 | 66.67 |
| **7** | 2 | 2 | 0 | 3 | 66.67 |
| **8** | 2 | 2 | 0 | 3 | 66.67 |
| **9** | 2 | 2 | 0 | 3 | 66.67 |
| **10** | 3 | 3 | 0 | 3 | 100.00 |
| **11** | 3 | 3 | 0 | 3 | 100.00 |
| **12** | 2 | 2 | 0 | 3 | 66.67 |
| **13** | 3 | 3 | 0 | 3 | 100.00 |
| **14** | 3 | 3 | 0 | 3 | 100.00 |
| **15** | 1 | 1 | 0 | 3 | 33.33 |
| **16** | 1 | 1 | 0 | 3 | 33.33 |
| **17** | 3 | 3 | 0 | 3 | 100.00 |
| **18** | 3 | 3 | 0 | 3 | 100.00 |
| **19** | 1 | 1 | 0 | 3 | 33.33 |
| **20** | 3 | 3 | 0 | 3 | 100.00 |
| **21** | 2 | 2 | 0 | 3 | 66.67 |
| **22** | 2 | 2 | 0 | 3 | 66.67 |
| **23** | 2 | 2 | 0 | 3 | 66.67 |
| **24** | 1 | 1 | 0 | 3 | 33.33 |
| **25** | 2 | 2 | 0 | 3 | 66.67 |
| **26** | 3 | 3 | 0 | 3 | 100.00 |
| **Average percentage of saturated terrain across interviews/focus groups:** | | | | | **70.51** |

***Themes saturation worktable for research question 2: Children's engagement in the intervention sessions, with interviews/focus groups arranged in the order in which they were conducted***

| Interview/ focus group | Number of themes | Number of shared themes with previous interviews/ focus groups | Number of new themes per interview/ focus group | Total number of themes | Percentage of saturated terrain per interview/ focus group |
|---|---|---|---|---|---|
| **1** | 11 | | | 11 | 84.62 |
| **2** | 8 | 8 | 0 | 11 | 61.54 |
| **3** | 11 | 9 | 2 | 13 | 84.62 |
| **4** | 10 | 10 | 0 | 13 | 76.92 |
| **5** | 5 | 5 | 0 | 13 | 38.46 |
| **6** | 6 | 6 | 0 | 13 | 46.15 |
| **7** | 8 | 8 | 0 | 13 | 61.54 |
| **8** | 7 | 7 | 0 | 13 | 53.85 |
| **9** | 8 | 8 | 0 | 13 | 61.54 |
| **10** | 8 | 8 | 0 | 13 | 61.54 |
| **11** | 6 | 6 | 0 | 13 | 46.15 |
| **12** | 6 | 6 | 0 | 13 | 46.15 |
| **13** | 8 | 8 | 0 | 13 | 61.54 |
| **14** | 10 | 10 | 0 | 13 | 76.92 |
| **15** | 10 | 10 | 0 | 13 | 76.92 |
| **16** | 6 | 6 | 0 | 13 | 46.15 |
| **17** | 6 | 6 | 0 | 13 | 46.15 |
| **18** | 7 | 7 | 0 | 13 | 53.85 |
| **19** | 6 | 6 | 0 | 13 | 46.15 |
| **20** | 8 | 8 | 0 | 13 | 61.54 |
| **21** | 10 | 10 | 0 | 13 | 76.92 |
| **22** | 8 | 8 | 0 | 13 | 61.54 |
| **23** | 8 | 8 | 0 | 13 | 61.54 |
| **24** | 4 | 4 | 0 | 13 | 30.77 |
| **25** | 7 | 7 | 0 | 13 | 53.85 |
| **26** | 7 | 7 | 0 | 13 | 53.85 |
| **Average percentage of saturated terrain across interviews/focus groups:** | | | | | **58.88** |

***Themes saturation worktable for research question 3: Intervention outcomes, with interviews/focus groups arranged in the order in which they were conducted***

| Interview/ focus group | Number of themes | Number of shared themes with previous interviews/ focus groups | Number of new themes per interview/ focus group | Total number of themes | Percentage of saturated terrain per interview/ focus group |
|---|---|---|---|---|---|
| **1** | 6 | | | 6 | 66.67 |
| **2** | 6 | 5 | 1 | 7 | 66.67 |
| **3** | 2 | 2 | 0 | 7 | 22.22 |
| **4** | 5 | 3 | 2 | 9 | 55.56 |
| **5** | 2 | 2 | 0 | 9 | 22.22 |
| **6** | 4 | 4 | 0 | 9 | 44.44 |
| **7** | 2 | 2 | 0 | 9 | 22.22 |
| **8** | 5 | 5 | 0 | 9 | 55.56 |
| **9** | 6 | 6 | 0 | 9 | 66.67 |
| **10** | 5 | 5 | 0 | 9 | 55.56 |
| **11** | 4 | 4 | 0 | 9 | 44.44 |
| **12** | 5 | 5 | 0 | 9 | 55.56 |
| **13** | 6 | 6 | 0 | 9 | 66.67 |
| **14** | 5 | 5 | 0 | 9 | 55.56 |
| **15** | 6 | 6 | 0 | 9 | 66.67 |
| **16** | 4 | 4 | 0 | 9 | 44.44 |
| **17** | 5 | 5 | 0 | 9 | 55.56 |
| **18** | 4 | 4 | 0 | 9 | 44.44 |
| **19** | 4 | 4 | 0 | 9 | 44.44 |
| **20** | 7 | 7 | 0 | 9 | 77.78 |
| **21** | 7 | 7 | 0 | 9 | 77.78 |
| **22** | 6 | 6 | 0 | 9 | 66.67 |
| **23** | 7 | 7 | 0 | 9 | 77.78 |
| **24** | 4 | 4 | 0 | 9 | 44.44 |
| **25** | 6 | 6 | 0 | 9 | 66.67 |
| **26** | 6 | 6 | 0 | 9 | 66.67 |
| **Average percentage of saturated terrain across interviews/focus groups:** | | | | | **55.13** |

***Themes saturation worktable for research question 4: Sustainability of intervention delivery, with interviews/focus groups arranged in the order in which they were conducted***

| Interview/ focus group | Number of themes | Number of shared themes with previous interviews/ focus groups | Number of new themes per interview/ focus group | Total number of themes | Percentage of saturated terrain per interview/ focus group |
|---|---|---|---|---|---|
| **1** | 6 | | | 6 | 100.00 |
| **2** | 6 | 6 | 0 | 6 | 100.00 |
| **3** | 3 | 3 | 0 | 6 | 50.00 |
| **4** | 1 | 1 | 0 | 6 | 16.67 |
| **5** | 5 | 5 | 0 | 6 | 83.33 |
| **6** | 5 | 5 | 0 | 6 | 83.33 |
| **7** | 1 | 1 | 0 | 6 | 16.67 |
| **8** | 3 | 3 | 0 | 6 | 50.00 |
| **9** | 3 | 3 | 0 | 6 | 50.00 |
| **10** | 2 | 2 | 0 | 6 | 33.33 |
| **11** | 4 | 4 | 0 | 6 | 66.67 |
| **12** | 4 | 4 | 0 | 6 | 66.67 |
| **13** | 2 | 2 | 0 | 6 | 33.33 |
| **14** | 3 | 3 | 0 | 6 | 50.00 |
| **15** | 2 | 2 | 0 | 6 | 33.33 |
| **16** | 4 | 4 | 0 | 6 | 66.67 |
| **17** | 3 | 3 | 0 | 6 | 50.00 |
| **18** | 6 | 6 | 0 | 6 | 100.00 |
| **19** | 6 | 6 | 0 | 6 | 100.00 |
| **20** | 5 | 5 | 0 | 6 | 83.33 |
| **21** | 6 | 6 | 0 | 6 | 100.00 |
| **22** | 5 | 5 | 0 | 6 | 83.33 |
| **23** | 6 | 6 | 0 | 6 | 100.00 |
| **24** | 5 | 5 | 0 | 6 | 83.33 |
| **25** | 5 | 5 | 0 | 6 | 83.33 |
| **26** | 6 | 6 | 0 | 6 | 100.00 |
| **Average percentage of saturated terrain across interviews/focus groups:** | | | | | **68.59** |

# List of Abbreviations

| | |
|---|---|
| AFLY5 | *'Active for Life Year 5'* intervention |
| ANCOVA | Analysis of covariance |
| ANOVA | Analysis of variance |
| APPLES | *'Active Programme Promoting Lifestyle Education in Schools'* intervention |
| BDNF | Brain-derived neurotrophic factor |
| BMI | Body mass index |
| bpm | Beats per minute (heart rate) |
| CAS | Cognitive Assessment System |
| CogS: 9–11 | Cognition in Schools: 9–11-year-olds, the test battery created as part of the research (see Study 1) |
| CPD | Continuing professional development |
| cpm | Accelerometer counts per minute |
| DV | Dependent variable |
| FITKids | *'Fitness Improves Thinking in Kids'* intervention |
| fMRI | Functional magnetic resonance imaging |
| GCSE | General Certificate of Secondary Education |
| HRmax | Maximal heart rate |
| IV | Independent variable |
| LTM | Long-term memory |
| MANCOVA | Multivariate analysis of covariance |
| MANOVA | Multivariate analysis of variance |
| MDI | Middle Years Development Instrument |
| MVPA | Moderate-to-vigorous intensity physical activity |
| Ofsted | Office for Standards in Education, Children's Services and Skills |
| PA | Physical activity |
| PACER | Progressive Aerobic Cardiovascular Endurance Run test |
| PE | Physical Education |
| PedsQL | Pediatric Quality of Life Inventory |
| PSHE | Personal, Social, Health and Economic education |

| | |
|---|---|
| RCT | Randomised controlled trial |
| SATs | National curriculum tests, commonly referred to as SATs |
| SEAL | *'Social and Emotional Aspects of Learning'* programme |
| SEN | Special educational needs |
| SES | Socioeconomic status |
| ToL | Tower of London task |
| WRAT | Wide Range Achievement Test |

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