THE ROLE OF THE SOCIAL ENVIRONMENT IN PACING, SPORTS PARTICIPATION, AND PERFORMANCE OF INDIVIDUALS WITH INTELLECTUAL IMPAIRMENTS

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Abstract

Pacing, the process in which people need to decide how and when to distribute their energy resources throughout an exercise activity, is impaired in people with Intellectual Impairments (II). This may partially explain their low levels of sports participation and the shortfalls in their performance. The social environment may be pivotal in supporting the pacing of people with II in sports. However, the role of the social environment in sports of people with II is still unknown. Thus, the overarching purpose of this thesis is to explore the role of the social environment in pacing, sports participation, and performance of individuals with II. We developed a theoretical framework that focusses on how the social environment can support the process of pacing and explored the social environment's role in the sports environment of people with II. Then, this knowledge was used to investigate how the social environment can support the pacing behaviour of people with II in sub-maximal and maximal trials. The findings revealed that the social environment can support the self-regulatory skills which are critical in pacing but impaired in people with II. Moreover, coaches require more guidance to effectively coach people with II. The experimental studies showed the influence of the II in pacing and suggested directions to support people with II in sub-maximal and maximal sports activities. A pacer (e.g., peer) can positively influence the self-regulatory process of exercise regulation and offer an intuitive, visual guidance to people with II during a sub-maximal trial. The presence of an opponent during a maximal trial however, could create a cognitive demanding and anxious situation that negatively influences the pacing and sports performance of people with II. Awareness of these findings could help promote an inclusive, long-term sports participation and help people with II to develop their sport-related skills.

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The following abbreviations have been used throughout the PhD thesis:

Abbreviation	Meaning
II	Intellectual Impairments
ICF	International Classification of Functioning, Disability and Health
AAIDD	American Association on Intellectual and Developmental Disabilities
BPS	British Psychological Society
TA	Think Aloud
fMRI	functional Magnetic Resonance Imaging
NIRS	Near-infrared Spectroscopy
IQ	Intellectual Quotient
GCTB	Generic Cognitive Test Battery
IPC	International Paralympic Committee
FIBA	International Basketball Federation
SRL	Self-Regulation of Learning
SDT	Self-Determination Theory
IBQ	Interpersonal Behaviours Questionnaire
SRM	Social Relational Model of disability
PARQ+	Physical Active Readiness Questionnaire+
IPAQ	International Physical Activity Questionnaire
RTE	Relative Treatment Effects
APD	Absolute Percentage Deviation
RPE	Rate of Perceived Exertion
SRL-SRS	Self-Regulation of Learning Self-Report Scale
6MWT	Six Minute Walk Test

Publications

I confirm that I took the major role in all aspects of production of the papers below, including the formulation of ideas, design of methodology, data acquisition, data analysis, original draft preparation in journal format, reviewing, and editing. I also confirm that all the authors contributed to the conceptualisation and revision of each paper. The last author contributed to the conceptualisation and revision of each paper and supervised the whole process. In addition, Prof. Florentina Hettinga supervised (or co-supervised) all the papers, from the ideas' formulation to the papers' submission/publication.

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1. Sakalidis KE, Burns J, Van Biesen D, Dreegia W, Hettinga FJ. The impact of cognitive functions and intellectual impairment on pacing and performance in sports. Psychol Sport Exerc. 2021;52:101840.

2. Sakalidis KE, Menting S, Elferink-Gemser M, Hettinga FJ. The role of social environment on pacing and sports performance: a narrative review from a self-regulatory perspective. Int. J. Environ. Res. Public Health. 2022;19:16131. https://doi.org/10.3390/ijerph192316131.

3. Sakalidis KE, Pérez-Tejero J, Khudair M, Hettinga, FJ. Ball possessions and game rhythm in basketball games involving players with and without Intellectual Impairments. (under review). 2022.

4. Sakalidis KE, Hettinga F, Ling F. Coaching styles and sports motivation in athletes with and without Intellectual Impairments. (under review). 2022.

5. Sakalidis KE, Fadeeva A, Hettinga FJ, Ling F. The role of the social environment in sports participation of athletes with Intellectual Disabilities through the coaches' eyes: A qualitative inquiry. PloS one. 2022; 18(1):e0280379. https://doi.org/10.1371/journal.pone.0280379

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2. Sakalidis KE, Pérez-Tejero J, Khudair M, Hettinga FJ. The impact of Intellectual Impairment on game rhythm in basketball. VISTA 2021 Conference; Dec 16 Online; 2021.
3. Sakalidis KE, Hettinga F, Ling F, editors. Coaches' interpersonal styles and the motivational differences between athletes with and without Intellectual Impairment. European Conference of Adapted Physical Activity (EUCAPA) 2022; 2022 June 9-11; Coimbra, Portugal.
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Introduction

According to the convention of the rights of people with disabilities, individuals with Intellectual Impairments (II) have the right to participate in the sports activity of their choice [1]. Sports participation can enhance physical and psychological well-being of people with II. It can also facilitate their cognitive and transferable skills development [2, 3]. Despite the benefits of sports participation, only a limited number of individuals with II (9%) regularly participate in sports activities [4]. Within this small number, there are some athletes with II who want to improve their sport-related skills and participate in elite competitions [5]. However, as people with II are one of the most understudied populations, it is not well-documented how to properly include, guide, and train them in sports environments [6]. A better understanding of the needs of people with II and their relationships with their social environment (e.g., coaches) are important in tackling ableism (discrimination in favour of people without disabilities) and driving inclusivity in sports settings [7]. This could facilitate the development of mainstreaming (integration of disability and non-disability sports organisations) and will provide more pathways to people with II to participate in the sport activity of their choice [8].

While the term ‘Intellectual Disability’ is commonly used internationally, and the term ‘Learning Disability’ is frequently used in the UK, in this PhD thesis we use the term ‘Intellectual Impairment’ to be consistent with the International Classification of Functioning, Disability and Health (ICF) [9-12]. Within the ICF framework, there is a distinction between disability and impairment, with disability being ‘any restriction or lack of ability to perform a task in the manner or within the range considered normal for a person’ and impairment being ‘any loss or abnormality of physiological, psychological, or anatomical function or structure’ [12]. Additionally, we took into consideration the socio-cultural perceptions of impairment [13] and that an impairment may put a person at risk of participation restrictions [14].

In this PhD thesis we used the diagnostic criteria of the American Association on Intellectual and Developmental Disabilities (AAIDD) for the international papers/chapters [11], and the British Psychological Society (BPS) for the national papers/chapters [10]. According to the AAIDD and the BPS, people with II are dealing with intellectual functioning (IQ ≤ 75 and IQ ≤ 70 respectively) and adaptive behaviour limitations [10, 11]. This means that cognitive skills, like decision-making and self-regulation, which are critical in behavioural processes towards sports engagement, are impaired in individuals with II [15, 16]. These cognitive deficits can also negatively influence their sports development and performance [10, 17]. Moreover, people with II may misinterpret other people’s behaviour, and/or inadequately convey messages across, which can hinder social interaction [18]. Apart from their challenging behaviours, people with II are also dealing with anxiety, decreased confidence, and social phobia [19]. These might lead them to respond differently to the environmental cues (e.g., interaction with coaches) and negatively influence their sports engagement and performance [20, 21]. Because of these cognitive limitations and psychological barriers, people with II may become more dependent on the support of others in exercise settings (e.g., parents, coaches, other exercisers) [22]. However, even if it is evident that the social environment could affect peoples’ exercise motivation and behaviour, especially for people without II [23-25], it is still unknown the relationship of people with II with their social environment (e.g., coaches) in sports participation and performance settings, and how II may impact on their sports motivation and performance progression. Thus, a better understanding of this population’s needs, motivations, and social interactions, is critical in understanding the challenges in adopting inclusive practices, providing sports opportunities, and improving their sport-related skills [7, 26].

An insight in these relationships could trigger a further exploration of approaches that promote the long-term sports participation and optimise performance for people with II. A concept that seems to be promising in both sports participation and performance settings is pacing [27, 28]. In pacing, people need to decide how and when to distribute their energy resources throughout an exercise task [29, 30]. It is characterised as a self-regulatory process because skills like planning, monitoring, and evaluating, are crucial for the development of pacing [29]. For instance, athletes need to plan their performance before the race, monitor their pacing behaviour during the race and evaluate their actions afterward to optimize sport performance [31]. To initiate and optimize this self-regulatory process, the social environment can support the acquisition and implementation of critical self-regulatory skills [32]. However, the first studies which have tried to integrate the self-regulatory framework in pacing behaviour, emphasise mainly the role of individuals' efforts in their own self-regulatory process [29, 33]. Thus, a further investigation of the role of the social environment and motivation on the self-regulatory process of pacing could help us better understand how to promote long-term engagement in sports and improve athletes' performance. It could also inform coaches about the strategies they can follow, with a purpose to optimise peoples' pacing [29]. The inadequate pacing behaviour in maximal and sub-maximal trials of people with II has been linked to less sports participation [20] and poorer sports performance [34, 35]. For this reason, it is important to further investigate the impact of II on pacing behaviour and explore ways to improve the pacing skills of people with II [34, 35].

To our knowledge, only few studies investigated the pacing behaviour of people with II in sports [34-36]. The results showed that athletes with II deviate more from a targeted pace during a sub-maximal trial [35] and their competitive pacing behaviour differed compared to athletes without II [34, 36]. Additionally, Khudair et al [36, 37] suggests that more intuitive visual cues for action might be beneficial to guide pacing in individuals with II to compensate for deficiencies in their (deliberate) planning capacity. Thus, their pacing behaviour in a constantly changing sport environment will likely be affected by different perceptual affordances which invite them to adapt and continuously alter their pacing behaviour and their actions [30, 36]. Thus, other people (e.g., pacers and/or opponents) could act as affordances and provide intuitive, visual guidance during sports activities to people with II and facilitate their self-regulatory behaviour. However, none of these studies took into consideration the influence of the social environment in the pacing behaviour of people with II [34, 35]. An in-depth exploration of pacing behaviour in sport activities where pacing is salient (e.g., cycling) could shed light on the potential problems that people with II may experience when participating in sports and how these problems influence their performance [34, 35]. At the same time, by considering the impact of the social environment, we can propose strategies to enhance the pacing abilities of people with II.

Purpose and aims of the PhD thesis

Based on all the above, the overall purpose of this PhD thesis is to better understand the sports environment of people with II and to explore the role of the social environment in pacing, sports participation, and performance optimisation of individuals with II (for the schematic overview of this PhD thesis please see Figure 1). The specific aims of this PhD thesis are to:

- Explore in the literature the reasons for inadequate pacing behaviour of people with II (chapter 1) and investigate the impact of the II in pacing through an observational study (chapter 2).
- Develop a theoretical framework that focusses on how the social environment can support the self-regulatory process of pacing (chapter 3).
- Gain a comprehensive understanding of the sports environment of people with II using a quantitative (chapter 4) and a qualitative approach (chapter 5) aiming to include stakeholders, in this case coaches', perceptions, that could support the development of proper pacing experiments.
- Develop experimental studies by using the knowledge of the previous chapters to examine how the social environment can influence and support the pacing behaviour of people with II (chapter 6 and 7).

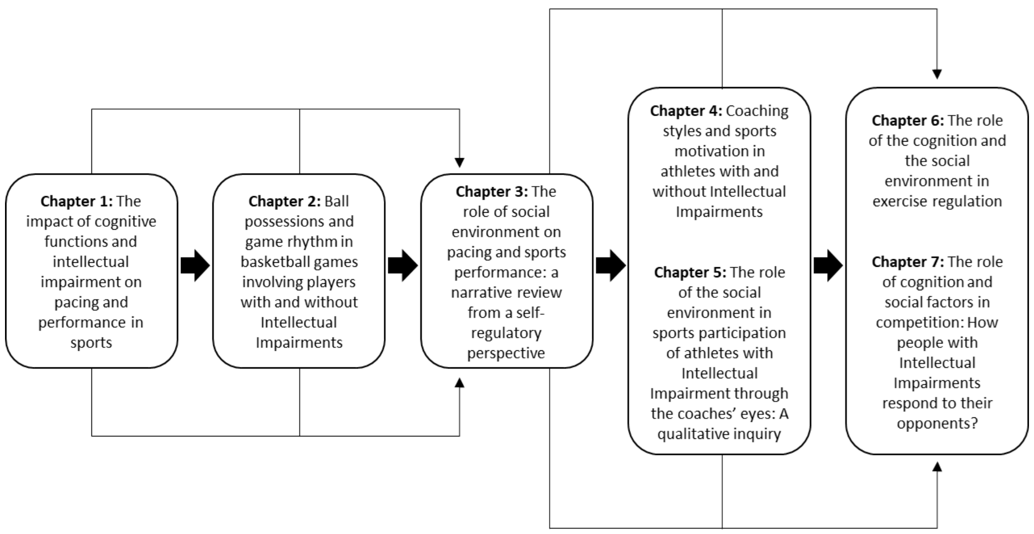

Figure 1. Schematic overview of the PhD thesis.

Chapter 1: The impact of cognitive functions and Intellectual Impairment on pacing and performance in sports

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Abstract

An essential determinant for success in sports is pacing. Cognitive mechanisms like self-regulation and executive functions are strongly related to adequate pacing behaviour, and people with Intellectual Impairments (II) experience shortfalls in those skills. Previous literature in children without II revealed that pacing is at least partly dependent on cognitive development. Research that focuses on pacing abilities of individuals with II strengthens the assumption that intellectual functioning is involved in pacing, as elite athletes with II are not able to maintain a pre-planned sub-maximal velocity and they regulate their exercise intensity differently compared to athletes without II. This review highlights the role of cognition and adaptive behaviour in pacing and provides insight into the impact of II on pacing behaviour. It is also proposing pacing as a significant component of Paralympics' evidence-based classification for athletes with II. Finally, we propose future directions for research to uncover the impact of cognitive mechanisms on regulation of exercise intensity.

Keywords: Intellectual Disabilities; cognition; self-regulation; Paralympics

Introduction

Participation in sports has been associated with a range of physical, mental, and social health benefits [38]. For this reason, it is a responsibility of an inclusive society to ensure that people with Intellectual Impairments (II) engage in sports activities and master their sports performance. Indeed, there are various multi-sports international events that offer opportunities to individuals with II to participate and compete (Special Olympics programmes, Global games) [39]. However, after the re-introduction of athletes with II in London's Paralympic Games in 2012, the scientific interest in sports performance of this population in elite competition has also increased [40]. More specifically, many researchers have investigated the link between cognition and sports performance [17, 34, 35, 41], but the nature of this link is still largely unexplained.

As elite performance is a complex and multicomponent function [42], we can assume that deficits in intellectual functioning play a role in sports performance. However, only Tilinger [43] examined and detected substantially lower athletic achievements of elite athletes with II compared to elite athletes without II. Other studies have mainly focused on the technical aspects of sports performance and expertise. For instance, individuals with II demonstrate a significantly reduced velocity and acceleration in athletics [44], different swimming efficiency indicators and temporal synchronisation measures [45] in swimming, and they cannot reach the same level of technical proficiency in table tennis compared to individuals without II [17, 41].

Additionally, some of the findings of previous research, in terms of the impact of cognitive impairment on sports performance, are related to pacing behaviour [15, 35]. Pacing behaviour is widely recognised as an essential component of success in various sports and is comprised of a range of cognitive skills [28, 29, 39, 46-51]. With a purpose to establish pacing as a significant cognitive component of sports performance optimisation, the aim of this review is to systematically examine studies focusing on the cognitive aspects relevant to pacing and consistently investigate the impact of II on pacing behaviour. The specific objectives of the review are to: 1) describe the theoretical foundation of pacing, 2) investigate cognitive aspects of pacing behaviour such as decision-making and executive skills, to 3) explore the intellectual functioning and adaptive behaviour limitations of individuals with II and report the influence of these deficits on pacing and performance and finally to 4) indicate the possibilities for further integration of pacing in the Paralympics' evidence-based classification system. At this point, it is worth highlighting that this review supports the paradigm that research in athletes with II could give an insight into the role of cognition in sports and clarify how limitations or strengths in cognitive functions impact on pacing and sports performance.

Pacing and sports performance

Pacing has been described as a multifaceted goal-directed process of decision making in which athletes need to decide how and when to distribute their energy throughout an exercise task [28, 30, 52]. Optimal pacing behaviour in time trial competitions is characterised by balancing between starting fast to optimally use available energy resources while at the same time preventing negative technical alterations in the trial due to early fatigue, and inefficient energy losses associated with velocity fluctuations over the race [49, 53]. In order to determine the most appropriate pacing strategy, an amalgamation of interoceptive (e.g., biomechanical, physiological and/or psychological) and exteroceptive (e.g., environmental) factors [54] is crucial to maintain internal homeostasis [55] and/or to avoid premature exhaustion [56-58]. When opponents are involved, such as in head-to-head competition, this has also been found to impact on pacing-related decision-making and performance [58].

The concept of pacing has also become increasingly popular in team sports with the improvement of tracking technology. Pacing in team sports is considered the distribution of energy resources to enhance match-running performance and it is the result of various physiological and psychological factors [59]. To optimise running performance, whole-match players adopt 'slow positive' pacing strategies (gradual decline in running intensity)

[60-62], while partial-match players select either ‘reserve’ or ‘all-out’ pacing strategies [59, 60]. It is worth mentioning that research in basketball pacing, a popular sport for II and non-II individuals, is scarce. Only two studies have explored the concept of pacing in basketball settings, where pacing was defined as the frequency of ball possessions per quarter [63, 64]. As this approach does not take into consideration the pacing behaviour of each player or the dynamic pacing behaviour of basketball players, new research that investigates pacing strategies of basketball players via a global positioning system (GPS) is strongly recommended.

Decision making in pacing - history and model development

In order to gain a better understanding of the cognitive aspects of pacing, a description of the theoretical foundation of this skill is essential. Pacing is a decision-making process, however, the mechanisms supporting this process involved in regulation of exercise intensity are still strongly debated [58]. Numerous theories and models attempt to explain the decision-making processes involved in the regulation of exercise intensity and shed light on the complex mechanism of pacing [58].

The first theory related to exercise intensity and pacing was based on Hill’s model which states that performance limitations occur due to metabolic changes in the exercise muscles [65, 66]. However, this model was questioned, mostly because it did not integrate the role of the brain in the regulation of exercise and homeostasis protection [67]. As an alternative, the process of teleoanticipation as a crucial element of exercise regulation was proposed by Ulmer [68]. Based on this theory, the brain has a dominant control position, and exercise is regulated by efferent commands and central calculations that attempt to couple biomechanical and metabolic limits of the body to the task demands. Additionally, a central programmer that would act as an input/output ‘black box’ was introduced, in order to coordinate efferent and afferent signals and prevent the intensity of exercise to exceed metabolic limits [68].

Later, Renfree et al [69] attempted to integrate decision-making theories in pacing and developed a heuristic decision-making model, in which heuristics are considered as intuitions that require low cognitive demands. However, the heuristic decision-making model does not include the coupling of perception and action that occurs in complex tactical pacing environments in which athletes need to respond to their opponents' behaviour [30, 37, 69]. At the same time, Smits et al [30] provided a more detailed explanation of pacing as a behavioural outcome of the decision-making process by including the human-environment interactions. In pacing, individuals are constantly required to make decisions in a complex exercise environment demanding and they have to choose, modify, and evaluate their behaviour [70]. In this environment, affordances are detected as information to support numerous action possibilities and are associated with an individual's capability to use them [71, 72]. In order for individuals to get involved efficiently in action selection and action specification procedures, brain and cognitive processes are involved as an information processing system [73].

Even if the presented models have fundamental differences, some cognitive features are present in nearly all of them [74]. The crucial elements in pacing are perceived level of exertion and effort, fatigue sensations, knowledge about the endpoint or the expected duration and distance of the race and the aspiration of the athlete to overcome discomfort in anticipation of extrinsic rewards. The importance of human-environment interaction has been also considered as a critical cognitive factor of pacing [74].

Human-environment interaction in pacing

Sports environments consist of perceptual affordances that invite athletes to respond and adapt their pacing behaviour [30, 74]. Affordances allow athletes to decide if they will persist in a pre-planned behaviour or they will switch to a different one (e.g., faster or slower pace). In a complex performance environment, athletes are surrounded by a great number of action invitations (affordances) however, the presence of these invitations does not imply that the action will occur, even if the environment contributes to the probability of that action [75, 76].

Several experimental and observational studies have shown that opponents are one type of affordance which can significantly influence sports performance [74, 77-80]. Athletes generally improve their sports performance during competitive trials compared to non-competitive trials [74, 79-81]. However more research is needed to reveal the reasons behind this behaviour. Investigating critical factors of sports performance like motivation, self-efficacy, self-regulatory skills, and competitiveness [29, 33, 82, 83] of athletes in various sports competition settings, could shed some light on the rationale of athletes' performance improvements during competitive trials. It has also been demonstrated that interpersonal competitions affect pacing decisions in various sports like running, rowing, cycling and speed skating [81, 84-86]. An interesting fact is that in time-trial competitions, where athletes have to complete a given distance as fast as possible, the presence of other competitors does not significantly affect the pacing behaviour of individuals [87-89]. On the other hand, in head-to-head competitions, where the athletes' goal is to finish the race before their opponents, pacing behaviour is usually adjusted based on the pacing behaviour of competitors, especially when athletes are competing in the same lane as in speed skating [81] and track cycling [90]. Athletes compare themselves with the opponents and adapt their behaviour based on their actions. Opponents also influence athletes' attentional focus, motivation, collective behaviour, the ability to tolerate pain and fatigue, positioning and fall risk [74].

Opponents are the most common and obvious affordances in sports competition however, there are other environmental factors that could also affect the pacing behaviour of athletes. Music [91], pacing and performance feedback [92, 93] and weather conditions [94] can affect pacing and overall performance. Furthermore, competitive environments such as the stage of competition [95], the importance of the competition [81, 95], and the likelihood of time qualification [81] can also alter the pacing behaviour of an athlete.

Pacing as a developmental skill

Adequate pacing behaviour may be dependent on intellectual skills that are developed in the later cognitive development stages [96]. More specifically, initial pacing and ongoing pacing adaptations are complex actions that depend on decision-making and goal-directed processes that use planning, anticipation, inhibition and logical reasoning, skills which tend to develop, according to Piaget [97], at the 'formal operational stage of cognitive development' (e.g., 11 or 12 years of age and onwards).

A first study on this examined the pacing strategy differences between children of different ages and cognitive development stages [98]. The researchers evaluated the Piagetian stage of cognitive development and the pacing strategy by means of a best effort running task in children of four different age groups (5–6, 8–9, 11–12 and 14 years old). Significant differences in pacing strategy were found between children of different age and cognitive development as well as between cognitive abilities after controlling for age. More specifically, the results revealed that the ability to choose an optimal pacing strategy develops during childhood. The inability of the younger schoolchildren to successfully anticipate the pacing demands of the trial was concluded to be due to their intellectual deficits rather than any adopted pacing strategy [98]. The findings confirmed that pacing is partly dependent on intellectual development and the attainment of specific cognitive skills, as demonstrated by previous researchers, such as the ability to choose an appropriate strategy [99, 100] or the capacity to estimate distance and time [101, 102]. Also in youth athletes, pacing behaviour was found to change throughout adolescence which could indicate a development of pacing-related self-regulatory and cognitive skills [29].

In addition, Lambrick et al [103], demonstrated that pre-adolescent individuals tried to regulate and conserve their exercise intensity throughout a running trial to ensure that they successfully complete it within their personal physiological limits. This study [103] confirmed the findings of previous researchers [98] that pacing behaviour is developing in childhood and the cognitive development stage is correlated with the level of performed regulation of exercise intensity that can be accomplished by young individuals. Menting et al [104] found that at a younger age, speed skaters use a less conservative pacing and so a less successful strategy, in contrast to older speed skaters. However, the intellectual basis of pacing is a complex phenomenon and warrants further investigation. As the study of Micklewright et al (2011) is the only one available where intellectual and cognitive development is directly explored, more research is needed to clearly differentiate the impact of cognitive development from the impact of training and experience on pacing behaviour. For instance, research on the pacing strategy of athletes in different developmental stages, but similar training age (e.g., novice athletes) could shed some light on this issue.

Self-regulation and executive functions in pacing

Self-regulation enables people to exert control of their own learning, train to master a certain activity, and successfully monitor these activities in different contexts and situations [105, 106]. Moreover, executive functions are a set of cognitive processes that are necessary for the adaptation and support of flexible, goal-directed behaviour in challenging situations [107]. It seems that executive functions and self-regulation are interconnected, as they both share common brain regions (prefrontal cortex) [108]. In addition, basic skills of executive functioning like working memory, inhibition, and task-shifting, are involved in successful self-regulation [109].

In sports performance, two frameworks tried to report pacing behaviour from a self-regulatory perspective. On the one hand, Elferink-Gemser and Hettinga [29] proposed a model for the performance development of youth athletes in endurance sports, highlighted the importance to include pacing in talent development programs and matched pacing with the forethought, performance, and self-reflection phase of Zimmerman's theory of self-regulation of learning [110]. Based on this framework, skills like planning, monitoring and evaluating, are crucial for the development of pacing, as athletes need to plan their performance before the race, monitor their pacing behaviour during the race, and evaluate their actions afterward [31] in order to achieve an optimal sport performance. On the other hand, Brick, MacIntyre and Campbell [111, 112], tried to give an explanation of why and when elite endurance athletes initiate cognitive strategies in running settings and proposed an alternative self-regulatory framework of cognitive control and attentional focus during endurance performance. More specifically, this theoretical framework based on features of planning, monitoring, evaluating skills, but also metacognitive experiences like feelings (inform the person about performance in the form of a feeling) and judgements (the result of both implicit and explicit processes) [111].

Behaviour (pace) and thinking (attention) are critical components of self-regulation and what athletes are thinking about influences physiological outcomes, effort perceptions and sports performance [113]. A method that uses the metacognitive framework of Brick et al [111, 112] to collect cognitive thought processes in sports like cycling [51, 89] is the Think Aloud (TA) protocol [114]. The TA protocol requires participants to actively engage in the process of verbalising their thoughts during an exercise task [114] and in a later stage, the verbalisations are coded in four primary themes (Internal Sensory Monitoring, Outward Monitoring, Active Self-Regulation and Distraction) [51, 111, 112]. Massey et al [89] and Whitehead et al [51] applied the TA protocol in participants during a cycling trial and found that trained cyclists have more task relevant thoughts whereas novice athletes focus mostly on task completion and use distractive cognitive strategies to overcome perceptions of fatigue and pain. It is interesting however that both trained and novice cyclists verbalise notably more motivational thoughts in the final stage of the trial [51], an observation in line with the findings by Brick et al [115] who revealed that endurance athletes use self-regulatory strategies like the motivational self-talk to deal with negative thoughts.

With a purpose to get a novel insight into the interaction of cognitive and visual processes that are occurring during a performance trial, Massey et al [89] combined the

TA protocol with an eye-tracking technique (measure of overt attentional allocation). More specifically, eye-tracking glasses were worn by participants and allowed researchers to identify different areas of interest during an exercise bout (time elapsed, heart rate, distance covered, power, speed, cadence, and course scenery). The course scenery was the most viewed area of interest for both novice and trained cyclists however, no significant differences were found in information-seeking behaviour between the two groups [89]. It is worth mentioning that Boya et al [116] also used an eye-tracking technology to compare information acquisition behaviour between novice and experienced cyclists during a 16.1 km trial. The results revealed that novice athletes had a greater dependence upon distance feedback, and they were less consistent in their information acquisition behaviour compared to the experienced cyclists [116]. Interestingly, in another eye-tracking study [117], researchers considered a virtual opponent as an additional information feedback category during a 4-km cycling trial. The findings highlighted that the information-seeking behaviour of cyclists depends on the circumstances in which the cyclists have to act, and a higher interdependency between a cyclist and an opponent increases the attentional focus on the virtual opponent [117]. Based on all the above, it is critical for future research to pay special attention to the TA protocols and eye-tracking techniques to explore cognition related aspects of pacing and performance. As a more realistic sports environment could lead to different thought processes compared to a controlled laboratory research condition, future research should use the TA protocols and eye-tracking techniques in field research settings with a special attention to the coping strategies of athletes in the final stages of the exercise task. It could be also illuminating to investigate the self-regulatory strategies and thoughts of individuals via those two approaches in team sports. Team sports require a numerous set of cognitive skills [118] and players could adopt a more complicated cognitive thought process and information-seeking behaviour compared to athletes in individual sports.

Executive functions play a key role in the regulation of exercise intensity and deficits or challenges in these functions could lead to reduced pacing performance [119]. Cona et al [119] administered a battery of computerized tests and compared the cognitive performance of faster and slower ultra-marathon runners. They found that faster runners have better motor inhibition and are more efficient at performing two tasks simultaneously. In comparison, the cognitive performance of slower runners seems to be more influenced by emotional stimuli. Executive functions seem to be also involved in other critical components of pacing such as decision-making under risk [120] however, this need further investigation in sports performance settings. Furthermore, the ability to sustain attention to a goal-directed action, recall a pre-race strategy from working memory (updating), resist self-generated and environmental distractions (inhibition) and adjust a pacing strategy according to opponents' behaviour (shifting) are executive functions that support the self-regulatory process involved in pacing [108]. Taking into consideration the importance that has been recently given to executive functions in pacing, there is a lot of scope for future research in this area. As exercise impacts on cerebral hemodynamics (blood flow) and brain networks that related to executive functions [121-123], non-invasive methods like functional magnetic resonance imaging (fMRI) and near-infrared spectroscopy (NIRS) could help us better understand the brain activity differences during an exercise bout of athletes of different developmental ages and to examine the impact of opponents and opponents' behaviour on athletes' brain activation.

Intellectual Impairment, pacing and sports performance

Pacing-specific limitations

In order to examine the impact of II on pacing behaviour, a critical objective of this review is to explore the cognitive deficits of individuals with II that relate to pacing. A diagnostic component of II is that the individual has significantly impaired intellectual capacities as identified by a total IQ score two standard deviations below the average (IQ ≤ 75) [11]. This means that an athlete may have impaired cognitive abilities including problem solving, reasoning, planning, judging, abstract thinking, decision making, and learning by experience [16, 17]. These complex skills are crucial for sufficient regulation of exercise intensity and so are implicated in poor pacing control [30, 124].

Individuals with II are also dealing with limitations in adaptive behaviour (social, conceptual, and practical skills) [11], and significant indices of adaptive behaviour are robustly correlated with self-regulation [125]. Poor self-regulation has been shown to negatively impact on daily life and learning new skills, especially for people with II [126] and also on pacing [29]. Goal determination, problem solving, self-management, and adaptability are some of the strategies to effectively self-regulate, but Agran [127] and Whitman [128, 129] demonstrated a generalised shortfall of these self-regulation strategies in a sample of people with II.

Furthermore, Moreno and Saldana [130] highlight the importance of self-regulation in limitations of individuals with II. Van Biesen et al [15], via the Generic Cognitive Test Battery (GCTB), assessed cognitive abilities and cognitive functions relevant to sports went one step further and demonstrated reduced skills, like proactive cognitive control (goal-oriented processing of information, anticipatory regulation) and attention, which impact upon pacing in elite athletes with II. Previous research has also demonstrated differences in executive functioning in individuals with II [131-133]. More specifically, visuospatial difficulties [131], inhibition and limited strategies for sustaining attention [132] have been observed in people with II.

Intellectual Impairment and pacing

Micklewright et al [98] and Lambrick et al [103] have confirmed that pacing is influenced by cognitive development. However, they focused only on different cognitive development stages of children without II. Many aspects of pacing ability of individuals with II are still unknown, as there are only a couple of studies [34, 35] that investigated the regulation of exercise intensity in this population. The first study [35] included elite runners with and without II (equally well-trained), and the aim was to investigate a core element of pacing behaviour, the ability to maintain a pre-planned sub-maximal velocity. The results revealed that athletes with II have the tendency to deviate more from the targeted pace than athletes without II, especially when coach feedback was not provided. Additionally, this group was not able to maintain its pacing without auditory feedback and athletes with II encountered difficulties to perform at an externally imposed pace. The findings of this study strengthen the assumption that intellectual functioning is involved in pacing.

In the second study Van Biesen et al [34] analysed the pacing profiles of 400 m and 1500 m runners with and without II during competitive track races. Significant differences in pacing profiles, especially during the first half of the trials, were observed between the two groups with runners with II regulating their exercise intensity differently and with greater variance compared to runners without II in both 400- and 1500-m races. The results support the supposition that individuals with II are less able to regulate their exercise intensity compared to individuals without II. This is an important finding as it suggests that athletes with II might find it harder to run to a tactical strategy and may not be able to respond to an opponents' affordances (decision-making) as effectively, suggesting that limited cognitive resources may constrain the successful integration of appropriate pacing behaviour during competitive races.

Pacing and classification of Paralympics athletes

The International Paralympic Committee (IPC) has adopted an evidence-based approach to classification [5], which classifies participants according to the impact of their impairment on sport performance and requires all Paralympic athletes to be classified through this approach. Classification of athletes with II occurs after primary eligibility has been determined (athletes meet the diagnostic criteria of II) and it is sports specific, as the impact of impairment on sports performance needs to be established [134]. Initially, the GCTB that assesses the cognitive abilities which are critical in sports [15] is used, and it is common for all athletes. Hereafter, a sport specific 'minimum impairment' criterion has to be established, in order to demonstrate that the severity of the impairment is significant enough to require Paralympic inclusion [134]. Lastly, the observation of athletes with II in competition is the fourth and the final step of the classification process [134]. Efforts are currently underway to provide a conceptual approach to classification of athletes with II in Paralympics [135].

The impaired cognitive abilities of athletes with II are implicated in poorer athletic performance and as such, form part of the Paralympic approach to classification of athletes with II [40]. At the same time, pacing specific limitations may lead athletes with II to impaired sports performance. Sports-specific cognitive abilities like attentional control and executive functioning that are evaluated in the first part of the classification procedure using the GCTB [15], are crucial in pacing performance and impaired in people with II [108]. More specifically, the GCTB evaluates cognitive skills which have a general application across most sports and impacts on the execution of complex skills such as pacing in running events [134]. At the third stage of the evidence-based classification athletes are asked to perform a sport-specific test, in which the key determinants of sport performance are assessed. For example, in running events, athletes with II are asked to perform a pacing test [134]. Van Biesen et al [34, 35] research findings indicate that runners with II are less capable to regulate their exercise intensity over the race compared to runners without II and mainly, the inability of athletes with II to keep a steady pace over a race and led the decision to reinclude athletics in the Paralympic Games as well as to establish pacing as a critical skill to demonstrate the impact of II [134].

Discussion and future directions

There is a growing body of literature that highlights the important role of cognition in pacing and reveals pacing factors which depend on intellectual capacity [28, 29, 34, 35, 98, 103]. Metacognitive skills like the ability to use previous experiences, plan in advance, keep track of the actions during the performance, and evaluate this performance afterwards, are strongly connected with pacing [29]. Additional cognitive abilities relevant to pacing and performance are the capability to correctly judge and react (decision-making) to the actions of your opponent [95] and the ability to keep conscious attention focused on the performance [108]. All these factors are linked to the cognitive capacity of participants and having an II could have a deleterious impact on pacing behaviour and sport performance. However, further research is needed to explore the cognitive skills that are relevant to the complex behaviour of pacing. For instance, research should directly investigate the impact of executive functions on pacing behaviour and explore the difference of those skills between athletes with and without II and between athletes with II in different developmental stages (adolescents and adults). An interesting research approach could be the administration of executive function tests and the application of the functional magnetic resonance imaging (fMRI) method in athletes with II during an exercise bout (e.g., running). The executive function tests will assess concepts which are critical in pacing like the mental flexibility, inhibitory control and working memory of athletes with and without II [108] and fMRI will detect activations of the brain networks that are related to these executive functions [121-123].

Moreover, as the athlete-environment interaction is a critical cognitive component of pacing [30, 74], the impact of affordances [71, 72] on pacing behaviour of athletes with II needs more attention. Due to deficits in executive functions (cognitive flexibility) [15] and adaptive behaviour [11], opponents could influence the decision making of athletes with II and lead them in a greater deviation from the theoretically optimal pacing strategy compared to non-II athletes. More research is needed to unravel how athletes with II react to opponent’s presence as well as opponents’ different pacing behaviours (positive, negative, and even pacing strategy) during competition and to explore the impact of opponents on sports performance of athletes with II.

It is clear that the research so far has only started to unravel the complex pathways between cognition, pacing, and performance. For instance, a couple of studies investigated the pacing ability of athletes with II in the discipline of running [34, 35]. However, running is considered a ‘closed skill’ (relatively stable, predictable, and controlled environment) that requires a limited set of cognitive skills to be executed [118]. For this reason, it could be beneficial to expand our research to more ‘open’ skills’ activities which require a wider range of cognitive skills [118] like team sports. Even if there is a growing interest of pacing in team sports in general [47, 59, 60], the regulation of exercise intensity in team sports for people with II also needs attention. Currently work is ongoing in order to investigate the differences on pacing behaviour and performance between basketball players with and without II [36]. More specifically, Khudair et al [36] coded four movement categories that represent different levels of intensity: jumping, standing, walking, and running [136]. This approach is easily applicable in various team sports (e.g., football, handball, and volleyball) and could shed some light on the pacing differences between II and non-II team players.

This literature review has also illuminated connections of pacing with the cognitive and sport specific skills tested within the Paralympic classification procedure for athletes with II. As pacing is a considerable factor of sport excellence in many sports, like cross-country skiing, cycling, swimming, and speed skating [50, 51, 137], sport-specific pacing tests, such as those available in athletics [35], could be a crucial step for the development of an evidenced-based classification system for these sports. For example, the investigation of the ability of athletes with II to maintain a sub-maximal velocity (a core element of pacing) during a 5 km Nordic skiing cross-country trial, could be the first step to develop a specific classification system in Nordic skiing according to the guidelines of the International Paralympic Committee. More specifically, the comparison of pacing ability between skiers with and without II could reveal the impact of II on pacing and sports performance in Nordic skiing settings.

In the past few years, there is a growing interest in research of team sports for people with II and various studies have tried to identify how II impacts on basketball performance [138-140]. This is a critical step to develop an evidence-based eligibility system for II-basketball according to the guidelines of the IPC. However, as pacing is a critical component of sports performance in team sports [47, 59, 60], it could be also rewarding to investigate the importance of pacing in the II evidence-based classification process of sports like basketball and football with a purpose to enable the process of inclusion of these sports in Paralympics in the future. For instance, different team game-based scenarios could significantly influence the pacing behaviour of players with II and affect their sports performance. Due to cognitive limitations, it is expected the match status manipulation (winning/losing) and task duration knowledge to significantly affect the pacing behaviour of players with II in team game-based activities. On the other hand, it is already known that match status manipulation did not influence the pacing activity profile of players without II when the players were aware of the exercise task duration [47].

Additionally, as sport-specific skills in the classification system should be resistant to training, it would be beneficial to investigate the abilities of individuals with II to train and improve their pacing behaviour. For instance, the examination of pacing behaviour differences between trained and novice athletes (individual sports) or players (team sports) with II will help researchers to better understand this issue. If research demonstrated the ability of athletes with II to train and improve the maintenance of a pre-planned sub-maximal velocity, the use of pacing tests in evidence-based classification might need to be revisited. Progressing all the directions above will provide a clearer picture of the impact of cognition in pacing and could contribute to introducing elite athletes with II into further Paralympic sports, as they will enrich the strategies to achieve evidence-based classification for athletes with II.

The findings of this study revealed how critical is to further explore the pacing behaviour of people with II, how cognition impacts on sports behaviour and performance, and how people with and without II pace themselves during a sports activity.

Conclusion

This review provided a broader understanding of the cognitive basis of pacing, by bringing together concepts like decision making, self-regulation and executive functions, indicating that the role of those cognitive skills contributes significantly to adequate pacing behaviour. It has set out the case as to why II may impact on the pacing skills of these athletes and result in lower sports performance. It also illustrated how pacing ability can be an important component of an evidence-based classification system. However, further research is required to clarify the impact of II on pacing and sports performance, and if this is a training resistant factor. More research is needed to fully uncover the impact of cognitive mechanisms on regulation of exercise intensity and to establish pacing as a reliable eligibility component in various Paralympic sports for athletes with II. Thus, this review also proposed future research directions that could shed more light on the different cognitive components of pacing.

Chapter 2: Ball possessions and game rhythm in basketball games involving players with and without Intellectual Impairments

This work has been submitted:

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Abstract

Ball possessions and game rhythm are promising variables to better understand teams' collective behaviour during a basketball game. However, the role of these variables is not-well documented in teams with Intellectual Impairments (II). This study aimed to explore ball possessions and game rhythm differences between II and non-II basketball games. Data were obtained through video observations (53 II games) and FIBA records (53 non-II games). Independent t-tests ($p \leq .05$) revealed that the number of ball possessions was higher and game rhythm was faster in II games. Two-way repeated measures ANOVA ($p \leq .05$) showed that ball possessions and game rhythm developed differently throughout the II games compared to non-II games. The differences may be due to the decision-making, tactical and self-regulatory limitations, of players with II, as these limitations adequately explain why players with II respond differently to the environmental cues and monitor their actions insufficiently compared to players without II. Additionally, the higher number of ball possessions and the faster game rhythm in II games could be an indicator of more intuitive, and thus faster, game-related decision-making. In conclusion, the study provides further understanding of the role of cognition in basketball and contributes to better explain the differences between an II and non-II game.

Keywords: decision-making; self-regulation; team-sports; pacing; Intellectual Disabilities

Introduction

In an effort to shed some light on how Intellectual Impairments (II) impact on basketball performance and to develop evidence-based classification relevant to Paralympic Sports [5], there has been a growing interest in research of basketball for people with II [139, 141]. Individuals with II experience critical limitations in intellectual functioning (IQ $\leq$ 75) and in adaptive behaviour, which manifest themselves before the age of 18 [11]. Moreover, this population is dealing with sports-specific cognitive limitations, which impact on their performance [15].

In basketball settings, ball possession is defined as the time a basketball team gains possession of the ball until it scores, commits a violation, or loses the ball [142] while game rhythm can be expressed based on the average ball possessions of the two opponent teams [63, 64]. The relationship between ball possessions and game rhythm is complementary. Ball possessions provide information about each team's collective behaviour (team variable) and is an influential factor of basketball performance [143]. On the other hand, game rhythm takes into consideration both teams' collective behaviour and interaction within a game (game variable), but it doesn't directly influence performance [63, 64, 142]. In this collective environment, athletes have to work together, take appropriate decisions, and adequately regulate their actions [144]. However, collective behaviours, decision-making, and self-regulation are impaired in people with II [15, 36, 141]. This could lead basketball players with II to pace their actions and respond to the environmental cues differently within a basketball game compared to players without II [36, 37, 145, 146]. However more research is needed, as there is a lack of evidence on the influence of II on basketball's ball possessions and game rhythm. To our knowledge, only the study of Pinilla et al [146] investigated ball possession differences between teams with and without II, and the results revealed that ball possessions are higher in games of basketball teams with II. It is worth mentioning though that this study did not take into consideration the game rhythm variable nor the ball possessions as an influential variable of basketball performance (e.g., game outcome). It did not also investigate the ball possession and game rhythm development differences of II and non-II teams throughout the game. A more thoroughly investigation will provide a better understanding of the role of II in basketball and will shed more light on the basketball performance differences between II and non-II teams.

Thus, with a purpose to shed some light on the basketball team performance differences between II and non-II games, the current study aims to explore the influence of ball possessions on games' outcome (II and non-II games) and to better understand how ball possessions and game rhythm develop over the course of a basketball game in both populations. We hypothesise that: 1) winning teams will demonstrate less ball possessions than the losing teams in II games and non-II games, and 2) II games will have a significantly faster game rhythm and will demonstrate more ball possessions compared to non-II games. It is also expected that 3), ball possessions and game rhythm will be distributed differently within the game between II and non-II basketball games (per quarter). Through the comprehension of how II impacts on basketball variables, we will be able to gain a better insight into the role of cognition in basketball-specific decision making and performance and offer inclusive sports environments to basketball players with and without II [147].

Methodology

Sample and Procedures

Ball possessions can be calculated using the following equation: ball possessions = (field goals attempted) - (offensive rebounds) + (turnovers) - 0.4 × (free throws attempted) [142]. Additionally, game rhythm can be expressed based on the average ball possessions of the two opponent teams [63, 64]. Thus, game related statistics data (field goals attempted, offensive rebounds, turnovers, and free throws attempted) were collected and ball possessions and game rhythm data were calculated based on the above equations [64, 142].

The game-related statistics data were obtained for II games through video observations from the VIRTUS Games (5x5) in Ankara, Turkey (2013), Guayaquil, Ecuador (2015), Loano, Italy (2017), and Brisbane, Australia (2019), as the four last top international competitions for II basketball worldwide. Teams that participated in VIRTUS games are consisted of basketball players with II and played 53 games in total (22 teams, 223 players), as VIRTUS is the international organization for sport for people with II. Basketball players with II met the criteria for diagnosis of II as set by the AAIDD: Intellectual functioning impairment (IQ ≤ 75), adapted behaviour limitations, and evidence of the impairment during the developmental period of individual (before the age of 18). All players fulfilled the AAIDD criteria thus, were eligible to participate in VIRTUS competitions [11]. Additionally, game related statistics data (field goals attempted, offensive rebounds, turnovers, and free throws attempted) were collected through open-access official FIBA play-by-play records for the FIBA U18 European Championships (non-II games) in Samsun, Turkey (2016), Bratislava, Slovakia (2017), Liepaja, Riga and Ventspils, Latvia (2018), and Volos, Greece (2019) and ball possessions and game rhythm data were calculated. The researchers obtained ball possessions and game rhythm data from 53 games in total (31 teams, 372 players). We chose U18, non-II teams as they are more comparable in terms of training volume, training age and sports-specific cognitive abilities with II teams than adult non-II teams [146]. Additionally, even if previous studies showed that there are basketball-performance differences between II teams and U16 non-II teams [138, 146], the comparison with U18, non-II teams may offer less variability in the analysis [146]. This study was based on secondary data (already collected data from another institution and/or data that were available online). Ethics approval was not required, but the authors ensured that the data were de-identified, participants' consent reasonably presumed, and the use of these data did not cause any damage or distress. All data were gathered by one researcher (KES). Two weeks later, the researcher (KES) randomly selected two games per competition to test the intra-rater reliability.

Additionally, with a purpose to explore the inter-rater reliability, the data from eight random games were gathered from different observers and compared with the researcher's data. The results showed excellent intra-rater and inter-rated reliability (kappa above .88) for all the ball possession data [148, 149].

Statistical Analysis

In an effort to test our first (winning teams will demonstrate less ball possessions than the losing teams in II and non-II games) and second hypothesis (II-games will have more ball possessions and will demonstrate a significantly faster game rhythm compared to non-II games), independent t-tests were used. Moreover, with a purpose to investigate our third assumption that ball possessions and game rhythm will be distributed differently within the game for basketball teams with and without II, a two-way repeated measures ANOVA was used (two analyses). Quarters of the game were considered as the within-subjects factor while the type of population as the between-subjects' factor. A Bonferroni correction test was also used to determine significant group differences if the two-way repeated measures ANOVA yielded any significant results. When the assumption of sphericity was violated (according to Mauchly's test of Sphericity), the Greenhouse Geisser correction was applied to interpret the results. Partial Eta squared (η^2) was also calculated with the following values interpretation: small = 0.01, medium = 0.06 and large = 0.14 [150]. The statistical analysis was performed on SPSS v.26.0 and the level of significance was set at $p \leq .05$. Prior the data analysis, a log scaling normalization technique was used.

Results

The first two independent t-tests showed that there are not significant ball possession differences between the winning (M = 1.82, SD = .06) and losing condition (M = 1.83, SD = .08) in II games $t(104) = -1.15$, p = .25, neither a significant difference between the winning (M = 1.16, SD = .05) and losing condition (M = 1.17, SD = .05) in non-II games $t(104) = -1.25$, p = .21. Moreover, the other two independent t-tests showed that II games have significant higher number of ball possessions, $t(210) = 6.47$, $p < .001$, and a significant faster game rhythm, $t(104) = 5.32$, $p < .001$, compared to non-II games. For the descriptive data, please see Table 1.

Table 1

Descriptive statistics of ball possessions and game rhythm variables over different time periods of the games for a) II teams and b) non-II teams.

Variable	Source	Game Rhythm	*N*	*Min.*	*Max.*	*M*	*SD*
Ball possessions							
	II teams	1st Quarter	106	1.03	1.43	1.23	.09
		2nd Quarter	106	.87	1.49	1.21	.11
		3rd Quarter	106	.81	1.43	1.20	.11
		4th Quarter	106	.98	1.46	1.22	.09
		1st Half	106	1.33	1.75	1.52	.08
		2nd Half	106	1.27	1.70	1.52	.08
		Whole Game	106	1.61	2.03	1.82	.07
	Non-II teams	1st Quarter	106	.94	1.35	1.17	.09
		2nd Quarter	106	.85	1.37	1.17	.10
		3rd Quarter	106	.88	1.33	1.16	.09
		4th Quarter	106	.53	1.36	1.11	.12
		1st Half	106	1.27	1.63	1.48	.06
		2nd Half	106	1.15	1.61	1.45	.08
		Whole Game	106	1.58	1.89	1.76	.05
Game rhythm							
	II teams	1st Quarter	53	1.10	1.41	1.23	.07
		2nd Quarter	53	1.04	1.45	1.22	.09
		3rd Quarter	53	.89	1.42	1.20	.09
		4th Quarter	53	1.02	1.42	1.23	.08
		1st Half	53	1.39	1.70	1.52	.07
		2nd Half	53	1.28	1.66	1.52	.07
		Whole Game	53	1.67	1.94	1.82	.06

Non-II teams	1st Quarter	53	1.05	1.31	1.18	.06
	2nd Quarter	53	.97	1.32	1.17	.07
	3rd Quarter	53	1.01	1.27	1.17	.06
	4th Quarter	53	.81	1.29	1.12	.09
	1st Half	53	1.37	1.59	1.48	.04
	2nd Half	53	1.26	1.56	1.45	.05
	Whole Game	53	1.65	1.85	1.77	.04

Note. *N* = number of items (game rhythm expressed by ball possessions). *Min*. = minimum value. *Max* = maximum value. *M* = mean. *SD* = standard deviation.

The results of the two-way repeated measures ANOVA confirmed that there are significant ball possessions differences between the groups (II and non-II games; interaction effect), $F(2.87, 604.27) = 6.88$, $p < .001$, $\eta^2 = .03$ and significant game rhythm differences between the groups (II and non-II games; interaction effect), $F(2.81, 292.39) = 5.71$, $p = .00$, $\eta^2 = .05$. Pairwise comparisons revealed significant ball possessions differences between the groups at each quarter of the trial ($p < .001$ for first and fourth quarter and $p < .05$ for the second and the third quarter). Pairwise comparisons also showed significant game rhythm differences between the groups at each quarter of the trial ($p < .001$ for first and fourth quarter and $p < .05$ for the second and the third quarter).

A further analysis revealed statistically significant ball possessions differences within the non-II games, $F(2{,}85, 300.22) = 8.10$, $p < .001$, $\eta^2 = .06$, but non-significant ball possessions differences within the II games, $F(2.84, 298{,}97) = 2.64$, $p = .05$, $\eta^2 = .02$. Post-hoc test using the Bonferroni correction revealed that non-II games are dealing with significant ball possessions differences between the first and the fourth quarter ($p < .001$), the second and the fourth quarter ($p = .00$), and between the third and the fourth quarter ($p = .00$). Specifically for the game rhythm, the analysis found that statistically significant game rhythm differences within the non-II games, $F(2.72, 141.60) = 7.72$, $p < .001$, $\eta^2 = .12$, but non-statistically significant game rhythm differences within the II games, $F(2.70, 140.86) = 2.00$, $p = .12$, $\eta^2 = .03$. Post-hoc test using the Bonferroni correction revealed that non-II games are dealing with significant game rhythm differences between the first and the fourth quarter ($p < .001$), the second and the fourth quarter ($p = .01$), and between the third and the fourth quarter ($p = .01$). For the ball possessions and game rhythm fluctuations of II and non-II games, please see Figure 1.

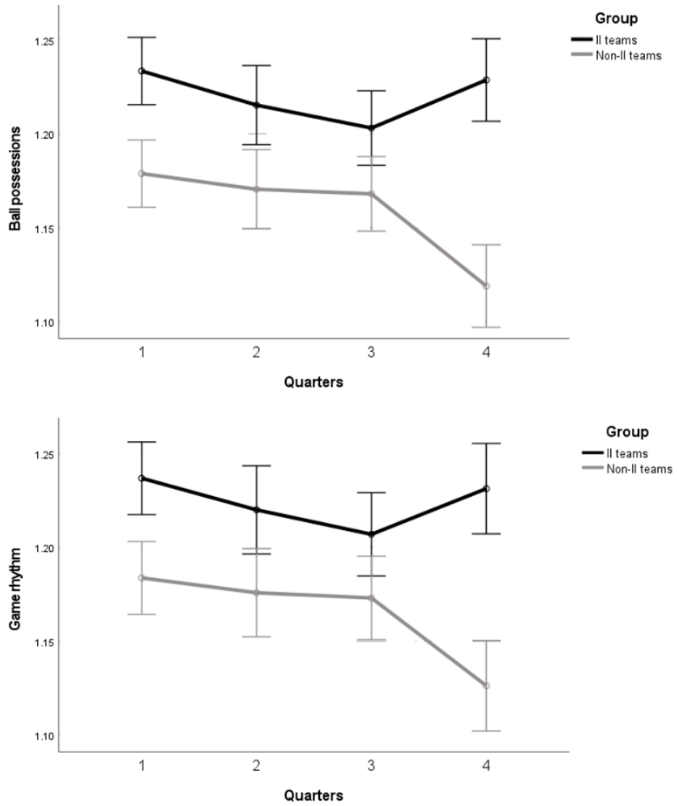

Figure 1. Ball possessions (Figure 1a) and game rhythm differences (with the 95% confidence interval error bars) within (and between) the game (Figure 1b) of II and non-II games.

Discussion

This study aimed to shed light on the basketball variables differences between II and non-II games. The results did not confirm our first hypothesis, indicating that ball possessions did not influence the game outcome in II and non-II games. Our second hypothesis was supported, as II basketball games demonstrate significantly more ball possessions and faster game rhythm compared to non-II games. The results also supported our third hypothesis, that ball possessions and game rhythm were distributed differently within II and non-II basketball games, with only non-II games to demonstrate significant ball possessions and game rhythm differences across the four quarters of the games. This study was the first one that thoroughly demonstrated ball possessions and game rhythm differences in different time periods of a basketball game between the two populations. These differences could occur due to the game intelligence deficits of individuals with II [40]. Game intelligence is a critical component of a player's performance and can be expressed by two related attributes: decision-making and tactical skills [151]. Decision making in sports is a complex and dynamic process where players choose, modify, and evaluate their behaviour based on numerous action invitations (affordances) that the environment offers (e.g., opponents and teammates) [152]. Tactical skills related to decision-making and are dealing with how players should perform the correct actions at the right moment [153]. Both decision-making and tactical skills are critical in basketball [146] but seem deteriorated in individuals with II [41, 139]. Previous studies revealed that basketball players with II make slower (and less) accurate decisions compared to basketball players without II with similar training volume and experience [139, 146]. Moreover, coaches and referees report that basketball players with II are dealing with significant offensive and defensive tactical limitations [141]. Decision making and tactical limitations could lead basketball players with II to plan differently their actions (deliberate actions) [139], respond differently to the environmental cues (intuitive actions) [36, 139], adopt fewer collective behaviours, make quicker offensive decisions, and attempt more field shots during the game [146] compared to basketball players without II, facts that could explain the ball possessions and the game rhythm differences between the II and non-II games. Moreover, the higher number of ball possessions, the faster game rhythm, and the slower decision-making ability of players with II compared to players without II [140] could indicate that the basketball games of II-teams are based more on intuitive than deliberate decision-making [36]. Thus, the behaviour of athletes in this constantly changing environment significantly depends on various perceptual affordances (e.g., opponents) that invite players to adapt and continuously alter their pace and their actions

[74, 152]. The fast pace of II teams though, could lead their players to commit more turnovers, while their quicker offensive decisions may lead them to low shooting percentages [154].

The ball possession and game rhythm differences might also have been occurred due to self-regulatory deficits that players with II are dealing with [145, 155]. This could be important in sports environments where collective actions are required, as the implementation of self-regulatory strategies improves the team performance and the cooperation within the team [156]. During a basketball game, players within a team need to pay attention to their actions and exert self-control in order to perform sufficiently and reach their goals [32]. Inadequate attention skill is a common characteristic of players with II that alters and deteriorates their performance [15] and impacts their ability to self-monitor their actions and maintain on-task behaviours [157]. Moreover, the low levels of inhibition [132], the impulse behaviours of individuals with II, and their lack of strategies to maintain self-control [158] could justify the different ball possessions and game rhythm distribution within the game between teams with and without II. The shortfalls of individuals with II in problem solving, reasoning, judging, and shifting between tasks [15], could significantly affect the behaviour of players with II against their opponents and force them to respond differently compared to individuals without II, an assumption that provides an additional explanation of the ball possessions and game rhythm distribution differences within the game between the two populations.

Based on all the above, it would be interesting to highlight that the number of ball possessions could be characterized as a representation of a team's collective activity throughout a basketball game that depends on the on court-players' actions and could be affected by their decision-making, tactical proficiency, and self-regulatory skills. Thus, ball possessions could be interpreted as an aspect of pacing, the decision-making and self-regulatory ability of people to distribute effort across an exercise task [29, 30]. In athletic competitions (like running), pacing is usually expressed by the velocity or the power output of the athlete during the trial [28]. Basketball though, requires a broader range of cognitive skills [118] and demands from players to react appropriately in a dynamically changing and unpredictable environment [159]. To our knowledge, there is only one research study that also tried to shed some light on the pacing ability of basketball players with II and investigated the pacing differences between players with and without II [36]. It is interesting to mention though, that the study came to different findings, probably due to the different methodologies and the different approach to pacing that they used. More specifically, Khudair et al [36] focused on the individuals' actions of the players and coded pacing in different movement categories and used time-motion analysis to investigate the pacing behaviour differences between basketball players with and without II. The findings indicated that the pacing behaviour of the two groups were similar, while players with II demonstrated a lower frequency and duration in high intensity activities than players without II [36]. This approach though, is completely different to our methodology, in which we took into consideration ball possessions, an aspect of pacing that depends on the teams' collective actions [142]. Thus, these two studies together provide a broader representation of pacing, suggest that decision-making related to individual and collective actions could differ, confirm the complexity of pacing in this specific sport and indicate the necessity to investigate the concept of pacing in team sports from different perspectives.

The International Paralympic Committee (IPC) is using an evidence-based approach to determine which athletes are eligible to compete in a Paralympic sport and how athletes are classified for competition [5]. At present, the classification of athletes with II is an individual process, where the impact of their II on sports performance needs to be determined [5]. By taking into consideration the difficulties to develop an evidence-based classification for II team sports [140, 141, 146] and the importance of collective behaviour in team sports [160], the investigation of team performance variables could be an additional classification stage that facilitates the process. Ball possessions is a team performance variable which are related to players' collective behaviour [63, 64, 144] and significantly differ between basketball teams with and without II. Thus, this variable could demonstrate the impact of II in the classification procedure and help re-include teams with II in Paralympics, but further investigation is needed to explore the impact of ball possessions in basketball performance.

Limitations and future studies

This study also presented some limitations that need to be addressed. More specifically, it justified the ball possessions and game rhythm differences between II and non-II games based on the decision making and self-regulatory skills deficits of individuals with II [34, 145]. However, it only indirectly explored how and to what extent these skills could affect the frequency of ball possessions and game rhythm of basketball teams with and without II. Thus, we consider necessary future research to investigate, through valid measurements, the impact of cognitive skills on basketball performance (e.g., game outcome), pacing, and game rhythm of basketball players with and without II. This approach will provide a clearer picture of the role of II in basketball. Additionally, as we mentioned before, this study did not thoroughly take into consideration the role of ball possessions and game rhythm in basketball performance. Future studies that want to focus on the ball possessions differences between winning and losing teams they should consider if the ball possessions variable could be a predictor of game related statistics. Another limitation is that we did not address if and how opponents could affect the game-related statistics (e.g., turnovers) and the ball possessions of a team. Additionally, this study did not take into consideration the impact of training and experience on tactical decision-making process during a ball possession. For this reason, time motion analysis looking at the reactions to the spatial configuration of elite and novice basketball teams could be a good starting point for discussion and further research. Future research should also make a comparison of game-related statistics in different game rhythm intensities to provide a better justification of the importance of a game rhythm in basketball performance of teams with and without II. Last, it is important to explore more thoroughly the complex and cognitive demanding concept of pacing in basketball settings, with a purpose to shed more light on the role of pacing in basketball performance. Pacing could be also investigated through global positioning system units and the average speed displacements of the basketball players, in a similar methodology that Ferraz et al (2018) used in football. To take a step further, an exploration of pacing differences between teams with and without II through this method and a comparison between the suggested study, our study and Khudair et al [36] study, could provide a clearer picture of pacing, and the pacing differences between teams with and without II.

Thus, due to the cognitive and pacing and pacing deficits of people with II, there is a necessity to develop a theoretical framework that could facilitate and support the pacing behaviour and development of people with potential implications to people with II.

Conclusion

In summary, this paper highlighted the impact of cognitive differences between players with and without II by arguing that II games demonstrate more ball possessions and faster game rhythm compared to non-II games and the frequency of ball possessions and game rhythm develops differently throughout II and non-II games. These results might have emerged due to the decision-making, tactical proficiency, and self-regulation deficits of individuals with II and could indicate also that II games might be associated with more intuitive than deliberate decisions. Additionally, this paper sheds light on how teams distribute their energy during an exercise bout, and how principles related to pacing are relevant in a team sport such as basketball. In conclusion, the study is taking a step further to understand the impact of cognition on basketball performance and provide valuable information to people of interest who wish to offer inclusive sports environments.

Chapter 3: The role of social environment on pacing and sports performance: a narrative review from a self-regulatory perspective

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Abstract

As proposed by Triplett in 1898 and evidenced by a recent series of lab and field studies, racing against other competitors consistently results in increased performance compared to when racing alone. To explain this phenomenon, we will explore the process of self-regulation, a process relevant to pacing which is linked to athletes' emotions and facilitates their sports performance optimisation. We will apply the cyclical model of Self-regulation of Learning to pacing and sports performance settings and explore the role of the social environment (in particular opponents, but also coaches) in each phase of the self-regulatory model. It seems that the social environment could be considered as a significant self-regulatory and sports performance facilitator. More specifically, athletes can focus on their social environment (opponents) when they have to set goals and select appropriate strategies to achieve them (forethought phase), monitor and manage their actions and their emotions (performance phase), and make self-judgements and choose self-reactions (self-reflection). Moreover, the social environment (coaches) can observe, step in, and facilitate these intricate processes. These findings could guide athletes and their coaches towards more effective pacing acquisition and development, and better sports performance, which could be of particular relevance for youth athletes or athletes with disabilities impacting on their self-regulatory skills.

Keywords: metacognition, self-control, motivation, coaches, opponents, athletes

Introduction

Pacing has been described as a goal-directed process of decision making in which athletes decide when and how to distribute their limited energy resources throughout an exercise task [28, 30]. Adequate pacing behaviour is critical in sports as it facilitates optimal performance [49, 87]. In sports settings, numerous lab and field studies consistently revealed that the social environment is an influential factor in athletes' pacing and performance [58, 74, 104, 161-164], as first observed by Triplett [165]. In head-to-head sports such as cycling, running, and speed skating, opponents can act as social placebos, inviting changes in athletes' pacing behaviour [58, 74, 162] impacting positively on performance [117, 163, 166], while their rate of perceived exertion remains the same [167]. According to the ecological perspective, this occurs because opponents act as social affordances (invitations for actions), providing the athlete with additional performance feedback and therefore influencing their decision-making [30, 74, 167]. This suggests that when coaches and athletes use the environment and its opportunities to provide performance feedback smartly, this could enhance training as well as competitive performance. To understand how this can be done, we will explore pacing and racing against opponents from a self-regulatory perspective, in which learning from previous feedback is a central component. This approach will also allow us to incorporate the role of emotions in competition.

The pacing behaviour of athletes can be characterised as a self-regulatory process of energy regulation [29]. To be more specific, self-regulation commonly refers to cognitive and behavioural processes that facilitate behaviour adaptation. It is essential to a person's functioning and an early marker of life success [168]. Central to self-regulation is the learning process, as proposed by the framework of Self-Regulation of Learning (SRL), whereby individuals are responsible for their own learning. In this learning process, individuals have to acquire and adapt self-regulatory skills to overcome challenges and attain behaviour goals [169]. Thus, the concept of SRL is relevant to pacing because skills like planning, monitoring, and evaluating, are thought to underpin the cyclical process of refining the performance template underpinning pacing behaviour [29]. By cycling through this process, the athletes' pacing behaviour is adapted to the task demands (e.g., task duration, biomechanics, and environmental factors) resulting in improved exercise task performance [29, 170]. The self-regulatory processes of pacing could be influenced by opponents as previous studies suggest [117, 163, 166], but this has not been explored in depth.

Indeed, the self-regulatory perspective seems to provide a promising framework for studying both the development and optimalization of pacing behaviour and performance [16]. However, the few studies that have tried to integrate the SRL framework within the pacing and sports performance settings emphasise the role of individuals' efforts in their own self-regulatory process [29, 33, 112]. It is not well documented how athletes can use their opponents as an influential factor in enhancing the self-regulatory skills which are important in pacing. This is remarkable considering influence of the social environment in developing and optimizing athletes' pacing behaviour [74, 170]. The further investigation of the relationship between self-regulatory skills, pacing, and the opponents could inform coaches about the appropriate strategies that they should follow to enhance athletes' pacing optimisation in training and competition and guide the development of athletes [29]. It could also advise athletes how to appropriately react to opponents' actions, regulate their emotions, and pace themselves. In view of the above, the purpose of this narrative review is to explore why and how we should consider the social environment in SRL in the context of pacing behaviour and sports performance.

Based on all the above, the aims of this review are: 1) to apply the cyclical model of SRL to pacing and sports performance settings and 2) to explore the role of the opponents and coaches in each phase of the self-regulatory model (forethought, performance, and self-reflection phase). This approach could provide in-depth information and novel insights with impact on further development of interventions, coaching and guidance towards pacing acquisition and development, and optimal performance. It could also inform athletes how to use their social environment to regulate their actions, emotions, and pace and perform better.

The Cyclical Model of SRL

The Cyclical Model of SRL describes the interrelation between the cognitive, metacognitive, and motivational mechanisms in three self-regulatory phases: forethought, performance, and self-reflection [169]. The forethought phase consists of task analysis and self-motivation processes [169]. Task analysis involves two parts: setting goals (the outcomes that an individual wants to attain) and strategic planning (choosing learning methods which are appropriate for the task). The forethought phase is influenced by different sources of self-motivation, such as outcome expectations (believed consequences of an individual's behaviour), goal orientation (reasons for engaging in specific behaviours), intrinsic interest/intrinsic motivation (the individual's liking or disliking of an activity due to intrinsic motives) and self-efficacy (individual's beliefs in their abilities to think and act towards their learning goals) [171, 172].

The performance phase follows the forethought phase and is composed of self-control and self-observation methods [169]. Individuals use a variety of strategies to attain self-control such as imagery (forming mental pictures to facilitate the learning process), help-seeking (providing assistance when an individual performs an activity) and self-consequences (setting rewards or punishments). However, these strategies need to be adapted based on the individual's learning goals. Thus, self-observation is considered a critical process that guides individual's self-control to perform an activity. Self-observation consists of two processes: self-monitoring (mental tracking of the individual's performance) and self-recording (creating records of outcomes and learning processes).

The self-reflection phase is the last of the three phases and consists of two processes: self-judgements and self-reactions [169]. Self-judgements involve comparisons of an individual's performance with a standard such as prior performance, social comparison with others, or expert mastery. Self-reactions are composed of self-satisfaction (affective and cognitive reactions to the individual's self-judgements) and adaptive/defensive decisions (individual's willingness to further engage in the learning process or not). People who decide to further engage in the learning process, plan, monitor and evaluate their actions based on the previously gathered experiences. It is worth mentioning that the Cyclical Model of SRL pays special attention to the reciprocal and dynamic interaction of the individual's behaviour and the environment (reciprocal determinism) [173]. In other words, individuals learn to self-regulate through social means such as social support, feedback, and modelling (observational learning) [169, 173]. For the cyclical model of SRL please see Figure 1.

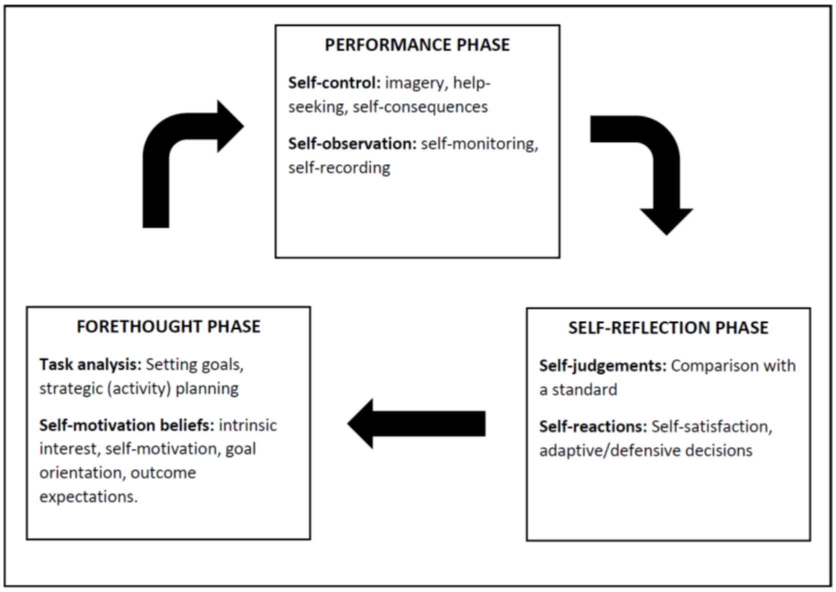

Figure 1. The Cyclical Model of SRL. Adapted from Zimmerman and Moylan [169].

The Integration of Pacing and Sports Performance within the Cyclical Model of SRL

The cyclical model of SRL [169] seems to be applicable in elite performance sports. Successful athletes have to take responsibility of their own training and learning procedures over a period of multiple years and take appropriate actions to improve their pacing behaviour and stay motivated throughout the process [29]. To gain a better understanding of the self-regulatory aspects of pacing, this study will try to integrate different performance periods within the three phases of the cyclical model of SRL, similarly to Elferink-Gemser and Hettinga [29]. More specifically, we will first examine the forethought phase of the cyclical model of SRL which is the period where individuals plan their appropriate pacing strategy in training (before competition; training period). During this phase, athletes should be able to set goals (e.g., keep a set pace for the first half of a 10 km race; pacing strategy) and plan how they will attain them (e.g., additional training sessions, twice a week) [29, 169]. Subsequently, during the performance phase, athlete compete in an event (during competition) and they try to attain self-control through imagery (e.g., runners imaging themselves to appropriately distribute their energy during the race by taking into consideration the competitors' actions), help-seeking (e.g., basketball players asking instructions from a coach to improve their ball possessions' frequency during a game) and self-consequences (e.g., setting a reward for a pacing accomplishment). More importantly, athletes monitor and self-record their effort exertion, use numerous strategies to keep themselves motivated and adapt their effort exertion to optimally reach the exercise task goal [29, 169]. Lastly, the self-reflection phase could be considered as the period after the participation of athletes in competition. After a competition, athletes judge their pacing behaviour based on specific standards (e.g., outcome of the competition, comparison with opponents or other athletes) and react accordingly [29, 169]. Based on their self-judgements, athletes decide if they will continue to engage, adapt, and improve their pacing (adaptive decisions), or they will avoid further efforts to learn and improve (defensive decisions) [174]. When the athlete decides to continue engaging, the goals are set based on the experience gathered during and after competition, restarting the cycle with the forethought phase. Thus, it is not surprising that high scores on self-reflection are associated with a higher level of performance, as elite athletes are more aware of their strengths and weaknesses in performance settings [175, 176]. Based on all the above and with a purpose to provide pacing related guidelines to the coaches, the study will try to explore the impact of opponents within these three phases.

Social Environment, Pacing, and Sports Performance within the Cyclical Model Of SRL

Forethought Phase

The social environment could be a noteworthy self-regulatory, pacing and sports performance facilitator during this phase. It offers multiple opportunities in order to guide and assist athletes to set realistic performance goals before a competition. For instance, athletes can use opponents as goal setters, as their presence and/or their pacing behaviour could influence their goal setting and motivate them to engage in a specific pacing behaviour (e.g., athletes are planning how to optimise their pacing behaviour to perform better that their opponents) [177]. Athletes who are more oriented towards wins and losses (e.g., beating an opponent) plan their pacing behaviour and performance less appropriately compared to athletes who are more focused on their personal goals [178]. For example, better competitors could lead them to adopt unrealistic and/or ineffective pacing and performance goals [177, 179], a finding that athletes and their coaches should take into consideration during the training period.

During the forethought phase, coaches have an important role in the facilitation of athletes’ goal setting and strategic planning, two self-regulatory skills which are relevant to pacing. For instance, coaches’ goals can influence the goals that athletes set for themselves [180]. Moreover, coaches who set more challenging goals (e.g., beat an elite athlete) and have higher expectations from their athletes have a positive impact on their performance [181]. It seems though, that setting of training and competition goals (short- and long-term goals) along with the coach (co-orientation) also plays an important role in improving athletes’ skills, and potentially pacing, as it keeps them motivated and focused (e.g., their common goal is the athlete to respond better to external factors like opponent during competition) [182, 183]. When coaches and athletes are setting goals (e.g., based on the pacing behaviour of their opponents), special attention should be paid to athletes’ personality. Athletes with a more internal locus of control (control over the events that influence peoples' lives) spend more time on-task when they set their own goals (self-set goals). Athletes with a more external locus of control (events which happen in peoples' lives are out of their control) spend more time on-task when coaches set their goals, and these goals could be dictated by their opponents' behaviour and/or abilities [184]. Thus, it might be more beneficial for coaches who coach athletes with external locus of control, to set their athletes' goals based on their opponents' behaviour/abilities. This mental visualisation of the goal could act as a motivational factor during the forethought (and later at the performance) phase [184].

To optimally develop and guide athletes' pacing, coaches can play a major role and help athletes to strategically plan their activities and empower them in making the right decisions at the right time, particularly in relation to energy distribution, training load distribution across a training period, and general fatigue and recovery management [185-187]. Coaches who want to facilitate the strategic planning process should give a lot of emphasis on how they can assist athletes to anticipate potential obstacles in competition (e.g., anxiety) and empower them to be prepared for future barriers (e.g., athlete has to compete against faster paced opponents) [186]. In order to engage athletes in the strategic planning process, coaches devote a lot of time to support athletes' motivational beliefs (motivation and self-efficacy, e.g., opponents can be used as external motivators), as this type of focus would lead athletes to their desired outcome [186]. These behaviours are in line with the findings of Goffena and Horn [187], where there is a relationship between autonomy-supportive coaching and athletes' strategic planning.

Performance Phase

During sports competition, athletes are constantly looking for information in order to monitor their pacing behaviour and achieve the specific performance goals that were established at the forethought phase. Their interaction with the opponents could facilitate these processes. Opponents could be characterised as the visual representation of a goal throughout the race, hereby providing direct feedback to the athletes about the progress of the competition and their own pacing behaviour and performance [77, 164, 166, 167, 188]. Thus, it is not surprising that the attention of athletes (with a purpose to monitor their actions) mainly focuses on the opponent, especially where there is a high interdependency between them [51, 166, 188-190]. For example, when athletes are experiencing a positive momentum in relation to their opponents, they are able to regulate more efficient their exercise intensity within the race compared to a negative momentum [191]. Another interesting finding is that, even if athletes performed significantly faster in head-to-head (against an opponent) compared to time trial (no opponents) cycling and running trials, athletes rated their perceived effort similarly in both conditions [164, 188]. This finding could be explained by the notion that the opponents function as an external distraction that decreases the athletes' perceived exertion. During this phase, the opponents are the visual representation of a goal throughout the race and act as a motivational factor, shift athletes' attentional strategies and influence their decision-making [113]. Thus, when athletes compete against others, they can better regulate their afferent feedback, their pain and fatigue, information that seems critical in pushing the limits of athletes' sports performance [113, 164, 188].

In addition to all the above, the presence and the perception of the opponent during competition could play a role in athletes' decision-making process and self-control ability, as the behaviour of an opponent affects the actions of an athlete and acts as a help-seeking factor [77, 80, 81, 95, 163, 192]. For instance, a faster starting opponent evoked a faster start compared to a slower starting competitor in 4-km cycling time trials [163]. Moreover, Zouhal et al [192], observed that drafting behind a runner improved the athletes' performance in a 3-km trial, even in the absence of any physiological benefits. This finding indicates that following another runner may lead athletes to engage less in the decision-making process, a situation that decreases their cognitive loading (less depleting) and facilitates a more efficient self-control of their pacing during the competitive trial.

Coaches should take into consideration the important role of opponents on pacing and performance and prepare their athletes by engaging them in various competitive activities (against an opponent/s) that provide similar constraints in decision-making [117, 163, 192]. Due to the nature of sports competition, in this phase it may be more challenging for coaches to influence athletes' behaviour and their ability to monitor their actions [161, 193-198]. However, the provision of motivational feedback and encouragement by the coach could alter athletes' activity monitoring, improve their attention, increase their objective performance, and may lead to a more appropriate pacing behaviour and improved sports performance outcome [161]. For example, external encouragement in both endurance and sprint trials resulted in improvements in athletes' performance (faster pace) but they also reported significantly higher perceived exertion levels compared to the control trials (no external encouragement) [193]. Additionally, as opponents could alter athletes' attention and improve their tolerance of fatigue [164, 188], coaches' feedback could focus more on the opponents' actions and behaviour, so they improve athletes' motivation, pacing behaviour and performance.

There is also some evidence about the role of the coaches in athletes' self-control [197-199]. For instance, Englert et al [198] demonstrated that athletes who engaged in autonomously motivated self-control performed better under pressure compared to the athletes who engaged in extrinsically motivated self-control. This finding indicates that the autonomously motivated self-control is less depleting and gives an advantage to athletes under high pressure situations [198]. Except of the autonomously exerted self-control, imagery instructions provided by the coaches (method of self-control) could guide athletes towards an external focus of attention [e.g., opponents-related instructions) [199], a finding that could have potential application in pacing. Coaches who focus on external cues (e.g., opponents) could alter athletes' decision-making, facilitate their self-control abilities, and influence athletes' drafting, positioning, and packing behaviour during a head-to-head trial [163, 192, 199].

Self-reflection Phase

In sports settings, the social environment plays a significant role in the self-judgements and self-reactions process of athletes through their comparison with opponents and their affective reactions [200-203]. At a situational level, especially in a competitive environment where direct comparison can become salient, it is not surprising that the athlete may be susceptible to judging competence, evaluating success and failure and continue engaging in the learning process (restarting the cycle with the forethought phase) based on social comparisons (e.g., outperforming an opponent due to a more efficient pacing behaviour at the beginning of the race) [200, 201]. These social comparisons could also influence athletes' affective reactions and cause athletes to experience positive or negative emotions towards their next performance [204]. The consequences of social comparison are interesting for pacing, as affective feelings are positively and/or negatively influenced by the opponents during a head-to-head trial and could alter athletes' performance [205, 206]. For instance, racing against an opponent could cause early fatigue (due to high intensity) and negatively influence athletes' affective feelings [205, 206]. Additionally, athletes experience more tension/pressure when they compete in groups compared to individual or 1vs1 race [177]. The opponents' pacing abilities could also play a role in athletes' affective responses [206]. When athletes compete against a slower opponent, their affective feelings are increasing in the final stages of a 10-km cycling trial, which may linked to increased certainty with regards to goal achievement [206]. Thus, through social comparisons opponents could play a significant role in the self-reflection phase and influence the further engagement of athletes in the pacing skills acquisition process [205, 206].

Coaches could affect athletes' self-reactions and promote their self-satisfaction (willingness to further engage in the pacing acquisition) through the facilitation of their affective reactions [207, 208]. With a purpose to regulate their affective responses, coaches could focus on their athletes' superiority over the opponent when athletes faced an inferior or equal opponent (lateral or downward comparison). In case of a superior opponent (upward comparison) though, coaches could focus on realistic expectations and pay more attention to athletes' personal improvement [209]. Furthermore, there is an emotional connection between coaches and athletes. Coaches' expressions of happiness predict athletes' positive emotions (experience happiness) and could be associated with more appropriate pacing and better performance [210]. These positive affective reactions could increase the athletes' willingness to develop their pacing based on their experiences gathered before, during and after competition, and facilitate their maintenance in a sports performance environment[207]. For an overview of the social environments' (opponents and coaches) role in pacing and performance within the three phases of the cyclical model of SRL and how the athlete can actively use the social environment please see table 1.

Table 1. Overview of the social environments' (opponents and coaches) role in pacing and performance within the three phases of the cyclical model of SRL and how the athlete can actively use the social environment.

Phases (cyclical model of SRL)	Self-regulatory skills	Opponents	Coaches	Athletes
Forethought phase	Task Analysis. Self-motivation beliefs.	Motivate athletes. Act as goal setters. Inspire athletes to plan their actions.	Motivate athletes. Set athletes' goals. Help athletes to set their own goals and make the right decisions. Assist athletes to anticipate potential obstacles.	Set goals based on their opponents. Set goals with their coaches. Plan their activities with the coaches' assistance.

Performance phase	Self-control. Self-observation.	Provide direct pacing and performance feedback. Act as external distractions. Facilitate athletes' decision-making. Improve athletes' attention. Act as help-seeking factors.	Provide motivational feedback and encouragement. Use imagery techniques. Focus on external cues (e.g., opponents).	Focus on opponents' actions. Use opponents as pacing and performance feedback facilitators. Modify their actions based on their opponents' behaviours.
Self-reflection phase	Self-judgements. Self-reactions.	Enable athletes to compare athletic performance (social comparisons). Influence athletes' affective reactions.	Provide support and feedback. Regulate athletes' affective responses based on social comparisons.	Compare themselves with their opponents. Judging competence and evaluating success and failure based on social comparisons.

Discussion

The study explains how self-regulatory skills influence pacing and sports performance. More importantly, it provides a theoretical rationale of the role of the social environment in the self-regulatory process of pacing and sports performance, expanding on the framework proposed by Elferink-Gemser and Hettinga [29]. This approach could partially predict the athletes' sports behaviour and explains why racing against competitors consistently results in increased performance compared to when racing alone [58, 74, 104, 163-165]. Thus, this study could guide athletes and coaches how to appropriately use the opponents to facilitate pacing and performance acquisition. For instance, opponents could be characterised as athletes' emotional influencers prior, during, and after the competition and alter athletes' emotions which are critical in pacing. More specifically, opponents act as an external motivational factor that influences athletes' goal setting and self-efficacy [177, 186]. They also decrease athletes' cognitive loading (less depleting) and perceived exertion, and facilitate a better regulation of their fatigue, afferent feedback, and pain during the trial [188, 195]. Lastly, opponents could cause athletes to experience positive or negative emotions after the competitive trial and influence athletes' affective feelings [205, 206]. This is important because the ability to manage physical effort demands, tolerate unpleasant sensations and experience positive emotions through competitions, could influence the further engagement of athletes in the pacing and performance skills acquisition and development process [205, 206].

The important role of self-regulatory processes in pacing and the impact of the opponents altering athletes' emotions has not been thoroughly explored in previous pacing-related theoretical frameworks. To be more specific, the ecological framework towards pacing thus far has been the only framework that included the role of opponents through paying attention to the human-environment interactions [2, 6, 8]. Opponents could act as affordances for athletes and offer numerous action possibilities that enhance their motivation to attain their goals [2]. However, the ecological framework did not further expand on learning processes, or what athletes think, feel, and experience when an opponent is present. Through applying the self-regulation framework to pacing we can now obtain a deeper understanding of their learning trajectory and the role opponents can play in this context, also allowing a role for emotions.

Practical applications

For all the aforementioned reasons, it is important for athletes to understand the important role of their competitors in head-to-head competitions. They have to realise how the opponents can influence their goal setting (opponent as a goal-setter), their ability to monitor their actions during a competitive trial (opponent as a help-seeking factor and motivational/attentional facilitator) and their self-judgements and self-reactions processes after the trial [166, 205, 206]. Within this sports settings, the social environment (e.g., coaches), could observe, step in, and facilitate these intricate processes, especially when athletes are less proficient at self-regulated learning [32]. Thus, the role of the social environment could be even more beneficial in populations such us youth athletes and/or people with Intellectual Impairments (II) who are struggling to regulate their exercise intensity during competitive events [20, 145]. Coaches should realise their crucial role in assisting athletes to develop the self-regulatory skills that a pacing and sports performance optimisation requires. It is also important for coaches to identify strategies to facilitate these processes by taking into consideration the role of opponents as well as athletes' abilities, traits, personality and needs (e.g., through social support, encouraging communication style and positive feedback in a socially safe environment) [169, 172]. For instance, at the forethought phase coaches could take into consideration opponents' abilities and assist athletes to set challenging but realistic goals [181]. Based on the opponents' profile, coaches could facilitate athletes' sports performance skills acquisition (e.g., pacing) [161]. During the performance phase, coaches' feedback and encouragement, with a purpose to alter athletes' emotional state [161], could be based on opponents' actions and behaviour (when this is appropriate). Lastly, at the self-reflection phase coaches should be aware that the opponents could positively or negatively influence athletes' affective reactions and should adapt their coaching behaviour accordingly [207]. Due to the important coach-athlete relationship in this self-regulatory framework of pacing and performance, we suggest, coach education to take into consideration the link between self-regulation, motivation and opponents in pacing and sports [48, 170]. It should also consider the coaching suggestions that we provided above and provide coaches with a methodical approach to optimise athletes' pacing behaviour and performance.

As this study was based on people without II, it is critical to further explore the sports environment of people with II. Due to the critical role of coaches, there is also a necessity to better understand the coaches' practices. Their role in people's sports motivation and participation will help us to better understand needs and issues that arise in the field and will generate rich and novel knowledge to further support people with II in sports settings. It will also facilitate the development of appropriate pacing experiments, tailored to the coaches' and athletes' needs.

Conclusion

This review provided an expanded understanding of the self-regulatory basis of pacing and sports performance behaviours, building on the previously proposed model of Elferink-Gemser and Hettinga [29]. It revealed the significance of the social environment within the three phases of the cyclical model of SRL (forethought, performance, self-reflection). More specifically, athletes can focus on their social environment (opponents) when they have to set goals and select appropriate strategies to achieve them (forethought phase), monitor and manage their actions and their emotions (performance phase), and make self-judgements and choose self-reactions (self-reflection). Coaches can facilitate these intricate processes. As the social environment is even more crucial in facilitating the self-regulatory skills acquisition and improving the pacing behaviour and sports performance of athletes who are less proficient at self-regulated learning, special attention should be paid to special populations as youth athletes and athletes with II.

Chapter 4: Coaching styles and sports motivation in athletes with and without Intellectual Impairments

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Sakalidis KE, Hettinga F, Ling F. Coaching styles and sports motivation in athletes with and without Intellectual Impairments. (under review). 2022.

Abstract

The cognitive limitations of athletes with Intellectual Impairments (II) may influence their sports behaviour and lead them to rely on coaches' support. However, it is still unclear how II may influence sports performance progression and motivation and how coaches perceive their athletes with II and coach them. Thus, this study aims to examine 1) coach's perceptions of motivation and performance progression in athletes with and without II, 2) coaching style (dis)similarities, and 3) the association between these factors. Coaches of athletes with (n = 122) and without II (n = 144) were recruited and completed three online questionnaires, analysed using a series of non-parametric analyses ($p \leq .05$). Results showed that perceived performance progression and controlled motivation were higher of athletes with II while perceived autonomous motivation was higher of athletes without II. No coaching style differences were found between the two groups. Additionally, a need-supportive coaching style negatively predicted amotivation, and a need-thwarting coaching style predicted lower autonomous motivation in athletes with II only. Overall, it seems that the coaches perceived that their athletes with II demonstrate different motivations and react dissimilarly to their coaching styles compared to athletes without II. They may also adopt different standards of sporting success for them. Due to these differences, it is important to offer appropriate training and knowledge to coaches about disability sports and the adaptations needed to effectively coach athletes with II. In summary, this paper emphasises the importance of the coach-athlete relationship and highlights the necessity to further support the sports development of people with II.

Keywords: Learning Disabilities; physical activity; self-determination theory; social environment; coaching styles; inclusion

Introduction

According to the convention of the rights of individuals with disabilities, people with Intellectual Impairments (II) have the right to participate in the sports activity of their choice [1]. Previous studies have highlighted the importance of engagement in sports for people with II [2, 3]. Sports participation can improve cardiovascular endurance, muscle strength, and motor skills [2], and it can enhance psychological well-being and cognitive skills improvements of this population [2, 3]. It can also facilitate the development of athletes' transferable skills, like the ability to follow instructions and complete independent tasks [211]. Physical fitness and sports-related skills improvements serve as mediators for increased motivation in people with II [212]. However, only a limited number of people with II regularly participate in recreational or competitive sports, compared to people without II [213]. Due to the insufficient levels of sports participation and the additional health issues, their general fitness is significantly lower compared to the average population [214, 215].

Moreover, the intellectual functioning (IQ $\leq$ 70) and adaptive behaviour deficits in people with II [10] can negatively impact on physical, physiological, psychological, and social aspects of their sports performance [16, 34, 35, 145]. For instance, skills like self-regulation, decision-making, and learning by experience which are important in sports performance and proficiency, are underdeveloped in persons with II [20, 145]. Moreover, due to the impaired reasoning and judging abilities, athletes with II could misinterpret the others' social behaviour (e.g., coaches, teammates and/or opponents) and respond differently to the environmental cues [216]. In cycling trials for example, the performance feedback that the social environment offers (e.g., coaches) cannot facilitate the ability of people with II to maintain a steady pace [217], a critical skill for optimal performance progression [58, 74].

A theoretical framework which can explain the influence of coaches' attitudes on athletes' motivation, self-regulatory behaviour, and sports performance progression, is

Self-Determination Theory (SDT) [172, 218]. SDT is a macro-theory of human motivation that makes a distinction between autonomous (e.g., individuals identify an activity as valuable or personally meaningful) and controlled motivation (e.g., individuals engage in an activity for external reasons) [172]. Autonomous motivation includes three types of motivation regulation – intrinsic regulation, integrated regulation and identified regulation. Controlled motivation includes two types of motivation regulation – introject regulation and external regulation. Both autonomous and controlled motivation direct behaviour, unlike amotivation which refers to a lack of motivation [172]. According to SDT, motivation orientation depends on the satisfaction of three psychological needs [172]. Psychological needs refer to the inherent need for competence (e.g., through mastering an activity; positive reinforcement; winning a competition), autonomy (experience of volition) and relatedness (social environment's support) [172]. These needs are critical in athletes with II as they guide their sports behaviour and facilitate their long-term engagement in sports [219]. However, the cognitive impairments (e.g., reasoning and judging), the high anxiety levels and the low self-esteem of people with II [10, 220], could negatively influence their autonomous motivation and in turn, make them progress less in sports [218].

In sports settings, coaches create a context through which their coaching style can support (need-supportive) or thwart (need-thwarting) athletes' fulfilment of psychological needs [172, 221] . On the one hand, need-supportive coaches can promote athletes' autonomous motivation (more self-determined behaviour). This type of motivation has a significant impact on athletes' long-term sports participation and performance progression, as it is associated with better learning, effort, and persistence [24, 218]. On the other hand, need-thwarting coaches can promote athletes' controlled motivation (externally regulated behaviour), which is considered less optimal as it is related to negative outcomes like burn-out and failure [24, 25, 172]. Due to the cognitive deficits of athletes with II (e.g., self-regulation and decision-making), this population tends to be more reliant on others

[222] and could subsequently lead their coaches to adopt a more need-supportive coaching style. Moreover, these cognitive deficits could lead athletes with II to judge and respond differently to their coaches' coaching styles compared to athletes without II [16, 216].

In an effort to ensure an inclusive and fair sporting system, there has been a growing emphasis on mainstreaming disability sports in recent years [8]. Mainstreaming aims to integrate disability and non-disability sports organisations and to offer a range of possible and inclusive sports and exercise opportunities to people with disabilities [223]. Athletes of all abilities and their coaches play a central role in supporting the mainstreaming development. Therefore, in order to offer appropriate inclusive sports environments to people with II, it is imperative to understand more about their sports performance progression and motivations as well as the coach-athlete relationship. Additionally, a better knowledge about the differences of the aforementioned variables between people with and without II could facilitate a smoother mainstreaming in sports and offer more exercise pathways to people with II [8]. However, as athletes with II are one of the most understudied populations in sports settings, it is not well-documented how to properly include them in sports and how to guide coaches during this process [6]. Moreover, even if it is evident that coaches could affect athletes' motivation and sports performance development, especially for athletes without II [24, 25, 217, 221], it is not yet clear the impact of the II on sports performance progression and motivation. It is still unknown also the role of coaches towards athletes with II and how this might differ compared to athletes without II. In this study, we chose to focus on coaches' reports because by exploring coaches' perceptions of their athletes' performance progression and motivation, we can better examine the relationships between these perceptions and their coaching styles. We can also explore how coaches' perceptions can promote (or restrict) the inclusion of people with II in sports [224, 225]. The researchers are aware of the lurking danger of promoting intellectual ableism when a proxy respondent is preferred over a person with II [226] thus, their future studies are trying to 'give a voice to the voiceless'. For this study however, the exploration of the athletes' motivation and progression from different perspectives will give us the opportunity to deeper explore the coach-athlete relationship in sports settings [224].

Therefore, this study is based on the theoretical framework of SDT, and it aims to examine if: 1) there are differences in sports performance progression and motivation orientations between athletes with and without II as reported and perceived by their coaches, 2) there are differences in coaching styles between coaches of athletes with and without II, and 3) coaching styles are predictors of sports performance progression and motivation orientation in athletes with and without II. We hypothesize that: 1) coaches of athletes with II perceive their athletes to have made less progression in their sports performance and have adopted more controlled types of motivation compared to athletes without II, 2) coaches of athletes with II will adopt a need-supportive coaching style, compared to coaches of athletes without II, and 3) coaching styles are predictors of sports performance progression and motivation orientation in athletes with II and that these predictors differ between the two groups (II and non-II).

Methodology

Participants

Recruitment of coaches of athletes with and without II athletes was done through sports organisations, recreational centres, and sports clubs via phone calls and e-mails (from January until May of 2021). The authors did not have access to information that could identify individual participants during or after data collection. Two hundred and sixty-six coaches with coaching experience in different sports (e.g., athletics, gymnastics, basketball, football etc.) consented to participation (45.9% coaches of athletes with II). Their average age was 41 (*SD* = 16, range 17 to 81 years old) and 58.6% of them were males (please see Table 1). We included coaches who were fluent in English, had at least one year of coaching experience, and their athletes were adolescents or adults (aged 12 or above). Coaches were asked to act as proxy respondent for a group of persons (athletes with or athletes without II) [227] and provide their overall view of their athletes' motivation, similarly to Rocchi [228]. Their athletes were categorised in the 'participation' or 'performance' stage of sports development (focus on sports skills development with experience in competitive events) [229]. Athletes with II must met the criteria for diagnosis of II as set by the BPS [10]: limitations in intellectual and adaptive functioning with an IQ ≤ 70, limitations in social, practical, and conceptual skills, and manifested before the age of 18 years old. The study was reviewed and approved by the Institutional Ethics Board.

Measures and Procedure

Coaches of athletes with and without II completed questionnaires (please see appendix A, B, and C) via an online platform (JISC). All coaches completed the 3 questionnaires overviewed below, which lasted approximately 20 minutes.

Rated Performance (Coaches' report of sports performance progression)

This instrument is completed by coaches and is used to investigate the extent to which the athletes had progressed in the (a) physical, (b) tactical, (c) technical, and (d) psychological domain over the past year [230]. These items are combined and form an intraindividual athletic performance scale (total performance progression). The scale uses a 7-point scale, ranging from 1 (strong regression) to 7 (strong progression) and showed excellent internal consistency [230]. Due to the lack of exercise and training routine during the COVID-19 outbreak, coaches were instructed to complete the questions retrospectively.

Revised Sports Motivation Scale - Perceived Player Motivation

This instrument is founded on the SDT [172] and assesses coaches' perspectives of athletes' reasons for participating in sports (e.g., 'because they feel better about themselves when they do play'; 'because people around them reward them when they do play') [228, 231]. The scale measures sports motivation according to six types of behavioural regulation - intrinsic regulation, integrated regulation, identified regulation (under the autonomous motivation subscale; 9 items), introjected regulation, external regulation (under the controlled motivation subscale; 6 items), and amotivation (3 items). The scale uses a 7-point scale, ranging from 1 (does not correspond at all) to 7 (corresponds completely). This instrument demonstrates a strong factor structure and acceptable internal consistency [228].

Interpersonal Behaviours Questionnaire - self (IBQ-self)

This questionnaire is also founded on the SDT [172] and assesses coaches' reports of their own interpersonal behaviours (IBQ-self) in sports settings [232]. The questionnaire consists of 24 items (e.g., 'when I am with my athletes, I provide valuable feedback'; 'when I am with my athletes. I pressure them to adopt certain behaviours') and six subscales - autonomy-supportive, competence-supportive, relatedness-supportive (collectively they form the need-supportive scale), and autonomy-thwarting, competence-thwarting, and relatedness-thwarting (collectively they form the need-thwarting scale). The measure uses a 7-point scale, ranging from 1 (do not agree at all) to 7 (completely agree) and showed a strong factor structure, internal consistency, and validity [232].

Statistical Analysis

Perusal of the data using Shapiro-Wilk test of normality suggests that the assumption of normality was violated. Therefore, we conducted a series of non-parametric analyses. To address aims 1 and 2 (e.g., differences in perceived total performance progression, perceived motivation orientation and coaching styles), we conducted a rank MANOVA to test if there were differences in autonomous motivation, controlled motivation, amotivation, total performance progression, need-supportive, and need-thwarting differences (six dependent variables) between the reports of coaches of athletes with and coaches of athletes without II (group; independent variable).

To address aim 3 (e.g., predictors of total performance progression and motivation orientation), we first performed two Spearman Correlation analyses to assess the relationship between the variables for each group. Variables indicating significant correlations with coaching styles were entered into a series of Additive Nonparametric Regressions (Generalized additive model), with need-supportive and need-thwarting coaching styles as independent variables. The statistical analyses were performed on *R* version 4.1.1 and the level of significance was set at $p \leq .05$.

Results

The rank MANOVA analysis showed that there were no group differences between coaches' need-supportive ($p = .53$) and need-thwarting style ($p = .41$) and no group differences between perceived athletes' amotivation ($p = .63$). Furthermore, perceived autonomous motivation was significantly lower ($p < .001$) and perceived controlled motivation was significantly higher in athletes with II compared to athletes without II ($p < .001$). Finally, perceived total performance progression of athletes with II was significantly higher compared to athletes without II ($p = .01$) (see Table 2 for the descriptive data, and Figure 1 for the univariate post-hoc comparisons between the variables).

Table 1. Participants' Demographic Information

Coaching group	*N*	Gender (Male/Female)	Age in years M(SD)	Years of coaching experience M(SD)
Athletes II	122	62/60	38(15)	11(18)
Athletes without II	144	94/50	42(16)	14(12)

Note. N = Number of coaches.

Table 2. Descriptive statistics of Need-Supportive, Need-Thwarting, Performance Progression, Autonomous Motivation, Controlled Motivation and Amotivation for athletes with and without II.

Variable	Source	*N*	*Mdn (IQR)*	*M (SD)*
Need-Supportive	II	122	68.00 (17.00)	66.02 (11.59)
	Non-II	144	71.00 (19.50)	66.36 (12.67)

Need-Thwarting	II	122	31.00 (21.00)	32.95 (12.65)
	Non-II	144	31.50 (26.50)	35.56 (16.34)
Performance Progression	II	122	22.00 (5.00)	21.19 (4.21)
	Non-II	144	21.00 (6.00)	19.82 (4.38)
Autonomous Motivation	II	122	44.00 (15.00)	43.75 (9.72)
	Non-II	144	51.00 (12.50)	49.83 (9.91)
Controlled Motivation	II	122	29.00 (8.00)	29.34 (5.93)
	Non-II	144	25.00 (7.50)	25.40 (6.08)
Amotivation	II	122	8.00 (6.00)	8.36 (4.36)
	Non-II	144	8.00 (6.50)	6.02 (11.59)

Note. *N* = number of items (coaches' reports). *Mdn* = Median, *IQR* = Interquartile Range, *M* = mean. *SD* = standard deviation.

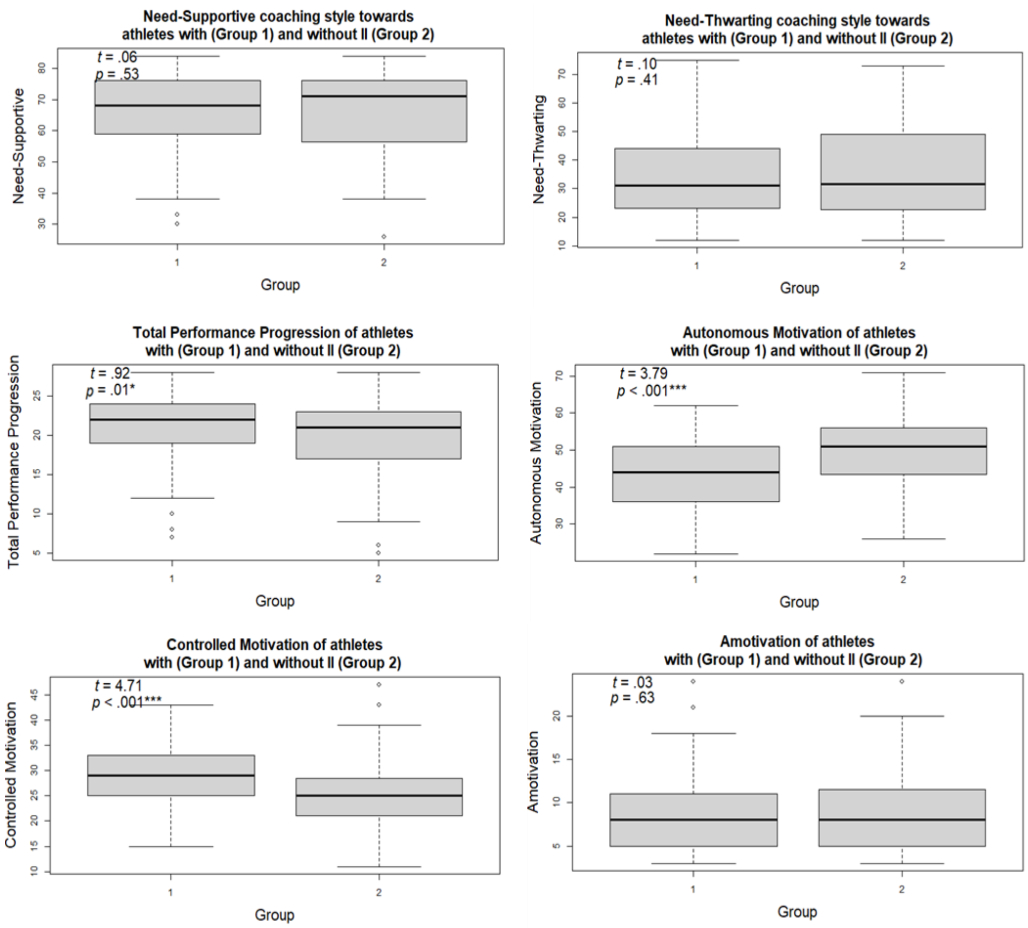

Figure 1. Results of the rank MANOVA. Univariate post-hoc comparisons of Need-

Supportive, Need-Thwarting, Total Performance Progression, Autonomous Motivation, Controlled Motivation and Amotivation for athletes with and without II. *Note.* t = t Value, p = p Value (* shows the mean differences are significant at the .05 level; ** shows the mean differences are significant at the .01 level; *** shows the mean differences are significant at the .001 level).

Results of the Spearman Correlation analyses indicated that both coaching styles (need-supportive and need-thwarting) were significantly correlated with autonomous motivation and amotivation in II and non-II group (p <.001). Additionally, both coaching styles were significantly correlated with the total performance progression in non-II group (p <.001) (see Table 3). Therefore, only these variables were entered into the series of Additive Nonparametric Regression analyses.

Table 3. Spearman Correlation matrix for Need-Supportive, Need-Thwarting, Total Performance Progression, Autonomous Motivation, Controlled Motivation and Amotivation for -athletes with and without II.

Group	Variable	1	2	3	4	5	6
II							
	1. Need-Supportive	-					
	2. Need-Thwarting	-.62**	-				
	3. Total Performance Progression	.13	-.08	-			
	4. Autonomous Motivation	.51**	-.45**	-.01	-		
	5. Controlled Motivation	-.06	.03	.13	-.19*	-	
	6. Amotivation	-.45**	.41**	-.24**	-.41**	.05	-

Non-II						
1. Need-Supportive	-					
2. Need-Thwarting	-.82**	-				
3. Total Performance Progression	-.19*	.24**	-			
4. Autonomous Motivation	.65**	-.57**	.04	-		
5. Controlled Motivation	-.00	.10	.01	-.07	-	
6. Amotivation	-.48**	.62**	.10	-.45**	.22**	-

Note. * Shows the mean differences are significant at the $p < .05$ level; ** shows the mean differences are significant at the $p < .01$ level.

A series of Additive Nonparametric Regressions were run to examine if need-supportive and need-thwarting were predictors of autonomous motivation and amotivation in the II group. A second series of Additive Nonparametric Regressions were run to examine if need-supportive and need-thwarting were predictors of autonomous motivation, amotivation and total performance progression in non-II group. Results showed that a need-supportive coaching style positively predicted autonomous motivation in athletes with and without II ($p < .001$, *adj.* $R^2 = .28$ and $p = .00$, *adj.* $R^2 = .47$ respectively). It also negatively predicted amotivation in athletes with II ($p = .00$, *adj.* $R^2 = .25$). Additionally, a need-thwarting coaching style positively predicted amotivation in athletes with and without II ($p = .02$, *adj.* $R^2 = .25$ and $p < .001$, *adj.* $R^2 = .37$ respectively), and negatively predicted autonomous motivation in athletes without II ($p = .00$, *adj.* $R^2 = .47$). Figure 2 presents the partial effects plots with the approximate significance of smooth terms for predictors of autonomous motivation and amotivation in athletes with and without II. Neither coaching style significantly predicted total performance progression in both groups.

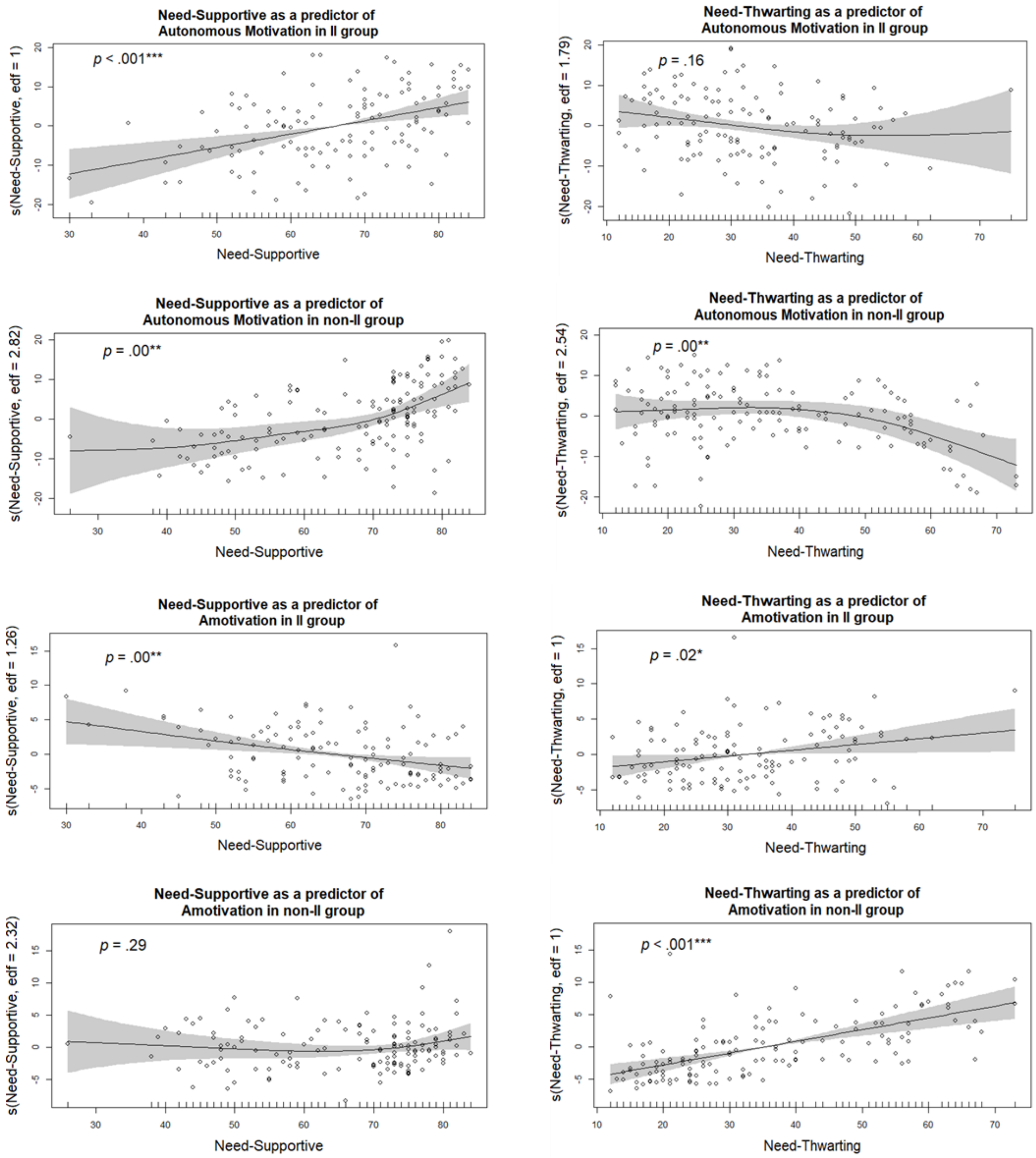

Figure 2. Partial Effects Plots with Partial Residuals and Standard Errors (95% confidence interval) and Approximate Significance of Smooth Terms for Predictors of Autonomous Motivation and Amotivation in athletes with and without II. *Note*. *Edf* = effective degrees of freedom, $p = p$ value (* shows the mean differences are significant at the .05 level; ** shows the mean differences are significant at the .01 level; *** shows the mean differences are significant at the .001 level).

Discussion

This study aimed to shed light on athletes' sports performance progression, athletes' motivation orientations and coaching styles differences, as well as the relationships between these factors, as reported and perceived by coaches of athletes with and without II. The results did not fully support our first hypothesis that coaches of athletes with II perceive their athletes to have made less progression in their sports performance and have adopted more controlled types of motivation compared to athletes without II. More specifically, coaches' reports indicated that athletes with II were perceived to progress more in their sports performance (total performance progression) compared to athletes without II. However, as we hypothesised, coaches reported and perceived that athletes with II adopt more controlled types of motivation than athletes without II, and less autonomous types of motivation, than athletes without II.

A reason that total performance progression of athletes with II is perceived to be higher could be due to lower long-term engagement in sports and the lower levels of physical fitness and muscle strength of this population compared to athletes without II that previous studies reported [233, 234]. The strength and muscle mass alternations of people with lower levels of physical fitness and muscle strength are rapid, followed by slowed progression over time [235, 236]. Thus, our speculation is that the total performance progression of athletes with II might be more obvious to their coaches. However, more research is needed to explore the relationships between training age and physical fitness with the sports performance progression of athletes with II. However, as this study was based on coaches' perceptions, another explanation for these findings could be due to disability stereotype where achievements by people with disabilities are rated more positively from the able-bodied society [237]. Thus, coaches of athletes with II might unconsciously adopt different standards of sporting success and overestimate their athletes' total performance progression [238]. For instance, coaches may have relatively low expectations from their athletes, while a great physical, tactical, technical, and/or psychological progression of athletes with II could be perceived by the coaches as paradoxical [232]. These attitudes may be well-intentioned however, when athletes with II accomplishments are portrayed as surprising and/or inspirational it can perpetuate ableism [232, 238]. If these unintentional (but still ableist) attitudes occur, this could make the mainstreaming of disability sports more challenging for this population. Thus, there is a necessity to reshape coaches' assumptions of what athletes with II can and cannot do and help them set realistic sports performance goals for their athletes.

The results also indicated that athletes with II adopt more controlled types of motivation compared to athletes without II and less autonomous types of motivation compared to athletes without II (as perceived by their coaches). Previous research has shown that athletes with II present higher ego orientation and lowered self-regulation compared to athletes without II [145, 239]. This could partly explain the lower levels of long term participation in sports of athletes with II compared to athletes without II [4, 240], as autonomous motivation functions in a dyadic relationship with self-regulation and facilitates athletes' long-term exercise engagement and persistent sports behaviour compared to athletes who adopt more controlled forms of motivation [24, 25, 172]. The higher level of perceived controlled motivation could be a result of the high levels of anxiety, decreased confidence, and social phobia that people with II experience and may influence their sports motivation [19, 203]. In addition, the lack of awareness and societal support that athletes with II reported [241], could hinder the fulfilment of their relatedness' needs [172] which could in turn fuel more controlled types of motivation compared to athletes without II. However, the motivational differences between athletes with and without II could have occurred due to the difficulties of proxies (such as coaches) to recognise that people with II can have a good, personally meaningful life [232] and accept the role of people with II in their own autonomous decision-making [226]. Thus, coaches may perceive that the sports participation of athletes with II depends more on external and less on internal motivations in comparison to athletes without II, but further research is needed to explore the level of intellectual ableism in coaching settings.

The results of our study did not support our second hypothesis, indicating that the coaching style between the two groups is similar. A possible explanation of the coaching style similarities could be that most of the coaches of athletes with II are coming from mainstream sports and have a traditional coaching education background [7]. Previous studies in sports for people without II showed that coaching behaviour is influenced by athletes' motivation [242, 243]. However, the different motivation orientations of athletes with and without II and the similar coaching styles of their coaches, indicate coaching behaviour towards athletes with II seems less adapted to athletes' motivation. Moreover, these findings could indicate that coaches may have difficulties in adapting their approach to athletes with II needs, thus more effort is needed to enhance the autonomous motivation of this population. Due to the reciprocal relationship between coaching behaviour and athletes' motivation [243], future qualitative research should further investigate the coach-athlete with II relationship, coaches' practices, how and why they do it, and how beneficial this could be for their athletes' long-term sports participation and development.

The series of additive nonparametric regression analyses partially supported our third hypothesis, indicating that coaching styles are predictors of motivation orientation in athletes with II and that these predictors differ between the two groups (II and non-II). Specifically, the results show that the coaches' need-supportive style is a predictor of the autonomous motivation (positive) and amotivation (negative) of athletes with II. At the same time, coaches' need-thwarting style positively predicts amotivation of this population (Figure 2). These findings indicate the importance of the coach-athlete relationship in II sports and suggest that athletes with II may have the capability to recognise different coaching styles and respond accordingly, contrary to common beliefs [216]. They also highlight the necessity of coaches to nurture the basic psychological needs of athletes with II. Coaches of athletes with II should provide their athletes with choices and meaningful rationales for the assigned exercises and show them trust in their capabilities regardless of their cognitive limitations. They should also give them clear and simplified instructions and the opportunity to express their needs and anxieties in a socially safe and supportive sports environment [24]. These attitudes could be essential in athletes with II, a population dealing with increased anxiety, social phobia, and decreased confidence (Harris & Joanne, 2017) and that they tend to adopt more controlled types of motivation. Coaches' need-supportive style can increase athletes' chances to adopt more autonomous motivation regulations, avoid amotivation, increase their positive affect [221], facilitate their self-regulatory development and inspire their long-term engagement in sports [24, 217]. Contrariwise, coaches who thwart athletes' basic psychological needs could engender their feelings of pressure, failure, and loneliness [221], demotivate them from continued sports participation (amotivation), and increase their chances of depression and burnout [221].

It is also important to explore the different role that the coaching styles have in athletes with and without II. It seems that the need-supportive style predicts autonomous motivation only in athletes with II. On the other hand, the need-thwarting style predicts amotivation only in athletes without II. The impaired cognitive abilities of athletes with II could lead them to respond differently to the environmental cues (e.g., coaches' attitude) and react dissimilarly to the coaching styles compared to athletes without II [10, 16, 35]. These differences, along with the different motivation orientations between athletes with and without II, should be taken into consideration in future sports disability education programs. It is thus crucial to educate coaches of athletes with II on how to effectively deal with the cognitive deficits of this population, appropriately interact with them, and effectively support their basic psychological needs [7, 244]. Nonetheless, coaches' education towards disability will be beneficial and will facilitate the mainstreaming development in sports only if the coaches acknowledge that each athlete (II and non-II) has a unique personality, and that they should adapt their behaviour to each athlete's needs in order to foster meaningful athlete-coach relationships [245, 246]. Currently, coaching education opportunities within disability sports is still lacking, which makes it even more challenging for coaches to gain any advanced learning about the most progressive and effective way to coach athletes with II and offer them inclusive sports opportunities [7].

This study presented some limitations that need to be addressed. First, due to the lack of validated self-report instruments that measure motivation orientations in athletes with II, this study was based on coaches' perception of athletes' motivation orientations. However, the communication difficulties that athletes with II experience could lead their coaches to misinterpret their needs, behaviours, and motives [247]. Future studies should investigate the role of their significant others (e.g., coaches, carers, parents, peers) in fostering different motivation orientations. Future research should also aim to develop appropriate and valid instruments that measure motivational regulations in athletes with II. Another limitation is the lack of device-based measurements that investigate the sports performance progression of athletes. A criticism of self-report measurements of sports performance development is that they could be affected by coaches' bias towards athletes who have specific roles within the team [248]. However, due to COVID-19 restrictions during the data collection process, it was not feasible to include device-based measurements of sports performance. Future work could integrate both device-based and self-report performance assessments to gain a better understanding of athletes' progression and better support their long-term development in sports performance settings [248].

Conclusion

In summary, this paper highlights the significance of the coach-athlete relationship in sports and the importance of a need-supportive coaching style to enhance autonomous motivation and prevent the amotivation of athletes with II. While self-reported coaching styles were similar between coaches of athletes with and coaches of athletes without II, their perceptions of their athletes' performance progression and motivation orientations seemed to differ. This could have occurred due to the differences in sports opportunities and experiences between athletes with and without II or/and due to the different sports standards that their coaches adopt. Thus, it is important to offer appropriate training and knowledge to coaches about disability sports and the adaptations needed to effectively coach athletes with II and to appropriately offer them inclusive sports activities.

Chapter 5: The role of the social environment in sports participation of athletes with Intellectual Impairment through the coaches' eyes: A qualitative inquiry

This work has been submitted:

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Abstract

Despite the efforts of mainstreaming in sports, inclusive participation of people with Intellectual Impairments (II) in sports remains challenging. In sports settings, the social environment may influence athletes' motivation and promote (or restrict) inclusive sports participation of athletes with II. Thus, this study aims to explore athletes' and coaches' motivations and to investigate the role of the social environment in sports participation of athletes with and without II. Coaches who coach athletes with II (*n* = 11), athletes without II (*n*=13) and both groups (*n* = 2) were involved in semi-structured interviews. From the inductive thematic analysis, three themes were identified for the sports motivations of athletes with II (Sport-related Progression, Social Interaction, Positive Emotions), two for their coaches' motivations (Help others, Personal and Professional Development) and four for coaching practices toward athletes with II (Psychological and Life skills development, Building Meaningful Relationships, Behaviour adaptations and Participation-focused). Moreover, 'Teammates and Opponents' and 'Family' were classified as social agents that influence the sport participation of athletes with II. Coaches of athletes without II reported additional themes about their athletes' motivations (Health-related Reasons), their coaching motivations (Career aspirations) and their coaching practices towards athletes without II (Performance-focused). Athletes' motivations and coaches' practices could promote sports participation of athletes with II, but more work is needed to address athletes' sports motivations and overcome the ableist attitudes and the social oppression

that may make their inclusion in sports more challenging. These sports participation barriers and facilitators could provide direction to stakeholders for developing inclusive sports pathways to people with II.

Keywords: motivation; sports; coaching practice; Intellectual Impairment; social environment; coaches; inclusion; mainstreaming

Introduction

In recent years, there is growing emphasis on the integration of non-disability and disability sports organisations, known as mainstreaming, due to the continued global call for equal opportunities in sports [8]. To champion the mainstreaming movement, it is crucial to promote inclusivity within the sports environment. Inclusive practices refer to the provision of enhanced opportunities to people with disabilities to participate in the exercise and sport activity of their choice [223]. A better understanding of athletes' needs and motivations as well as athletes' social environment, including coaches' and parents' active involvement, are pivotal in driving inclusivity in sports settings [7, 26]. While there is considerable understanding of the role of social agents for athletes without disabilities [32], such is relatively understudied in athletes with Intellectual Impairments (II) [6]. The lack of appreciation of the similarities and differences in athletes with and without II, and their interactions with their social environment, may have hindered progress of inclusivity within the sport settings, as well as sport engagement for individuals with II [213].

People with II are dealing with limitations in intellectual capacities (IQ $\leq$ 70) and adaptive skills (conceptual, practical, social skills). These limitations can negatively influence sports-related skills like decision-making, self-regulation (e.g., goal setting, self-reactions) and learning by experience, resulting in deteriorated sport performance and development [10, 17]. For instance, people with II demonstrate reduced technical proficiency [17] and inadequate pacing behaviour in competitive races [34]. People with II also have difficulties in understanding and executing coaches' instructions [34]. Additionally, they may misinterpret other people's behaviour, and/or inadequately convey messages across, which can hinder social interaction [18]. Consequently, people with II might respond differently to environmental cues [21, 193] impacting on their interaction with their coaches, teammates (e.g., during training sessions), and/or their opponents. In head-to-head competitions for instance, the ability to appropriately respond to opponents' actions, a relevant skill for optimal performance [74], is underdeveloped in athletes with II

[34]. Apart from their challenging behaviours, people with II are also dealing with anxiety, decreased confidence, and social phobia, all of which can influence sports motivation [19, 203]. Because of these cognitive deficits and psychological barriers, people with II may become dependent on the support of others in their daily lives (e.g., coaches, parents, carers) [22]. For example, as people with II are less proficient in self-regulation, the social environment can step in and help them set goals, give feedback, and alter their affective reactions [32, 34]. Thus, the social environment is critical in influencing sports motivation and promoting and/or restricting sports participation of this population [145, 249].

For this reason, we are interested in understanding the motivation and the social environment for athletes with II, and compare it with athletes without II, in order to understand the challenges in adopting inclusive practices in the mainstreaming initiatives. Although there is a growing interest in the intricate role of the social agents in the inclusive sport environment [7, 241], research is still scarce. In this study, we focus on coaches' lived experiences because coaches play a key role in enhancing athletes' sport-related skills (e.g., self-regulation), creating an exercise motivational climate and promoting athletes' sports engagement [250, 251]. We will consider how the athletes' and coaches' sports-related motivations shape their relationships and guide athletes' sport behaviour [252], a gap in literature, especially in the II population, that warrants investigation. Hence, a comparison in motivations between coaches, and the motivations of their athletes (with and without II), as well as coaches' behaviour will provide insights into the needs and challenges of creating a sustainable inclusive sport environment [8].

In view of the above, the aims of this study are to 1) investigate athletes' motivations for sports participation (as perceived by coaches), 2) explore coaches' coaching motivations, 3) gain a better understanding of the coaching practices and iv) explore the role of the social environment in athletes' sports participation and development based on coaches' reports. Perspectives of coaches from II and non-II athletes will be compared.

Methodology

Participants and Recruitment

After gaining ethical approval by the Institutional Ethics Board, participants were recruited from January until May of 2021 through a combination of criterion-based and maximum variation sampling strategy [253] in order to capture key variations in participants' coaching experience, age, and type of sport. With regards to the inclusion criteria, we recruited coaches of athletes with and without II who were fluent in English, had at least one year of coaching experience, and their athletes were adults or adolescents (above 12 years old) who met the criteria for diagnosis of II: limitations in intellectual and adaptive functioning with an IQ ≤ 70, limitations in social, conceptual, and practical skills, and manifested before the age of 18 years old [10]. For comparability purpose, all athletes were in the 'participation' or 'performance' stage of sport development where focus is on sports skill acquisition, and with some experience in competition at local and/or regional level [229, 254]. Participants were recruited through websites, social media, and emails via charities, sports organisations, and sports clubs. A code was given to each participant; therefore, the collected and stored data did not reflect any personal information of the participants. Moreover, researchers did not store email addresses and/or phone numbers which were essential for the interviews. Twenty-six coaches consented to participation (aged 21-79 years, coaching experience between one and 43 years, types of sport include basketball, archery, badminton, athletics, boccia, cycling, swimming, tennis, weightlifting, rugby, football, gymnastics, goalball, cricket, netball, and table tennis; see Table 1. for detailed demographics information). Data collection was completed when the researchers considered no additional information could be yielded from additional interviews.

Table 1. Participants' Demographic Information

Coaching group	*N*	Male %	Age (< 40yrs %)	Years of coaching experience (<20yrs %)
Athletes with II	11	72.72	54.54	72.72

Athletes without II	13	61.53	38.46	61.53
Athletes with and without II	2	50	50	50

Note. *N* = Number of coaches.

Procedure

All participants were involved in semi-structured interviews conducted by the first author (KS) via video-calling platforms (Skype or Zoom; n = 24) or telephone (n = 2). Each interview lasted about an hour and participants were asked about their coaching motivations (e.g., "What motivates you to continue coaching your sport?"), their relationship with their athletes (e.g., "How would you describe your relationship with your athletes?") and interpersonal styles (e.g., "How would you characterise yourself as a coach?"). Coaches also gave opinions about their athletes' motivations (e.g., "Why are your athletes participating in sports?") and athletes' social environment in sports (e.g., "How are your athletes behave to one another during training and competition?"). The interviewer used the interview guide flexibly, and follow-up questions were used during the process to elicit richer data [253]. All interviews were recorded and transcribed verbatim with the assistance of an online transcription software (Otter.ai) for data analysis.

Analytic procedure

Transcripts were analysed using a reflexive thematic analysis with an inductive orientation, an iterative and progressive method that allows the authors to identify and provide a detailed analysis of patterns across the data set [255, 256]. Initially, the first author (KS) immersed in the data, making notes of preliminary patterns, and generating initial ideas. Codes were then generated from the transcripts using the NVivo software and finally, grouped into themes [255, 257]. KS then discussed the structure and the content of the themes with the second author (AF), who also coded the transcripts. AF acted as a 'critical friend', questioning KS's assumptions, codes, and themes to promote reflection and ensure further development of meaningful themes [253]. To improve fidelity, the researchers tried to become familiar with the participants' culture and to collect data from coaches with diverse characteristics (in terms of coaching experience, age, and type of sport) [258]. The analysis was underpinned by the constructivist paradigm, individuals construct knowledge through their own experience and interaction with the world [259]. In terms of participants' coaching experiences and perceptions, we interpret them as the reality of coaches' experiences while at the same time we take into consideration the cultural, political, and historical context in which they occur [259]. The investigators were aware that their own experiences and perspectives could influence the research process. To effectively deal with this issue, researchers used open-ended questions and nonleading language during the interviews [258]. During data analysis, KS recorded reflective notes (memoing) to manage his own perspective and ensure fidelity [258].

Results

Athletes' sports motivations (as perceived by coaches)

With regards to sports motivations of athletes with and without II, three themes were identified and categorised into 'Sport-related progression', 'Social Interaction' and 'Positive Emotions'. We identified an additional theme for the sports motivations of athletes without II ('Health-related reasons').

Sport-related Progression

According to coaches, athletes with and without II participate in sports because they want to 'try something different' and because they want to learn new skills: 'They want to learn every intricacy of basketball' (P01, II coach), 'They want to see how far they can go, how good they can get' (P22, non-II). They also want to progress in their sport and improve their skills: 'Athletes want to improve, to get better.' (P19, II coach). This sports performance progression gives them the chance to achieve something meaningful to them: 'They can wear their cricket shirts and have this sense of pride. It is a sense of achievement for them.' (P18, II coach). The awareness of their progression and their sense of achievement 'give them the confidence' to continue training.

Social Interaction

Participation in sports gives athletes the opportunity to interact and socialise with each other: ‘Some of them just want to come and have a chat. It's a bit of a social group’ (P01, II coach). For athletes with II, sports offer an inclusive environment where ‘they can feel safe with other people that are like them, where they don't have to feel like they're being judged’ (P17, II and non-II coach). Many participants mentioned that sports are more than a social event, as they help athletes to make new friends, develop social/sport skills and a sense of belonging:

> They mostly like coming to see their friends. So, I think playing the sport and gain enough confidence and gain in that friendship network game in order to gain in so many of those and soft skills that they take through sport and interacting with others (P05, II coach).

> I think the fact that you come into the gym to see your friends, this is a really big factor. Even if people aren't amazing weightlifters, I think a main factor that keeps bringing them back is because they are training with the group (P12, non-II coach)

Positive emotions

Athletes participate in sport because they ‘love it’ and it is an indispensable part of their life:

> We have a football team. So, they actually take it seriously, like it's their life... they actually want to be there, they choose to be there. And they've trained for it. And their mindset is that they're playing a professional football game (P06, II coach).

Through sports, athletes with II experience enjoyment: ‘The thing that keeps the athlete coming back is that they are having fun’ (P1, II coach), ‘If it wasn't fun, they wouldn't come’ (P10, non-II coach). Lastly, it is important for the athletes that they can be independent and express themselves through sports:

> He said, that's the only time that he hasn’t got carers. He can just be himself in his own quietness. If he is annoyed, he can shout. If he is happy, he can be happy.

> And it is probably the only opportunity he gets in a week, that he can kind of just be himself and be like any other person (P04, II coach).

Athletes' sports motivations differences: Health-related reasons (non-II athletes)

According to coaches' reports, athletes without II participate in sports also for health-related reasons. According to PO7 (non-II coach) they want to 'get fit' and to 'lose some weight'. Sports are a pathway for athletes to regulate their mental health as well. They relieve stress through sports and help them forget their personal problems:

> Athletes found that doing archery gave them that break from whatever it caused them problems, gave them the chance to not think, because you can't really do archery and think about anything else. (P02, non-II coach).

Coaches' coaching motivations

Having understood athletes' motivations in sport participation, we would like to gain an in-depth view about coaches' coaching motivations and the extent to which they complement their athletes' motivations. We identified two themes for coaches of athletes with and without II - 'Help others' and 'Personal and Professional development'. We identified an additional theme for coaches of athletes without II ('Career aspirations').

Help others

Coaches want to help athletes 'reach their potential' and develop their life skills: 'I'm quite keen to make sure that they are allowed to make decisions' (P18, II coach), 'I want my athletes to see what is possible through their body and mind, to help them be themselves' (P22, non-II coach). For coaches, it is important to convince athletes that they can achieve something:

> I thought the best thing to do with D. is to give him a cricket bat. We got to this point where 'bang', he hit the ball... That was a small win, but in his world, it was a huge win. It was emotionally very powerful. And it's still even to this day, one of the things that continues to motivate me into doing what we're doing, because it makes a difference (P18, II coach).

Personal and Professional Development

Coaches reported that they 'love the sport' that they are coaching. They also 'enjoy' interacting with their athletes, as this interaction brings the best out of them personally and professionally:

> I love it and you get so much out of it. As a coach, it's really rewarding. And you have more fun. I feel like the students bring the best out of me as a coach as well as a person… that makes your job worthwhile. You do not mind putting in the extra work and the extra enthusiasm into your job. (P06, II coach).

Coaches are also intricated by the psychological and the social benefits that sports can offer them and their athletes: 'Sports can improve your mental health your well-being. So that's what I really love about sports coaching' (P19, II coach), 'I love the aspect that the sport itself is a support network' (P16, non-II coach).

Coaches' coaching motivations differences: Career aspirations (non-II coaches)

Apart from personal and professional development, coaches of athletes without II are also driven by their career aspirations. 'I want to have respect in my local area (P23, non-II coach). For example, one female participant wants to become one of the first female coaches in a male-dominant sport:

> Olympic weightlifting is a very male dominant sport, just in general, not just in the coaching. One of my motivations of becoming a coach was because I didn't know any female coaches when I was learning, I was always taught by males. And I just thought I would love to try and really drive the participation of females in this male dominance sport (P12, non-II coach).

Coaching practices towards athletes with and without II

Having a clearer picture of athletes' motivations in sport participation and coaches' coaching motivations, we would like to the understand how coaches' motivations may influence coaching practices, and in turn, shape coach-athlete relationship. With regards to coaching practices towards athletes with and without II (second aim), three themes were identified - 'Psychological and life skills development', 'Building Meaningful relationships' and 'Behaviour adaptation'. We identified an additional theme for the coaching practices towards athletes with II ('Participation-focused') and without II ('Performance-focused').

Psychological and life skills development

For coaches, sports are an excellent opportunity to help their athletes acquire the necessary soft skills for optimal functioning in daily life: 'I give them a lot of autonomy, I give them a lot of choices' (P15, non-II coach). Coaches encourage their athletes to be independent, engage them in the learning process and give them responsibilities and options:

> I'm quite keen to make sure that the students are allowed to make decisions. Because I think that those sorts of things are transferable. I think our responsibility is to get them to understand all the different options that they have… is an individual's decision to choose one of those options (P18, II coach).

Coaches are also trying to build values of 'teamwork', encouraging the interaction between their athletes, and are trying to improve their social skills: 'Get them feel comfortable talking to people**,** as some of them are very shy' (P03, II coach), 'I want them to engage with each other and work together as a team. Otherwise, gymnastics could be a quite lonely sport' (P15, non-II). Moreover, they are trying to make them aware that in sports, as in life, failure is an option and athletes have to 'learn to win and lose' and that they can be better persons through sports: 'Our coaching philosophy should be around making better people' (P18, II coach).

Building Meaningful relationships

Coaches are constantly trying to connect with their athletes and build meaningful relationships. 'They respect me because I respect them.' (P15, non-II coach) and they are trying to find 'what works well for them'. They are also trying to interact and conversate with their athletes as much as possible, offer them a safe training environment and gain their trust:

> The trust is the most important... one of the things that I've always say to people: ‘try yourself to be him, how would you do it yourself?’. They have to trust you. You will never ask them to do something, you wouldn’t do yourself, right? (P08, II coach).

A number of coaches highlighted the importance to be a ‘role model’ of their athletes and act as a family member to them: ‘I'm like a father figure to then, care for them, look after them’ (P08, II coach). Coaches are also trying to be ‘friendly’, ‘funny’ and ‘lovable’ to their athletes.

However, a meaningful relationship is also based on setting clear boundaries to facilitate optimal functioning of this relationship. Thus, coaches are trying to run the sessions as smoothly as possible, avoid conflicts and promote a safe environment. To achieve that, they require from their athletes to ‘follow rules’ and ‘have good manners’.

Behaviour adaptations

Coaches reported the importance to adapt their sessions: ‘I'm quite flexible as to what the training can be, depending on how they feel’ (P20, II coach) and interact with flexibility with the athletes: ‘What you have to do is to find out to what they respond to the best’ (P08, II coach). Being aware of athletes' behaviour issues could help guide coaches’ behaviour and coaching approach: ‘You can trigger someone if you are too instructive and authoritarian’ (P01, II coach). ‘I have to be aware of the capacity of people to understand what I'm saying’ (P09, non-II coach). Throughout this process, patience is key:

> ... although they've done (the drill) several times, they may want to start right from the beginning and right from the basics every time. I think you just have to be patient and, and just be aware of that, because you will have to go through things a million times. And if it doesn't work, then there's no point shouting or being forceful (P05, II coach).

Their adaptations are also based on athletes’ personal needs and abilities: ‘Everyone is an individual, isn't it? Everyone has different abilities and skills (P05, II coach), ‘At our club we tend to tailor the coaching according to people's ability and the time they can spend on the sport' (P02, non-II coach).

Coaching practices differences: Participation-focused (II coaches)

A main goal from II coaches is to engage more people with II in sports: 'Some of the guys, if they do 10 minutes without leaving, that's a massive achievement' (P01, II coach). Thus, they are trying to make their sessions inclusive and offer to people with II different sports opportunities: 'The opportunity for them to be able to participate in whatever activity it may be, whether it's actually a proper competition, or whether it's just a fun social event' (P17, II and non-II coach). For coaches, inclusion to sports have different interpretations:

> Inclusion can be interpreted and can be seen in different ways. Because if you're working with a group of people where some people have a disability, and some haven't, you may have an inclusive session, but it doesn't necessarily mean that they all mixed together. I suppose to that is the door should be open for everybody. The answer to all of this is really simple. We just need to be kind to each other, just be nice to each other (P18, II coach).

Even if inclusivity is perceived differently by the coaches, they highlighted the importance to focus on sports participation of people with II and not on their performance: 'This is not a performance environment, it is a participation environment' (P18, II coach).

Coaching practices differences: Performance-focused (non-II coaches)

While both coaches of athletes with and without II focus on the sports progression of their athletes, the latter are more performance-focused. Coaches have 'high expectations' from their athletes, encourage them to improve their skills and reach their sport performance potential: 'You have to reflect on your performance, and work with the coach and create a training plan and next steps to meet your next goal.' (P12, non-II coach).

Coaches want their athletes to perform well in competitions and win: 'It's not just we're taking part for the fun of it. We go out to win' (P21, non-II coach). For this reason, they ‘keep track of their sports performance progression’ and ‘prepare them physically (e.g., ‘match drills) and ‘mentally (e.g., imagery)’ for competitions.

Social Environment and Sports Participation

Our third aim was to explore the role of the social environment (besides coaches) in sports participation of athletes with and without II. Coaches perceived different social agents that may influence athletes’ sports participation and performance. We identified two groups of social agents - ‘Teammates and Opponents’ and ‘Family’.

Teammates and Opponents

Athletes with and without II are generally friendly with each other and encourage their teammates to participate (and improve in their chosen sport) in training sessions: ‘They have a laugh and a joke to carry on’ (P20, II coach), ‘They are committed and dedicated to helping each other’ (P22, non-II). This positive environment enhances ‘team bonding’ and athletes’ ‘confidence’. Teammates are also trying to ‘support’ and ‘encourage’ each other during competition while at the same time they are respectful towards their opponents:

> And everyone is a bit more friendly with each other, there's a lot of mutual appreciation. Like if someone scores a basket, there's just a lot of cheers from both sides (P01, II coach).

However, the relationships between athletes could also be challenging. Coaches reported arguments and conflicts between teammates in training and competition: ‘I can remember a small quarrel between two of them, they were arguing over sports equipment’ (P26, II coach), 'I had a situation where one of the girls was being bullied, and she got really upset' (P10, non-II coach). These behavioural problems are also present when athletes have to compete against opponents: ‘As soon as someone starts misbehaving, my athletes really start feeling a little bit anxious and stressed about it. And so that can cause bad behaviours from them as well’ (P06, II coach). P06 (II coach) highlighted that the athletes are 'lacking of team work experience' and due to their social interaction difficulties, sometime 'they prefer to be on their own' during the training session.

Family

Parents can facilitate the sports participation of athletes with (adults and adolescents) and without II (only adolescents). They know the athletes' personality and can encourage them to continue participation in sports 'The parents play a big part in athletes' life, they know how to deal with them better than me and they encourage them to participate' (P18, II coach), 'One of my athletes was really proud of his park run time. And I think that's because a member of his family was also really into park run. So, he had this kind of support' (P07, non-II coach). They also provide 'positive feedback' and 'reinforcement' to the athletes. For all these reasons, coaches consider their cooperation with the parents crucial:

> I kind of ask parents if anybody's available to join. And that's great, because that means that there is some networking going on, there is a need to be some sustainability around it. And the parental involvement is vital for that (P18, II coach).

Nonetheless, specifically for athletes with II, parents can be barriers for sports participation. Sports engagement of people with II depends heavily on their parents' support. However, it seems that some parents are not enthusiastic about their children's involvement in sports: 'Yeah, it's very difficult to get parents involved. I think a lot of the time they see it as a respite.' (P05, II coach). According to coaches, a possible explanation for this behaviour is that the parents do not believe in their children's abilities: 'Parents always say, my daughter can't do this, my daughter can't do that (P03, II coach) and are overprotective: 'They don't want to let go, they don't want anybody else to look after them, because it's their child' (P04, II coach).

Discussion

This study investigated athletes' sports participation motivations, coaches' coaching motivations, and the social environment-athlete relationship and interaction in sports settings. According to the social relational model of disability (SRM), the restrictions of an activity (e.g., sports participation) can be caused by impairment (e.g., cognitive deficits) and psycho-emotional oppressions (e.g., social factors) [260]. Thus, the exploration of individual (motivations) and societal factors (social environment attitudes) of sports participation can inform coaches and stakeholders about potential strategies to create a sustainable inclusive environment for people with II through the mainstreaming pathway. Within the sport coaching context, the relationship between coaches' perceptions of athletes' motivations and the enacted coaching practices and behaviours is not well-documented. As far as we know this is the first study that makes this connection in the sports environment of people with II.

One of study's aims was to investigate athletes' sports participation motivations (as perceived by coaches), an individual factor that can have significant impact on athletes' long-term participation in sports [7]. The results showed that athletes with II, as well as athletes without II, participate in sports mainly for intrinsic reasons (Positive emotions', 'Social Interaction' and 'Sport-related Progression' themes), which is likely to lead to long-term engagement in sport due to greater persistence and effort [24, 172, 261]. For instance, the affective response of enjoyment that the athletes with and without II experience (according to their coaches), can positively influence their goals and their adherence in sports [262]. Additionally, this study confirms the need of athletes with and without II to interact with each other [263]. This attitude can promote an inclusive sport participation as teammates can boost athletes' confidence and sense of belonging. While athletes with II and without II were perceived to be motivated by their sport progression, the athletic identity of the former is less clear. Further investigation is needed to better understand the athletic identity of athletes with II and how they think and act within the sports context.

It seems that athletes without II also participate in sports for physical and mental health reasons, as they want to get fit and relieve stress through sports, but this theme ('Health-related reasons') was not identifiable in athletes with II. The difference could be partially due to the lack of understanding of their physical and mental conditions [264, 265]. Raising awareness of a tailored health management plan that would help people with II to communicate their health-related issues better, could potentially encourage sustained engagement in an inclusive sport environment [264].

Our second aim was to gain a better understanding of the coaches’ coaching motivations. This could inform us the extent to which they contribute to athletes’ motivations and coaches’ coaching practices. Our results have demonstrated that there are inherent reasons that aspire coaches of athletes with and without II to coach their chosen sport (‘Personal and Professional Development’ and ‘Help others’ theme). Being driven by internal rewards can lead to greater satisfaction in and commitment to their coaching role [242, 261], which we have repeatedly seen from the interviews. These coaching motivations could act as a societal facilitator according to the SRM [260], as they empower the athletes, make them feel more competent, and encourage them to participate in sports and reach their goals [193].

This led us to dive more into the coaches' practices (third aim) and to explore their relationships with athletes' and coaches' motivations. Specifically, all of our coaches’ intrinsic reasons for coaching a sport (‘Personal and Professional Development’ and ‘Help others’ themes) could explain why they emphasize the importance of connecting with their athletes (‘Build Meaningful Relationships’ theme), adapting their behaviour towards them (‘Behaviour adaptations’ theme) and developing their life skills (‘Psychological and Life skills development’ theme) [266, 267]. The coaching practices also seem to address the athletes’ intrinsic motivations (‘Social Interaction’ and Positive Emotions’ themes). This could be crucial, as coaches who meet athletes' needs and motivations, give them options and facilitate their development, can cultivate a fertile ground for their athletes' long-term participation in sports [7]. Importantly, the similarities in athletes’/coaches’ motivations and coaches’ practices between the two groups (II and non-II) could facilitate sports inclusion of people with II. For instance, athletes’ common motivations to progress in their sports, socialise with each other, and experience enjoyment through sports can promote group cohesion, psychological collectivism, and athletes' engagement in sports [268]. Coaches' common motivations (e.g., help athletes reach their potential) and practices (e.g., adapt their practices to athletes' needs and abilities) could mean that they require fewer fundamental adaptations in their attitudes towards different populations, which can facilitate a smoother transition from a segregated to an inclusive sports environment [7]. However, some barriers in coaches' practices were identified.

A potential barrier to mainstreaming is the lack of emphasis on inclusivity from coaches of athletes without II, while coaches of athletes with II are trying to be supportive, develop athletes with II life skills and engage them as much as they can in sports (the 'Performance-focused vs 'Participation-focused' theme). The difference could stem from the fact that coaches of athletes without II might be more motivated by 'Career aspirations' which might have led to a performance-focused approach, compared to the participation-focused approach that encourages inclusivity, adopted by the coaches of athletes with II. This difference in coaching motivation and coaching behaviour might suggest that coaches of athletes with and without II perceived themselves (or their coaching identity) differently, with coaches of athletes with II to adopt mainly a mentor rather than a sport-coaching role [269]. While coaches of athletes without II may overlook the importance of inclusivity in a mainstreaming environment, coaches of athletes with II may underestimate the athletic identity that people with II may wish to develop [270]. We can only speculate that a reason for the difference in the coaching approach is the ableist mentality that leads the coaches to adopt different sporting standards of success for athletes with and without II [237]. To achieve a balance between performance-focused and participation-focused approaches, be it for athletes with or without II, it is crucial for coaches to listen to their athletes' sporting aspirations and respond to them accordingly. This could help coaches and athletes to set more appropriate and desirable goals and plan realistically how to achieve them [32]. With flexibility in coaching focus in place, mainstreaming initiatives are likely to be achievable and sustainable [8].

Another potential societal barrier for introducing mainstreaming in sport could come from overprotective parents. Their overprotectiveness may arise from the prejudice that they experience from other parents, as they are considered responsible for their child's disability [271, 272]. All these factors confirm the social oppression that arises from the negative interactions between people with and without II [260]. Lack of understanding athletes' needs and unhelpful societal attitudes towards athletes with disabilities are quite common in sports, and act as barriers for the long-term participation of athletes with II in an inclusive environment [249]. While the coaches in our interviews had recognized the importance of adapting their sessions and their attitudes in order to avoid conflicts with their athletes (e.g., the behavioural problems of the athletes with II during competition that this study found, probably due to increased stress and anxiety of the competitive environment) [19], education to parents and coaches of people without II is also vital. By raising understanding of the needs and challenges faced by parents of people with II, stigma against parents of people with II can be prevented, and coaches can acquire knowledge in their approach towards athletes with II in inclusive practices. For mainstreaming to be substantiated in sports and fair inclusive participation of people with II in it, it is critical to address these issues through multisectoral campaigns that will promote disability sports participation awareness and offer inclusive coaching training opportunities [273]. Within and beyond research, co-producing initiatives to promote disability sports and inclusivity, with athletes with and without disability, as well as with their social agents, could generate rich and novel knowledge, deliver meaningful strategies that can positively influence the lives of people with and without II, and further support public health campaigns [274].

Limitations and Future Studies

The study presents some limitations that need to be mentioned. First, this study was based only on coaches' experiences of athletes' motivations and did not include athletes' own perceptions. We chose to focus only on coaches due to the critical role of coaches in athletes' sports' engagement [250] and the challenges in interviewing people with II [275]. However, the cognitive limitations of athletes with II could lead their coaches to misinterpret their motivations and behaviours [18]. To gain a better understanding of the sport of athletes with II, future work should directly explore the sports experiences of this population. Future research should also consider the combination of interviewing and observational methods [276]. This approach could elicit more diverse views and opinions related to sports for people with II and the role of the social environment. Moreover, this study did not take into consideration the varying cognitive ability and age (adolescents and adults) of athletes with and without II. Due to the potential behavioural and need differences that may exist within the population [277], future studies should investigate the motivational and coaching practices differences between athletes with mild and severe II.

With the knowledge that we gain from Chapter 4 and 5, the next chapters aimed to further confirm the impact of II on pacing and investigate and how the social environment can support, or debilitate, the pacing behaviour of people with II, considering their motivation for competence and social connection.

Conclusion

In summary, this paper has highlighted the challenges in promoting inclusivity in the sports environment through understanding athletes' and coaches' motivations from the perspectives of coaches of athletes with and without II. The intricate relationship between coaches' motivations and their coaching practice, as well as the role of other social agents of the athletes were also explored. Based on the many similarities in the coaches' practices and motivations of coaches' and athletes' with and without II, we are cautiously optimistic that the numerous individual and societal facilitators can promote long-term sports participation of athletes with II through enhanced awareness of inclusivity. However, more work is needed to overcome potential existing sports participation barriers, for example, ableism, addressing athletes' sports-related needs and motivations, and educating non-II athletes and their social agents challenges faced by II athletes. The findings can inform stakeholders about the necessity of a multidisciplinary collaboration (e.g., governing and community bodies, coaches, families, researchers) that will further support athletes with II and will offer them enhanced opportunities to participate (and maintain) in sports.

Chapter 6: The role of the cognition and the social environment in exercise

This work has been submitted:

Sakalidis KE, Menting S, Hettinga FJ. The role of the cognition and the social environment in exercise regulation. (under review). 2022.

Abstract

The role of cognition in exercise regulation has remained largely unexplored, yet recent studies have indicated cognition-related impaired pacing skills in people with Intellectual Impairments (II). In a well-controlled laboratory environment, this study aims to 1) establish the role of cognition in pacing and explore the ability of people with and without II to maintain a steady pace and 2) to investigate if verbal feedback and/or 3) the presence of a pacer can improve the ability of people with II to maintain a pre-planned sub-maximal velocity. Participants with (n = 10) and without II (n = 10) were recruited and performed 7-minute sub-maximal trials on a cycle ergometer (Velotron). Participants with II also performed a cycling trial with a pacer (virtual avatar). During the trials, verbal feedback was given only for the first five minutes. The non-parametric tests for repeated measures data ($p \leq .05$) showed that 1) people with II deviated more from the targeted pace compared to people without II, 2) the verbal feedback did not influence their ability to keep a steady pace and 3) they deviated less from the targeted pace when a visual pacer was introduced. These results demonstrated that cognition is important in exercise regulation. They revealed the difficulties of people with II to plan and monitor their exercise as well as the difficulties to appropriately respond to auditory and verbal feedback. Coaches and stakeholders who want to offer inclusive exercise pathways should take into consideration that people with II perform and pace themselves better when supported by intuitive, external, less cognitively demanding stimuli such as direct visual stimuli (e.g., another cyclist).

Keywords: pacing, self-regulation, Intellectual Disabilities, coaches, exercisers, opponents

Introduction

Despite of the psychological and physiological benefits of an active lifestyle [278] only a small number (9%) of people with Intellectual Impairments (II) regularly participate in exercise and sports activities [4]. Within this small number, there are also athletes with II who want to participate in sports competitions [5]. On account of this, it should be mentioned that individuals with II are dealing with intellectual functioning (IQ ≤ 70) and adaptive behaviour limitations (social, conceptual, and practical skills) [10]. This means that people with II may have impaired cognitive skills such as decision-making and self-regulation which are critical in pacing, an essential process for fatigue management, the management of affective responses, and optimal performance [15, 16]. Pacing is the self-regulatory decision-making process in which people need to decide how and when to distribute their energy resources throughout an exercise activity [29, 30]. It is also characterised as a developmental skill that depends on various cognitive processes like updating (recall a pacing strategy), inhibition (resist to the environmental distractions), and shifting (adjust the pacing behaviour based on the social environment's actions) [108]. Pacing is an influential factor of exercise regulation and behaviour in people with chronic conditions and disabilities [20, 279] and essential for optimal sports performance in athletes [28, 49, 87]. Thus, it is not surprising that the inadequate pacing behaviour in maximal and sub-maximal trials of people with II is proposed to be linked to reduced physical activity levels [20] and negatively impacts on their sports performance [34, 35].

To our knowledge, only few studies investigated the pacing behaviour of people with II in sports and exercise [34-36]. The results strengthen the hypothesis that pacing is a cognitive demanding component, as they showed that athletes with II deviate more from a targeted pace during a sub-maximal running trial [35] and their competitive pacing behaviour differed compared to athletes without II [34, 36]. This is suggested to occur due to the deficits that people with II experience in self-regulatory skills which are involved in pacing, such as goal setting, self-monitoring, self-control, and self-reactions [10, 280].

Thus, in order to optimize pacing, it is important to explore strategies to facilitate the self-regulation and pacing behaviour of people with II [145]. This may help individuals with II to better regulate their affective responses and fatigue, facilitate their exercise engagement, and improve their sports performance in competitions [20, 35, 279].

The social environment (e.g., peers, coaches, and opponents) could play an important role in people's pacing and self-regulatory skills [21, 162, 280]. It can act as social placebo, motivate exercisers and athletes to set goals and plan their actions, provide direct pacing and performance feedback, improve peoples' attention, and positively influence their affective reactions [21, 162, 280]. Moreover, when people are less proficient at the self-regulatory process of pacing (as people with II are), coaches can use the environment to facilitate their self-regulatory and pacing skills' [280, 281]. For instance, coaches' verbal feedback and encouragement could reduce exercisers'/athletes' cognitive load, alter their activity monitoring, and facilitate their self-control during an activity [280, 281], and visual stimuli such as avatars have been shown to positively impact on performance [74], providing social invitations for action through direct perception [74].

In addition to this, it has been suggested that decision-making in pacing is based on deliberate (pre-planned) and/or intuitive (responses to the environmental cues) responses [37]. Above models are particularly useful to understand and try to mitigate the limitations that people with II experience when exercising. For example, it could be proposed that more intuitive visual cues for action might be beneficial to guide pacing in this population to compensate for deficiencies in their (deliberate) planning capacity [37]. Previous studies revealed that athletes with II engage mainly in intuitive, less cognitive demanding decision-making [36]. Thus, their pacing behaviour in a constantly changing sport environment will likely be affected by different perceptual affordances which invite them to adapt and continuously alter their pacing behaviour and their actions. [30, 36, 74]. That means that other exercisers/athletes (e.g., pacers) could act as affordances and provide intuitive, visual guidance during exercise tasks to people with II and facilitate their self-regulatory behaviour [30, 36, 74]. However, none of the previous studies took into consideration the influence of other exercisers on the pacing behaviour of people with II [34].

An in-dept exploration of pacing behaviour in sport activities where pacing is salient (e.g., cycling) could shed some light on the potential problems that people with II may experience when exercising and how this problems impact on their performance [34, 35]. At the same time, considering that the social environment can provide visual intuitive guidance to athletes/exercisers [30, 74] could give us the opportunity to propose strategies to enhance the pacing abilities of people with II. As there is an effort for sports to be more mainstream (integration of non-disability and disability sports organisations), better knowledge of athletes' relationships and interaction could facilitate the smoother inclusion of people with II in sports [8, 282].

Based on all the above, and with a purpose to better understand the role of cognition in exercise regulation, this paper aims to: 1) explore the differences in the ability of people with and without II to maintain a pre-planned steady pace in a well-controlled laboratory environment, 2) investigate if verbal feedback could facilitate the ability of people with II to maintain a sub-maximal velocity and 3) explore if the introduction of a pacer (visual feedback) can help participants with II to keep a steady pace during a cycling activity. We hypothesise that people with II will have an impaired ability to maintain a pre-planned sub-maximal cycling velocity, confirming the field study of Van Biesen et al [35], while verbal feedback and mainly, the presence of a pacer (more intuitive processes) will help them to significantly improve their pacing performance during the trial.

Methodology

Participants

After reviewing and obtaining ethical approval by the Institutional Ethics Board (reference number: 15746), participants were recruited through sports clubs, charities, and sports organisations via e-mails and phone calls. Ten participants with (two females and eight males; age = 37 ± 7 years old) and another ten participants without II (four females and six males; age = 24 ± 2 years old) consented to participate in our study. All participants gave their consent prior their participation in the research activity. The information letter that had been provided to the participants with II was tailored to their cognitive abilities (easy-to-understand language). Due to the vulnerability of participants with II, an additional information letter was given to their legal guardians and their consent was also asked prior the participation of their protected individual in the study.

None of the participants had any previous experience in time trial cycling. Additionally, participants with II met the criteria for diagnosis of II as set by the BPS [10]: limitations in intellectual and adaptive functioning with an IQ ≤ 70, limitations in practical, social, and conceptual skills, and manifested before the age of 18 years old. Prior the testing, participants (legal guardians assisted the participants with II) completed the Physical Active Readiness Questionnaire+ (PARQ+) [283-285]. Participants with severe II and/or participants who could not understand the concept of activities were excluded from the study. Participants with physical impairments or participants with any related chronic conditions which may be contraindicated or exacerbated by cycling were excluded. The International Physical Activity Questionnaire short form (IPAQ-short form), a valid and reliable measure that estimated participants' physical activity levels [286], was used to recruit moderate to highly active participants with and without II. For the PARQ+ and the IPAQ short form, please see appendix D and E.

Procedure

All participants visited the laboratory on three separate occasions and performed a 7-minute sub-maximal cycling trial per visit (totally three trials with at least one week difference between each visit). The goal of the cycling trials was to maintain a pre-planned, sub-maximal velocity for seven minutes. All the trials performed on the Velotron cycle ergometer and Velotron 3D software (Velotron Dynafit, Racermate, Seattle, USA), using a straight and flat course with no wind and with white markers every 75 meters. A projector was used so participants could see their virtual avatar on a projection screen during the trials. The purpose of the familiarisation visit (visit 1) was for participants to understand the protocol and to get familiar with the equipment and the sub-maximal cycling trial. After completing the sub-maximal cycling trial, participants performed a 4-km cycling time trial at maximal effort. During visit 2 and 3, the goal velocity was set to 70% of the mean velocity reached on the 4-km cycling time trial during the familiarisation visit. The researchers kept track of participants' velocity, power output, and distance covered during all the trials (25Hz). Researchers took safety precautions and measures to prevent unnecessary injuries and illness (COVID-19 related) and thoroughly explained them to the participants. All trials were conducted in ambient temperature level, between 19°C and 21°C.

Participants with II participated in two different, randomised conditions, alone and with a real-life sized pacer (virtual avatar). Participants without II participated only in one condition, without another pacer (alone). For all the conditions, participants first reached their pre-planned, targeted velocity based on researchers' standardised velocity-related feedback (e.g., please go faster, please go slower, keep that speed), and then the trials began. For the condition without the pacer (alone), audio speakers were used so participants could hear an auditory signal whenever they reach a 75m marker. Hearing the auditory signal before reaching the 75m marker implies that the participants needed to cycle faster. Hearing the auditory signal after passing the 75m marker implies that the participants needed to cycle slower. For the condition with a pacer, a second virtual avatar was introduced who was cycling with the targeted velocity (70% of the mean velocity that the participant reached on the 4-km cycling time trial during the familiarisation visit), next to the participant's avatar. Participants with II were instructed to always cycle side by side with the second avatar. Cycling in front of the pacer implies that the participants need to cycle slower. Cycling behind the pacer implies that the participants need to cycle faster. In all trials, researchers gave standardised, speed-related feedback during the first five minutes of the trial. During the last two minutes of the trial, feedback was not provided. The participants did not receive any numerical feedback regarding their performance during or after the trial (e.g., power output, speed, distance covered). A computerized randomization using Excel (Microsoft Office Excel, 2007) was used to determine: 1) the condition that each participant with II participated in each visit and 1) the visit (2 or 3) that the researchers should take into consideration in the analysis for each participant without II (for the research protocol flow chart please see Figure 1).

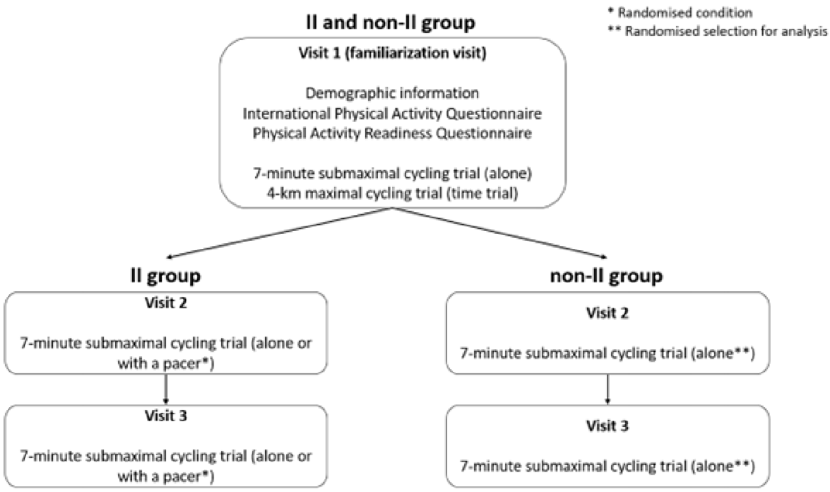

Figure 1. Flow chart of the research protocol for the II and the non-II group.

Statistical analysis

Due to the violation of normality assumption using a Shapiro-Wilk test of normality, a series of rank-based non-parametric analyses were conducted. For all the analyses, the velocity (provides direction from the targeted velocity) and the Absolute Percentage Deviation (APD; the percentage deviation from the targeted velocity without taking into consideration the direction of the deviation) were used as the main dependent variables.

To test the differences in the ability of people with and without II to maintain a pre-planned steady pace (aim 1), we performed non-parametric tests for repeated measures data. More specifically, the Anova-Type Statistic (ATS) and the modified ATS were used to test main and interaction effects [287-289]. For the first aim's analyses we used the minutes as the within-subjects factor (seven time points). For the velocity differences, participants' velocity and targeted velocity for each group were used as the between-subjects factors while for the APD differences, the group (II and non-II group) was used.

To test whether verbal feedback could facilitate the ability of people with II to maintain a sub-maximal velocity (aim 2) we performed a series of ATS per condition (for the 'alone' and the 'pacer' condition) with the minutes as the within-subjects factor (seven time points). Multiple stepwise procedures confirmed if there were any significant velocity and/or APD differences between the first five (with feedback) and the sixth or seventh minute (without feedback) within each trial (with an adjusted *p* value based on Campbell and Skillings modification).

To explore if the introduction of a pacer can help participants with II to keep a steady pace (aim 3), we performed another ATS for each dependent variable. For the third aim's analyses we used the minutes as the within-subjects factor (seven time points). For all the velocity differences, participants' velocity (in both conditions) and targeted velocity were used as the between-subjects factors while for the APD differences, the condition ('alone' and 'pacer') was used.

If any of the ATS yielded any significant differences (between-factor main effects and/or interactions effects), pairwise comparisons between groups and/or conditions were performed at each time point (with a Bonferroni-adjusted *p* value). The statistical analyses above were performed using the 'nparLD' and 'nparcomp' functions in R [287-290]. Using these functions, the relative effects (RTE) were also calculated (increase in the effect indicates an increase in the measured conditions/groups/distances) [287-290]. In addition to all the above, the interquartile range (IQR) and the non-parametric coefficient of variation (np-CV) explored velocity's variation of each group (per minute). Moreover, the Mann-Whitney U test explored the IQR and the np-CV differences between the groups while a Wilcoxon Signed-Rank Test explored the IQR and the np-CV differences between the conditions of the II group. All the analyses were performed using R version 4.1.1 and the level of significance was set at $p \leq .05$ (in addition to the 'Results' section, please see appendix G).

Results

The first aim's analyses (the investigation of differences in the ability of people with and without II to maintain a pre-planned steady pace) did not reveal significant (main nor interaction effects) differences between the participants' velocity and the targeted velocity in II, nor in the non-II group. The velocity's IQR and the np-CV however, were significantly higher in participants with II ($p < .001$ for both variables; see Table 1 and Figure 2 for the velocity variability per minute of the non-II and the II group). The APD was significantly higher in participants with compared to participants without II, $F(1, 13.13) = 64.87$, $p < .001$ (between-factor main effect). The multiple comparisons revealed significant between groups differences ($p < .001$ for the first five minutes and $p=.01$ for the seventh minute) at each time point of the trial except of sixth minute ($p = .16$). In both groups, the APD did not significantly change throughout the duration of the trial (see Table 2 for the descriptive statistics and Figure 2 for the participants' velocity deviation from the targeted velocity for the non-II and the II group).

Within the II group, there were no significant velocity or APD differences in the 'alone' condition ($p = .22$ and .67 respectively) nor in the 'pacer' condition ($p = .48$, and .11, respectively) between the first five (with feedback) and the last two minutes (without feedback). The stepwise multiple comparison analyses confirmed that there were no significant velocity and APD differences between any of the first five (with verbal feedback) with any of the last two minutes (without verbal feedback) in both conditions (aim 2, whether verbal feedback could facilitate the ability of people with II to maintain a sub-maximal velocity).

The third aim's analyses (explore if the introduction of a pacer can help participants with II to keep a steady pace) did not reveal significant (main nor interaction effects) differences between the participants' velocity and the targeted velocity of II group in the 'alone' nor in the 'pacer' condition. The velocity's np-CV were significantly higher in the 'pacer' condition (p =.02; see Table 1 and Figure 3 for the velocity variability per minute of II group in both conditions). The APD was significantly lower in participants with II when they were cycling together with a pacer than alone, $F(1, \infty) = 45.40$, $p < .001$ statistics respectively (between-factor main effect; aim 3). Pairwise comparisons revealed significant between conditions differences ($p < .001$) at each time point of the trials except of the first minute ($p = .09$). In both conditions, the APD did not significantly change throughout the trial (see Table 2 for the descriptive statistics and Figure 3 for the APD differences between the 'alone' and the 'pacer' condition).

Table 1. Velocity variability of the non-II group and the II group in both conditions ('alone' and 'with a pacer').

Variable	Group	Condition	Minutes						
Minutes			1	2	3	4	5	6	7
np-CV (%)									
	Non-II	Alone	.95	5.03	2.08	4.20	.76	1.52	1.80
	II	Alone	20.59	22.24	20.46	18.85	23.50	28.34	33.51
	II	Pacer	15.56	20.33	20.90	18.02	15.78	19.04	15.40

Note. *np-CV (%)* = non-parametric Coefficient of Variation (%).

Table 2. Descriptive statistics of APD (%), velocity (km/h), and targeted velocity (km/h) variables for II and non-II group in both conditions (alone and with a pacer) during the 7-minute trials.

Variable	Source	*Mdn*	*IQR*	*Min*	*Max*
APD					
	II group (alone)	11.16	32.14	.13	74.41
	II group (pacer)	2.92	7.31	.08	37.62
	Non-II group (alone)	.90	.89	.08	2.31

Velocity					
	II group (alone)	12.47	4.71	10.73	20.36
	II group (pacer)	13.25	3.71	10.94	15.38
	Non-II group (alone)	20.85	1.42	18.67	23.59
Targeted Velocity					
	II group	13.00	2.50	9.40	15.40
	Non-II group	20.80	1.30	18.60	23.60

Note. *Mdn* = Median, *IQR* = Interquartile Range, *Min* = Minimum, *Max* = Maximum.

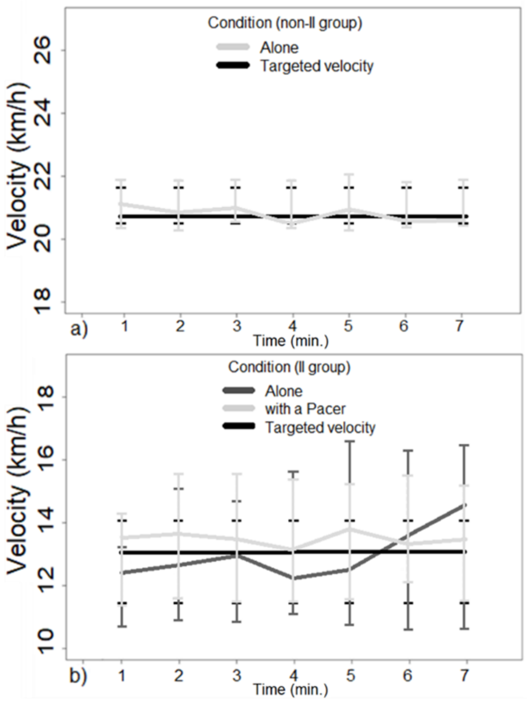

Figure 2. Line graphs with the participants' median velocity and targeted velocity (+ interquartile ranges) for the non-II group (Figure 2a) and the II group (Figure 2b).

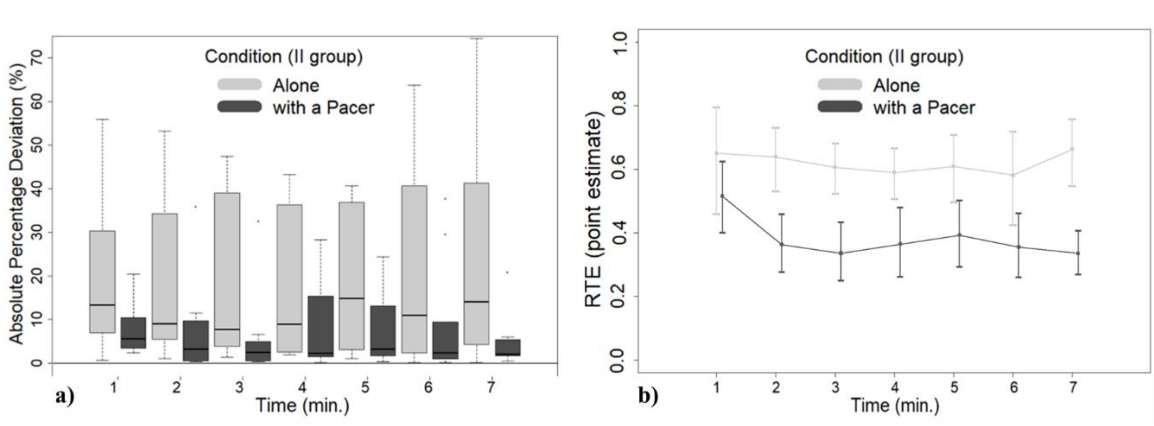

Figure 3. Box plots with the APD differences and the relative effects (+95% confidence intervals) of the II group at the 'alone' and the 'with a pacer' condition.

Discussion

The current study aimed to explore the differences in the ability of people with and without II to maintain a pre-planned steady pace (aim 1), if verbal feedback could facilitate the ability of people with II to maintain a sub-maximal velocity (aim 2), and if the introduction of a pacer can help participants with II to keep a steady pace during a cycling activity (aim 3). The results supported our first hypothesis, as they revealed that people with II have an impaired ability to maintain a pre-planned sub-maximal cycling velocity and have higher velocity variability compared to people without II. This establishes the role of cognition in exercise regulation, related to the self-regulatory limitations of people with II [145]. People with II are dealing with impaired attention skills [15] which impact on their ability to appropriately maintain on-task behaviours and monitor their actions [157]. Their inadequate strategies to maintain self-control and their low inhibition levels [132] could also justify their inability to adequately maintain a pre-planned steady pace. Additionally, the ability to focus attention to the trial's goal (e.g., maintain a pre-planned velocity), recall a previous pacing behaviour (e.g., from familiarisation trial; updating), and resist self-generated distractions (e.g., their emotions; inhibition), are executive functions that support the self-regulatory action of pacing [108], but are impaired in people with II [15, 132]. During the cycling trial, the auditory (beeps) and visual (markers) stimuli could be characterised as affordances to support action possibilities and are related to the participants' ability to use them [72]. The decision-making deficits and the multisensory (combined visual/auditory) difficulties that people with II experience, could lead them to inappropriately react to the trial's affordances and deviate more from the targeted velocity in comparison to the participants without II [15, 291].

Due to the impaired pacing skills of people with II, it is important to explore how we can improve the pacing behaviour of this population using less cognitive-demanding strategies [145]. The findings do not support our hypothesis (verbal feedback will facilitate the participants' pacing performance) as the researchers' verbal feedback did not improve the ability of this population to maintain a steady pace. Even if coaches could facilitate the pacing behaviour of their athletes [193, 280], it seems that providing verbal feedback to people with II is more complicated. Due to their impaired judging and communication abilities, they may misunderstand instructions and respond differently to the verbal cues [216]. Moreover, due to the multitasking and multisensory (combined visual/auditory) deficits of people with II [291, 292], the coupling of visual and verbal feedback (as well as the coupling of visual and auditory feedback at the 'alone' condition) may be more challenging for this population and cannot sufficiently reduce the cognitive load of the cycling trial. This outcome is contrary to that of Van Biesen et al [35] who found that runners with II deviate less from the target pace when the verbal feedback is present. The differences may occur due to the different test settings, as our testing protocol took place in a laboratory environment with less environmental cues that may influence their attention and make them deviate even more from target pace.

As the verbal feedback seems challenging and did not improve the pacing skills of people with II, it is important to further explore other less cognitive-demanding processes to assist their pacing behaviour and associated performance. The findings supported our hypothesis (the presence of a pacer will facilitate the pacing performance of the participants), as the presence of a pacer improved the ability of participants with II to maintain a pre-planned sub-maximal cycling velocity. This could be an indication that cycling with a pacer (visual feedback only), is a less cognitive demanding strategy which is based mainly on intuitive than deliberate decision-making [37]. During this process, the coupling of perception (e.g., the position of the pacer) and action (e.g., velocity adaptation) could facilitate a more appropriate pacing behaviour [30, 74]. More specifically, it seems that the pacers act as social affordances that alter the pacing actions of the cyclists with II by keeping people with II focused, motivated, and engaged. [36, 74]. This enhanced focus and motivation could be supported by the need of people with II in interacting with others [282], and positively influence participants' attentional flexibility and performance, distract them from external cues, focus more on the pacer's behaviour, and perform better during the cycling activity [280, 293]. Moreover, the pacers could be considered as the visual representation of the trial's goal (maintain a sub-maximal velocity) and provided feedback to the participants about their pacing behaviour and enhance athletes' self-control ability [117, 164, 280].

This study revealed that people with II have an impaired ability to maintain a pre-planned sub-maximal cycling velocity and the presence of a pacer, but not verbal feedback, improved the ability of participants with II to maintain a pre-planned sub-maximal cycling velocity. The self-regulatory deficits of people with II could negatively impact how and where they distribute their energy in physical activities and lead them to inadequate, faster pacing patterns and early fatigue [15, 20, 279]. As affective reactions are more negative during high intensity exercise activities [294], the faster pacing patterns of people with II may critically influence their affective responses and lead them to low levels of exercise and sports engagement [4, 295]. This is something that coaches should take into consideration, as it could make the inclusion of people with II in exercise and sports more challenging. Thus, it is important coaches to have the appropriate knowledge of people with II needs and adaptations-needed to sufficiently interact with them in exercise settings and offer them mainstreamed exercise and sports opportunities [282]. For instance, due to the communication deficits, verbal feedback may not be the most beneficial way to give directions and instructions. The coupling with a peer without II however, could help them feel more included in mainstream sport activities, build rapport with other exercisers, and improve their sport-related skills [282]. As people with II participate in sports to interact with other individuals [282], the coupling with a peer is a need-supportive coaching style technique (focusses on the peoples' need of relatedness) that could enhance the autonomous motivation of people with II and their willingness to participate in sports [23, 296]. Additionally, the lower levels of pacing variability when a pacer is present, will give us the opportunity to better generalise results and predict the behaviour of athletes with II during an exercise task, and ensure a smoother inclusion in exercise and sports [8, 297].

The current study, however, is subject to limitations. For instance, due to our focus on participants with II, the role of the pacer on the ability of participants without II to keep a steady pace was not explored. Future research should pay more attention to the exercisers-social environment interdependency, and how other individuals could influence the pacing skills and behaviour of exercisers without II.

As this study revealed that the ability to maintain a pre-planned sub-maximal cycling velocity is a critical component of pacing in sports participation and performance [35], it would be interesting to explore the role of the social environment in pacing of people with II in sports performance specific activities. This would give us more knowledge to efficiently support and coach people with II and offer them more sports participation and performance pathways.

Conclusion

This study confirmed the role of cognition in exercise regulation, by showing that people with II have an impaired self-regulatory ability to maintain a pre-planned sub-maximal steady pace. Moreover, verbal feedback may not be appropriate to improve the self-regulatory and pacing skills of people with II. However, the introduction of a social affordance (another cyclist) is an intuitive stimulus that provides direct pacing and performance feedback (visual stimuli), improves peoples' attention, and positively influences the pacing skills of people with II. The study provided deeper insights in our understanding of exercise behaviour and the role of cognition and self-regulation. Knowledge gained from this study can be used by coaches who want to effectively coach people with II and who want to offer inclusive exercise opportunities.

Chapter 7: The role of cognition and social factors in competition: How do people with Intellectual Impairments respond to their opponents?

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Abstract

Exploring pacing behaviour in people with Intellectual Impairments (II) in competition will help to better understand the impact of cognition and social environment in sports, which helps in guiding us in shaping proper inclusive sports environments. The present study aimed to 1) compare the pacing behaviour and performance between people with and without II who are inexperienced in cycling and 2) investigate how these are influenced by an opponent. Participants with (n = 8) and without II (n = 10) performed two randomised 4-km maximal cycling trials, alone and against an opponent (head-to-head). Non-parametric tests for repeated measures data ($p \leq .05$) revealed that people with II cycled slower, but with higher inter-individual variation (both conditions) and paced themselves differently compared to people without II when they compete against an opponent. In the presence of an opponent, the performance of the participants with II decreased, where previous literature in athletes without II consistently led to performance improvements. This could suggest that the pacing behaviour of people with II during a competitive trial significantly depends on intuitive actions and less on deliberate planning skills. The negative influence of the opponents however, indicates the difficulties of people with II to adequately use their opponents as a self-regulatory, motivational, pacing, and performance facilitators in maximal trials. Coaches who want to offer inclusive sports environments for people with II should take these findings into consideration.

Keywords: pacing; time trial; head-to-head trial; sports performance; self-regulation

Introduction

People with Intellectual Impairments (II) want to progress in their chosen sport, improve their sport-related skills and become better athletes [282]. Thus, it is a responsibility of an inclusive society to ensure that people with II can participate and compete in the sport of their choice and master their sports performance [145, 223]. However, recent studies' results revealed that the coaches often do not know how to appropriately coach people with II and how to adapt to the specific needs of this population [7, 282, 296]. It also seems that coaches are struggling to offer appropriate sports environments to people with II to develop and improve their sport-related skills [296]. Thus, more research in sports performance of people with II could offer the appropriate knowledge to efficiently support and appropriately coach them [282, 296]. It could also facilitate their inclusion in sports competitions, through a better understanding of the impact of cognition on sport performance [34, 145].

People with II are dealing with intellectual (IQ ≤ 70) and adaptive skills limitations (practical, social, and conceptual skills) which are manifested before the age of 18 years old [10]. Their cognitive limitations resulted in lower sports achievements [43] and impaired technical aspects of sports performance, including impaired pacing skills in athletics and cycling [34, 35, 145].

Pacing in sports is the self-regulatory process in which athletes need to decide how they will distribute their limited energy resources during a race [29, 30] and it is characterised as a critical component of sports performance [49, 87]. During sport competitions, athletes are constantly looking for information to monitor and self-control their pacing behaviour [108]. The presence of opponents, a well-known competitive scenario in sports, has been shown to impact on this process [74, 163]. Through the coupling of perception and action, opponents have been suggested to act as visual stimuli (social affordances) providing visual guidance and feedback during sports trials and inviting athletes to adapt their pacing behaviour [30, 74, 163, 298]. Interestingly, even though we have consistently found that athletes perform better when they compete against an opponent compared to alone, they rate their perceived exertion similarly in both conditions [164, 188]. Thus, opponents may act as social placebos, motivate athletes, and help them to better regulate their effort and the negative perceptions of fatigue less (through distraction/dissociation) [58, 162, 164, 188, 280].

The studies above focused on athletes without II, while the pacing behaviour of people with II has received limited attention in the literature. Recent studies showed the impact of cognition and social environment in pacing skills [35, 217]. For instance, the introduction of a pacer (direct visual stimuli) improved the impaired ability of people with II to maintain a steady pace during a sub-maximal intensity cycling trial [217]. However, it is still unknown how the social environment influences time trials at maximal intensity, and if people with II can adequately respond to their opponents and appropriately pace their actions during a competitive situation. It has been proposed that decision-making in pacing is based on intuitive (responses to the environment) and/or deliberate (pre-planned) responses [37]. Previous research [36] revealed that people with II engage mainly in intuitive decision-making, where the social environment (e.g., opponents) offers visual guidance during a sports activity. Due to this interdependency and the difficulties of people with II to regulate their pacing [34, 35, 145], opponents could be a beneficial pacing and performance facilitator for this population. More specifically, they could provide direct pacing feedback, act as external distractions and positively influence the affective responses of people with II [30, 280]. Due to the high levels of ego orientation [239], people with II could be motivated by their opponents and use the competition to demonstrate competence [299]. Further investigation of the pacing behaviour of this population in different competitive environments (e.g., with and without opponents) in sports where pacing is critical (e.g., cycling) could help us better understand the impact of cognition in sport performance and how people with II respond to different social situations. It will also provide information to coaches on how to appropriately train and develop the pacing skills and performance of people with II in an inclusive sport environment [8].

Based on all the above, this paper aims to: 1) investigate the performance and pacing behaviour differences of people with and without II during a maximal cycling time trial and 2) explore the influence of a competitive opponent on the cycling performance and pacing behaviour of people with and without II. Due to the impact of II on sports performance [34, 135], we hypothesise that people without II will perform better in all cycling trials compared to people without II. Due to the cognitive nature of pacing [15, 35] and the cognitive deficits of people with II (e.g., decision-making) [10], we expect that people with and without II will pace themselves differently within the 'alone' trial (without an opponent). Moreover, as previous studies revealed, the presence of an opponent ('head-to-head' trial) will positively influence the pacing behaviour and performance of people without II [58, 117, 163]. Due to the pacing limitations of people with II, we also hypothesise that the role of the opponent will be even more beneficial in this population, will offer self-regulatory guidance and assistance, and will improve the pacing behaviour and performance of people with II at the head-to-head trials [280].

Methodology

Participants

After obtaining ethical approval by the university's Ethics Board (reference number: 15746), participants were recruited through charities, sports clubs and sports organisations via phone calls and e-mails. Eight people with (seven males and one female; age = 37 ± 8 years old) and ten people without II (six males and four females; age = 24 ± 2 years old) consented to partake in our research study. An information letter written in 'easy read' language had been provided to the participants with II. Due to the vulnerability of the participants with II, the researchers provided an additional information letter to their legal guardians and also asked for their consent prior the participation of their protected person in the study.

Our purpose was to recruit participants with and without II with similar exercise levels thus, we administered the International Physical Activity Questionnaire short form (IPAQ-short form), a valid and reliable instrument that estimated participants exercise levels [286]. We recruited only moderate to highly active adult participants who were novices in cycling. Moreover, participants with II met the criteria for II diagnosis as set by the BPS [10]: limitations in adaptive and intellectual functioning (IQ $\leq$ 70) and limitations in conceptual, practical, and social skills which manifested before the age of 18 years old. People with severe II and people who could not understand the activities' concept and/or instructions were excluded from the study. Prior to testing, participants (legal guardians and researchers assisted the participants with II) completed the Physical Active Readiness Questionnaire+ (IPAQ+) [283-285]. Participants with any related chronic conditions which may be contraindicated or exacerbated by cycling and/or participants with physical impairments were excluded.

Procedure

All participants visited the laboratory on three separate occasions and performed a 4-km maximal cycling trial per visit (three visits in total, with at least one week difference between each visit). Before each trial, the participants performed a warm-up consisting of seven minutes of sub-maximal cycling. The trials were performed on a Velotron cycle ergometer (Velotron Dynafit, Racermate, Seattle, USA), using a flat and straight course. A projector was used so participants could see a real life-sized virtual avatar of themselves on a projection screen. During the first visit, participants were familiarised with the equipment, the protocol, and performed a familiarisation trial (without an opponent).

During the second and the third visit, participants cycled in two different conditions, alone and against an (virtual) opponent (head-to-head). A computerized randomization using Excel (Microsoft Office Excel, 2007) was used to determine the order of the condition that each participant cycled in the second and third visit (alone or against an opponent). During the 'alone' condition, participants were instructed to 'finish the cycling trial as fast as possible'. During the 'head-to-head' condition, participants were instructed to 'beat the virtual opponent'. To ensure the participants' perception of a realistic opponent, the virtual opponent's cycling velocity was based on the participant's own performance in the familiarisation trial. As a previous study revealed that inexperienced athletes without II improved their performance by 5% after one visit, the opponents' cycling velocity was set at +5% of the participants' cycling velocity at the familiarisation trial, so the participants were set to compete against a similar level opponent [48]. Before each trial, researchers ensured that the participants were aware of the trial's goal. Researchers did not provide any performance feedback (e.g., time or velocity feedback) during the trials.

Researchers recorded participants' rate of perceived exertion (RPE) before, after, and twice during the trials (first, second or third km, based on a computerized randomization using Excel). A 3-point OMNI scale was used for the participants with II and a 0- 10 OMNI scale was used for the participants without II (Please see appendix F) [300]. Additionally, participants' power output and velocity were recorded (25Hz) and their average values per 500 meters were calculated. Researchers took safety measures to prevent unnecessary illness (COVID-19 related) and injuries and carefully explain them to the participants. All trials were conducted in ambient temperature level, between 19°C and 21°C.

Statistical analysis

For the analyses, the power output and the velocity were used as the dependent variables. The violation of normality assumption (Shapiro-Wilk test of normality) led us to conduct a series of rank-based non-parametric analyses. To address aim 1 (e.g., if there are performance and pacing behaviour differences between people with and without II during the trials), we performed non-parametric tests for repeated measures data. More specifically, the Anova-Type Statistic (ATS) and the modified ATS were used to test main and interaction effects [287-289]. Analyses were performed separately for each condition.

For the analyses we used the two groups (participants with and without II) as the between-subjects' factor and the distance (eight distance points, per 500 meters) as the within-subjects' factor.

To address aim 2 (e.g., if the presence of an opponent can influence the cycling performance and pacing behaviour of people with and without II), we performed a series of ATS. For these analyses we used the different condition of each group ('alone' and 'head-to-head') as the between-subjects' factor and the distance (eight distance points, per 500 meters) as the within-subjects factor.

To better understand the participants' performance and pacing behaviour, we used two additional ATS (one for each group) to investigate the velocity differences between the participants at the 'head-to-head' condition and their virtual opponents (between-subjects) during the eight distance points of the cycling trials (within-subjects). ATS and modified ATS were also used to explore the RPE differences between the 'alone' and 'head-to-head' condition (between-subjects) of each group during the three time points (before, during and after) of the cycling trials (within-subjects).

The between-factor main effects represent the performance differences between groups/conditions. The within-factor main effects represent the pacing behaviour differences within the groups/conditions. If any of the ATS analyses yielded significant interaction effects, pairwise comparisons between groups/conditions (with a Bonferroni-adjusted p value) and within each group/condition (with an adjusted *p* value based on Campbell and Skillings modification) were performed to determine where the differences occurred. The statistical analyses were performed on R version 4.1.1, using the 'nparLD' and 'nparcomp' functions [287-290]. Using these functions, the relative effects (RTE) were also calculated (increase in the effect indicates an increase in the measured conditions/groups/distances) [287-290]. A non-parametric version of the coefficient of variation (np-CV) was also used to analyse the inter-individual variation of each group in each condition. The level of significance for all the analyses was set at $p \leq .05$ (in addition to the ‘Results’ section, please see appendix H and I).

Results

Pacing and performance differences between groups (II and non-II group in each condition; aim 1)

In the ‘alone’ condition, the power output, $F(1, 15.98) = 44.49$, $p < .001$, and the velocity, $F(1, 15.89) = 45.90$, $p < .001$, were significantly lower in participants with compared to participants without II (between-factor main effect). The analysis also showed significant within-factor differences (eight distance points, per 500 meters) for the power output, $F(3.25, \infty) = 5.77$, $p < .001$, and the velocity, $F(3.37, \infty) = 10.19$, $p < .001$, but did not reveal significant interaction effects.

In the ‘head-to-head’ condition, the power output, $F(1, 15.98) = 52.99$, $p < .001$, and the velocity**,** $F(1, 15.73) = 61.27$, $p < .001$, were significantly lower in participants with II, compared to participants without II (between-factor main effect). The analysis also revealed significant within-factor differences (eight distance points, per 500 meters) for the power output, $F(2.51, \infty) = 4.64$, $p < .01$, and the velocity, $F(3.10, \infty) = 11.62$, $p < .001$. Furthermore, it revealed significant interaction effects for the velocity, $F(3.10, \infty) = 61.27$, $p = .01$, but not for the power output. Pairwise comparisons revealed significant between group velocity differences between the participants with and without II at each time point of the trials ($p < .01$). A further analysis showed significant velocity differences only within the ‘head-to-head’ condition of the participants without II ($p < .001$). Multiple comparisons within groups revealed significant within group (participants without II) differences between the 0-0.5-km (*Mdn* = 27.30, *IQR* = 4.10, RankMeans = 27.00) and the 1-1.5-km (*Mdn* = 30.61, *IQR* = 2.75; $p = .02$, RankMeans = 36.00) and between the 0-0.5-km (*Mdn* = 27.30, *IQR* = 4.10, RankMeans = 27.00) and the 3.5-4-km (*Mdn* = 31.53, *IQR* = 3.62; $p = .04$, Rank Means = 39.37). For the descriptive data and the inter-individual variances of power output and velocity for both groups, in both conditions, please see

Table 1. Please also see Figure 1 for the individual pacing strategies and figure 2 for the relative effects.

Table 1. Descriptive statistics of power output (Watts) and velocity (km/h) variables for II and non-II group in 'alone' and 'head-to-head' condition (4-km) and the minute-by-minute np-CV(%) of power output and velocity.

Variable	Source	*Median*	*IQR*	*Min*	*Max*	*np-CV (%)*
Power output						
	II group (alone)	45.05	42.01	28.71	107.93	34.96
	Non-II group (alone)	161.49	40.46	117.42	197.31	18.53
	II group (head-to-head)	36.13	23.63	19.76	102.83	32.28
	Non-II group (head-to-head)	176.77	43.71	122.17	214.26	16.71
Velocity						
	II group (alone)	16.77	6.29	13.74	25.56	19.56
	Non-II group (alone)	30.33	2.72	26.70	32.58	6.97
	II group (head-to-head)	15.13	5.37	11.07	24.58	23.27
	Non-II group (head-to-head)	31.45	2.66	27.04	33.67	6.93

Note. *IQR* = Interquartile Range, *Min* = Minimum, *Max* = Maximum, *np-CV* = non-parametric version of the coefficient of variation.

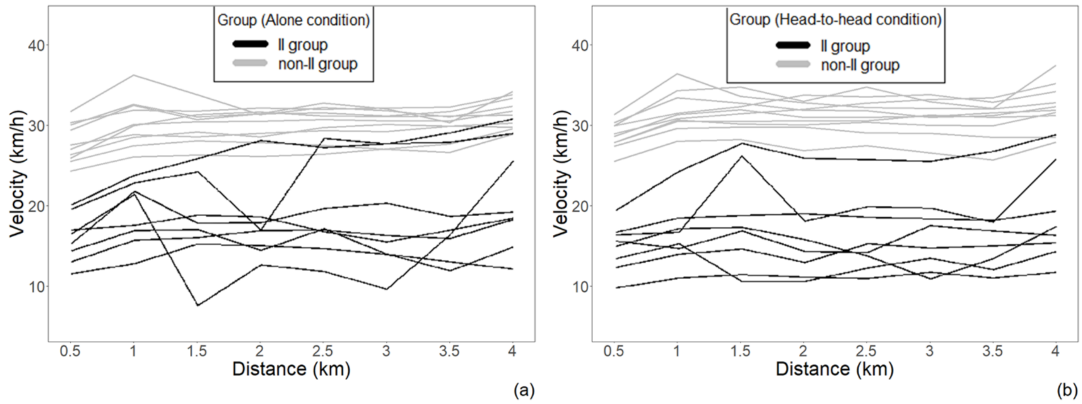

Figure 1. Individual pacing strategies of II and non-II group at the 'alone' condition (Figure 1a.) and the 'head-to-head' condition (Figure 1b.).

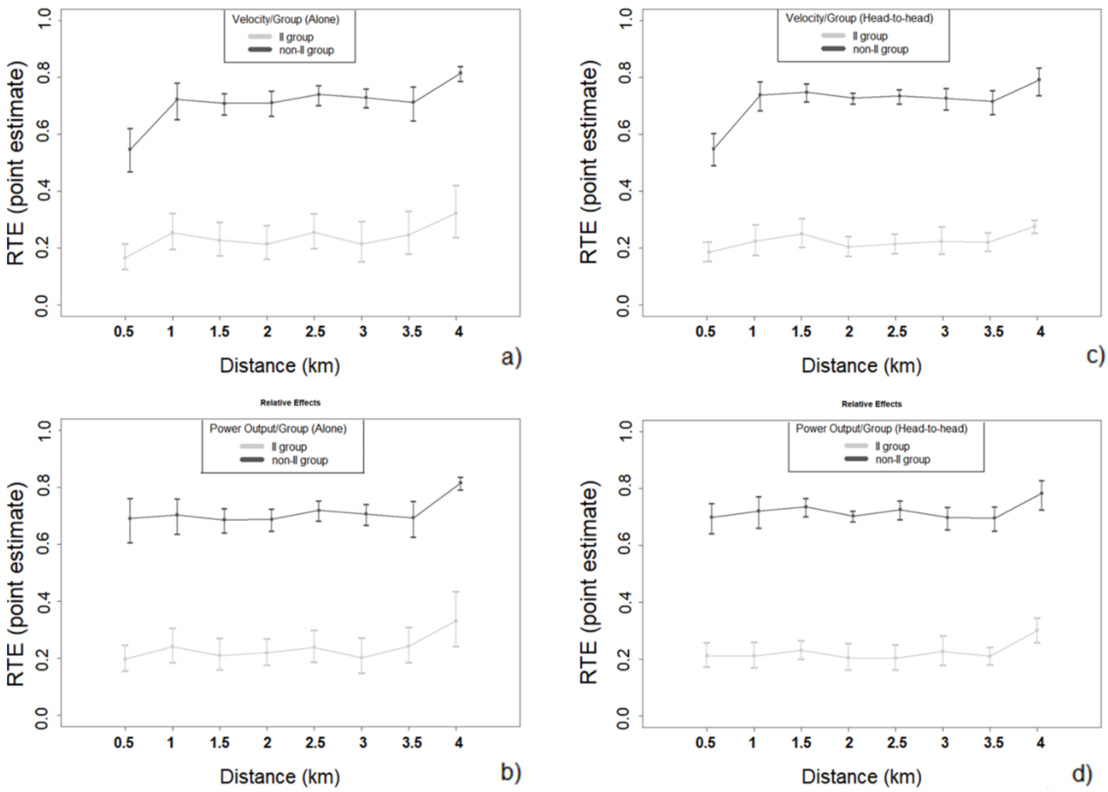

Figure 2. Relative effects and 95% confidence intervals for the velocity and power output of the II and non-II group during the 'alone' (Figure 2a and 2b) and 'head-to-head' condition (Figure 2c and 2d).

Pacing and performance differences between conditions ('alone' and 'head-to-head'; aim 2)

The power output and the velocity of the participants with II were significantly higher in the ‘alone’ compared to the ‘head-to-head’ condition, $F(1, \infty) = 5.27$, $p = .02$ and $F(1, \infty) = 5.58$, $p = .01$ respectively (between-factor main effect). The analysis did not reveal a significant within-factor main effect nor significant interaction effects for the participants with II.

The results showed significant power output, $F(2.31, \infty)= 5.11$, $p < .01$, and velocity differences, $F(2.71, \infty)= 21.90$, $p < .001$, within the ‘alone’ and ‘head-to-head’ condition of the participants without II (within-factor main effect). It did not reveal significant between-factor main effects, $F(1, \infty)= 3.38$, $p = .06$ and $F(1, \infty)= 3.01$, $p = .08$, for power output and velocity respectively (which could be considered a trend), nor interaction effects (see Table 1 for the descriptive data and Figure 3 for the II and non-II group box plots respectively).

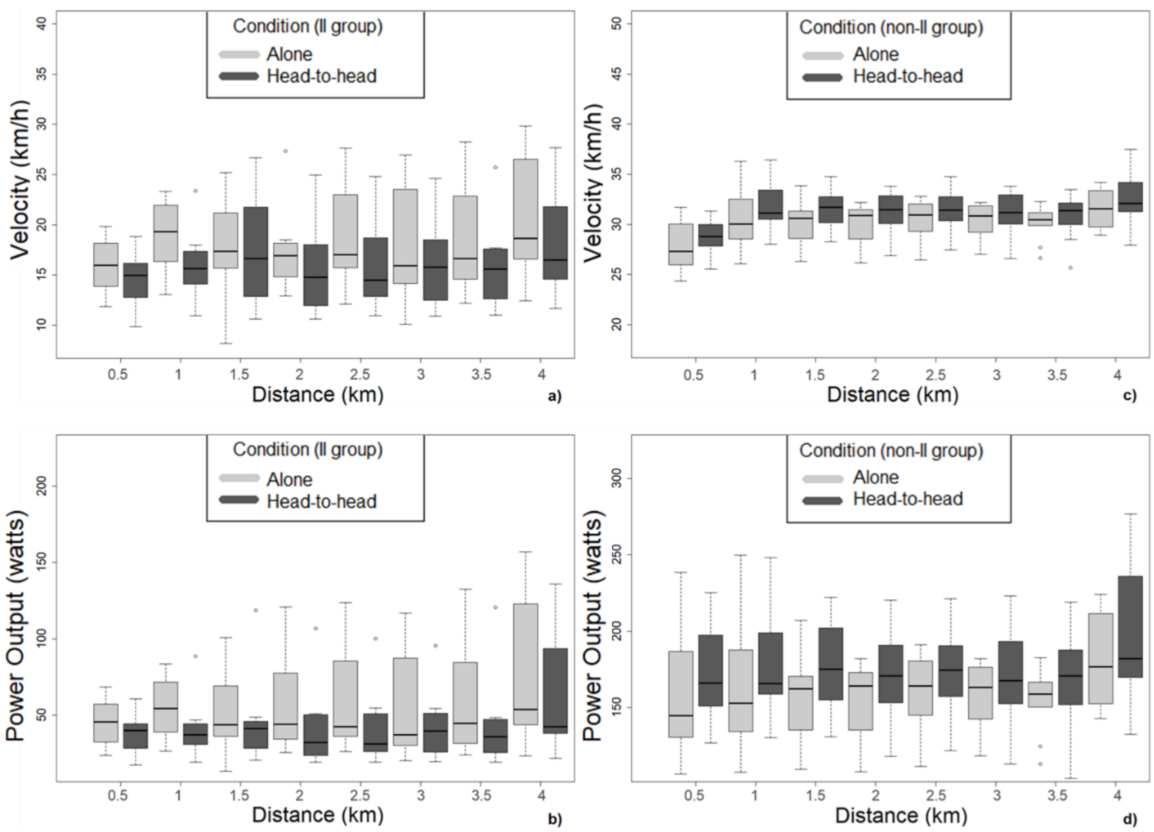

Figure 3. Box plots with the velocity and power output differences per condition (‘alone’ and ‘head-to-head’) for the II (Figure 3a. and 3b.) and the non-II group

(Figure 3c. and 3d.) at different distance points. *Note.* * shows the significant differences at the .05 level.

Moreover, the RPE analysis did not show any significant main effects nor interaction effects for the participants with II between the 'alone' and 'head-to-head' condition. On the other hand, for the participants without II, the RPE level in the 'alone' condition (*Mdn* = 5.50, *IQR* = 1.25) was significantly lower, $F(1, \infty) = 7.94$, $p < .01$, compared to the 'head-to-head' condition (*Mdn* = 5.75, *IQR* = 1.50). The RPE analysis also revealed significant interaction effects, $F(1.86, \infty)= 4.08$, $p = .01$ for the participants without II between the 'alone' and 'head-to-head' condition. Pairwise comparisons revealed significant RPE differences between the 'alone' and 'head-to-head' condition only at the final RPE measurement within the trials ($p < .01$; second or third km, based on a computerized randomization). Additionally, a further analysis showed significant RPE differences within the 'alone' and within the 'head-to-head' condition ($p < .001$). Multiple comparisons within groups revealed significant RPE differences ($p < .05$) between each distance point of the 'alone' and 'against an opponent' trial of the participants without II.

Pacing and performance differences between participants with and without II and their virtual opponents ('head-to-head' condition).

In this study, we also compared the pacing and performance differences of the participants (with and without II) with their virtual opponents (during the head-to-head trial). The comparison between the participants ('head-to-head') and their virtual opponents revealed significant velocity differences within the trials for the participants with, $F(2.70, \infty)= 4.02$, $p < .001$, and without II, $F(2.40, \infty) = 42.16$, $p < .001$. But the results did not reveal significant main effects nor interaction effects for both groups (see Figure 4).

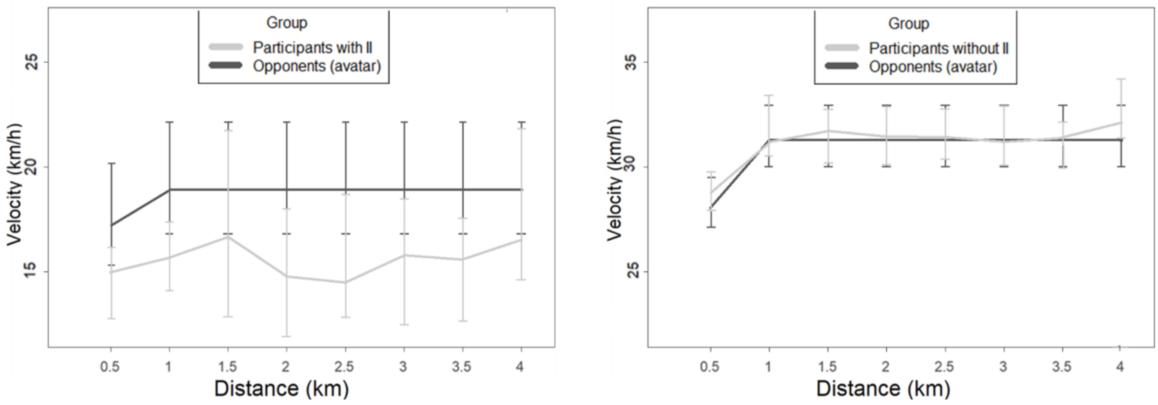

Figure 4. Line graphs with the median velocity differences (+ interquartile ranges) at the 'against an opponent' condition between the participants with (Figure 4a) and without II (Figure 4b) and their virtual opponents (avatars).

Discussion

The first aim of the study was to explore the performance (between-factor effects) and pacing behaviour (interaction effects) differences of people with and without II during a maximal cycling trial. The results partially confirmed our first hypothesis (people with and without II will pace themselves differently within the trials). We found that the power output and the velocity, were significantly lower in participants with, compared to the participants without II (in both conditions). Nonetheless, we only found significant velocity differences within the eight distance points (per 500 meters) of the 'head-to-head' condition of the participants without II. Moreover, the inter-individual variation was higher in all the trials of the participants with, compared to the participants without II. The study also aimed to investigate the influence of an opponent on the cycling performance (between-factor effects) and pacing behaviour (interaction effects) of people with and without II (aim 2). The results did not confirm our hypothesis (the presence of an opponent will influence the pacing behaviour and performance of people with and without II), as they revealed that the presence of an opponent negatively influenced the cycling performance of the participants with II (slower during the 'head-to-head' condition) but not their pacing behaviour. Furthermore, the pacing behaviour of the participants without

II was similar between the ‘alone’ and ‘head-to-head’ condition, while there was a trend towards a faster performance during the latter condition. A possible explanation of the trend, and not the significant performance differences that previous studies demonstrated when people compete against an opponent than alone [164, 188], could be the participants’ experience. The athletic experience positively influences the athletes’ performance and lead them in a better pacing regulation [170]. Thus, the novice participants who were recruited in this study, may respond differently towards their opponents compared to more experienced people [58, 170].

The different pacing behaviours of the participants with and without II during the ‘against an opponent’ condition and the negative influence of an opponent only for the II group, could further support the suggestion that people with II engage mainly in intuitive decision-making in pacing and sports [36]. It could also indicate that people with II perceive and respond differently to the social environment during a maximal trial compared to people without II [30]. People with II experience deficits in interpreting and judging other peoples’ behaviour, social interactions’ difficulties, increased anxiety, and social phobia [10, 18, 19, 203]. These important social cognition processes could lead people with II to analyse a social situation, respond to the environmental cues, and regulate their actions differently compared to people without II [30, 280, 301].

Opponents could be characterised as self-regulatory, pacing, and performance facilitators [280]. The presence of an opponent is theorized to act as a goal-setter, facilitate the self-monitoring skill of people without II, increase their motivation, and help them improve their performance [280]. However, people with II may not properly use the opponents as pacing and performance feedback facilitators during a maximal trial and may find the goal (beat the opponent) challenging and confusing [145]. Interestingly, and in contrast to our results, the presence of a pacer during a sub-maximal cycling trial can facilitate the ability of people with II to self-monitor and improve their ability to maintain a pre-planned sub-maximal velocity [217]. This could be an indication that the self-monitoring skill during a maximal trial is more cognitively demanding, as it requires from athletes to take decisions faster compared to a sub-maximal trial [217, 280]. As people with II make slow and inaccurate decisions during a sport activity [139], the presence of an opponent may be a challenging component that makes their pacing and sports performance development more complicated in competitive sports. These findings indicate the cognitive element of pacing and competition and highlight the impact of II on pacing behaviour and sports performance.

Motivation could also partially explain why participants with II performed slower when they compete against an opponent. In people without II, opponents act as goal setters and motivate them to compete and reach their pacing and performance goals [145, 239]. People with II however, present high controlled motivation [282] and ego orientation [239]. That means that they engage in actions mainly for externally referenced reasons such as to demonstrate competence (e.g., beating an opponent) [299]. Thus, they may abandon the goal to win an opponent who is 5% faster as they could be perceived it as a challenging and unreachable situation. Menting et al [49] revealed that inexperienced athletes without II improved their performance by 5% after one visit however, this may not be realistic for people with II who experience impaired learning skills [10]. Indeed, during the 'against an opponent' trial, the participants with II where always behind their opponents. Until the 1.5-km, participants with II tried to reach their opponents but after that distance point, their velocity gradually decreased (Figure 3.). Even if they increased their velocity the in last km of the trial, it was not enough to reach their opponents' velocity and overtake them (see Figure 4). At a situational level the athlete may be susceptible to judging competence, evaluating success and failure, and continue engaging in sports based on social comparisons [200]. As the pacing behaviour of people with II significantly depends on visual affordances (e.g., the opponents) [36, 302], their inability to outperform their opponents may negatively influence their motivation and their emotional state [200]. For instance, the similar RPE level but the significant slower velocity at the ‘against an opponent’ trial compared to the ‘alone’ trial could be an indication of the emotional challenges that people with II are dealing with when they compete against an opponent and their difficulties to use the opponents as external distractions [280]. The competitive environment could be a challenging situation for people with II [282] that requires further investigation.

Some of the pacing and performance differences between the groups (participants with and without II) were observed in both conditions (‘alone’ and ‘head-to-head’). For instance, participants with II demonstrated higher inter-individual variations in both trials compared to participants without II. This might occur due to the inability of people with II to maintain a pre-planned steady pace [35, 217] and confirms the previous studies which they demonstrated high inter-individual variations in exercise-related activities like technical proficiency [17], physical fitness [303] and reaction time [234]. Additionally, even though we recruited participants with similar physical activity levels who were novice in cycling, participants with II were cycling significantly slower in both conditions compared to the non-II group. Even if the cognitive, self-regulatory and pacing differences between the groups that we mentioned above could partially explain these differences, aspects that are identified in people with II like low muscle strength, low voluntary activation levels and lack of motivation to use maximum effort in sports may also contribute [304, 305]. Moreover, the participants with II were older, which might influence their fitness ability and their capacity to appropriately pace their actions during a maximal trial [170, 306]. Another explanation could be the lack of experience that people with II have in performing maximally [282]. Whilst people with II want to participate in sports, and improve their sport-related skills, coaches may underestimate the athletic identity that they want to develop, focus less on their performance development, and provide less maximal, competitive sports activities [282].

All the information above could be useful for coaches who want to include people with II in sports and improve their performance. With the appropriate adaptations coaches can develop a mainstreaming sports environment where athletes with II will have the opportunity to practice and develop their self-regulatory, pacing and sports performance skills [7, 217]. For instance, in sub-maximal activities, the introduction of another person could provide a visual stimulus which improves exercisers' attention and positively influences the exercise behaviour [217, 280]. In maximal trials however, the competition against (faster) opponents could be a stressful situation [282] that negatively influences the perception and the action of people with II and leads towards deteriorated performance. Thus, coaches who engage people with II in this type of competitive, mastery-avoidance situation, may undermine peoples' sports motivation and negatively influence their further engagement in sports [282]. Coaches who aim to introduce competitive environments to people with II could provide fewer external cues (e.g., social affordances), engage them in mastery competitive experiences (e.g., compete against a slower opponent), introduce less stressful competitive situations (e.g., competitions against peers), and provide additional supportive strategies tailored to their needs and motivations [217, 280, 282, 296]. Moreover, Sakalidis et al [217] revealed that the auditory and verbal feedback (performance feedback) is not helpful to people with II during an exercise task. However, external encouragement can improve the performance of athletes without II [193] and may be a promising (and less cognitive demanding) strategy in people with II which warrants further investigation.

Future studies should further explore the influence of different competitive environments in the pacing behaviour and performance of people with II. For example, the competition against a slower opponent could be a less stressful competitive situation for novice athletes with II that positively influences athletes' emotions, pacing and performance. As pacing can enhance the exercise engagement of people with disabilities and chronic diseases [27, 279] a further investigation of the role of the social environment (e.g., peers, significant others) in physical activity pacing of people with II could be fruitful. More specifically, research should further explore if the social environment can help people with II to better regulate their physical activities, reduce their fatigue perceptions, and ensure a long-term engagement in an active lifestyle.

Conclusion

This study explored the pacing behaviour and performance of people with and without II during different competitive conditions ('alone' and 'head-to-head'). It seems that people with II are cycling slower compared to people without II and they pace their races differently, when they compete against an opponent. Moreover, people with II may not be able to pace themselves appropriately when an opponent is present. The significantly faster power output and velocity during the 'alone compared to 'head-to-head' condition, seem to indicate that the pacing behaviour of people with II significantly influenced by visual affordances. In contrast with the sub-maximal trials however, this independency may negatively influence the self-regulatory behaviour, motivation, and emotions of people with II, revealing the complexity of competitive environments in non-elite athletes. Coaches who want to include people with II in sports environments, should take these findings into consideration, and explore less cognitive demanding approaches to improve athletes' self-regulatory, pacing and performance skills. This study could promote the participation of people with II in sports competitions.

General discussion

The overarching purpose of this PhD thesis was to better understand the sports environment of people with II and to explore the role of the social environment in pacing, sports participation, and optimisation of individuals with II. More specifically, this PhD thesis explored the reasons of the inadequate pacing behaviour of people with II (chapter 1) and investigated the impact of the II in pacing (chapter 2). Then, it proposed a theoretical framework that focusses on how the social environment can support the self-regulatory process of pacing (chapter 3). This thesis also provided a comprehensive understanding of the sports environment of people with II and their motivation in sports participation (chapter 4 and 5). Lastly, using the knowledge of the previous chapters, this thesis examined how the social environment can influence (e.g., peers, opponents) and support (e.g., coaches) the pacing behaviour of people with II (chapter 6 and 7).

Chapters' synopsis

Initially, reasons for the inadequate pacing behaviour of people with II and how the cognitive functions and II may play a role in exercise regulation were explored in literature (chapter 1). It was found that self-regulatory skills, such as the ability to use previous experiences, plan in advance, keep track of the actions during the performance, and evaluate this performance afterwards, are strongly connected with pacing [29]. Moreover, the capability to correctly judge and react (decision-making) to the actions of others [163] and the ability to keep conscious attention during an activity [108] are also relevant to pacing. All these factors are linked to the cognitive capacity of participants and having an II could thus have a deleterious impact on pacing behaviour. For instance, these factors could partially explain the difficulties of athletes with II to maintain a pre-planned sub-maximal velocity and the pacing profile differences between athletes with and without II during both 400- and 1500-meters races [34, 35].

Taking into consideration of these findings, chapter 2 addresses if athletes with II indeed show inferior pacing behaviour in the field setting (in a basketball game) compared to athletes without II. The findings of the observational study (chapter 2) revealed that II games have a higher number of ball possessions and a faster game rhythm (elements of pacing) compared to non-II games. Moreover, the two groups develop their ball possessions and game rhythm over the course of a basketball game differently, with only non-II games to demonstrate significant ball possessions and game rhythm differences across the four quarters of the games. Basketball requires a broader range of cognitive skills [118] and demands from players to react appropriately in a dynamically changing and unpredictable environment [159]. Thus, these differences could be due to the decision-making, tactical and self-regulatory limitations of players with II. These limitations could lead basketball players with II to plan differently their actions (deliberate actions) [139], respond differently to the environmental cues (intuitive actions) [36, 139], adopt fewer collective behaviours, and make quicker offensive decisions during the game compared to basketball players without II [146]. Additionally, the higher number of ball possessions and the faster game rhythm in II games could be an indicator of more intuitive, and thus faster, game-related decision-making [37]. As the social environment is a significant component of intuitive guidance during sports activities [37], the collective pacing behaviour of II teams will likely be affected by different perceptual affordances (e.g., opponent teams) which invite them to adapt and continuously alter their pacing behaviour and their actions [30, 36].

Due to a lack of understanding of the cognitive and pacing deficits of people with II, there is a necessity to develop a theoretical framework that could facilitate and support the pacing behaviour and development of people with II. A promising influential factor of pacing is the social environment [58, 74]. Thus, chapter 3 aimed to develop a theoretical framework that focusses on how the social environment can support the self-regulatory process of pacing. Through review of the literature, we found that self-regulatory processes such as goal setting, peoples' ability to monitor their actions during a trial and to regulate their affective reactions towards them, are affected by the opponents [117, 205, 206]. Moreover, the coaches could observe, step in, and facilitate these processes, especially when athletes are less proficient at self-regulated learning [32]. However, this study was based on the general population. For this reason, an in-depth investigation is needed to explore if the social environment (coaches, opponents, other exercisers) could play an even more critical role people with II who have impaired self-regulatory skills [15, 16] and struggle to regulate their pacing [20, 34]. Due to the complexity of sports for people with II [6] and the potential challenges at the social environment-athlete with II interaction [20, 21], it is necessary to better understand the sports environment for people with II first. For instance, a better understanding of coaches' practices and their role in people's sports motivation and participation will help us to understand needs and issues that arise in the field, will generate rich and novel knowledge to further support people with II in sports settings, and will facilitate the development of appropriate pacing experiments, tailored to the coaches' and athletes' needs [50]. Then, we can further investigate the role of the social environment in the pacing of people with II, test if strategies that tap into their motivation would influence their actions and suggest more proper strategies to support and guide their pacing behaviour.

In light of the above, chapter 4 investigates coaches' perceptions of their coaching practice and their athletes' motivation from the Self-determination Theory perspective. We also explored coaches' perception of their athletes' sports performance progression. We found that the perceived autonomous motivation was lower, and the perceived controlled motivation was higher in athletes with II compared to athletes without II. We also found that the perceived sports performance progression was higher in athletes with II. The results showed also that coaches' need-supportive coaching style can enhance autonomous motivation and prevent the amotivation of athletes with II. At the same time, coaches' need-thwarting style positively predicts amotivation of this population. These findings indicate the importance of the coach-athlete relationship in II sports and suggest that athletes with II may have the capability to recognise different coaching styles and respond accordingly, contrary to common beliefs [216]. However, the different motivation orientations of athletes with and without II and the similar coaching styles of their coaches, indicate that the coaching behaviour towards athletes with II may be influenced less from athletes' motivation. Moreover, these findings could indicate that coaches may have difficulties in adapting their approach to athletes with II needs. Lastly, coaches of athletes with II might unconsciously adopt different standards of sporting success and overestimate their athletes' sports performance progression [238]. These attitudes may be well-intentioned however, when athletes with II accomplishments are portrayed as surprising and/or inspirational it can perpetuate ableism [238].

In chapter 5, we delved further into the motivation of sport participation in athletes with II through their coaches' qualitative account. We found that athletes with II participate in sports to experience positive emotions, interact with other individuals and progress in their chosen sport. Moreover, coaches are trying to be supportive and build meaningful relationships with their athletes. However, coaches of athletes with II adopt mainly a mentor rather than a sport-coaching role and may pay less attention to the athletic identity that people with II may wish to develop [270]. In summary, chapter 4 and 5 revealed that coaches play an important role in the sport participation of athletes with II. However, their challenges in coaching that were detected could make the promotion of inclusive sport opportunities to this population more difficult. In order to further support and guide coaches to effectively coach athletes with II, the next chapters aimed to further confirm the impact of II on pacing and investigate and how the social environment can support, or debilitate, the pacing behaviour of people with II, considering their motivation for competence and social connection (chapter 6 and 7).

Capitalising on the motivation for social connection, the self-regulatory aspect of pacing [29], and the self-regulatory deficits (e.g., planning) of people with II [10], we conducted an experimental study to examine the influence of the social environment (another pacer) on the ability of people with II to maintain a pre-planned sub-maximal velocity (chapter 6). The findings revealed that the ability of this population to maintain a steady pace is impaired. However, the presence of a pacer improved the ability of participants with II to maintain a pre-planned sub-maximal cycling velocity. This could be an indication that sub-maximal cycling with a pacer (visual feedback only), is a less, cognitive demanding strategy as it is based mainly on intuitive than deliberate decision-making [37]. This suggests that the pacing behaviour of people with II depends on various affordances (e.g., pacers, peers) that alter their actions [29, 36] and adequately fulfil their need of relatedness [172, 299]. This highlights the importance of the social environment in keeping people with II focused, motivated, and engaged in a specific sport activity. As the ability to maintain a pre-planned sub-maximal cycling velocity is a critical component of pacing in both sport participation and performance [35], it would be interesting to explore the role of the social environment in pacing of people with II in sports performance specific activities. This would give us more knowledge to efficiently support and coach people with II and offer them more sports participation and performance pathways.

Thus, the seventh study (chapter 7) tested the pacing behaviour of people with II in maximal, competitive conditions. The results revealed that the presence of an opponent negatively influenced the cycling performance of people with II but not their pacing behaviour. We hypothesised that, similar to athletes without II, the presence of an opponent could facilitate the self-monitoring skill of athletes without II, increase their motivation, and help them improve their performance [280]. It seems however, that during a maximal trial, the opponents cannot provide adequate performance and pacing feedback to people with II and act as external distractions [280]. As people with II make slow and inaccurate decisions during a sport activity [139] and experience social cognition deficits [301], the presence of an opponent may be a challenging component that makes their pacing and sports performance development more complicated in competitive sports. Additionally, competing against a faster opponent could undermine the need of competence of athletes with II, decrease their motivation to compete, and further increase the anxiety that people with II experience in competitive events. This could partially explain why participants with II performed slower during the head-to-head trial [172, 239, 299].

What this PhD thesis adds?

This is the first project that explored in depth the role of the social environment in pacing, sports participation, and performance of people with II. It is also the first that made the connection between the social environment, self-regulation, and pacing, and developed a theoretical framework that could further support the self-regulatory process of pacing, as detailed in chapter 3. This project filled the gap in literature about the importance of the coach-athlete with II relationship and provided additional explanation for the sports inclusion difficulties of people with II. It used novel tests and interventions (e.g., the introduction of a pacer in chapter 6 and the instruction of an opponent in chapter 7) to explore the importance of intuitive, visual responses (e.g., other exercisers, opponents) in the sports engagement and performance of individuals with II, providing novel insights and understanding.

With a purpose to ensure a rigorous PhD thesis, the chapters were consisted of accurate and appropriate experimental designs, valid and reliable measurements (e.g., Velotron, questionnaires), randomisation techniques (e.g., randomised order of the participation in different conditions in chapter 6 and 7) and accurate and robust statistical analysis techniques [307]. Moreover, the exploration of the athletes' motivation and progression from different perspectives gave us the opportunity to deeper explore the coach-athlete relationship in sports settings [224]. Additionally, for the qualitative study (chapter 5), we were aware that the interviewer's own experiences and perspectives could influence the research process. To effectively deal with this issue, we used open-ended questions and nonleading language during the interviews. During data analysis, reflective notes (memoing) were recorded to manage interviewer's own perspective and ensure fidelity [258].

The findings revealed that the social environment can support the self-regulatory skills which are critical in pacing but impaired in people with II. The coaches, who have a critical role in enhancing athletes' motivation and promoting an inclusive sports participation, may not know how to effectively coach people with II. The experimental studies provided the necessary insights to provide guidance and showed that a pacer (e.g., peer) can positively influence the exercise regulation of people with II during a sub-maximal trial. The presence of an opponent during a maximal trial however, could have created a cognitive demanding and anxious situation that negatively influence the pacing and sports performance of athletes with II. This PhD thesis focussed on one of the most understudied populations (people with II) [6], explored the impact of cognition in sports, the sports environment of people with II, and ways to support them. Thus, the fruitful findings of the included chapters could guide coaches towards a more inclusive, impactful, and respectful coaching practice towards exercisers and athletes with II. By taking into consideration the insights and the guidance of this thesis, the social environment can offer to people with II more inclusive and positive experiences and promote long-term engagement in sports. They could also facilitate the development of interventions and design of further novel research studies that aim at sustained sports participation of people with II. Last, the findings could promote an appropriate sports performance development of athletes with II and facilitate their re-introduction in sports competitions like Paralympics.

Implications and Practical Recommendations

This PhD thesis provided insightful directions to stakeholders (e.g., coaches) who want to better understand the sports environment of people with II, include them in sports activities, and improve their sport-related skills. It is critical for coaches to realise their crucial role in assisting people to develop the self-regulatory skills that pacing and sports require. It is also important for coaches to identify strategies to facilitate these processes by taking into consideration the role of the social environment (e.g., opponents) as well as peoples' abilities, traits, personality and needs (e.g., through social support, encouraging communication style, and positive feedback in a socially safe environment) [169, 172].

Coaches have an important role in promoting their athletes' autonomous motivation and regulating their amotivation. Thus, it is crucial for coaches to nurture the basic psychological needs of athletes with II. Coaches of athletes with II should provide their athletes with choices and meaningful rationales for the assigned exercises and show them trust in their capabilities regardless of their cognitive limitations. They should also give them clear and simplified instructions and the opportunity to express their needs and anxieties in a socially safe and supportive sports environment [24, 188]. Contrariwise, coaches should avoid thwarting athletes' basic psychological needs as this could engender their feelings of pressure, failure, and loneliness [24, 25], demotivate them from continued sports participation (amotivation), and increase their chances of depression and burnout [221]. Coaches of athletes with II may also unconsciously adopt some ableist attitudes. They may underestimate the athletic identity that people with II may wish to develop and adopt different standards of sporting success [270]. Thus, it is crucial for coaches to listen to their athletes' sporting aspirations and respond to them accordingly. With flexibility in coaching focus in place, inclusive initiatives are likely to be achievable and sustainable [8].

In chapter 6, we have shown that coaches' verbal feedback may not be the most beneficial way to give directions and instructions. However, coupling with a peer could be a need-supportive technique that coaches can use to enhance autonomous motivation of athletes with II, build rapport with other athletes, and improve their sport-related skills [282, 296]. Chapter 7 provided useful information to coaches who want to include people with II in sports and improve their performance. The pairing with an (faster) opponent may hinder the need-supportive coaching style that coaches should develop to enhance autonomous motivation and prevent amotivation of athletes with II [282]. With the appropriate adaptations however (e.g., less external cues, compete against a slower opponent or peer) coaches can develop an appropriate sports environment where athletes with II will have the opportunity to practice and develop their self-regulatory, pacing and sports performance skills [280].

Besides to coaches, this thesis could provide valuable information to athletes with II. The athletes with II should understand the important role of the social environment in sports. They should build meaningful relationships with their coaches and other athletes (chapter 3 and 4) and seek their support before, during, and after exercise tasks. The thesis could also inform them that the social environment may positively (e.g., pacers, teammates, or peers) or negatively (e.g., opponents) influence their sports engagement and performance (chapter 5 and 6).

Additionally, the thesis has provided some insights for the re-introduction of athletes with II in Paralympics. The International Paralympic Committee (IPC) is using an evidence-based approach to determine which athletes are eligible to compete in a Paralympic sport [5]. At present, the classification of athletes with II is an individual process, where the impact of their II on sports performance is determined [5]. Chapter 1 illuminated connections of pacing with the cognitive and sport specific skills tested within the Paralympic classification procedure for athletes with II. Chapter 2 proposed that the investigation of team performance variables, such as ball possessions, could be an additional classification stage that facilitates the classification of athletes with II in team sports. Moreover, the pacing behaviour differences between people with and without II that we found in chapters 6 and 7 could be the first step to develop eligibility criteria for athletes with II so they can participate in future Paralympic Games [5].

Limitations

Specific limitations related to each study are outlined in each chapter respectively. The following section will explore more general limitations related to this course of investigation that warrants acknowledgement.

First, a limitation could be that the chapters 3 and 4 were based only on coaches' perceptions and did not take into consideration the opinions and the lived experiences of people with II. This approach could raise some issues of intellectual ableism, where a proxy respondent is preferred over a person with II [226]. Due to the difficulties in administering questionnaires and interviewing people with II [275, 308] and the challenging period of the data collection (pandemic) we chose to focus on coaches' perceptions. The exploration of the athletes' experiences from a different perspective also gave the opportunity to further explore the coach-athlete with II relationship in sports settings [224]. Future studies should focus more on the perspectives of athletes with II with a purpose to 'give a voice to the voiceless'.

Another limitation was that participants' legal guardians were not willing to provide us with the exact IQ score of their protected individuals (chapter 6 and 7). The researchers were ensured that participants with II met the criteria for diagnosis of II as set by the BPS [10]: limitations in intellectual and adaptive functioning with an IQ $\leq$ 70, limitations in practical, social, and conceptual skills, and manifested before the age of 18 years old. However, a better idea of this population IQ score would give us the opportunity to shed more light on the impact of cognition in sports behaviour and how differently people with mild or moderate II react to their social environment's actions. Moreover, the high variability and the broad confidence intervals that were detected for the II group in these chapters (6 and 7), could be an indication that a larger sample size may needed to increase the generalisability of the chapters' results [309].

Furthermore, the self-regulatory skills of athletes with II could not be directly tested due to a lack of validated instruments that measure self-regulatory skills for this population. For instance, Toering et al [310] developed the Self-Regulation of Learning Self-Report Scale (SRL-SRS). The SRL-SRS is 46-items scale [310] that is based on Zimmerman's self-regulated learning theory [169] and is constructed to measure self-regulation in multiple learning domains, such as school, exercise, physical activity, and sports. The SRL-SRS subscales are planning (8 items), self-monitoring (8 items), evaluation (8 items), reflection (5 items), effort (8 items), and self-efficacy (9 items). In general, SRL-SRS is a reliable scale, with acceptable construct and content validity [310]. The SRL-SRS seems the most appropriate instrument to use however, the exploration of instrument's validity and reliability was not feasible, and the questionnaires' length was not appropriate for people with II. Due to the challenges of administrating questionnaires to people with II [311], we could not directly explore the relationships between participants' self-regulatory skills and pacing behaviour. Thus, we used a narrative approach to explain why the social environment influences the pacing behaviour of the participants with II (e.g., a pacer influence participants' self-monitoring and distract them from external cues).

Future studies

It is important to acknowledge that future research could fruitfully explore the questions that this thesis has raised. For instance, future research should develop and validate a self-regulation instrument, adapted to the needs and the cognitive limitations of people with II. For example, more time should be allowed to complete the questionnaires, and a minimum level of verbal expression or reading comprehension should be incorporated (short sentences, use of easy words, easy answer formats) [311]. This will provide researchers the opportunity to further investigate the relationships of the self-regulatory skills (e.g., planning, self-monitoring, self-judgement) with the pacing behaviour of people with II. It will also demonstrate how self-regulation may predict the pacing of this population in different conditions (e.g., with or without opponent, pacer, or another exerciser) in sports participation and performance settings.

Future research could also examine the pacing behaviour of athletes with II in training and in competitions. The field studies could explore the pacing behaviour of novice and elite athletes with II in different competitive environments. For instance, it could be useful to explore in a real-word and natural sport environment, how athletes with II pace themselves in time-trials and in head-to-head trials (with one or more opponents). This could help coaches to develop most appropriate training sessions for their athletes with II so they can develop their sports performance skills. Moreover, the comparison of the pacing behaviour of athletes with and without II in the conditions above, would shed light on the role of cognition in pacing and how pacing specific limitations may lead athletes with II to impaired sports performance. This could be useful in the evidence-based approach to classification in Paralympics [5], which classifies participants according to the impact of their impairment on sport performance and could further support the decision to reinclude athletics in the Paralympic Games.

It is a question for future research to examine the pacing behaviour of people with II in leading an active lifestyle and to explore how the social environment could facilitate this process. For example, one of our future studies will try to explore the influence of the social environment in the pacing behaviour of people with and without II during the Six Minute Walk Test (6MWT), a well-known standardised test predicting daily functioning [312]. Moreover, waist-worn triaxial accelerometers, self-report, and proxy measures could be used to assess the physical activity levels and patterns of people with II within the day [313]. Then, the relationships of physical activity behaviour with the social support could be explored, to find out the importance of the social environment in the pacing behaviour and physical activity engagement of people with II. The insights from our findings (chapters 4, 5, and 6), and the suggested studies above could facilitate the development of a socio-environmental physical activity intervention. For instance, a Randomised Controlled Trial (RCT) where people with II participate in various physical activities with their peers, carers, and/or parents, could provide valuable information about how the social environment can facilitate physical activities regulation of people with II within the day and their importance in the physical activity engagement and enjoyment of this population.

Conclusion

This PhD thesis has furthered our understanding the sports environment of people with II and the role of the social environment in pacing, sports participation, and performance optimisation of individuals with II. We investigated how II and self-regulation may impact pacing behaviour in people with II. We developed a theoretical framework that focusses on how the social environment can support the self-regulatory process of pacing before, during and after the competition. Then, we shed light on the complexity of the coach-athlete relationship in sports settings and revealed how coaches can promote sports motivation and inclusive sports participation of people with II. However, the difficulties and challenges in coaching people with II may hinder their sports participation. Thus, coaches need more support and guidance to effectively coach athletes with II in order to enhance their positive sporting experiences. By considering the theoretical framework that we developed and the necessity to suggest sports participation and performance strategies to coaches, this PhD thesis investigated how the social environment can support and guide the pacing behaviour of people with II. The findings of the experimental studies suggest that verbal feedback does not influence the pacing skill of people with II. The introduction of a pacer however, can positively influence the self-regulatory processes which are critical in pacing and offer an intuitive, visual guidance to people with II during a sub-maximal trial. Lastly, the presence of an opponent during maximal trials could be a demanding and anxious situation that makes the pacing and sports performance development of athletes with II more complicated. The findings of this thesis could facilitate the inclusion of people with II in sports, develop their performance, and suggest sports participation and performance pathways to people with II. They can also guide coaches towards more appropriate coaching practices towards athletes with II.

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APPENDICES

APPENDIX A: Rated Performance [230].

Please rate on a 7-point Likert scale ranging from 1 (strong regression) to 7 (strong progression) the extent to which your athletes had progressed in the:

	1	2	3	4	5	6	7
Technical domain:							
Tactical domain:							
Physical domain:							
Psychological domain:							

APPENDIX B: Revised Sports Motivation Scale - Perceived Player Motivation [228, 231].

This questionnaire aims to investigate the reasons why your players participate in their sports and try to answer to the best of your knowledge. Using the scale below, please indicate the extent each of the following statements corresponds to the reasons why the majority of your athletes are participating in their sport.

	Strongly disagree	Disagree	Somewhat disagree	Neither agree or disagree	Somewhat agree	Agree	Strongly agree	Not applicabl e n/a
Because they would feel badly if they did not take the time to practice								
They used to have good reasons for playing, but now I am asking myself why they should continue								
Because they find it interesting to learn how they can improve								
Because sports reflect the essence of who they are								
Because people they care about would be upset with them if they didn’t								
Because they believe it is a good way to develop aspects of themselves that they value								
Because they would not feel worthwhile if they did not play								
Because they think others would disapprove of them if they did not play								
Because they find it interesting to discover new performance strategies								
They don’t know anymore; they have the impression that they are incapable of succeeding in sport								
Because their sport is an integral part of their lives								
Because they have chosen it as a way to develop themselves								
It is not clear anymore; they don’t think that their place is in sport								
Because through playing their sport, they are living in line with their deepest principles								
Because people around them reward them when they do play								
Because they feel better about themselves when they do play								
Because it gives them pleasure to learn more about their sport								
Because it is one of the best ways they have chosen to develop other aspects of themselves								

APPENDIX C: Interpersonal Behaviours Questionnaire - self (IBQ-self) [232].

We are interested in your behaviour towards athletes. Please choose the correct answer.
When I am with my athletes:

	Do not agree at all	Disagree	Slightly disagree	Neither agree or disagree	Slightly agree	Agree	Completely agree
I give them the freedom to make their own choices							
I pressure them to do things my way							
I encourage them to improve their skills							
I point out that they will likely fail							
I am interested in what they do							
I do not comfort them when they are feeling low							
I support their decisions							
I impose my opinions on them							
I provide valuable feedback							
I send them the message that they are incompetent							
I take the time to get to know them							
I am distant when we spend time together							
I support the choices that they make for themselves							
I pressure them to adopt certain behaviours							
I acknowledge their ability to achieve their goals							
I doubt their capacity to improve							
I honestly enjoy spending time with them							
I do not connect with them							
I encourage them to make their own decisions							
I limit their choices							
I tell them that they can accomplish things							
I question their ability to overcome challenges							
I relate to them							
I do not care about them							

APPENDIX D: Physical Activity Readiness Questionnaire+ (PAR-Q+) [285].

General Health Questions
Please read the 7 questions below carefully and answer each one honestly: check YES or NO.

		YES	NO
1)	Has your doctor ever said that you have a heart condition ☐ OR high blood pressure ☐ ?		
2)	Do you feel pain in your chest at rest, during your daily activities of living, OR when you do physical activity?		
3)	Do you lose balance because of dizziness OR have you lost consciousness in the last 12 months? Please answer NO if your dizziness was associated with over-breathing (including during vigorous exercise)		
4)	Have you ever been diagnosed with another chronic medical condition (other than heart disease or high blood pressure)? PLEASE LIST CONDITION(S) HERE:……………………………………………..		
5)	Are you currently taking prescribed medications for a chronic medical condition? PLEASE LIST CONDITION(S) AND MEDICATIONS HERE:………………………………………		
6)	Do you currently have (or have had within the past 12 months) a bone, joint, or soft tissue (muscle, ligament, or tendon) problem that could be made worse by becoming more physically active? Please answer NO if you had a problem in the past, but it does not limit your current ability to be physically active. PLEASE LIST CONDITION(S) HERE:………………………………………………………….		
7)	Has your doctor ever said that you should only do medically supervised physical activity?		

If the participant answered YES to one (or more) of the general health questions, the participant was advised to consult his/her doctor prior the participation in the research activities.

APPENDIX E: International physical activity questionnaire (IPAQ) [286].

We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. The questions will ask you about the time you spent being physically active in the **last 7 days**. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport

Think about all the **vigorous** activities that you did in the **last 7 days**. **Vigorous** physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Think *only* about those physical activities that you did for at least 10 minutes at a time.

1. During the last 7 days, on how many days did you do vigorous physical activities like heavy lifting, digging, aerobics, or fast bicycling?

_________ days per week

☐ No vigorous physical activities *Skip to question 3*

2. How much time did you usually spend doing vigorous physical activities on

one of those days?

_________ hours per day

_________ minutes per day

☐ Don't know/Not sure

Think about all the moderate activities that you did in the last 7 days. Moderate activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

3. During the last 7 days, on how many days did you do moderate physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking.

_________ days per week

☐ No moderate physical activities *Skip to question 5*

4. How much time did you usually spend doing moderate physical activities on one of those days?

_________ hours per day

_________ minutes per day

☐ Don't know/Not sure

5. During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time?

_________ days per week

☐ No walking ***Skip to question 7***

6. How much time did you usually spend **walking** on one of those days?

_________ hours per day

_________ minutes per day

☐ Don't know/Not sure

The last question is about the time you spent **sitting** on weekdays during the **last 7 days**. Include time spent at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television.

7. During the **last 7 days**, how much time did you spend **sitting** on a **week day**?

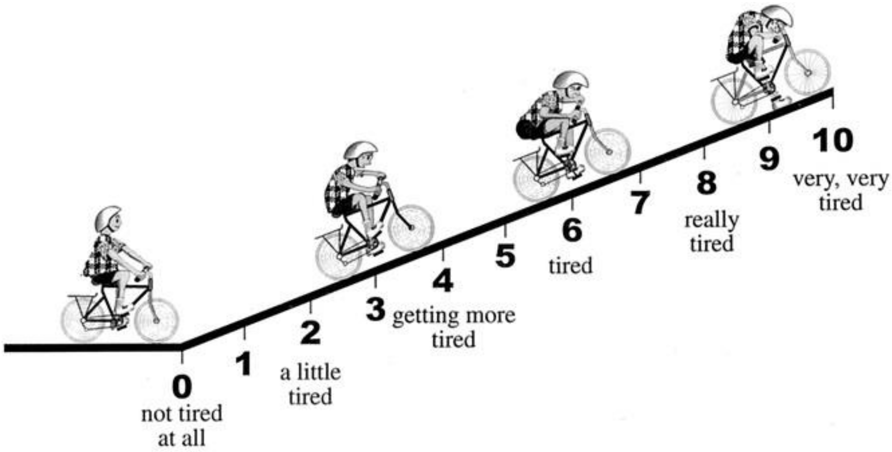
_________ hours per day

_________ minutes per day

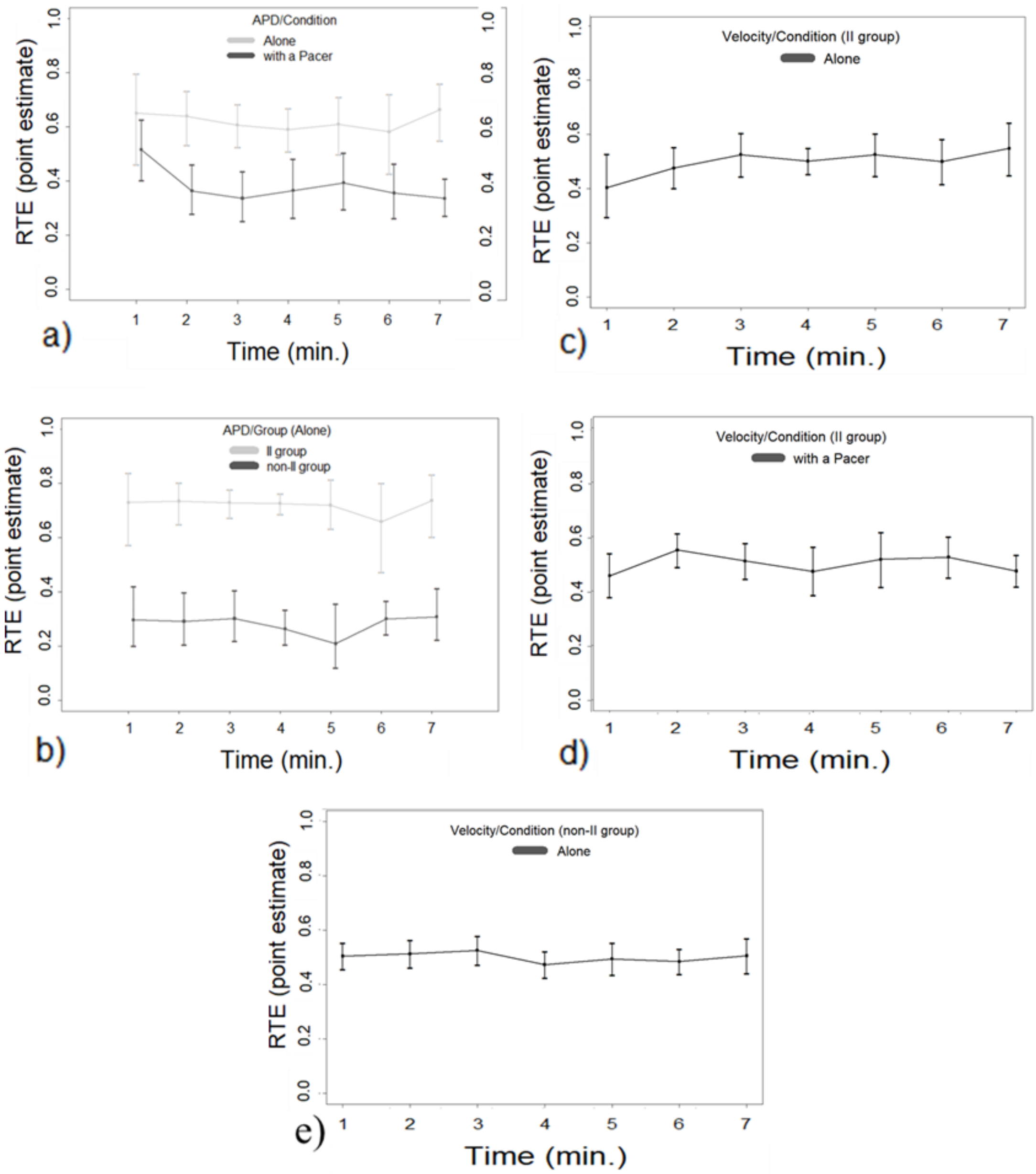
☐ Don't know/Not sure

This is the end of the questionnaire, thank you for participating

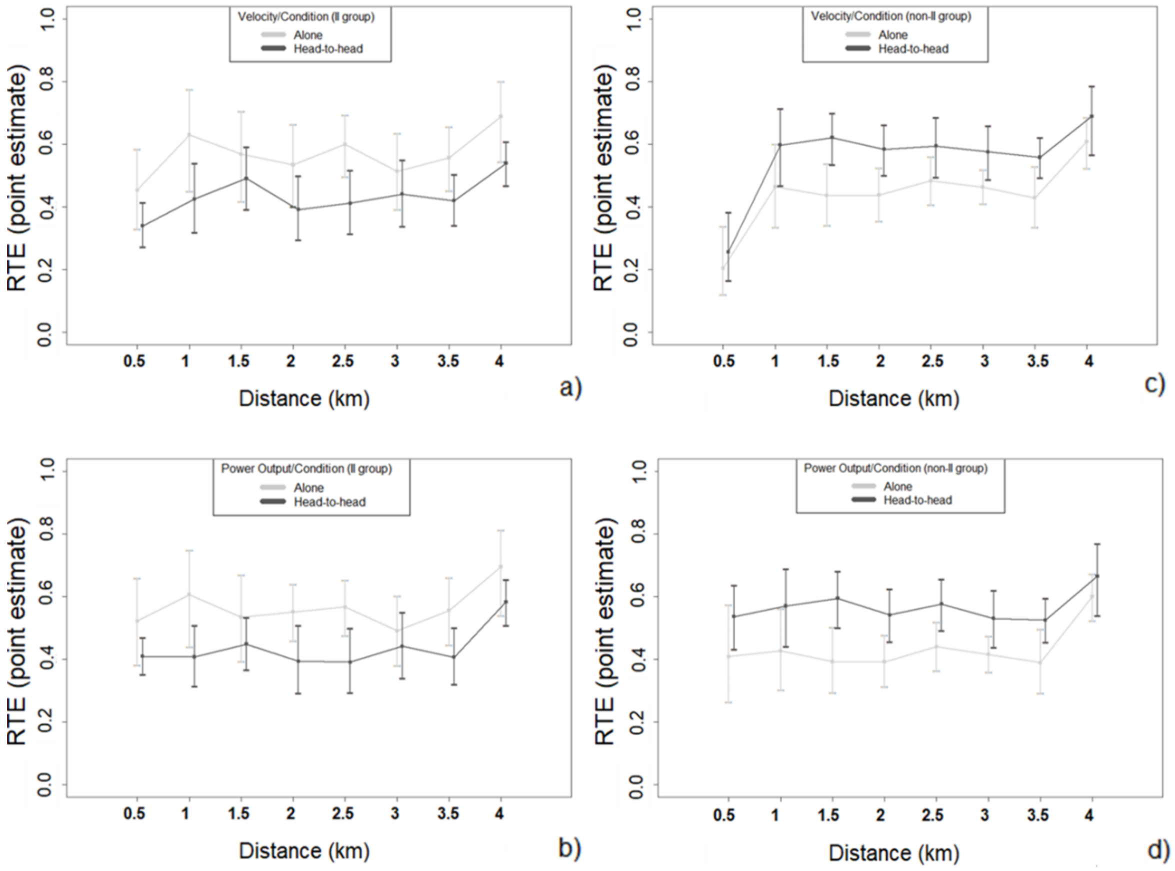
APPENDIX F: OMNI scale (Rate of Perceived Exertion) [300].



APPENDIX G: Relative effects and 95% confidence intervals for the APD between conditions (a') and between groups (b'), and relative effects and 95% confidence intervals for the velocity during the 'alone' (c') and 'with a Pacer' condition (d') for the II group and during the 'alone' condition for the non-II group (e'; Chapter 6).



APPENDIX H: Relative effects and 95% confidence intervals for the velocity and power output of the II (a’ and b’) and non-II group (c’ and d’) during the ‘alone’ and ‘head-to-head’ condition (Chapter 7).



APPENDIX I: Relative effects and 95% confidence intervals for the velocity of the II (a') and the non-II group (b') and their opponents (avatar) during the 'head-to-head' condition (Chapter 7).