The intentionality bias in schizotypy: A social matter

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Abstract

Introduction: We aimed to investigate the association between schizotypy and intentionality bias, the tendency to interpret ambiguous actions as being intentional, for social and non-social actions separately. This bias contributes to interpersonal difficulties, and has been associated with psychotic symptoms, such as delusions. However, results have been inconsistent for an association between putative psychosis proneness, schizotypy, and intentionality bias. Further, the multidimensional nature of schizotypy has not been considered. Agreeableness was measured to examine the specificity of the relationship, and inhibition to examine its potential role as a mediator.

Methods: Two online studies are reported (n = 280 and n = 163) in which participants made intentionality judgements about ambiguous actions described in sentences. They also completed questionnaire measures of schizotypy and agreeableness, and inhibitory efficiency (a sentence completion task).

Results: Schizotypy was associated with perceiving ambiguous actions as intentional, particularly in social contexts, after controlling for agreeableness. The association with social intentionality was stronger for schizotypy subscales capturing paranoia and unusual beliefs. Inhibitory efficiency as not a significant predictor of intentionality bias.

Conclusion: These finding suggest intentionality biases for social and non-social events are distinguishable. In relation to schizotypy, social situations appear to generate perceptions of intentionality. Intentionality bias represents a phenotypic cognitive risk for psychosis which should be further investigated.

Keywords: schizotypy; intentionality bias

Social interaction is an essential part of human life that is dependent on a host of psychological processes. The ability to understand the intentions behind the actions of others is one capacity that is fundamental to successful social interaction (Stone, Baron-Cohen, Calder, Keane & Young, 2003). It assists in reducing the uncertainty of social interactions and successful interpretation of intentionality increases positive engagement. While a wide range of motives might drive any single action by another human, a basic distinction that can be drawn concerns whether the action was intentional or accidental. Some actions may be ambiguous, for example, failing to acknowledge a greeting when walking past someone. The action may be deliberate or it may be accidental: the greeting may not have been heard, or it could have been intentionally ignored. The tendency to perceive ambiguous actions such as this as either intentional or accidental has been shown to vary amongst individuals and has been referred to as the intentionality bias (Rosset, 2008).

Rosset (2008) asked participants to judge a set of sentences describing different actions as either intentional or unintentional, and demonstrated that the tendency to attribute intentionality was greater when judgments were made under time pressure. She argued that the perception of action as intentional may be a default that must be overridden by more controlled processes, which draw on acquired knowledge about behaviour and social norms. Consistent with this notion, Bègue, Bushman, Giancola, Subra and Rosset (2010) demonstrated that the bias towards an intentional interpretation of behaviour was stronger when people had consumed alcohol than when they were sober, and attributed this to the detrimental effect of alcohol on effortful processes such as inhibition.

Recently a number of research papers have examined whether the intentionality bias might be stronger in those who experience difficulties in social relationships, in particular, people with schizophrenia or people who score high on the personality variable of schizotypy, a dimension which is seen as a non-clinical analogue of psychosis proneness. In

the context of an impairment in theory of mind in schizophrenia (for a review see Zucchelli & Ugazio, 2019), a number of studies have demonstrated an impairment in the ability to attribute intention in schizophrenia (e.g. Sarfati, Hardy-Baylé, Nadel, Chevalier and Widlöcher, 1997). Brunet, Sarfati & Hardy-Baylé (2003) demonstrated that this impairment was specific to inferring intention and understanding of physical causality was unaffected. However, it has been suggested that an intentionality bias could be associated with specific symptoms in schizophrenia. Peyroux, Strickland, Tapiero and Franck (2014) argued that the over-attribution of intentionality, i.e. deliberate action, characterises some delusions in schizophrenia, and may reflect an exaggerated intentionality bias due to the breakdown of inhibitory control (Waters, Badcock, Maybery, & Michie, 2003). Peyroux et al. gave patients and controls a set of action-describing sentences to judge and found that patients indicated a greater proportion of the actions were intentional than did controls, although the difference was not striking (.57 vs .52). For a proportion of the patients, a rating scale of symptom severity was available and the intentionality bias in these patients correlated .54 with an item assessing poor impulse control.

A question arises whether intentionality biases are a product of psychotic symptoms per se or whether they reflect the broader risk phenotypes for psychosis. Examining whether intentionality biases are present in people from the general population who express schizotypy provides some evidence for an association with broader risk rather than symptoms. People from the general population who score high on schizotypy show a similar pattern of deficits across a range of cognitive tasks to patients with schizophrenia (Raine, 2006), including difficulties in identifying their actions and thoughts as their own, as well as perceptual biases which lead to the externalisation of their internal experiences (Badcock & Hugdahl, 2012; Brookwell, Bentall, & Varese, 2013). People high on schizotypy experience higher levels of distress (Abbott, Do, & Byrne, 2012; Barkus et al., 2010) and greater

difficulties in relationships (Aguirre, Sergi, & Levy, 2008) and it is possible that a stronger intentionality bias in these people may contribute to this. The attribution of intentionality relates to the purpose of another person's actions. Interpreting unintentional actions as intentional will undermine trust, potentially increase hostility or social withdrawal and create a vicious circle of deteriorating relationships. Intentionality is part of a collection of processes involved in determining the experience of actions in the world, including agency and assumptions of causality (Antusch, Aarts, & Custers, 2019). These processes are compromised in both patients with schizophrenia and in those from the general population who express schizotypy (Chhabra, Badcock, Maybery, & Leung, 2014). It is possible that difficulties in judging intentions are associated with specific symptoms, such as delusions (Blakemore, Sarfati, Bazin, & Decety, 2003) as well as with schizotypy more broadly (Fyfe, Williams, Mason, & Pickup, 2008). Although these differences are not always reported in early psychosis (Fett et al., 2015). Even though the potential influence on social functioning seems sufficient to motivate an examination of the relationship between schizotypy and intentionality bias, the two papers in the literature examining this relationship (Moore & Pope, 2014; Morrison & Cohen, 2014) draw heavily on the correlates between schizotypy and symptoms associated with schizophrenia for their rationale and methodology.

Moore and Pope (2014) developed a task to assess intentionality where participants judged the deliberateness of a hand movement in a video-recorded stimulus. Participants were told that the movement could be intentional or forced by an apparatus but, in fact, the same stimulus showing a forced movement was presented on all trials. They examined the relationship between the proportion of trials judged as intentional and measures of two experiences associated with schizophrenia and schizotypy, delusions and hallucinations. Both of these measures correlated moderately with the judgement of intentionality.

A broader approach to assessing schizotypy was taken by Morrison and Cohen (2014) who chose to relate it to a more specific notion of intentionality. They used the Schizotypyal Personality Questionnaire (SPQ) – Brief Revised (Cohen, Mathews, Najolia, & Brown, 2010) to identify high schizotypes and controls in order to compare them on a number of measures, including the Ambiguous Intentions Hostility Questionnaire (AIHQ; Combs, Penn, Wicher, & Waldheter, 2007). Although the AIHQ had previously been shown to differentiate first-episode schizophrenia patients and those at high-risk of developing schizophrenia from controls (An, Kang, Park, Kim, Lee, & Lee, 2010) it did not differ significantly between high schizotypes and controls in the study of Morrison and Cohen (2014). Here we consider the associations between intentionality and schizotypy across two studies.

Study 1

Given this small number of studies and inconsistent findings, the aim of the present study was to examine the relationship between schizotypy and intentionality bias in detail, by examining how the components of schizotypy might relate to the broader assessment of intentionality in the sentences created by Rosset (2008). Morrison and Cohen (2014) did find that high schizotypes differed from controls on a measure of paranoia; however, they did not report the data on subscales of the SPQ, which include suspiciousness, a dimension related to paranoia. Moore and Pope (2014) also found that measures of delusions and hallucinations, which are represented by the Odd beliefs or magical thinking, Ideas of reference and Unusual Perceptual experiences subscales of the SPQ, were correlated with intentionality. In the study reported here, the relationship between the subscales of the full SPQ (Raine, 1991; Raine et al, 1994) and intentionality are examined. Based on the research described above, it is anticipated that intentionality bias will correlate with the Suspiciousness subscale of the SPQ, along with the Odd beliefs or magical thinking, Ideas of reference and Unusual Perceptual experiences subscales. The other subscales of the SPQ include social anxiety,

Odd or eccentric behaviour, having no close friends, Odd speech, and Constricted affect, and are less related to the concepts of paranoia, delusions and hallucinations so no correlations are expected between these subscales and the intentionality measure.

A measure of inhibitory capacity is included in the study in order to determine whether inhibition might partially mediate any relationships between schizotypy subscales and intentionality. This seems plausible as people high on schizotypy have previously been demonstrated to perform more poorly in tasks requiring inhibition (e.g. Beech, Baylis, Smithson & Claridge, 1989;Moritz & Mass, 1997; Sahakyan, Kwapil & Jang, 2019), although some studies have failed to find such a relationship (e.g. Green & Williams, 1999). In addition, the broader personality factor of agreeableness is measured to examine the specificity of any relationships between the subscales of schizotypy, in particular suspiciousness, and intentionality bias. Agreeableness has been shown to correlate negatively with delusion proneness (Larøi, Van der Linden, DeFruyt, van Os & Aleman) and with schizotypy (Asai, Sugimori, Bando & Tanno, 2011). Agreeableness is expected to correlate negatively with intentionality bias and so offers a test of the specificity of the relationship between schizotypy and intentionality bias. In summary, we anticipate that higher schizotypy scores, particularly for suspiciousness and unusual perceptual experiences, will be related to more frequent attributions of intentionality. Secondly, lower levels of inhibition will be related to both higher schizotypy scores and less effortful attributions of intentionality. Additional analysis will be performed concerning the context implied in the intentionality questions (social versus non-social) since social situations are inherently more ambiguous and most likely to be associated with judgements of intentional actions.

Method

Participants. A total of 300 participants were recruited from the online participation site Prolific.co and were paid £3 for completing the study. Participation was restricted to native English speakers from North America, the United Kingdom, Australia and New Zealand. Sixteen participants were excluded because they failed to follow the instructions for the inhibition task. A further 4 participants were excluded because they did not provide an identifier from the Prolific site. The remaining 280 participants (143 male, 132 female, 5 not reported) varied in age from 18 to 79, with a mean of 33 years (11.8 s.d.). The study was approved by the Humanities and Social Sciences Human Research Ethics committee of the University of Wollongong.

Materials. Intentionality bias was assessed by the 34 ambiguous sentences from Rosset (2008) which were presented in the same random order to all participants (e.g. “He broke the window”, “She drove over the speed limit”). Rosset (2008) included unambiguously accidental or deliberate sentences but these have not been included in this study due to the large number of items on the other measures and tasks. Participants were instructed to indicate whether the action in the sentence was more likely to be intentional or accidental by clicking the mouse on one of two buttons on the screen, but there was no instruction regarding the speed of response. The number of sentences, out of 34, endorsed as intentional was taken as the measure of intentionality bias. There is no cut-off for determining that a participant is or is not biased. Rather, the score reflects the tendency of the participant to ascribe intention across a range of behaviours which could be intentional or accidental.

Schizotypy was measured by the full SPQ (Raine, 1991) which contains 74 items and scores range from 0 to 74. Participants responded yes or no to each item. It is summed into nine subscales which correspond to the DSM-III-R criteria for schizotypal personality disorder. These include : Ideas of reference (e.g. Do you sometimes feel that things you see on the TV or read in the newspaper have a special meaning for you?); Social Anxiety (e.g. I

get very nervous when I have to make polite conversation.); Odd beliefs or magical thinking (e.g. Have you had experiences with astrology, seeing the future, UFOs, ESP or a sixth sense?); Unusual Perceptual experiences (e.g. Have you ever seen things invisible to other people?); Odd or eccentric behaviour (e.g. People sometimes comment on my unusual mannerisms and habits.); No close friends (e.g. I have little interest in getting to know other people.); Odd speech (e.g. I sometimes jump quickly from one topic to another when speaking.); Constricted affect (e.g. I am poor at expressing my true feelings by the way I talk and look.); Suspiciousness (e.g. Do you often feel that other people have got it in for you?).

Agreeableness was assessed by the 20 items from the International Personality Item Pool NEO scale (IPIP NEO) (Goldberg et al., 2006). People high on agreeableness are perceived as being cooperative, considerate, and warm (e.g. Accept people as they are; Trust what people say). Participants rated how accurately each item described them on a scale from 1 (very inaccurate) to 5 (very accurate), so scores can range from 20 to 100.

Inhibition was measured in a version of the Hayling Sentence Completion task (Burgess & Shallice, 1996) created for this study. The sentences were taken from the sentence completion norms of Block and Baldwin (2010) in which respondents were presented with a sentence with the final word missing and were required to produce a word to complete it. The 40 sentences that most consistently produced the same word were alternately split to create two sets. In Part A, the first set was presented, and participants were instructed to respond as quickly as possible with a word to complete the sentence. In Part B, the second set was presented and participants were instructed to type a word that did not fit with the sentence. The difference in time to respond between the two sets is taken as an index of the time taken to inhibit a strongly cued response and generate an alternate response. Participants were instructed to respond as quickly as possible in the sentence

completion task and the time taken to type the response and click the submit button was recorded for each item.

Procedure. The study received ethics approval from the Humanities and Social Sciences Human Research Ethics Committee at the University of Wollongong. Participants all provided informed consent to take part in the study. Participants completed all measures online at a time of their own choosing. They were initially presented with a brief introduction to the study before being asked to consent to participate. They then completed the SPQ, the agreeableness scale, the intentionality bias measure, and, finally, the Hayling sentence completion task.

Results

In the sentence completion task, any responses longer than 30 seconds were removed before calculating the median reaction time for Part A and Part B. Responses longer than this were taken as not reflecting true performance of the task as participation was online and there was no control over interruptions or participant behaviour when completing the task. This resulted in the removal of 0.4% of responses in Part A and 0.6% of responses in Part B. The difference in the median response time per item was taken as an index of inhibitory control, with a larger difference indicating greater difficulty inhibiting the response cued by the sentence. The descriptive statistics and Pearson correlations amongst the various measures are presented in Table 1.

[Table 1 near here]

The intentionality measure showed small to moderate correlations with the total score for the SPQ and its subscales. It also showed a small correlation with Agreeableness and the inhibition measure. As larger numbers on the inhibition measure reflect greater difficulty

with inhibiting the highly activated word, this correlation shows poorer inhibition is related to a stronger intentionality bias.

Intentionality Bias – Additional analysis

The intentionality measure is not a psychometrically derived instrument, and includes a number of items that describe an action between two people and others that describe an action that is not in relation to another person. As part of the motivation for this study is to better understand whether social functioning might be affected by intentionality bias, 7 items that describe an action of one person in relation to another were separated from the other 27 items to create a small set of "social" items and a larger set of "non-social" items. The "social" items all refer to two people through the use of two pronouns or imply a second person (e.g. She walked by without saying hello) while the "non-social" items describe a person interacting with an object (e.g. He drank the spoiled milk). The identification of the social items was by consensus of all the authors. The correlations of these sets with the other variables are also shown in Table 2. It can be seen that these two sets do not correlate equally strongly with the different subscales of the schizotypy measure. Notably, the suspiciousness and ideas of reference subscales correlate more strongly with the social intentionality items than the non-social items ($z = 3.399$, $p < .001$, and $z = 1.985$, $p < .05$, respectively). Although this was also true of most of the other subscales, the difference was not significant. Neither agreeableness nor inhibition differed in how strongly they correlated with the social and non-social intentionality items.

To examine the relationships more closely, a number of hierarchical linear regression analyses were performed. In predicting scores on the suspiciousness subscale of the SPQ, age and sex were entered on the first step and explained 3.3% of the variance ($\beta = -0.036$, $p <$

.01, and β = 0.365, n.s., respectively). Agreeableness was entered on the second step and explained 18.8% of the variance (β = -0.089, p < .001) and the social intentionality items explained a significant (β = 0.426, p < .001) additional 5.6% when entered on the third step. When the Ideas of reference subscale was the dependent variable, age and sex explained 5.9% of the variance (β = -0.051, p < .001, and β = 0.531, n.s., respectively) when entered on the first step. Agreeableness was entered on the second step and explained 4.8% of the variance (β = -0.048, p < .001) and the social intentionality measure explained a significant (β = 0.375, p < .001) additional 3.9% of the variance when entered on the third step. In both of these analyses, when the measure from the non-social intentionality items was added, no additional variance was explained (F(1,268) = 0.377 for suspiciousness, and F(1, 268) = 0.927 for Ideas of reference) and the social intentionality measure remained a significant independent predictor while the non-social measure was not significant.

Mediation analyses were conducted to examine whether the relationship between the social intentionality bias measure and Suspiciousness, and Ideas of reference might be mediated by inhibitory capacity, as indexed by the Hayling task. Neither of the analyses showed a significant indirect effect (95% bias corrected CI's -0.133 to 0.357, and -0.160 to 0.304, with 5000 sample bootstrapping, respectively) while the direct relationships remained significant (4.68, p < .0001, 95% CI 3.20 to 6.16, and, 4.07, p < .0001, 95% CI 2.46 to 5.68, respectively).

Discussion

The results of Study 1 clearly show a relationship between intentionality bias and schizotypy that is more nuanced than previously demonstrated. The intentionality bias, as measured by all the sentences from Rosset (2008), correlated with the total SPQ score such

that people who scored higher on the schizotypy measure also judged more of the actions to be intentional. This measure of intentionality bias did not correlate with the subscales of Excessive social anxiety or Odd beliefs and magical thinking, but did correlate with the other subscales. The strength of the correlation of the intentionality measure with any of the subscales did not surpass that of the total SPQ score.

However, when the intentionality items were divided into those involving direct social interaction and those that did not, a different picture emerged. The social items generally correlated more highly with the SPQ subscales than the non-social items, and this was particularly apparent for the subscales of Suspiciousness and Ideas of reference. In addition, the Suspiciousness subscale correlated with the social intentionality items more highly than the total SPQ, and the Ideas of reference subscale correlated as highly as the total score. This pattern demonstrates that judgements of intentionality for social interactions may be distinguishable from those for actions that do not involve direct interaction between two people, at least in how they relate to these personality dimensions relevant to social functioning. Importantly, the intentionality bias explained additional variance in the schizotypy subscales, over and above that explained by the more general personality factor of agreeableness, which itself correlated more strongly with schizotypy than did the intentionality bias. This demonstrates that the specific tendency to attribute intention to the ambiguous actions of others, where the actions mostly had negative consequences in these items, is related to schizotypy and may contribute to social functioning even after controlling for the more general personality factor.

Contrary to suggestions in the literature that intentionality bias may be related to elements of schizotypy as a result of poor inhibitory processes, the inhibition measure did not mediate the relationships between intentionality bias and those schizotypy subscales that were most highly correlated with intentionality. The inhibition measure generally did not

correlate with the SPQ total or subscales. This suggests that the relationship between intentionality bias and schizotypy does not rely on a failure to inhibit an automatic intentional interpretation of the action.

Study 2

A second study was run in an attempt to replicate the major results of Study 1, and to improve on the measurement of intentionality bias in order to evaluate better its relationship with the schizotypy measures. To that end, responses on the intentionality measure were changed to a likert scale rather than binary judgement in order to improve the reliability of the measurement of intentionality bias. Although the inhibition measure failed to mediate the relationship between intentionality bias and schizotypy in Study 1, it was included in this study to provide a second examination of how it correlated with the schizotypy measures.

Method

Participants. A total of 163 undergraduate psychology students at the University of Wollongong were recruited to participate in the study, which was the number who had completed it at the end of the academic semester. Participants completed the study as part of a course requirement to participate in research and received course credit for their participation. Seven participants were excluded either because they failed to follow the instructions for the inhibition task, or because they completed the online task very quickly and appeared to have responded in a random manner on some measures. The remaining 156 participants (32 male, 122 female, 2 not reported) varied in age from 17 to 36, with a mean of 20 years (2.3 s.d.).

Materials and procedure. The study received ethics approval through the Humanities and Social Sciences Human Research Ethics Committee and all participants provided informed consent. The materials and procedure were the same as in Study 1 with the

exception of the response required on the intentionality judgement task. Participants were asked to judge the intentionality of the action in each sentence, by indicating the degree to which the action described is generally done on purpose or by accident using an on-screen slider numbered from 0 (by accident) to 5 (on purpose).

Results

In the sentence completion task, the data from 6 participants were removed as they appeared not to have maintained concentration on the task and their pattern of responding was so variable that even the median did not give a good indication of their capability. For the remaining participants, any responses longer than 30 seconds were removed before calculating the median reaction time for Part A and Part B. This resulted in the removal of 1.2% of responses in both Parts A and B. Descriptive statistics and the Pearson correlations amongst the various measures are presented in Table 2.

[Table 2 near here]

The intentionality measure based on all 34 sentences showed small to moderate correlations with the SPQ total score and a number of the subscales. The Suspiciousness subscale was the only one to correlate more highly with intentionality than the total SPQ score. Intentionality also had a small correlation with agreeableness but no relationship with the inhibition measure.

The responses on the seven action sentences involving a social interaction were again distinguished from the others to create separate measures of social and non-social intentionality bias. The social intentionality measure correlated more highly than the non-social measure with the SPQ total score and most of the subscales. This difference was significant for the SPQ total ($z = 2.484$, $p < .01$), Ideas of reference ($z = 2.329$, $p = .01$),

unusual perceptual experiences ($z = 1.884$, $p < .05$), constricted affect ($z = 1.812$, $p < .05$) and suspiciousness ($z = 3.199$, $p = .001$, only).

To examine the relationships more closely a number of regression analyses were performed. In predicting scores on the total of the SPQ, age and sex were entered on the first step and explained 6.2% of the variance ($\beta = -0.935$, $p < .05$, and $\beta = 5.814$, $p < .05$, respectively). Agreeableness was entered on the second step and explained 13.1% of the variance ($\beta = -0.488$, $p < .001$) and the social intentionality items explained a significant ($\beta = 0.422$, $p < .05$) additional 3.0% when entered on the third step. When the Suspiciousness subscale was the dependent variable, age and sex explained 4.6% of the variance ($\beta = -0.150$, *n.s.*, and $\beta = 0.872$, *n.s.*, respectively). Agreeableness explained an additional 11.1% of the variance ($\beta = -0.081$, $p < .001$) and the social intentionality measure explained an additional 12.2% of the variance ($\beta = 0.155$, $p < .001$). When the Ideas of reference subscale was the dependent variable, age and sex explained 5.7% of the variance ($\beta = -0.220$, $p < .05$., and $\beta = 0.871$, *n.s.*, respectively). Agreeableness explained an additional 5.1% of the variance ($\beta = -0.038$, *n.s.*) and the social intentionality measure explained an additional 4.9% of the variance ($\beta = 0.110$, $p = .01$). When the Unusual perceptual experiences subscale was the dependent variable, age and sex explained 9.5% of the variance ($\beta = -0.119$, $p < .01$, and $\beta = 1.157$, $p < .01$, respectively). Agreeableness explained an additional 4.0% of the variance ($\beta = -0.045$, $p < .01$) and the social intentionality measure was not a significant predictor. When the Constricted affect subscale was the dependent variable, age and sex explained 0.1% of the variance ($\beta = 0.009$, *n.s.*, and $\beta = -0.1445$, *n.s.*, respectively). Agreeableness explained a significant 6.3% of the variance ($\beta = -0.046$, $p < .01$) and the social intentionality measure was not a significant predictor. In all of these analyses, when the measure from the non-social intentionality items was added, no additional variance was explained (all $F(1,148) < 1$)

and the social intentionality measure remained a significant independent predictor while the non-social measure was not significant.

Discussion

At the broad level, the results of the second study are very similar to those in the first study. The change of response format on the intentionality items appears to have improved the sensitivity of the measures derived from them, and the correlations with most of the schizotypy scales are larger than in Study 1. The total for all the intentionality items correlated with the SPQ total, but just as strongly, or more so, with the subscales of Suspiciousness and Ideas of reference, while the subscales of Social anxiety and No close friends correlated more weakly.

The results are more interesting when the intentionality items are divided into the social and non-social subsets, where a distinction is seen in how they relate to the schizotypy measures. As in Study 1, the social intentionality items correlated more strongly with the schizotypy measures than the non-social intentionality items. Changing to a likert scale response resulted in four subscales of the SPQ being significantly more strongly correlated with the social than non-social intentionality measure. Importantly, in the regression analyses only the social intentionality measure explained significant variance in these measures, and it did so after controlling for agreeableness. Suspiciousness and Ideas of reference subscales were again most strongly correlated with intentionality bias. The results suggest that bias to attribute intention to actions involving other people rather than towards objects is more relevant to aspects of schizotypal personality.

General discussion

The two studies reported here provide strong evidence of a relationship between measures of intentionality bias and aspects of schizotypy, in particular it is intentionality

around behaviour towards other people that is crucial to this relationship. The first study found a small correlation between inhibition and intentionality but failed to show any evidence that inhibition mediated the relationship between intentionality bias and schizotypy, while Study 2 found no relationship between inhibition and intentionality.

The results of the studies reported here are similar to those of the two studies in the literature described in the introduction, but provide clearer evidence of a relationship between schizotypy as a cluster of personality factors and intentionality judgement. Moore and Pope (2014) used an intentionality bias paradigm, which provides a true measure of bias, in the sense that random or unbiased responding is 50%, and found a relationship between this judgement and two experiences associated with schizotypy, delusions and halucinations. However, this measure of bias has not been used in other research and they did not relate it to a measure of schizotypy itself. In addition, their task required judgement about a physical movement rather than a social, or even functional behaviour. Morrison and Cohen (2014) used the SPQ to measure schizotpy, and although their data show a small effect in the anticipated direction on the Ambiguous Intentions Hostility Questionnaire, consistent with the data reported here, it failed to reach significance. Although their high schizotypy group were above the 95th percentile on at least one factor in the SPQ, the control participants were "below the mean" so it is possible they did not have sufficient separation between groups for their sample size. Overall, the results reported here align with those of the previous papers in demonstrating a relationship between intentionality judgment and schizotypy or experiences associated with it.

One of the clearest findings from both studies is that the tendency to attribute intention to ambiguous acts towards another person is more strongly related to schizotypy than the attribution around actions that do not directly involve another person. This suggests that, although the two sets of attributions correlate, they are separable, and that intentionality bias

around social interactions is more relevant to the schizotypy dimensions. The regression analyses showed that all of the relationship between intentionality and schizotypy was carried by these social interaction items as the non-social items added nothing independently to the prediction of schizotypy scores. Social interactions are complex and fraught with uncertainty. It is possible that the inherently ambiguous nature of social circumstances ensures that any cognitive biases a person possesses come to the fore in the interpretation of what is taking place around them. These biases ultimately shape the subjective experience of situations which ensures individuals can vary in their appraisal of the same social interactions. This may partly explain why patients with schizophrenia appreciate that other people hold different views to themselves while holding steadfast to their own unusual beliefs (Gallagher & Varga, 2015). Furthermore, considering the intentions of the social world can take place in both an "offline" and "online" manner. That is, we consider the intentions of others while reflecting before or after an interaction, as well as in the moment when an event occurs. Both of these potentially shape behaviour and future cognitions; however, potentially it is the "offline" consideration of intentionality which possesses the most insidious quality since it cannot be checked through immediate experiential feedback (De Jaegher, Di Paolo, & Gallagher, 2010). This notion is support by the Bell, Mills, Modinos, and Wilkinson (2017) theory of the social agent, which reflects that we all have an internal representation of the social agency of others.

Similar to the consideration of clinical symptoms, the results from the two studies reported here suggest that intentionality bias is not equally related to all aspects of schizotypy. The magnitude of the correlations varied between the studies in an inconsistent manner across the different subscales of the SPQ, although the Ideas of reference and Suspiciousness subscales were amongst the most highly correlated with intentionality in both studies. For instance, patients with paranoid delusions are more likely to perceive

intentionality movement in neutral moving shapes than those without delusions (Blakemore et al., 2003). The Unusual perceptual experiences and Odd or eccentric behaviour subscales were also among the more highly correlated with intentionality in Study 1, but not in Study 2. This may be a function of the difference in age between the two samples with the participants in Study 2 being younger and much more homogeneous in age than those in Study 1. The Odd or eccentric behaviour subscale in particular showed a larger difference in the correlation with intentionality between the two samples. The student sample in Study 2 gave lower scores on this subscale despite the fact that scores on all the subscales correlated negatively with age in the sample in Study 1. This suggests that there may be a meaningful difference in how the student sample responded to these items in comparison to the general population sample. The experience of social worlds and the participants' opportunity to "practice" processes related to social cognitions could have differed across our two samples as a function of their ages. Schizotypy reflects an organisation of personality which is related to both schizotypal personality disorder and schizophrenia (Blanchard, Collins, Aghevli, Leung, & Cohen, 2011; Raine, 1991, 2006). Difficulties in social situations are reported in all three of these constructs (Aguirre et al., 2008; Badcock, Barkus, Cohen, Bucks, & Badcock, 2016). Our data suggest that further research needs to focus on intentionality biases as a potential mechanism for the misinterpretation of, particularly social, acts as intentional rather than random events outside of any one person's control. Increasingly, interactions with social beings beyond the scope of college or university may do much to either endorse or challenge social beliefs held. These similarities and differences in the results across our two studies holds implications for psychological interventions designed to improve social skills across the age span. For instance, one study has demonstrated that there are improvements over age in informing relations between both social and non-social items (Magis-Weinberg, Blakemore, & Dumontheil, 2017), suggesting that our social reasoning and judgement

processes are subject to change and development over our lifetime. Consequently, psychological interventions need to assess someone's current understanding, capacity and flexibility in social cognition prior to commencing skills development. It is also worth noting that the initial work on intentionality bias in schizophrenia was in the context of suggested impairments in theory of mind and the addition of measures of theory of mind to future research on intentionality bias in schizotypy will help to identify if the impairment is specific to intentionality or a broader problem in interpreting the actions of others.

The Ideas of reference and Suspiciousness subscales showed robust correlations with the social intentionality items across both samples, and significantly weaker correlations with the non-social intentionality items. The finding that the tendency to see ambiguous social slights as deliberate correlates with a measure of suspiciousness seems intuitively reasonable. Intentionality bias, as measured by the social items, explained more variance in this subscale than any other, and notably, after controlling for agreeableness. The Ideas of reference subscale assesses the degree to which people think that other people and events in the world are focussed on or important to them. It captures the degree to which events in the wider environment hold meaning or significance. In those who express schizotypy it is possible that they see meaning and salience in events which carry no targeted intent. This could be seen as a type of self-focus bias in intentionality; that events in the world are happening with some purpose for the individual. The combination of higher scores on these subscales in particular seems likely to be related to a stronger intentionality bias which might be even more evident if the intentionality items also related to the individual. In the statements used in these studies, the social items referred to two other people. It may be possible to see evidence of a stronger intentionality bias related to the schizotypy subscales if the items were worded in relation to the person completing the task (e.g. He cut you off driving). A strong bias to see the actions of others in relation to oneself as intentional could make it significantly more

difficult to maintain healthy relationships. Many of the symptoms present along the psychosis continuum such as verbal hallucinations and delusions involve a social component as part of their perceptual phenomena or belief sequela. Intentionality forms part of the beliefs we attribute to the mental representations of social agents that we hold (Bell et al., 2017). While patients with schizophrenia often appear to be able to correctly predict the actions of others (Okruszek, Piejka, Wysokiński, Szczepocka, & Manera, 2019) the intentions prescribed by patients, particularly with paranoia or suspicion, are more intentional or causally linked (Blakemore et al., 2003; Frith, Blakemore, & Wolpert, 2000) and they have been shown to ascribe greater intentionality than non-patients (e.g. Buck, Hester, Pinkham, Harvey, Jarskog & Penn, 2018). Consequently, further research is needed to explore the nature of intentionality, specifically in the social context, to understand the individual differences which appear to be significant in prescribing deliberate intent to ambiguous events.

To move this area of research forward systematically, more consideration needs to be given to the measures used. It must be noted that while the intentionality measures used in the current studies are not psychometrically validated scales, and that no such scales exists to our knowledge. The intentionality task in Study 2 using a likert scale response had a Cronbach's alpha of .645 for the seven social items, which is somewhat lower than convention suggests for an acceptable scale. This implies that the results of these studies may not be entirely reliable, however the relative consistency of the results across the two studies does justify some confidence that the relationships observed are genuine. It also suggests that it would be worthwhile developing a more reliable measure of social intentionality bias to use in future research.

Failure of the inhibition measure to relate to intentionality or schizotypy may reflect the inadequacies of the task and data collection method rather than a genuine lack of relationship. Other researchers have found that schizotypy is related to less effective inhibition processes

(Giakoumaki, 2012). There are numerous tasks used to assess inhibition and different types of inhibition (Nigg, 2000), not all of which may be associated with schizotypy. Sahakyan et al (2019) examined performance in the directed forgetting paradigm, being presented with items and then being told to forget some and remember others, which bears some similarity to the requirements of the task used here to suppress a strongly activated word. They reported that positive schizotypy, characterised by odd beliefs, unusual perceptual experiences, and suspiciousness, was associated with greater difficulty deliberately forgetting words, in contrast to the findings of the current study. The online delivery in this study of a task that is usually done orally, and the increased variability around typed responses, may have decreased the sensitivity of this task in showing inhibitory deficits. This relationship should be examined further in studies conducted in more controlled environments.

In conclusion, the studies reported here provide strong evidence that schizotypy is associated with a stronger bias to interpret ambiguous actions as being deliberate, particularly if those actions involve an interaction with another person. This implies that some of the difficulties that people who are high on schizotypy experience in their relationships may be attributable to this cognitive bias. Further research investigating this possibility directly, along with research to improve our understanding of how cognitive biases might relate to schizotypy, is warranted.

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Table 1. Correlations amongst the measures in Study 1.

	M	*SD*	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Intentionality	12.85	3.98															
2. Agreeableness	73.52	12.00	-.24**														
3. Hayling (in seconds)	3.13	2.04	.13*	.05													
4. SPQ total	28.92	14.37	.26**	-.42**	.08												
5. SPQ Ideas of reference	2.69	2.58	.23**	-.23**	.07	.72**											
6. SPQ Social Anxiety	5.40	2.57	.10	-.13*	.03	.69**	.36**										
7. SPQ Odd beliefs	0.99	1.43	.04	-.14*	-.05	.40**	.46**	.14*									
8. SPQ Unusual perceptions	2.12	2.05	.23**	-.32**	-.01	.67**	.66**	.30**	.47**								
9. SPQ Odd or eccentric behavior	3.24	2.33	.26**	-.36**	.06	.71**	.41**	.35**	.19**	.41**							
10. SPQ No close friends	4.51	2.58	.18**	-.41**	.11	.69**	.22**	.56**	.05	.24**	.42**						
11. SPQ Odd speech	3.81	2.61	.13*	-.21**	.04	.73**	.44**	.37**	.20**	.44**	.56**	.38**					
12. SPQ Constricted affect	3.30	2.31	.19**	-.33**	.14*	.70**	.25**	.48**	.04	.25**	.49**	.70**	.52**				
13. SPQ Suspiciousness	2.86	2.43	.23**	-.44**	.08	.78**	.66**	.40**	.29**	.51**	.47**	.50**	.49**	.44**			
14. Intent - social	3.15	1.27	.68**	-.25**	.11	.29**	.29**	.13*	.08	.23**	.22**	.19**	.14*	.11	.36**		
15. Intent - nonsocial	6.39	2.68	.92**	-.19**	.07	.21**	.17**	.06	.04	.21**	.23**	.13*	.11	.17**	.15*	.45**	
Cronbach's α			.71	.89	-	.94	.82	.85	.70	.73	.84	.79	.77	.78	.82	.46	.64

Note: * $p < .05$; ** $p < .01$

Table 2. Correlations amongst the measures in Study 2 results are above the diagonal.

	M	*SD*	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Intentionality	1.94	0.61															
2. Agreeableness	75.67	9.66	-.30**														
3. Hayling (in seconds)	3.36	2.98	-.04	.14													
4. SPQ total	27.35	13.24	.23**	-.35**	-.13												
5. SPQ Ideas of reference	3.82	2.64	.23**	-.22**	-.06	.76**											
6. SPQ Social Anxiety	4.93	2.55	.18*	-.19*	-.12	.70**	.43**										
7. SPQ Odd beliefs	1.41	1.66	.14	-.09	-.10	.48**	.45**	.18*									
8. SPQ Unusual perceptions	2.96	2.19	.14	-.19*	-.13	.72**	.61**	.33**	.56**								
9. SPQ Odd or eccentric behavior	2.27	2.17	-.03	-.29**	-.04	.60**	.36**	.34**	.15	.33**							
10. SPQ No close friends	2.76	2.26	.19*	-.22**	-.12	.57**	.19*	.55**	.00	.18*	.22**						
11. SPQ Odd speech	3.99	2.36	.03	-.28**	-.09	.62**	.32**	.30**	.20*	.40**	.51**	.20*					
12. SPQ Constricted affect	1.99	1.76	.13	-.25**	-.09	.67**	.37**	.48**	.07	.37**	.31**	.66**	.31**				
13. SPQ Suspiciousness	3.22	2.37	.36**	-.33**	-.03	.79**	.67**	.43**	.41**	.55**	.34**	.37**	.38**	.47**			
14. Intent - social	2.16	0.74	.77**	-.36**	-.09	.32**	.32**	.18*	.18*	.21**	-.01	.23**	.10	.20*	.47**		
15. Intent - nonsocial	1.61	0.65	.95**	-.24**	.00	.15	.16*	.13	.09	.07	-.06	.14	-.01	.07	.26**	.59**	
Cronbach's α			.87	.84	-	.93	.78	.84	.70	.73	.81	.74	.74	.65	.78	.65	.85

Note: * $p < .05$; ** $p < .01$