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Thinking dispositions and cognitive reflection performance in schizotypy

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Abstract

Schizotypy refers to the continuum of normal variability of psychosis-like characteristics and experiences, often classified as positive schizotypy ('unusual experiences'; UE) and negative schizotypy ('introvertive anhedonia'; IA). Here, we investigated the link between schizotypy and cognitive processing style and performance. A particular focus was on whether schizotypy is associated more with Type 1 (automatic/heuristic) than Type 2 (reflective/effortful) processes, as may be expected from findings of impaired top-down control in schizophrenia. A large sample (n = 1,512) completed online measures pertaining to schizotypy (Oxford-Liverpool Inventory for Feelings and Experiences; O-LIFE), thinking style (Rational Experiential Inventory-10, Actively Open-Minded Thinking Scale), and reasoning performance (Cognitive Reflection Test). Higher positive (UE) and negative (IA) schizotypy were associated with more pronounced Type 1 processing, i.e. greater self-reported Faith in Intuition (FI), lower Need for Cognition (NFC), lower Actively Open-Minded Thinking (AOT), and lower cognitive reflection test (CRT) scores. Canonical correlation analysis confirmed a significant association between UE and increased FI, lower AOT and lower CRT performance, accounting for 12.38% of the shared variance between schizotypy and thinking dispositions. IA was more highly associated with reduced NFC. These findings suggest that schizotypy may be associated with similar thinking dispositions to those reported in psychosis, with different patterns of associations for positive and negative schizotypy. This result informs research on reasoning processes in psychosis and has clinical implications, including potential treatment targets and refinements for cognitive therapies.

Keywords: schizotypy, judgment, decision making, reasoning, schizophrenia, thinking disposition

1 Introduction

Schizotypy refers to a continuum of psychosis-like characteristics and experiences, ranging in intensity from low to states that might be observed in clinical psychosis (Ettinger, Meyhöfer, Steffens, Wagner & Koutsouleris, 2014). Schizotypy is thought to encompass a range of human experiences and traits including unusual beliefs and perceptions, magical thinking, anhedonia and introversion (Fisher et al., 2004), and has been linked to creativity and artistic pursuits (Acar, Chen & Cayirdag, 2018; Burch, Pavelis, Hemsley & Corr, 2006; O'Reilly, Dunbar & Bentall, 2001), but has also been found to be associated with deficits in cognitive task performance (Cohen, Mohr, Ettinger, Chan & Park, 2015).

Positive and negative schizotypy are considered to be the two most reliable dimensions of schizotypy (Kwapil, Barrantes-Vidal & Silvia, 2008), although other factors such as cognitive disorganisation and impulsive non-conformity have also been proposed (Mason, 2006). Positive schizotypy refers to unusual experiences, perceptions, beliefs and magical thinking, while negative schizotypy refers to experiences such as anhedonia (attenuated ability to experience pleasure) and introversion (Fisher et al., 2004). Schizotypy arguably captures the range, heterogeneity and multi-dimensionality (Barrantes-Vidal, Grant & Kwapil, 2015) of psychosis and psychosis-like experiences. Furthermore, investigation of schizotypy as a trait may circumvent the confounding effects of medication, which can have global sedative effects that can greatly impede validity when exploring cognition (Barnes & McPhillips, 1999; Lambert et al., 2004).

Dual-process theories of thinking and decision-making have become ubiquitous and influential within cognitive psychology, and are supported by considerable empirical evidence (Evans, Barston & Pollard, 1983; Klauer, Musch & Naumer, 2000). Within these frameworks, 'Type 1' processing is thought to be fast, intuitive and automatic, relying on heuristics (i.e. mental shortcuts) or 'gut feelings', and out of conscious cognitive control, while 'Type 2' processing is considered to be slow, reflective, effortful, and generally more rational (Bryan & Harter, 1899; Evans, 2003, 2008, 2010; Shiffrin & Schneider, 1977).

Importantly, dual process theories have been integrated into psychosis-related frameworks, particularly in relation to positive symptoms such as delusional beliefs and persecutory ideation. In general, the proposition is that a combination of over-reliance on Type 1 reasoning alongside a lower propen-

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sity to use Type 2 reflective reasoning is associated with the maintenance of unusual or distressing beliefs (Freeman, Evans & Lister, 2012; Ward & Garety, in press; Ward, Peters, Jackson, Day & Garety, 2018). For example, in people with delusional ideation, Freeman and colleagues (2012) identified a positive association between paranoid thoughts and intuitive thinking, while higher levels of deliberative thinking were associated with fewer paranoid thoughts. People with delusional beliefs have also been found to exhibit a cognitive disposition towards lower belief flexibility than people without delusions (Colbert, Peters & Garety, 2010), which may indicate a less flexible and open-minded reasoning style. Indeed, both delusion-proneness (Bronstein, Pennycook, Bear, Rand & Cannon, in press) and reduced data gathering (Ross et al., 2016) have been associated with a less analytical thinking style. Furthermore, intuitive (Type 1) thinking has also been associated with parapsychological/anomalous experiences (Irwin & Wilson, 2013) as well as paranormal explanations for anomalous experiences (Irwin & Wilson, 2013; Ross, Hartig & McKay, 2017).

Studies also suggest that people with psychosis demonstrate a greater propensity for a 'jumping to conclusions' (JTC) bias than non-clinical subjects (Garety, Kuipers, Fowler, Freeman & Bebbington, 2001; So, Siu, Wong, Chan & Garety, 2016). This bias refers to the tendency to make hastier decisions and/or decisions with greater conviction (Huq, Garety & Hemsley, 1988). Two independent meta-analyses have identified a more prominent JTC bias in people with psychosis than control participants (Dudley, Taylor & Wickham, 2015; McLean, Mattiske & Balzan, 2017) as well as an increased JTC bias in people with delusions vs. those without delusions in psychosis (Dudley et al., 2015; McLean et al., 2017). Another meta-analysis (Ross, McKay, Coltheart & Langdon, 2015) found an association between delusions and the JTC bias in delusion-prone samples. Investigating the mechanisms involved in JTC, Glöckner and Moritz (2009) found that more extreme confidence ratings were endorsed by people with schizophrenia than healthy controls when making decisions, while there was no difference in the amount of information gathered across the groups. However, the clinical group resorted to a less normatively effective strategy under stress; weighing all information equally regardless of its validity.

A further observation in the literature that is linked to the concept of thinking styles in people with psychosis (Eisenacher & Zink, 2017) is the cognitive bias against disconfirmatory evidence (BADE), reported particularly in people scoring highly in delusion-proneness (McLean et al., 2017; Woodward, Buchy, Moritz & Liotti, 2007). BADE refers to a tendency to be less likely to integrate new evidence that disconfirms one's existing beliefs. A recent meta-analysis identified greater BADE in people with psychosis than healthy controls as well as in people with delusions in psychosis than people without delusions in psychosis (McLean et al., 2017).

In contrast to the substantial literature in psychosis, the evidence base for reasoning processes in schizotypy is less well-established. Positive schizotypy, i.e. unusual beliefs, has been linked to intuitive thinking (Boden, Berenbaum & Topper, 2012) (assessed by the Rational Experiential Inventory; REI, Pacini & Epstein, 1999; see also Genovese, 2005). In terms of deliberative thinking, there is some evidence that Type 2 logical reasoning ability is reduced in schizotypy, but findings vary across tasks related to logical reasoning and across studies. For example, Dagnall, Denovan, Drinkwater, Parker & Clough (2016) found that higher positive schizotypy (unusual experiences) was associated with poorer performance on reasoning problems involving statistical bias. Tsakanikos (2004) found that *all* dimensions out of the four schizotypy dimensions tested (unusual experiences, introvertive anhedonia, cognitive disorganisation and impulsive non-conformity) were associated with impaired performance on logical reasoning problems. Interestingly, Karimi, Windmann, Güntürkün & Abraham (2007) reported *enhanced* reasoning in people with higher schizotypy scores for *creative* or lateral problem solving (as opposed to goal focused problem solving), although another study reported no such association (Webb, Little, Cropper & Roze, 2017).

Several studies have reported a significant JTC bias in high compared with low schizotypy (Brugger & Graves, 1997; Moritz et al., 2017; Moritz, Van Quaquebeke & Lincoln, 2012; Sellen, Oaksford & Gray, 2005), although some studies have found no evidence for a JTC bias in positive and negative schizotypy (Juárez-Ramos et al., 2014; Sellen et al., 2005). Research into the association between BADE and schizotypy have similarly yielded inconclusive results (Buchy, Woodward & Liotti, 2007; Orenes, Navarrete, Beltrán & Santamaría, 2012). This may reflect the need to use more sensitive measures in schizotypy compared with psychosis or clinical samples, in which the effect sizes are likely to be larger and more detectable.

In summary, previous research seems to point to an association between schizotypy and reasoning processes (thinking dispositions as well as performance), but the exact nature of this interplay has not been comprehensively investigated. Thus far these processes have been considered only in isolation, e.g., the association between schizotypy and thinking dispositions, or between thinking dispositions and thinking performance. Here, we sought to more comprehensively investigate the relationship between individual differences in schizotypy and reasoning processes in the context of dual process models. In addition to self-reported intuitive and deliberative thinking, we also considered actively open-minded thinking beliefs and a performance-based measure of cognitive reflection. The cognitive reflection test (Frederick, 2005) was used as it exhibits properties related to the JTC tasks mentioned above (Evans & Stanovich, 2013). We hypothesised that people with higher schizotypy scores would demonstrate greater experiential/intuitive reasoning (Faith

in Intuition; FI), lower propensity for deliberative/effortful reasoning (Need for Cognition; NFC), reduced open-minded thinking beliefs (AOT), and reduced reflective thinking performance (CRT).

2 Method

The study employed a cross-sectional quantitative design. Participants completed an online survey created through the Qualtrics (2018) survey platform. Participation took approximately 10–15 minutes and upon completion participants received brief, general and non-pathologising feedback summaries based on their scores for positive and negative schizotypy.

2.1 Participants

The study was advertised and distributed through personal social media, university contacts, small ads websites (Gumtree), psychology research websites, and local community settings (e.g. Cafés, Yoga studios). Purposive recruitment was also undertaken by advertising the study in Facebook groups dedicated to topics such as spirituality, esoteric knowledge, paranormal beliefs, gaming and introversion. Participants were required to be 17 years of age or older to participate.

2.2 Materials

2.2.1 Demographics

Participants recorded their age, gender and highest completed level of education.

2.2.2 Schizotypy

The Oxford-Liverpool Inventory of Feelings and Experiences (O-LIFE) short form schizotypy scale (Mason et al., 2005) was used to measure positive and negative schizotypy. The O-LIFE short form is briefer and easier to administer than the original, whilst retaining favourable psychometric properties (Mason et al., 2005). Twelve self-report items assess Unusual Experiences (UE) and ten items assess Introvertive Anhedonia (IA). There are two other subscales, Cognitive Disorganisation (CD) and Impulsive Non-Conformity (IN), which were not relevant for the present study and were therefore not administered. Items are rated as 1 for a 'yes' response and 0 for a 'no' (except reverse-coded items), and are summed to provide a score for each dimension of schizotypy.

Sample Items:

When in the dark do you often see shapes and forms even though there is nothing there? (UE)

Do you feel very close to your friends? (IA) (reverse-coded)

2.2.3 Cognitive Reflection (CRT)

The combined Cognitive Reflection Test (CRT; Frederick, 2005) was used to measure cognitive reflection or 'miserly processing'. The CRT is a performance-based measure consisting of brief math-like puzzles that assess the ability to withhold a tempting intuitive (but incorrect) Type 1 response and engage in reflective Type 2 processing to generate a correct response. It is negatively correlated with a variety of cognitive biases (Frederick, 2005).

All items proposed from across three papers (Frederick, 2005; Toplak, West & Stanovich, 2014; Thomson & Oppenheimer, 2016) were included, except for the 'bat and ball' problem, due to its now high level of familiarity in the public domain. A 'control' item consisting of a simple mathematical problem (with no 'lure' response) was embedded amongst the items, but did not contribute to CRT performance score. Correct responses were awarded a score of 1, while incorrect responses were awarded 0, with a maximum total score of 10. Higher total scores were indicative of greater ability to think analytically and override heuristic processing.

Sample Item (from CRT-2; Thomson & Oppenheimer, 2016):

A farmer had 15 sheep and all but 8 died. How many are left? [Intuitive answer: 7, Correct answer: 8]

An additional question "have you seen any of the above puzzles before?" was included and participants were asked to specify which puzzles they were familiar with. Accuracy scores were calculated based on the proportion of correct responses *only* for previously unseen items for each respondent.

2.2.4 Thinking Beliefs (AOT)

A shorter 7-item version (Haran, Ritov & Mellers, 2013) of the original Actively Open-minded Thinking Scale (AOTS; Stanovich & West, 1997) was used to measure beliefs about good thinking, particularly the tendency to engage in open-minded thinking and attend to evidence opposing favored conclusions. The short form has good face validity and reliability (Haran et al., 2013). Questions are answered on a 7-point scale and are summed to provide an overall score ranging from 7 to 49. Higher total score favors a more open-minded and flexible approach to thinking.

Sample Item:

People should revise their beliefs in response to new information or evidence.

2.2.5 Type 1 and Type 2 Processing

The Rational Experiential Inventory (REI-10; Epstein, Pacini, Denes-Raj, & Heier, 1996) comprises two unipolar scales each consisting of five items; Faith in Intuition (FI)

TABLE 1: Sample characteristics.

Variable	Mean(SD) OR n(%)
Age (years); Mean (SD); (range)	34.19 (13.36); (17–78)
Gender, n (%)	
Male	338 (22.4)
Female	1162 (76.9)
Other	6 (0.4)
Would prefer not to say	6 (0.4)
Highest Education, n (%)	
School	227 (15.0)
College or Sixth Form	309 (20.4)
Vocational Qualification	146 (9.7)
Bachelor's Degree (BSc/BA)	429 (28.4)
Postgraduate Diploma	74 (4.9)
Master's Degree (MSc/MA)	258 (17.1)
Doctorate/PhD	61 (4.0)
Questionnaire scores, Mean(SD)	
Unusual Experiences	5.06 (3.03)
Introvertive Anhedonia	3.10 (2.33)
Cognitive Reflection Test	4.04 (2.55)
Actively Open-Minded Thinking	36.21 (6.53)
Faith in Intuition	18.11 (3.73)
Need for Cognition	18.53 (3.41)

Note: Continuous variables were found to be normally distributed as assessed by histograms and Q-Q plots.

and Need for Cognition (NFC). Based on Epstein's Cognitive Experiential Self Theory (Epstein, 2003), they are thought to tap into Type 1 (intuitive-experiential) and Type 2 (analytic-rational) processes respectively. The original 40-item version (Pacini & Epstein, 1999) is reported to have good psychometric properties including high internal validity (Cronbach's alphas > 0.85). Responses are rated on a 5-point Likert scale and total scores indicate a preponderance to engage in intuitive or rational thinking processes respectively.

Sample Items:

My initial impressions of people are almost always right. (FI)

I would prefer complex to simple problems. (NFC)

2.3 Data Analysis

Gender was transformed from into a binary variable 'sex' with male coded as 0 and female coded as 1. This meant that for the 0.7% of respondents who entered 'Other' or 'Would prefer not to say' into the gender field, data for 'sex' was not coded and was not included in the analysis.

164 incomplete survey responses were retained in the dataset, and were included in the analysis where possible through pairwise deletion. Otherwise, cases with one-off item-level missing data were subject to mean imputation (Kalton & Kasprzyk, 1986). Mean imputation was carried out on a very small proportion of the data (0.0007% of items on both the AOT and REI-10) falling well within the acceptable recommended limits (Shrive, Stuart, Quan & Ghali, 2006).

3 Results

3.1 Sample Characteristics

A sample size of 1,512 participants was achieved. We sought a large sample in order to have a sufficiently powered study to detect potential nuances in the relationships between the different variables. Descriptive statistics are reported in Table 1. The majority of respondents were female (76.9%) and participant age spanned 17–78 years. Highest level of completed education was also well spread, with decent representation from those who had not completed higher education beyond school (15.0%), those who had completed sixth form (20.4%), vocational qualifications (9.7%), undergraduate degrees (28.4%), postgraduate degrees (22.0%) and doctoral degrees (4.0%).

3.2 Associations between Variables

Pairwise independent samples t-tests were performed between males and females, with all continuous variables of interest as dependent variables. The results are displayed in Table 2. Homogeneity of variance as assessed by Levene's test was not violated for any variables, except for CRT. Therefore, statistics for assumed equal variances are reported generally and unassumed equal variances are reported for CRT. CRT, IA, AOT and NFC was significantly higher in males than females, while UE and FI were significantly higher in females than males.

Pairwise Pearson's correlation coefficients are displayed in Table 3. As for significant correlations, positive schizotypy (UE) was positively associated with IA and FI, and negatively associated with age, CRT, AOT and NFC. Similarly, negative schizotypy (IA) was positively correlated with FI and negatively correlated with CRT, AOT and NFC, but was not significantly associated with age. None of the variables were found to be correlated to a degree that suggested they were measuring the same underlying construct, with the highest r being .39 for the association between Cognitive Reflection and AOT. While some of the variables undoubtedly overlap, they appear to be conceptually distinct.

TABLE 2: T-tests for schizotypy, thinking processes and thinking styles by sex.

	Male		Female			
Variable	Mean	SD	Mean	SD	t	p
UE	4.61	2.97	5.17	3.02	3.02	.003
IA	3.42	2.30	3.01	2.33	−2.77	.006
Age	34.47	13.94	34.15	13.17	−.40	.692
CRT	4.75	2.74	3.82	2.46	−5.19	<.001
AOT	37.56	6.64	35.81	6.43	−4.15	<.001
FI	17.65	3.83	18.24	3.69	2.45	.014
NFC	19.14	3.39	18.35	3.40	−3.56	<.001

Note: UE=unusual experiences, IA=introvertive anhedonia, CRT=cognitive reflection test, AOT=actively open-minded thinking, FI=faith in intuition, NFC=need for cognition. p-values are two-tailed. The minimum N is 303 for males and 1031 for males.

TABLE 3: Correlation coefficients.

	UE	IA	CRT	AOT	FI	NFC	Age
UE	.	.26	-.22	-.21	.32	-.07	-.09
IA	.26	.	-.11	-.11	.07	-.12	-.01
CRT	-.22	-.11	.	.39	-.22	.25	.02
AOT	-.21	-.11	.39	.	-.29	.30	.03
FI	.32	.07	-.22	-.29	.	-.07	.06
NFC	-.07	-.12	.25	.30	-.07	.	.05
Age	-.09	-.01	.02	.03	.06	.05	.

Note: CRT=cognitive reflection test, UE=unusual experiences, IA=introvertive anhedonia; AOT=actively open-minded thinking, FI=faith in intuition, NFC=need for cognition. All tests two-tailed. 95% confidence intervals are all ±.05. N's are at least 1330. r = .06 required for p<.05, r = .07 required for p<.01, r = .10 required for p<.001.

3.3 Canonical Correlation Analysis

A canonical correlation analysis was conducted between the two schizotypy variables (UE and IA) and the four thinking process variables (FI, NFC, AOT and performance based CRT) to evaluate the multivariate shared relationship between the two sets of variables.[1] The analysis yielded two functions with squared canonical correlations (R_c^2) of .123 and .014 for each successful function. Overall, the full model across both functions was statistically significant (Wilks' λ = .86, F (8, 2656) = 25.16, p < .001).[2] Tests of dimensionality further indicated that both of the canonical dimensions were statistically significant at the level p < .001. Thus, the best linear predictor of IA was not the same combination of the four predictors as the best predictor of UE.

Dimension reduction analysis tested the hierarchical arrangement of functions to establish their statistical significance. In addition to the full model (Functions 1 to 2) reaching statistical significance as highlighted above, the remaining function (Function 2) also explained a statistically significant amount of shared variance between the variable sets, F(3,1329) = 6.19, p < .001. However, referring to R_c^2 effects, Function 1 is considered far more noteworthy as it accounted for 12.38% of the shared variance. Function 2 needs to be interpreted with the caveat that it explained only 1.38% of the remaining variance after prior functions were extracted.

TABLE 4: Canonical correlation analysis between schizotypy and thinking process variables.

	Function 1		Function 2		
Variable	Coef	r[s]	Coef	r[s]	h^2
Schizotypy					
UE	.977	**.997**	−.351	−.074	99.95
IA	.076	.338	1.035	**.941**	99.97
Thinking processes					
FI	.735	**.881**	−.469	−.306	86.98
NFC	−.015	−.223	−.799	**−.878**	82.06
AOT	−.225	**−.581**	−.270	−.418	51.23
CRT	−.358	**−.611**	−.128	−.329	48.15

Note: Structure coefficients (r[s]) greater than |.45| are displayed in bold. Coef = standardized canonical function coefficient (weight of each variable); r[s] = structure coefficient (loading; correlation of each variable with function score); h^2 = communality coefficient (percent of variance in each measure accounted for by both functions); UE = unusual experiences; IA = introvertive anhedonia; FI = faith in intuition; NFC = need for cognition; AOT = actively open-minded thinking; CRT = cognitive reflection test.

[1]Canonical correlation looks for a linear combination of one set of variables that maximally correlates with a linear combination of another set, then for a second pair of linear combinations that account for what the first set misses, and so on, but here there can only be two of these functions because one set of variables has only two members. So the question comes down to whether the cognitive measures can predict the schizotypy measures overall, and, if so, which measures are more important, and whether different cognitive measures are relatively more important for one schizotypy measure than the other.

[2]As Wilks' λ represents how much variance is unexplained by the model, 1−Wilks' λ provides the full effect size for the model. Therefore, for the two canonical functions, the r^2 type effect size was .14. This suggests that the full model explained approximately 14% of the variance shared between schizotypy and thinking style.

Standardized canonical function coefficients and structure coefficients for both functions are displayed in Table 4, in addition to the communalities (h^2) across the two functions for each variable.

It is clear that Function 1 concerns mostly the predictor of UE (.977 vs. .076, upper left of Table 4) while Function 2 concerns the predictors of IA (−.351 vs. 1.035).

For Function 1, FI, AOT and CRT were the primary predictors of UE (but not NFC). UE was positively associated with FI and negatively associated with AOT and CRT.

For Function 2, the coefficients indicate that IA and NFC, especially NFC, are the primary variables relevant to the prediction of (mostly) IA and are inversely associated.

In summary, UE is most significantly associated with a combination of increased FI, lower AOT and lower CRT performance, while IA is best predicted by reduced NFC.

4 Discussion

This study sought to investigate how individual differences in schizotypy are related to reasoning processes in the context of dual process models. The aim was to generate a more comprehensive understanding of reasoning and decision-making in schizotypy, to build on current theoretical understandings and inform clinical interventions and practical applications in schizophrenia spectrum populations.

Sex differences in schizotypy mirrored previous literature (Fonseca-Pedrero et al., 2018; Mason & Claridge, 2006), with women reporting higher UE than men, and men reporting higher IA than women. Men were also found to attain higher average scores on the CRT, as reported elsewhere (Frederick, 2005). Both positive (UE) and negative (IA) schizotypy dimensions were associated with higher FI, lower NFC, lower self-reported AOT and lower cognitive reflection test (CRT) performance. This suggests that overall, schizotypy was associated with greater reliance on intuitive processing and less reliance on deliberative processing, as well as a less open-minded and reflective reasoning style. Further analyses of the shared relationship between the two sets of variables, found that positive schizotypy (UE) was positively associated with intuitive thinking (FI) and negatively associated with AOT and thinking performance (CRT). Negative schizotypy (IA), on the other hand, was inversely associated with deliberative thinking (NFC), but only to a small degree. This suggests that, in our sample, reasoning processes co-varied to a greater extent with positive schizotypy than they did with negative schizotypy.

A preponderance for greater intuitive thinking and lower deliberative thinking fits with our hypotheses related to reasoning processes in schizotypy. Such a profile has been reported in delusions (Freeman et al., 2012; Ward & Garety, in press; Ward et al., 2018) as well as in belief in conspiracy theories (Swami, Voracek, Stieger, Tran & Furnham, 2014). This is particularly consistent with our observed association between positive schizotypy (which is characterized by unusual experiences) and more intuitive, less open-minded thinking and a less reflective reasoning performance. While there appears to be a lower preponderance for rational Type 2 thinking in high schizotypy scorers, this may not extend to all types of higher-level thinking. For example, creative thinking has previously been reported to be *enhanced* in high schizotypy scorers (Karimi et al., 2007), which could be tested in future studies with objective performance-based measures of creative Type 2 reasoning.

A novel finding is that both UE and IA were inversely related to cognitive reflection test (CRT) performance. The negative association between schizotypy and AOT also suggests a lower propensity to consider alternative or conflicting evidence when reasoning (and a lower value placed on such consideration). The association was stronger between AOT and UE than it was for IA, suggesting a more robust association for positive than negative schizotypy. This is consistent with the literature, in which delusional beliefs are reported to be associated with lower belief flexibility, JTC and BADE in clinical samples (Ward & Garety, in press).

Similarly, UE (but not IA) was significantly associated with cognitive reflection after subjecting the two sets of variables to a canonical correlation analysis. The reason for this dissociation might be that negative schizotypy has a less cognitive quality, tapping more strongly into introversion or deriving less pleasure from activities: given a lower tendency to derive pleasure from reflective thinking, people scoring more highly in IA would reasonably be expected to gain less satisfaction from engaging in effortful and deliberative thought. This draws parallels with the lack of motivation (or 'amotivation') that is thought to be characteristic of clinical psychosis (Jean-Michel, Raoul & Marc, 2014), and the relatively strong negative correlation between IA and NFC suggests that NFC may be more sensitive than the other cognitive measures to motivation (as the NFC items also suggest).

"Epistemic self-regulation" (Evans & Stanovich, 2013) thus seems to play a role in cognitive reflection. Schizotypy then seems to affect (if we can infer causation) the ability (or desire in the case of IA) to self-regulate one's goals: there is less willingness to collect and consider more information or consider other points of view (AOT), and less of a tendency to think extensively about a situation and the future consequences. In addition, there is a direct relationship of UE (but not IA) with CRT score, which may reflect the assumed positive or additional processes causing either an increase in Type 1 activity (automatic responses) or an interference with Type 2 processing (constructive, reflective thought), or both, within positive schizotypy.

4.1 Implications

The present study has both theoretical and practical implications. Increasing people's capacity for cognitive reflection, through encouraging consideration of alternative options or further deliberative reasoning could be clinically useful. For example, eliciting analytic thinking has been successful in reducing beliefs in conspiracy theories (Swami et al., 2014). Furthermore, as Type 2 reasoning is reportedly poorer in clinical psychosis compared with psychosis-like experiences in non-clinical samples (Ward et al., 2018), effective rational reasoning may be protective in preventing paranoia or distressing appraisals associated with psychosis-like experiences.

Clinical interventions that target thinking processes have shown promise in treating various aspects of psychosis. For example, metacognitive training programs, which focus on amending reasoning biases have had favorable outcomes for people with psychosis, evidence which has been replicated and extended to the "gold-standard" of randomized-control trials (Aghotor, Pfueller, Moritz, Weisbrod & Roesch-Ely, 2010; Briki et al., 2018; Moritz & Woodward, 2007) and group formats (Moritz et al., 2011; Moritz et al., 2018). Cognitive Enhancement Therapy, a multidimensional program consisting of neurocognitive training and social cognitive group exercises, has also shown promising results (Eack et al., 2009; Hogarty et al., 2004), as has Cognitive Remediation Therapy, which aims to improve cognitive flexibility and psychosocial functioning (McGurk, Twamley, Sitzer, McHugo & Mueser, 2007; Wykes, Huddy, Cellard, McGurk & Czobor, 2011). While the effect sizes in our study were relatively small, it could reasonably be hypothesized that these effects would be more pronounced in clinical samples, which could be investigated in future research.

Our findings may suggest that clinical interventions related to negative schizotypy would be better placed to also focus on other aspects, such as potentially increasing wellbeing or psychosocial functioning (Greenwood, Landau & Wykes, 2005; Hunter & Barry, 2018; Lincoln, Mehl, Kesting & Rief, 2011). Interestingly, however, increased cognitive flexibility has been found to be a predictor of increased treatment response to Cognitive Behavioural Therapy for Psychosis (Garety et al., 1997; So et al., 2012), one of the recommended psychological interventions for psychosis (NICE, 2014). This finding suggests that encouraging flexible thinking or AOT could potentially also exert beneficial effects through enhancing therapeutic responses to evidence-based psychological interventions.

4.2 Strengths and Limitations

Strengths of the current study include the large sample size, which enhances the reliability and generalizability of the findings. There was also good representation across a wide range of ages and education levels and from across the schizotypy continuum. The present study is novel in its approach and adds meaningful and valuable contributions to the literature on schizotypy and decision-making.

Nevertheless, the study needs to be couched in a number of limitations. The psychological constructs examined are not absolute, clear-cut and categorical phenomena. As with any cognitive constructs, they likely tap into multiple processes and share a degree of overlap. The multiple variations in dual process theories in the literature reflect this heterogeneity (Evans & Stanovich, 2013). However, this is a caveat that applies across the field of personality research, and the approach we took arguably maximizes our ability to capture and identify these nuanced and reciprocal relationships.

The use of self-report measures also assumes that people are aware of and able to report their own reasoning tendencies and beliefs. Furthermore, intelligence or cognitive ability beyond the CRT were not explicitly assessed (Toplak, West & Stanovich, 2011) and mental health difficulties, substance misuse and neurological problems were not specifically screened for. However, it could be argued that this makes the data more representative of 'real' people and the population at large which it is intending to emulate.

4.3 Conclusions

The present study provides evidence that thinking processes and attitudes may vary according to schizotypy levels. These findings may highlight similar reasoning processes to those reported in psychosis; higher positive and negative schizotypy appeared to be related to greater reliance on intuitive thinking, less reliance on deliberative reasoning, a less open-minded thinking style and poorer reasoning performance, with more marked effects in positive than negative schizotypy. These findings carry clinical implications, including potential useful treatment targets and refinements for cognitive therapies.

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