



Metaphor processing in high and low schizotypal individuals

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ABSTRACT

Two hypotheses were considered regarding the relationship between positive schizotypy and metaphor processing. On the basis of continuity between schizophrenia and schizotypy, high schizotypal individuals would be expected to be impaired at metaphor processing. However, given the right hemisphere processing bias that has been associated with positive schizotypy, they would be expected to be superior at metaphor processing. A story completion task in which participants judged the appropriateness of literal and metaphoric statements was administered to 30 high and 29 low schizotypal individuals. Contrary to both hypotheses, groups did not differ in their ability to discriminate between appropriate and inappropriate statements, whether literal or metaphoric. However, the high schizotypal group demonstrated a less conservative response bias; they were more likely than the low schizotypal group to identify a statement as appropriate, whether it was or was not. Implications of these results for our understanding of language processing in schizophrenia and schizotypy are discussed.

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1. Introduction

The term 'schizotypy' refers to a constellation of cognitive and personality traits that leads to a person being perceived by others as unusual or eccentric. Although schizotypal traits indicate a vulnerability to psychosis (Meehl, 1962, 1990; Chapman et al., 1994; Johnstone et al., 2005; Lenzenweger, 2006), they do not in themselves constitute mental illness, and are distributed in the healthy population (Brod, 1997; Claridge, 1997; Green and Williams, 1999; McCreery and Claridge, 2002). Factor analysis of schizotypal traits vary according to assessment tools, but there are at least three distinct schizotypal dimensions that are proposed to correspond to the three syndromes of schizophrenia. Following Raine's terminology, these are *positive (or cognitive–perceptual) schizotypy*, characterised by delusion-like beliefs and hallucination-like experiences, *negative (or interpersonal) schizotypy*, considered to be deficits or the absence of common experiences, and a *disorganised* factor that taps odd speech and behaviour (Raine, 1991; Raine et al., 1994; Gruzelier et al., 1995).

The study of individuals with schizotypy is often undertaken to shed light on cognitive processes that are altered in schizophrenia, as schizotypal samples are not compromised by medication regimes or interference from psychotic symptoms that challenge task performance in schizophrenic patients. If high schizotypal individuals are psychosis-prone, they may well share similar patterns of cognitive processing observed in schizophrenia. One domain in which individuals with

schizophrenia are impaired is the pragmatic use of language (Cutting, 1990; Cutting and Murphy, 1990; Langdon et al., 2002a,b; Tényi et al., 2002; Brüne and Bodenstein, 2004; Mitchell and Crow, 2005), including an overly literal or concrete interpretation of metaphors and idioms (Spitzer et al., 1994; Titone et al., 2002; Tavano et al., 2008). Difficulties with metaphor processing in schizophrenia are thought to reflect degradation of the semantic system so that it fails to represent the figurative relationships upon which metaphoric interpretation depends (Langdon et al., 2002b; Langdon and Coltheart, 2004). Given continuity between schizotypy and schizophrenia, one might expect that high schizotypal individuals would show similar impairments in metaphoric processing.

Alternatively, one might well expect high schizotypes to demonstrate *superior* metaphoric processing to low schizotypes. This hypothesis is based on the finding that high schizotypy, particularly involving positive traits, is associated with increased activation of the right hemisphere (Rawlings and Borge, 1987; Brugger et al., 1993; Claridge, 1997) which plays an important role in metaphor processing (Winner and Gardner, 1977; Brownell et al., 1990; Bottini et al., 1994; Faust and Mashal, 2007; Schmidt et al., 2007). A shift towards greater right hemisphere contributions to language processing in positive schizotypy has been observed in studies of perceptual asymmetries (Broks, 1984; Rawlings and Claridge, 1984; Leonhard and Brugger, 1998; Weinstein and Graves, 2002; Mohr et al., 2005), and more recently with neuroimaging (Hori et al., 2008a,b). Studies of semantic processing in schizotypy have also demonstrated that individuals high in schizotypy display a more diffuse and longer lasting pattern of semantic activation (Pizzagalli et al., 2001; Morgan et al., 2006; Grimshaw et al., 2010) that is most typical of reliance on the right hemisphere semantic system (Burgess and Simpson, 1988; Beeman

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and Chiarello, 1998; Lindell, 2006). This activation of a broad range of distant semantic associates is precisely the pattern of activation that is necessary for the interpretation of figurative language such as metaphor.

Previous research findings on pragmatic language processing in schizotypy are equivocal. Nunn and Peters (2001) examined the relationship between scores on the Oxford-Liverpool Inventory of Feelings and Experiences (O-LIFE; Mason et al., 1995) and language processing, and found that higher scores on the Unusual Experiences Scale (a measure of positive schizotypy) were associated with poorer performance on “right hemisphere” language tasks including humour, proverb interpretation and a grammatical inferences task. This finding is consistent with the hypothesis that high schizotypes demonstrate similar pragmatic language deficits to those with schizophrenia. Metaphor processing, however, was not assessed.

In the only study to date to specifically examine metaphor processing in schizotypy, Langdon and Coltheart (2004) used a story completion task that had previously demonstrated deficits in schizophrenia (Langdon et al., 2002a). Participants read a short scenario, followed by a statement said by one of the characters. The final statement could be literally appropriate, metaphorically appropriate, or ironically appropriate or it could be an inappropriate statement. Participants indicated whether the statement was appropriate or inappropriate in the context of the story. Like individuals with schizophrenia, individuals with high schizotypy scores were impaired in interpreting ironic statements. However, they showed no deficits in metaphor processing, and were in fact non-significantly better than individuals with low schizotypy scores. The findings of this study are therefore unclear with respect to the status of metaphor processing in schizotypy, and Langdon and Coltheart suggest that their findings may have been limited by the statistical power of their design. Specifically, they examined a relatively small sample ($N = 36$) of individuals with a full range of schizotypy scores, categorised into high and low schizotypy groups according to a median split. Such a design has the advantage of allowing one to test for curvilinear relationships between schizotypy scores and language processing, but with a small sample it limits the statistical power of the study.

The present study used the same metaphor processing task used by Langdon and Coltheart (2004) with a more powerful statistical design to determine whether individuals with high schizotypy scores demonstrate poorer performance (as would be predicted by continuity between schizotypy and schizophrenia) or better performance (as would be predicted by the right hemisphere processing advantage observed in positive schizotypy). Power was increased in three ways. First, a larger sample was selected. Second, individuals were selected on the basis of their positive schizotypy (and not total schizotypy) scores, given that both right hemisphere bias and semantic processing differences have been specifically associated with positive schizotypy. Finally, individuals were selected from the upper and lower quartiles of positive schizotypy scores in order to minimise within-group variance and maximise between-group variance.

Determining whether a literal or metaphoric statement is appropriate is a subjective decision, and is therefore subject to individual differences in criterion. The metaphor task is essentially a signal detection task, with a hit corresponding to the correct interpretation of an appropriate statement as appropriate, and a false alarm corresponding to the incorrect interpretation of an inappropriate statement as appropriate. The task therefore provides two measures of participant performance; a sensitivity measure (d') that reflects the ability to discriminate between appropriate and inappropriate uses of metaphoric and literal statements, and a response bias measure (c) that reflects an individual's criterion for deciding that a statement is appropriate. Positive schizotypy has been associated with a relaxing of criterion and a greater willingness to assign meaning to meaningless situations across a number of different research paradigms (Tsakanikos and Reed, 2005; Reed et al., 2008; Grimshaw et al., 2010).

Signal detection analysis of performance on the metaphor task allows one to distinguish between effects of schizotypy on semantic organization and activation (as reflected in the sensitivity measure) and its effects on decision processes derived from that activation (as reflected in the response bias measure).

2. Method

2.1. Participants

The Schizotypal Personality Questionnaire (SPQ; Raine, 1991) was administered to 500 students during a laboratory class in Introductory Psychology. The SPQ yields nine subscales which make up three factors: *Cognitive-perceptual* (positive dimension), which consists of the ideas of reference, magical thinking, unusual perceptual experiences and suspiciousness subscales; *Interpersonal* (negative dimension), which consists of excessive social anxiety, no close friends, constricted affect and suspiciousness subscales; and *disorganised*, which consists of the odd or eccentric behavior, and odd speech subscales. Participants were screened on the basis of their score on the cognitive-perceptual factor, which produces possible scores between 0 and 33. Participants who scored in the upper quartile (Factor scores ≥ 13) and lower quartile (Factor scores ≤ 5) on this factor were invited to participate in the follow-up study.

Participants were 59 students of whom 30 (seven males and 23 females) were in the high schizotypy group, and 29 (10 males and 19 females) were in the low schizotypy group. Ages of participants ranged from 18 to 24, ($M = 19$ years), and did not differ between groups. All participants reported being native English speakers. The participants were not aware of the relationship between the SPQ measure and the experiment, and experimenters were blind to the schizotypy group status of each participant. The study was approved by the Victoria University of Wellington Human Ethics Committee.

2.2. Materials

Metaphor comprehension was measured using the story comprehension task adapted from Langdon and Coltheart (2004). Participants read stories which described a situation up to the point at which a story character made a concluding statement. Participants were asked to judge whether the concluding statement was an appropriate or inappropriate comment to make. The statements could be one of four types, literally appropriate, literally inappropriate, metaphorically appropriate or metaphorically inappropriate. The inappropriate statements were story endings taken from other stories.

Each participant saw four practice stories followed by 72 experimental stories with 36 stories requiring a 'yes' response (18 metaphorically appropriate endings and 18 literally appropriate endings) and 36 requiring a 'no' response (18 nonsense metaphor endings, and 18 nonsense literal endings). The assignment of concluding statements to stories was counterbalanced so that, across participants, each ending was seen equally often for each story. An example item is;

“It is the first day of school holidays. Luke has been up since the crack of dawn and has already been out skateboarding. His mother is in the kitchen making breakfast when he arrives home again. He is singing loudly as he comes in the door. Luke's mother says:” The story was followed by one of four possible endings;

“Dear me, you're full of beans” (Metaphorically appropriate);

“Dear me, you sure sound fit and healthy.” (Literally appropriate);

“Her eyes are glued on him.” (Metaphorically inappropriate);

“So, you don't think much of him then.” (Literally inappropriate).

Each participant saw each story once, with one of the four possible endings.

2.3. Procedure

The metaphor task was presented by a Pentium computer with a 17" monitor, in black 18 point font on a white background. The story was presented first, and the participant pressed the space bar to display the concluding statement when they were ready. The story remained on the screen while the concluding statement appeared at the bottom. Participants were told only to indicate whether the statement was an appropriate or inappropriate thing for the character to say in that situation; they were not informed that some of the statements were metaphors. Responses were made on the number pad of the computer keyboard, using the “1” key to indicate an appropriate response and the “2” key to indicate an inappropriate response. Accuracy was emphasised over response time, which was not recorded. No feedback was provided.

Participants first saw four practice stories, one from each type of character statement. The experimenter stayed with the participant during the practice trials. The 72 experimental trials took approximately 25 min to complete.

2.4. Design

The study employed a 2 (schizotypy: high, low) × 2 (sentence type: literal, metaphoric) mixed design with schizotypy as a between subjects variable and sentence type as a within subject variable. Dependent variables were hit and false alarm rates, as well as the signal detection parameters for sensitivity (d') and response bias (c).

3. Results

3.1. Schizotypy measures

The two groups were first compared on the factors and subscales of the SPQ (see Table 1). Degrees of freedom were adjusted whenever variances were unequal, and an alpha level of 0.005 was set given the large number of comparisons. As expected, groups differed in their positive (cognitive–perceptual) schizotypy scores, $t(33.9) = -17.485$, $P < 0.001$. Groups differed significantly on each subscale of this factor; *ideas of reference*, $t(57) = -11.880$, $P < 0.001$; *magical ideation*, $t(33.8) = -8.115$, $P < 0.001$; *unusual perceptual experiences*, $t(31.6) = -6.277$, $P < 0.001$; and *suspiciousness*, $t(41.7) = -7.479$, $P < 0.001$. The two groups did not differ on the negative (Interpersonal) factor, $t(57) = -2.435$, ns , nor on the disorganised factor, $t(57) = -1.311$, ns .

3.2. Metaphor comprehension

Because the metaphor comprehension task was essentially a signal detection task, accuracy was transformed into measures of sensitivity (d'), which is a measure of the participant's ability to discriminate between related and unrelated items, and criterion (c), which is a measure of the participant's bias to respond "related" or "unrelated" under conditions of uncertainty. Sensitivity (d') was calculated based on the Hit Rate (response of "appropriate" to an appropriate sentence) and the False Alarm Rate (response of "appropriate" to an inappropriate sentence) according to the formula

$$d' = z(\text{Hit Rate}) - z(\text{False Alarm Rate})$$

with the correction for rates of 0 and 1 to 0.025 and 0.975, respectively (MacMillan and Creelman, 1991). The criterion measure c was calculated as

$$c = -0.5(z(\text{Hit Rate}) + z(\text{False Alarm Rate})).$$

Positive values of c reflect a conservative criterion, that is, a bias to report sentences as inappropriate, and negative values reflect a lax criterion, that is, a bias to report sentences as appropriate.

Hits, false alarms, d' and c values are reported in Table 2. Each dependent measure was initially analysed in a 2 (schizotypy: high,

Table 1
Schizotypy scale scores for high and low positive schizotypy groups.

	Low (N = 30)		High (N = 30)	
	M	S.D.	M	S.D.
SPQ total	15.28	8.85	33.53	10.53
Cognitive–perceptual*	3.14	1.32	18.53	4.63
Ideas of reference*	1.35	1.15	5.90	1.75
Magical ideation*	0.28	0.66	3.50	2.08
Unusual perceptual experiences*	0.62	0.81	5.20	3.91
Suspiciousness*	0.87	0.94	3.93	1.98
Interpersonal	7.69	6.32	11.63	6.04
Social anxiety	4.00	4.87	3.43	2.25
No close friends	1.62	1.94	2.43	2.82
Constricted affect	1.10	1.31	1.83	1.83
Suspiciousness*	0.87	0.94	3.93	1.98
Disorganized	5.34	6.60	7.30	4.61
Odd speech	3.34	4.68	4.43	2.51
Odd behaviour	2.00	4.08	2.86	2.46

Note: Suspiciousness loads on both Cognitive–Perceptual and Interpersonal factors.

* $P < 0.001$.

Table 2
Metaphor task performance by high and low positive schizotypy groups.

	Low		High	
	M	S.D.	M	S.D.
<i>Literal</i>				
Hits	15.50	1.78	15.83	1.81
False alarms	1.50	0.88	2.60	2.70
d'	2.69	0.58	2.55	0.69
c	0.12	0.33	0.03	0.43
<i>Metaphoric</i>				
Hits	12.28	2.94	13.50	2.49
False alarms	1.57	1.41	2.30	2.28
d'	2.03	0.48	2.02	0.55
c	0.48	0.42	0.27	0.42

Note. Hits and False Alarms are out of 18 trials. Higher criterion values reflect more conservative responding.

low) × 2 (sentence: literal, metaphoric) × 2 (gender: male, female) mixed analysis of variance (ANOVA) with schizotypy and gender as between-subject variables and sentence as a within-subject variable. These initial ANOVAs revealed interactions between gender and sentence type in discrimination, $F(1, 55) = 4.172$, $P = 0.046$, and in criterion, $F(1, 55) = 5.277$, $P = 0.025$. Gender differences were observed for metaphoric sentence completions, but not for literal sentence completions. For metaphors, women had poorer discrimination than men, $t(57) = -2.423$, $P = 0.019$ and were more conservative in their criterion, $t(57) = -2.157$, $P = 0.035$. Given that there were no interactions between schizotypy and gender on any of the dependent variables, gender was included as a covariate in subsequent analyses to reduce error variance.

Each dependent variable was then analysed in separate 2 (schizotypy: high, low) × 2 (sentence type: literal, metaphoric) mixed ANOVAs. Main effects of sentence type were observed for hits, $F(1, 56) = 23.244$, $P < 0.001$, d' values, $F(1, 56) = 15.488$, $P < 0.001$, and criterion, $F(1, 56) = 18.184$, $P < 0.001$. Compared to literal completions, metaphoric completions yielded lower hit rates, lower d' values and a more conservative response criterion. The high SPQ group had significantly higher hit rates, $F(1, 56) = 4.304$, $P = 0.043$, and higher false alarm rates, $F(1, 56) = 4.010$, $P = 0.050$ than those in the low schizotypy group. The two groups did not differ at all in ability to discriminate between appropriate and inappropriate sentences, $F(1, 56) = 0.222$, ns . However, the two groups did differ in criterion $F(1, 57) = 4.692$, $P = 0.035$, with the high schizotypy group exhibiting a less conservative bias than the low schizotypy group; that is, they were more likely to identify all sentences as appropriate. None of the effects of schizotypy interacted with sentence type, indicating that all differences applied equally to literal and metaphoric sentence processing.

4. Discussion

The aim of this study was to examine the relations between positive schizotypy and metaphor processing. The literature suggests two hypotheses regarding this relationship. On the basis of continuity between schizophrenia and schizotypy, those high in schizotypy were expected to exhibit impaired metaphor processing; on the basis of right hemisphere activation associated with positive schizotypy, high schizotypal individuals were expected to exhibit enhanced metaphor processing. The data support neither of these hypotheses. Based on the signal detection measure d' , which measures the ability to discriminate between appropriate and inappropriate metaphors, high and low schizotypy groups demonstrated almost identical performance. This finding is strikingly similar to that reported by Langdon and Coltheart (2004) using the same task, even though the present study used several measures to enhance statistical power. The body of evidence strongly argues against any relationship between metaphor processing (at least with this task) and schizotypy within the non-clinical population.

The present finding reflects a discontinuity between schizophrenia and schizotypy. Although high schizotypal individuals are impaired in some aspects of pragmatic language processing (Nunn and Peters, 2001; Langdon and Coltheart, 2004), they are not impaired at metaphor processing. Impairments in metaphor processing are commonly observed in schizophrenia (reviewed in Mitchell and Crow, 2005), and have been reported using the same task used here (Langdon et al., 2002a). It has been proposed that the metaphor processing difficulties in schizophrenia reflect a degradation of the semantic system that is not seen in schizotypy (Langdon and Coltheart, 2004). In contrast, schizotypy appears to be associated with a loosening of the semantic system and a reduction in semantic inhibition (Mohr et al., 2001; Pizzagalli et al., 2001; Kiang and Kutas, 2006; Grimshaw et al., 2010). One could propose an underlying continuum of semantic disinhibition that would account for this discontinuity in language behaviour; within the non-clinical population schizotypy could be positively correlated with semantic disinhibition, which in turn would produce associations between positive schizotypy and many aspects of linguistic creativity (Zanes et al., 1998; Schulberg, 2001; Fisher et al., 2004; Tsakanikos and Claridge, 2005; Nettle, 2006). However, there may be a threshold of disinhibition beyond which the semantic system becomes so loose that it becomes dysfunctional, as is observed in schizophrenia. Such an interpretation cannot account for performance on the metaphor task used here however, as the high and low schizotypy groups did not differ in metaphor processing ability.

Alternatively, the finding of discontinuity between schizophrenia and schizotypy on this metaphor task may indicate that the deficits observed in schizophrenia are not semantic in nature. Brüne and Bodenstein (2004) found that performance on proverb comprehension tasks (which overlap strongly with metaphor comprehension tasks) in schizophrenia were correlated with “theory of mind” tests independent of executive function. Understanding metaphor requires both the ability to appreciate the figurative relationship described, as well as the ability to infer the speaker’s intention that the utterance be interpreted non-literally. Perhaps it is this metacognitive component of metaphor processing that is impaired in schizophrenia but not in schizotypy.

Findings are also inconsistent with other research showing increased activation of the right hemisphere in positive schizotypy (e.g., Weinstein and Graves, 2002). It is possible that the choice of metaphor task, while allowing for direct comparisons to metaphor processing in schizophrenia, was not sensitive to right hemisphere language processes that are associated with schizotypy. Although work with brain-damaged patients clearly points to a role for the right hemisphere in the processing of metaphors (Winner and Gardner, 1977; Brownell et al., 1990), research with neurologically intact individuals suggests that the right hemisphere advantage is specific to novel or anomalous metaphors that require the online formation of new semantic relationships. In contrast, the left hemisphere plays a dominant role in the processing of lexicalised metaphors for which the figurative meaning is part of an item’s semantic representation (Giora et al., 2000; Faust and Mashal, 2007; Schmidt et al., 2007). For example, Pobric et al. (2008) found that identification of novel metaphoric word pairs (e.g., *burning lie*) was impaired by repetitive transcranial magnetic stimulation (rTMS) of the right posterior superior temporal sulcus (rPSTS), but identification of conventional metaphors (e.g., *iron fist*) was not. Similarly, in a functional magnetic resonance imaging (fMRI) study, Mashal et al. (2007) found that, compared to conventional metaphors, novel metaphors were associated with increased activity in a number of right hemisphere areas, again including the rPSTS. The metaphors used in the present study were largely idiomatic and lexicalised (e.g., “*You’re a live wire*” and “*He’s got lead feet*”). The use of novel metaphors in future research may better tap the right hemisphere semantic processing associated with positive schizotypy.

Although high and low schizotypy groups did not differ in their ability to discriminate between appropriate and inappropriate metaphors, the two groups did differ in their criterion for judging a concluding statement as appropriate. High schizotypes were more likely than low schizotypes to report concluding statements as appropriate, whether they actually were or were not.¹ This was true for both literal and metaphoric completions. This finding contrasts with that reported by Langdon and Coltheart (2004) who found no association between schizotypy and criterion (in fact, the high schizotypy group was non-significantly more conservative than the low schizotypy group). There are no obvious explanations for this discrepancy in the results, but we note that a relaxing of criterion in high schizotypal individuals has been reported across a number of both perceptual and cognitive tasks in other studies. For example, individuals high in schizotypy were more likely than low schizotypes to falsely identify rapidly presented letter strings as words, although the groups did not differ in the correct identification of actual words (Tsakanikos and Reed, 2005; Reed et al., 2008). High schizotypes have also been reported to be biased towards reporting word pairs as related (Gianotti et al., 2001; Mohr et al., 2001; Grimshaw et al., 2010), and are more susceptible to the Barnum effect, in which they endorse “bogus” personality traits as their own (Claridge et al., 2008). On personality inventories, positive schizotypy is associated with the trait of intellectual openness (Ross et al., 2002; Miller and Tal, 2007; Bryson et al., 2009). Although these studies examined very different traits and cognitive abilities, the relationship between schizotypy and relaxed response criterion across paradigms suggests that schizotypy may be associated with decision-making processes that are common to all such tasks. The presence of such criterion shifts in high schizotypal individuals highlights the necessity of using measures that allow one to account for response bias when examining any cognitive ability.

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¹ Note that both groups demonstrated a conservative criterion, but the high schizotypes were less conservative than the low schizotypes.

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