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Semantic Ambiguity Resolution in Positive Schizotypy: A Right Hemisphere Interpretation

Gina M. Grimshaw and Frances M. Bryson
Victoria University of Wellington

Ruth Ann Atchley
University of Kansas

Megan K. Humphrey
Victoria University of Wellington

Positive schizotypal traits have been associated with right hemisphere activation. Previous research has indicated that the left and right hemispheres differ in their processing of semantic ambiguity; specifically, given sufficient time, the left hemisphere primes dominant meanings and inhibits subordinate meanings, and the right hemisphere primes both dominant and subordinate meanings. The authors examined whether individuals who differed in positive schizotypy demonstrated different patterns of priming on a semantic ambiguity task, reflective of differences in hemispheric activation. Individuals low in schizotypy demonstrated the expected pattern of priming the dominant meaning while inhibiting the subordinate meaning. Individuals high in schizotypy demonstrated similar priming of the dominant meaning but no inhibition of the subordinate meaning. The role of this failure of inhibition in the generation of schizotypal thought is discussed.

Keywords: schizotypy, semantic priming, right hemisphere, ambiguity

The term *schizotypy* refers to a constellation of personality traits that leads to a person being perceived by others as unusual or eccentric. Individuals with schizotypy often have few close friends, are socially anxious, and display odd speech, behavior, and particularly odd thinking patterns (Raine, 1991). Factor analysis has indicated that there are three distinct schizotypal dimensions: *positive schizotypy*, characterized by delusion-like beliefs and hallucination-like experiences; *negative schizotypy*, considered to be deficits in or absence of common interpersonal experiences; and a *disorganized* factor that reflects odd speech and behavior (Gruzelier, Burgess, Stygell, Irving, & Raine, 1995; Raine, 1991; Raine et al., 1994). These personality traits have been conceptualized as mild symptoms of schizophrenia, and many researchers have argued that schizotypy marks a cognitive and biological vulnerability that predisposes a person to psychosis (Eckblad & Chapman, 1983; Johnstone, Ebmeier, Miller, Owens, & Lawrie, 2005; Keshavan, Diwadkar, Montrose, Rajarethinam, & Sweeney, 2005). Others, however, have taken an individual differences approach and argued that schizotypal traits are distributed throughout the normal population and may even be associated with enhanced cognitive functioning (Brod, 1997; Fisher et al., 2004; Karimi, Windmann, Güntürkün, & Abraham, 2007; McCreery & Claridge, 2002).

Research on the neuropsychological correlates of schizotypy has indicated that positive traits are associated with increased activation of the right hemisphere (Brugger, Gamma, Muri, Schäfer, & Taylor, 1993; Rawlings & Borge, 1987). Positive schizotypy has been associated with leftward biases on line bisection tasks (Brugger & Graves, 1997; Kalaycioîglu, Nalçaci, Budanur, Genç, & Çiçek, 2000; Taylor, Zäch, & Brugger, 2002), leftward biases on the chimeric faces task (Luh & Gooding, 1999; Mason & Claridge, 1999), and leftward turning biases in unrestricted walking tasks (Mohr, Bracha, & Brugger, 2003; Mohr, Landis, Bracha, Fathi, & Brugger, 2005). Positive schizotypy has also been associated with an absence of the typical left hemisphere superiority for language processing, as demonstrated in lateralized lexical decision tasks (Leonhard & Brugger, 1998; Mohr, Krummenacher, et al., 2005), letter and syllable identification tasks (Broks, 1984; Rawlings & Claridge, 1984), and dichotic listening tasks (Weinstein & Graves, 2002). This pattern of hemispheric activation for language processing has recently been demonstrated in neuroimaging studies—compared with participants with low schizotypy, those with high schizotypy exhibit increased right frontal activation during verbal fluency tasks (Hori et al., 2008; Hori, Ozeki, Terade, & Kunugi, 2008).

Our goal in this study was to determine whether the right hemisphere activation that is consistently associated with positive schizotypy might have implications for the processing of semantic relationships. Research using a divided visual field presentation strategy has shown that the two hemispheres play qualitatively different roles in semantic processing, with the left hemisphere quickly activating a narrow set of closely related items and the right hemisphere slowly activating a broader set of distantly related items (Atchley, Burgess, & Keeney, 1999; Beeman, 1998; Beeman & Chiarello, 1998; Coney & Evans, 2000; Koivisto, 1999; Lindell, 2006). Research findings regarding semantic processing in positive schizotypy have been consistent in showing an increased reliance on the right hemisphere. Compared with those who scored low on positive schizotypy, those who scored high judged unrelated words to be more closely related (Mohr, Graves, Gianotti,

Gina M. Grimshaw, Frances M. Bryson, and Megan K. Humphrey, School of Psychology, Victoria University of Wellington, Wellington, New Zealand; Ruth Ann Atchley, Department of Psychology, University of Kansas.

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Correspondence regarding this article should be sent to Gina M. Grimshaw, School of Psychology, Victoria University of Wellington, P.O. Box 600, Wellington 6012, New Zealand. E-mail: gina.grimshaw@vuw.ac.nz

Pizzagalli, & Brugger, 2001) and produced more original associations to unrelated stimuli (Gianotti, Mohr, Pizzagalli, Lehmann, & Brugger, 2001), suggestive of a reliance on the right hemisphere's more diffuse semantic network. Similarly, Pizzagalli, Lehman, and Brugger (2001) reported that people with both low and high schizotypy exhibit direct priming (e.g., *sugar–sweet*) in the left hemisphere; however, only those with high schizotypy exhibit indirect priming (e.g., *lemon–sweet*) in the right hemisphere. The time course of semantic priming also differs in people with high and low schizotypy, with those with low schizotypy showing greater priming when the time between prime and target is very brief and those with high schizotypy showing greater priming at longer delays (Morgan, Bedford, & Rossell, 2006), again reflective of the left and right hemispheres, respectively (Atchley, Burgess, Audet, & Arambel, 1996; Burgess & Simpson, 1988; Chiarello, Maxfield, & Kahan, 1995; Koivisto, 1997).

An alternative approach to the study of semantic processing in schizotypy concerns the resolution of ambiguity. Many (or most) English words have more than one meaning; disambiguating the meaning of a word or sentence requires activation of the appropriate meaning and suppression of alternate meanings. Typically, this disambiguation process is guided by context, but in its absence, the semantic system must ultimately settle on one meaning on the basis of other constraints, such as the common usage of the ambiguous word. Ambiguity resolution can be studied through the use of biased homographs—words with two meanings but the same spelling.

Ambiguity resolution in schizotypy is of particular interest for two reasons. First, the processing of ambiguous words differs in the left and right hemispheres (Arambel & Chiarello, 2006; Atchley et al., 1996; Beeman, 1998; Beeman & Chiarello, 1998; Burgess & Simpson, 1988; Chiarello, 2003; Chiarello, Burgess, Richards, & Pollock, 1990; Chiarello, Liu, & Shears, 2001; Chiarello, Shears, Liu, & Kacinik, 2005; Coney, 2002; Coney & Evans, 2000; Koivisto, 1997). In the typical experiment, ambiguous prime words are presented centrally (*bank*), followed by lateralized target words that are either related to the dominant (*money*) or subordinate (*river*) meaning of the prime or unrelated to either meaning. Manipulation of the time between prime and target (the stimulus onset asynchrony, or SOA) indicates that the left hemisphere quickly activates both meanings (within 35 ms), whereas the right hemisphere takes much longer to activate both (about 300 ms). However, after about 750 ms, the left hemisphere shows reduced activation for the subordinate meaning of the word, causing it to be responded to with the same speed or even more slowly than a completely unrelated target. This negative priming or inhibition effect for the subordinate meaning is thought to reflect a strategic allocation of resources to the dominant meaning. In contrast, the right hemisphere continues to maintain activation for both meanings of ambiguous words for at least 800 ms (Atchley, Burgess, & Keeney, 1999; Burgess & Simpson, 1988). This right hemisphere activation may play a crucial role in higher order language processing.

Ambiguity resolution in schizotypy is also of interest because it involves both the activation of the selected meaning and the inhibition of the alternative meaning. Inhibitory processes have been specifically implicated in positive schizotypy, with Beech and Claridge (1987) arguing that cognitive disinhibition is a fundamental schizotypal trait. This can be illustrated through the use of negative priming tasks in which information that is to be ignored on one trial becomes relevant on the next trial. Individuals high in schizotypy show less negative priming than those low in schizotypy; that is, they are less likely to be slowed by previously inhibited information (Beech & Claridge, 1987; Moritz et al., 2000; Steel, Hemsley, & Pickering, 2007; Williams, 1995; but see Cimino & Haywood, 2008; Green & Williams, 1999). Positive schizotypy has also been associated with a relaxing of criteria, a greater willingness to endorse positive responses across a number of different research paradigms (Humphrey, Bryson, & Grimshaw, in press; Reed et al., 2008; Tsakanikos & Reed, 2005), and an association with the personality trait of intellectual openness (Bryson, Grimshaw, & Wilson, in press; Miller & Tal, 2007; Ross, Lutz, & Bailley, 2002), all of which can be considered to reflect reduced cognitive inhibition. Semantic processing differences between high- and low-schizotypy groups might therefore possibly be specific to the processing of subordinate meanings, which are typically inhibited.

This study is the first to examine the resolution of semantic ambiguity in individuals high and low in positive schizotypy, selected from a nonclinical population. All participants completed a line bisection task as an index of hemispheric activation (Brugger & Graves, 1997; Jewell & McCourt, 2000; Taylor et al., 2002). Participants who were high and low in schizotypy viewed ambiguous primes, followed by a centrally presented target word that was related to the dominant meaning, related to the subordinate meaning, or not related to the prime. They were required to indicate whether the two words were related or not related. Although semantic priming tasks often use a lexical decision to the target, we chose a relatedness judgment for two reasons. First, a relatedness judgment relies more heavily on the semantic processes of interest than on lexical decision, and previous research has indicated that lexical decision and relatedness judgments show similar hemispheric differences (Faust & Lavidor, 2003). Second, relatedness is a subjective decision, and a relatedness judgment is essentially a signal detection task, with a response of "related" to related items constituting a hit and a response of "related" to unrelated items constituting a false alarm. Thus, this design allowed us to also examine relations between schizotypy and sensitivity to relatedness (which would reflect differences in semantic organization between groups) and relations between schizotypy and criterion (which would reflect differences in biases to report items as related). We used a long SOA of 750 ms because previous research has suggested that this SOA taps maximal differences between hemispheres and is the SOA at which inhibitory processes are most commonly observed (Atchley, Burgess, & Keeney, 1999; Burgess & Simpson, 1988). If high schizotypy is associated with a greater right hemisphere contribution to the pattern of ambiguity resolution, then we would expect both groups to show equivalent priming of dominant meanings, but only the group low in schizotypy to show inhibition of the subordinate meanings.

Method

Participants

The Schizotypal Personality Questionnaire (SPQ; Raine, 1991) was administered to 300 students during a laboratory class in introductory psychology. The SPQ yields nine subscales that 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 the Excessive Social Anxiety, No Close Friends, Constricted Affect, and Suspiciousness subscales; and Disorganized, which consists of the Odd or Eccentric Behavior and Odd Speech subscales. The overall mean score on the SPQ was 21.84 ($SD = 11.51$), which was significantly lower than the value of 26.3 reported by Raine (1991). However, as described in the SPQ manual (Raine, 2009), absolute values on the scale vary widely according to cultural and demographic variables, and thus it is most important to determine whether individuals are high or low in schizotypy relative to their own population. Participants were then 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 of 13 or more) and lower quartile (factor scores of 5 or less) on this factor were invited to participate in the follow-up study.

Sixty students participated in this study, 30 from the group high in positive schizotypy and 30 from the group low in positive schizotypy. All participants reported being native English speakers. The study was conducted with the approval of the Human Ethics Committee of the School of Psychology, Victoria University of Wellington (Wellington, New Zealand).

Laterality Measures

Participants completed a line bisection task and the Waterloo Handedness Questionnaire—Revised (Elias, Bryden, & Bulman-Fleming, 1998). The line bisection task consisted of 10 lines, 2 each of 2, 3, 5, 8, and 12 cm in length, arranged pseudorandomly with 5 lines per page. Participants made a mark on each line to indicate its midpoint. Deviations from midpoint were calculated in millimeters and then divided by total line length to produce a percentage deviation. Negative values reflect leftward deviations, and positive values reflect rightward deviations. The Waterloo Handedness Questionnaire—Revised assesses hand preference for 36 skilled and unskilled activities on a 5-point scale (*left always, left usually, equally, right usually, right always*). Two handedness indices were derived: a direction measure, which ranges from −100 (*completely left handed*) to 100 (*completely right handed*) and a degree measure, which ranges from 0 (*not handed*) to 100 (*strongly handed*).

Semantic Ambiguity Task

In the semantic ambiguity task, participants were required to indicate whether centrally presented word pairs were related or unrelated. The first word (prime) was ambiguous (e.g., *ball*); the second word (target) could be related to either the dominant meaning of the prime (e.g., *round*) or the subordinate meaning of the prime (e.g., *dancing*). There were 40 ambiguous primes, taken from Burgess and Simpson (1988), producing 80 related word pairs (40 dominant pairs and 40 subordinate pairs). Each prime was also pseudorandomly paired with one dominant and one subordinate associate of a different prime to produce 80 unrelated pairs (40 dominant pairs and 40 subordinate pairs; note that the terms *dominant* and *subordinate* here refer to whether the target word was a dominant or subordinate target of a different prime). Participants saw each prime twice, once paired with a related target (half dominant and half subordinate) and once paired with an unrelated target (half dominant and half subordinate). They also saw each target twice, once preceded by a related prime and once preceded by an unrelated prime. Stimuli were counterbalanced so that if a participant saw a prime paired with a dominant, related target, he or she saw the same prime paired with a subordinate, unrelated target, and vice versa. Across participants, each stimulus pair was presented an equal number of times. Participants completed 80 trials, with 20 trials in each Meaning × Relatedness condition.

In each trial, a fixation mark (+) was presented in the center of the screen for 1,000 ms, followed by central presentation of the prime for 50 ms. After an SOA of 750 ms, the target was presented for 180 ms. Participants had up to 3,000 ms to respond, and there was an interstimulus interval of 3,000 ms between response and the onset of the next trial. Responses were made with the index and middle finger of the right hand on the *1* key (for *related*) and *2* key (for *unrelated*) on the computer keyboard's number pad. Participants were encouraged to respond as quickly and as accurately as possible.

Procedure

Participants were told they were participating in a language-processing experiment and were not aware of the relationship between the initial SPQ assessment and the follow-up study. Experimenters were unaware of participants' group membership. Participants completed the handedness and line bisection measures first, followed by the semantic ambiguity task.

Results

Demographic variables, SPQ scores, and laterality measures are presented in Table 1. Not surprisingly, the groups high and low in schizotypy differed significantly on the Cognitive–Perceptual (positive) factor of the SPQ, $t(58) = -17.56$, $p < .001$. They also differed on the Interpersonal (negative) factor, $t(58) = -2.53$, $p = .014$, but not on the Disorganized factor, $t(58) = -1.41$, $p = .165$. The relationship between the positive and negative dimensions is

Table 1
Demographic and Laterality Variables in Each Schizotypy Group

Variable	Schizotypy	
	Low ($n = 30$)	High ($n = 30$)
Age	20.27 (7.32)	18.62 (.94)
Gender (male/female)	10/20	7/23
Handedness index	55.25 (31.44)	44.28 (38.29)
Handedness degree	60.25 (19.770)	56.66 (13.08)
Line bisection (% deviation)*	−0.32 (1.67)	−1.16 (1.83)
Total Schizotypal Personality Questionnaire**	15.07 (8.85)	33.53 (10.53)
Cognitive–Perceptual**	3.1 (1.32)	18.53 (4.63)
Interpersonal**	7.6 (6.31)	11.63 (6.04)
Disorganized	5.23 (6.60)	7.3 (4.61)

* $p < .10$. ** $p < .05$.

largely carried by the fact that the Suspiciousness subscale loaded on both factors. Although there was no significant association between schizotypy and gender, $\chi^2 = 0.74$, ($df = 3$, $N = 60$), $p = .390$, men made up a larger proportion of the group low in schizotypy than of the group high in schizotypy, and thus we included gender in subsequent analyses. On the laterality measures, the group high in schizotypy showed a greater leftward deviation on the line bisection task than did the group low in schizotypy, $t(56) = -1.81$, $p = .038$, one-tailed. The groups did not differ in overall handedness index, $t(57) = 0.44$, $p = .223$, or in degree of handedness, $t(57) = 0.13$, $p = .416$.

Semantic Ambiguity Task

All response time analyses were based on median response times to concordant responses, that is, responses of "related" to related word pairs and "unrelated" to unrelated word pairs. Because the task was essentially a signal detection task, accuracy was transformed into measures of sensitivity (d'), the participant's ability to discriminate between related and unrelated items, and criterion (c), the participant's bias to respond "related" or "unrelated" under conditions of uncertainty. Sensitivity (d') was calculated on the basis of the hit rate (response of "related" to a related pair) and the false alarm rate (response of "related" to an unrelated pair) according to the formula

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

with the correction for rates of 0 and 1 to .025 and .975, respectively (Macmillan & Creelman, 1991). The criterion measure (c) was calculated as

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

Positive values of c reflect a conservative criterion, that is, a bias to report pairs as unrelated, and negative values of c reflect a lax criterion, that is, a bias to report word pairs as related.

Response Times

Participant analyses (F1). We analyzed response times in a 2 (meaning: dominant or subordinate) × 2 (relatedness: related or unrelated) × 2 (schizotypy: high or low) × 2 (gender: men or women) mixed-model analysis of variance (ANOVA) with meaning and relatedness as within-subject variables and schizotypy and gender as between-subjects variables (see Table 2). As expected, there were main effects of meaning, $F(1, 56) = 35.412$, $MSE = 6{,}292$, $p < .001$, $\eta_p^2 = .386$; relatedness, $F(1, 56) = 9.170$, $MSE = 9{,}461$, $p = .004$, $\eta_p^2 = .141$; and their interaction, $F(1, 58) = 37.630$, $MSE = 7{,}987$, $p < .001$, $\eta_p^2 = .402$. Overall, responses to dominant targets showed significant priming of 116 ms, $t(59) = 7.379$, $p < .001$, and responses to subordinate targets showed significant negative priming of 40 ms, $t(59) = -2.144$, $p = .036$. However, and most critically for the hypothesis, this effect interacted with schizotypy, $F(1, 58) = 4.490$, $MSE = 7{,}987$, $p = .039$, $\eta_p^2 = .074$. The nature of this interaction can be seen in Figure 1. The group low in schizotypy demonstrated the expected effect of significant priming for the dominant meaning, $t(29) = 5.286$, $p < .001$, and significant negative priming for the subordinate meaning, $t(29) = -2.149$, $p = .022$. In contrast, the group high in schizotypy showed significant priming of the dominant meaning, $t(29) = 5.070$, $p < .001$, and nonsignificant priming of the subordinate meaning, $t(29) = -0.427$, $p = .673$. There were no main effects or interactions involving gender. However, when gender was removed from the analysis, the Meaning × Relatedness × Schizotypy interaction failed to reach traditional levels of significance, $F(1, 58) = 2.348$, $p = .131$. Thus, although gender was not a significant factor on its own, it appears to account for some of the variance in semantic priming performance, and so we included it as a factor in all subsequent analyses.

Table 2
Median Response Times (and Standard Deviations) in Milliseconds on Semantic Ambiguity Task

Meaning	Related	Unrelated	Priming
Low schizotypy			
Dominant	761 (89)	883 (155)	121 (126)**
Subordinate	939 (211)	869 (135)	−70 (157)**
High schizotypy			
Dominant	743 (116)	854 (178)	110 (119)**
Subordinate	844 (154)	854 (136)	10 (122)

Note. Priming = (Unrelated Response Time−Related Response Time). Positive values reflect priming, and negative values reflect negative priming.
** $p < .05$.

We calculated a priming measure (Unrelated Response Time – Related Response Time) for each participant for both dominant and subordinate word pairs. Correlations were calculated between the two priming measures to determine whether they might reflect similar or different underlying mechanisms. For the group low in schizotypy, the correlation between priming on dominant and subordinate word pairs was negative and not significant, $r(30) = -.15$, $p = .422$. However, for the group high in schizotypy, the two priming measures were positively correlated, $r(30) = .350$, $p = .058$. These two correlations are significantly different from each other ($z = -1.69$, $p = .05$).

Participants in this study were selected on the basis of positive schizotypy scores. To determine whether the semantic priming differences between groups were specifically related to positive schizotypy, we correlated dominant and subordinate priming measures with Cognitive–Perceptual (positive), Interpersonal (negative), and Disorganized factor scores. Priming of the dominant meaning was unrelated to all three factors. However, priming of the subordinate meaning was correlated with positive schizotypy, $r(60) = .275$, $p = .034$, but not with the Interpersonal, $r(60) = .205$, $p = .116$, or Disorganized factors, $r(60) = .142$, $p = .278$.

Item analyses (F2). We calculated median response times across participants for each pair of items on the basis of concordant responses. Response times were analyzed in a 2 (meaning: dominant or subordinate) × 2 (relatedness: related or unrelated) × 2 (schizotypy: high or low) × 2 (gender: men or women) mixed-model ANOVA with meaning and relatedness as between-item variables and schizotypy and gender as within-item variables. A main effect of schizotypy was observed, $F(1, 139) = 8.958$, $p = .003$, $\eta_p^2 = .061$, with overall faster responses from individuals high in schizotypy ($M = 846$ ms) than from those low in schizo-

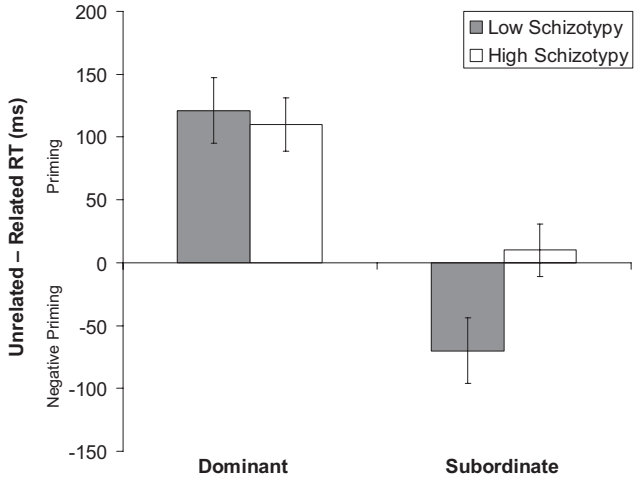

Figure 1. Priming of dominant and subordinate target. Positive values reflect priming, and negative values reflect negative priming. RT = response time.

typy (M = 886 ms). However, this effect was qualified by the critical three-way interaction of meaning, relatedness, and schizotypy, which approached significance, $F(1, 139) = 3.647$, $MSE = 25{,}332$, $p = .058$, $\eta_p^2 = .026$. Follow-up analyses revealed that this effect paralleled that seen in the participant analysis. Responses in the group low in schizotypy revealed significant priming of dominant targets, $t(78) = 3.835$, $p < .001$, and significant negative priming for subordinate targets, $t(78) = -2.484$, $p = .015$. Responses in the group high in schizotypy revealed significant priming of dominant targets, $t(78) = 2.810$, $p = .006$, but nonsignificant priming of subordinate targets, $t(78) = 0.795$, $p = .429$. When we examined the interaction by comparing groups high and low in schizotypy on each type of word pair, we found those high in schizotypy to be significantly faster than those low in schizotypy in the subordinate, related condition, $t(38) = 2.986$, $p = .005$, but not in any of the other conditions (all ps $> .20$).

Signal Detection Analysis

We analyzed sensitivity (d') and criterion (c) values separately in a 2 (meaning: dominant or subordinate) × 2 (schizotypy: high or low) × 2 (gender: men or women) mixed-model ANOVA, with meaning as a within-subject variable and schizotypy and gender as between-subjects variables (see Table 3). The sensitivity analysis revealed only a main effect of meaning, $F(1, 58) = 53.472$, $MSE = 0.383$, $p < .001$, $\eta_p^2 = .562$, with better discrimination between related and unrelated targets for dominant ($M = 2.31$) than for subordinate ($M = 1.38$) targets. Notably, the groups high and low in schizotypy did not differ in ability to discriminate between related and unrelated targets. The criterion analysis revealed a main effect of meaning, $F(1, 58) = 106.947$, $p < .001$, $\eta_p^2 = .656$, with responses more conservative (more likely to say "unrelated") for subordinate targets ($M = 0.48$) than for dominant targets ($M = -.02$). This effect should be interpreted with caution because criterion is constrained near zero when sensitivity is very high, as it was for dominant targets. There was also a main effect of schizotypy, $F(1, 58) = 4.179$, $MSE = 0.047$, $p = .046$, $\eta_p^2 = .386$. Although both groups were conservative overall, individuals high in schizotypy were less conservative ($M = 0.17$) than those low in schizotypy ($M = 0.29$). This effect did not interact with meaning, indicating that it reflected a general response strategy in the group high in schizotypy and was not specific to subordinate targets.

Discussion

This study demonstrated marked differences between individuals high and low in schizotypy in the processing of semantic ambiguity. The group low in schizotypy showed the pattern that is typically described in the literature (e.g., Simpson & Burgess, 1985); that is, they demonstrated reaction-time priming for relatedness judgments of dominant targets and negative priming (related trials being slower than unrelated trials) for judgments of subordinate targets. In contrast, the group high in schizotypy demonstrated priming for dominant targets but neither priming nor negative priming for subordinate targets.[1] This effect was observed in both the participant and item analyses, indicating that it was not carried by a few specific individuals or specific items.

The two groups appeared to process dominant semantic relationships similarly—they did not differ in semantic priming of dominant targets. They also demonstrated similar ability to discriminate between related and unrelated targets for both dominant and subordinate meanings, as indicated by the d' analysis. Thus, any differences between groups were not the result of differences in either vocabulary or overall semantic organization. However, the two groups did differ in their processing of subordinate relationships. Those low in schizotypy showed evidence of inhibiting subordinate meanings (as reflected by observed patterns of negative priming), but those high in schizotypy did not. The correlations between priming measures for dominant and subordinate meanings further suggest that those high and low in schizotypy process subordinate meanings through different mechanisms. In the group low in schizotypy, the two priming measures were unrelated, suggesting that priming of the dominant meaning and negative priming of the subordinate meaning might reflect two different cognitive processes. In contrast, priming of dominant and subordinate meanings was positively correlated in those high in schizotypy, suggesting that both meanings were activated in parallel but with greater activation for the dominant than for the subordinate meaning.

Although we did not directly assess hemispheric differences in language processing, the findings are consistent with two possible hemispheric mechanisms. First, the pattern of processing observed in individuals low in schizotypy is characteristic of ambiguity resolution in the left hemisphere; in contrast, the pattern observed in individual high in schizotypy is more characteristic of ambiguity resolution in the right hemisphere (Atchley, Burgess, & Keeney, 1999; Beeman, 1998; Beeman & Chiarello, 1998; Koivisto, 1999; Lindell, 2006). Although the group high in schizotypy did not show significant priming of the subordinate meaning, as would be expected by a strong form of the right hemisphere hypothesis, their lack of inhibition of the subordinate meaning suggests that they rely more heavily on right hemisphere access to meaning. The

[1] In fact, the schizotypal group demonstrated nonsignificant priming of subordinate meanings.

Table 3
Accuracy of Relatedness Judgments in High- and Low-Schizotypy Groups

	Schizotypy			
	Low		High	
Meaning	*M*	*SD*	*M*	*SD*
Dominant				
Hits	17.4	1.5	17.1	2.0
False alarms	2.8	2.2	3.3	2.2
d′	2.4	0.72	2.2	0.81
c	0.00	0.28	−0.05	0.38
Subordinate				
Hits	11.1	2.2	11.3	2.8
False alarms	2.3	1.3	2.9	1.4
d′	1.4	0.50	1.3	0.38
c	0.56	0.17	0.46	0.17

Note. Hits and false alarms are each out of 20 trials. Positive values of *c* reflect a conservative criterion (bias to report pairs as unrelated).

right hemisphere hypothesis is further strengthened by the finding that individuals high in schizotypy produced a greater leftward bias on the line bisection task, reflective of right hemisphere activation (Brugger & Graves, 1997; Jewell & McCourt, 2000).

Alternatively, the results could reflect a failure of left hemisphere inhibitory processes in positive schizotypy. Specifically, groups both high and low in schizotypy could be relying on left hemisphere semantic processing, but the group high in schizotypy may have specific deficits in left hemisphere inhibitory processes. The examination of ambiguity priming in central vision (as opposed to lateralized presentation) in this study was intentional because it allowed us to determine that a language behavior was associated with positive schizotypal traits. However, our results suggest that further research on the hemispheric processes that underlie the processing of ambiguous words, and particularly the inhibition of alternative meanings, is warranted.

We used an SOA of 750 ms between prime and target because this is the time period at which maximal differences are observed between left and right hemisphere patterns of semantic priming. However, the use of a single SOA means that we have taken only a snapshot in time of the ambiguity resolution process and are therefore unable to assess any possible differences in the time course of semantic processing between groups. For example, it is unclear whether the group high in schizotypy simply does not inhibit subordinate meanings or whether the onset of inhibition merely takes longer in these individuals. Clarification of the mechanisms that underlie both priming and inhibition will require studies that manipulate the SOA between prime and target. Regardless of whether these findings reflect a failure of inhibition (which would be indicative of right hemisphere contributions) or a slowing of inhibitory processes (indicating a less effective or efficient left hemisphere), it is clear that high schizotypy is associated with atypical semantic inhibition in the context of typical semantic activation. This study therefore adds to a growing body of research that indicates that positive schizotypy is associated with cognitive disinhibition across a diverse array of tasks including negative priming and latent inhibition (Beech & Claridge, 1987; Braunstein-Bercovitz, Rammsayer, Gibbons, & Lubow, 2002; Gray, Fernandez, Williams, Ruddle, & Snowden, 2002; Lubow, Kaplan, & De la Casa, 2001; Mass et al., 2007; Moritz & Mass, 1997; Steel et al., 2007; Tsakanikos, 2004).

The group high in schizotypy also demonstrated a less conservative response criterion than that low in schizotypy in their judgments of relatedness. Although both groups were more likely to report targets as unrelated than related (particularly for subordinate meanings), the group high in schizotypy was less biased toward the unrelated response. The conservative criterion is itself not surprising because some of the subordinate meanings were quite obscure, and participants may have been genuinely unaware of their relatedness.[2] Note that the signal detection design used here allows us to assess response bias independently of the ability to discriminate between related and unrelated targets, on which the two groups did not differ. This relaxing of criterion appears to be another cognitive trait of schizotypy and has been reported across a number of both perceptual and cognitive tasks. For example, on a metaphor completion task, people both high and low in schizotypy were equally capable of distinguishing appropriate metaphors and idioms from nonsense. However, those high in schizotypy were more likely to report all completions as appropriate, whether they were or not (Humphrey et al., ????). Similarly, individuals high in schizotypy were more likely than those low in schizotypy to falsely identify rapidly presented letter strings as words, although the groups did not differ in the correct identification of actual words (Reed et al., 2008; Tsakanikos & Reed, 2005). Although these studies examined very different cognitive abilities, the relationship between schizotypy and response criterion across studies suggests that schizotypy may be associated with decision-making processes that are common to all such tasks. Individuals high in schizotypy may be particularly disposed to assign meaning to meaningless situations. In fact, the definition of magical ideation, a component of positive schizotypy, includes the attribution of causality to independent or random events (Eckblad & Chapman, 1983).

It is tempting to speculate on the role that semantic processing may play in other schizotypal traits. For example, schizotypy has been repeatedly linked with creativity (Brod, 1997; Burch, Pavelis, Hemsley, & Corr, 2006; Fisher et al., 2004; Green & Williams, 1999; Schuldberg, 2001), and linguistic creativity in particular is facilitated by an ability to maintain activation of multiple meanings. Creativity may therefore be related to the pattern of semantic activation that is observed in those high in schizotypy. Atchley, Keeney, and Burgess (1999) studied college students of varying levels of verbal creativity. Creativity was assessed using the Wallach-Kogan Creativity battery (Wallach & Kogan, 1965), and using this measure participants were divided into three groups: those high, medium, and low in verbal creativity. Participants also completed a divided visual field ambiguity priming task with a long SOA of 750 ms. Although the use of a lateralized task makes direct comparison to this study impossible, the results support an association between creativity and the processing of subordinate meanings. Specifically, the participants testing low in creativity

[2] The response time–based priming and inhibition measures were based only on those trials in which participants correctly identified targets as related or unrelated to the primes. These measures are therefore unaffected by any differences in response criterion between groups.

did not show the expected priming for subordinate meanings in the right hemisphere. Because such information is not maintained in the right hemisphere at longer intervals, this finding suggests that individuals who scored low on this metric of linguistic creativity did not have sustained access to subordinate linguistic information that might contribute to sophisticated language skills. Also of interest, the participants testing high in creativity showed priming for the subordinate meaning of the ambiguous word in both the left and the right hemispheres. Consistent with earlier results (i.e., Burgess & Simpson, 1988), most participants (low-creative and medium-creative groups) did not show left hemisphere subordinate priming. Thus, activation of multiple meanings of ambiguous words at these longer durations in the left hemisphere appears to serve some special purpose for the highly creative people.

Participants in this study were selected on the basis of their scores on the positive dimension of the SPQ. These two groups also differed in their scores on the negative but not the disorganized dimension. An association between positive and negative schizotypy as assessed with the SPQ is partly artifactual because the Suspiciousness subscale loads on both factors. It is, however, possible that the relations we have identified between ambiguity resolution and schizotypy reflect an association with the negative, and not the positive, dimension. However, the literature consistently associates both the right hemisphere bias and cognitive disinhibition with positive schizotypy, and that is the most parsimonious interpretation of our findings. Correlational analyses indicated that only positive schizotypy was significantly associated with subordinate priming, although correlations with all three factors were positive.

In this study, we also used a sample both high and low in schizotypy, but in a nonclinical population. The use of extreme participants maximized this study's statistical power, but at the cost of losing information about ambiguity resolution across the whole range of schizotypy scores. It would be useful to determine whether the inhibition of subordinate meanings varies continuously with level of schizotypy. The relationship between ambiguity resolution and schizotypy within the nonclinical range also points to the utility of a dimensional, as opposed to taxonomic, view of schizotypy (e.g., Brod, 1997; Broks, 1984; Claridge, 1997). Although some researchers have studied schizotypy as a surrogate for schizophrenia (e.g., Gray et al., 2002; Mohr, Landis, & Brugger, 2006; Taylor et al., 2002), schizotypal traits (at least as assessed with the SPQ) are distributed in the normal population and are related to individual differences in cognitive and behavioral function. Although characterizations of schizotypy are typically negative or pathological, the lack of inhibition seen in this study's group high in schizotypy might well be adaptive for language function (again consider Atchley, Keeney, & Burgess, 1999). Future research should examine whether continued activation of subordinate meanings plays an important role in the processing of metaphor, poetry, or humor in people high in schizotypy, all of which rely on the use of unusual or unexpected semantic relationships and on right hemisphere language mechanisms (Beeman & Chiarello, 1998; Lindell, 2006).

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