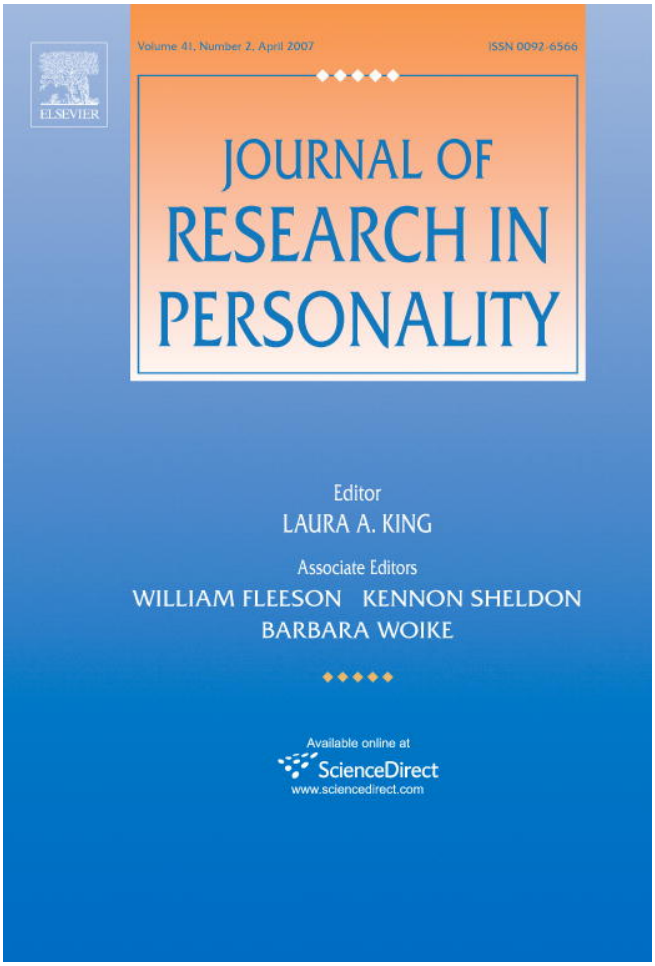

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Brief Report

Insight problem solving in individuals with high versus low schizotypy

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Abstract

Insight problem solving requires restructuring of a problem space by stepping out of the framework provided by the commonly activated cognitive schemas and acquiring a new perspective on the problem. Schizotypy has been linked with loosened associative and overinclusive thinking that may be advantageous for this process. The present study tested this hypothesis and found that individuals with a high degree of schizotypy show better performance on a set of insight problems relative to individuals with low schizotypy, but not on a set of incremental problems that required focused goal-related thinking. Results support the notion that schizotypy is associated not only with enhanced abilities in creative processes involved in divergent thinking but also in creative operations during analytical problem solving.

Keywords: Schizotypy; Insight; Problem solving; Creativity; Psychoticism

1. Introduction

The term "problem solving" is employed when referring to the cognitive processing that is involved when working out solutions to analytical problems. One of the classifications

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of the types of processing involved during analytical problem solving is the distinction between insight and noninsight or incremental problem solving (e.g. Metcalfe, 1986; Schooler, Fallshore, & Fiore, 1994; Schooler & Melcher, 1995; Weisberg, 1995). Both types of problems have well-defined means, which refers to the conditions of the task at hand, and a specified goal state, which is the objective of the problem or the solution that is to be reached. What makes problem solving strategies 'incremental' in an analytical task is that the goal is reached in a stepwise or algorithmic manner. The problem solving process develops with a gradual accrual of one premise after another and generally follows an incremental pattern (e.g. Davidson, 1995; Metcalfe & Wiebe, 1987). In contrast, solving an insight problem requires restructuring of the problem state or a vital change in the representation of the elements of the problem (e.g. Bowden, Jung-Beeman, Fleck, & Kounios, 2005; Duncker, 1945). The progression during the problem solving process is therefore not incremental, but involves a sudden discovery of a solution, a phenomenon that is also commonly referred to as the "aha" experience.

The fundamental difficulty one faces during insight problem solving is having to step out of the currently activated cognitive schemas and approach the problem from a completely new perspective. Schooler and his colleagues (1994) compiled a catalogue of factors that contribute to an inability to overcome impasses in attaining insights during problem solving (e.g. an overemphasis of irrelevant cues) and listed strategies that aid the restructuring of a problem situation in insight problem solving (e.g. changing the context). In recognizing that insights are not usually consciously mediated but merely involve sudden detection of an appropriate approach strategy, insight problem solving is postulated to be mediated by "approach-recognition" skills followed by "approach-execution" processes. Only after an appropriate approach for problem solving is recognized can the execution of problem solving processes commence. Incremental problem solving, however, is associated only with approach-execution processes as the correct approach to be adopted for problem solving is immediately obvious and only the execution processes need to be implemented.

Insight problem solving thus appears to require some degree of loosened associational thinking which would abet the capacity to restructure the problem situation. This type of thinking style has been proposed to be related to an enhanced capacity to be creative. In fact, Eysenck (1995) proposed that highly creative individuals are characterized by a loosened associational or overinclusive cognitive style because they have access to more broadly associated concepts than customary due to their wider conception of relevance. As a result, they are able to generate more innovative and unusual ideas. Eysenck's ideas have received some support in findings where individuals with an overinclusive cognitive style, such as those with a high degree of psychoticism personality traits, have been found to demonstrate greater creative abilities. Psychoticism was the first personality construct that was developed to tap a predisposition for psychosis in normal populations (Eysenck, 1992; Eysenck & Eysenck, 1976). The empirical evidence linking high psychoticism with enhanced creativity although not unequivocal is quite substantial (e.g. Abraham, Windmann, Daum, & Güntürkün, 2005; Merten, 1993; Rawlings & Toogood, 1997; Woody & Claridge, 1977).

An alternative personality construct that taps disposition for a psychotic disorder in normal populations is schizotypy. This construct is defined by non-dysfunctional personality features that correspond to attenuated forms specifically of schizophrenic psychotic symptoms. Of the many scales that have been developed to assess schizotypy, the Schizo-

typal Personality Questionnaire (SPQ; Raine, 1991) is among the most widely used contemporary scales. It was devised in accordance with the nine cognitive and behavioural indices in the DSM III-R (APA, 1987) of schizophrenia-prone personality disorder to provide an overall schizotypy index.

Studies that have focused on the relationship between schizotypy and creative thinking generally show a positive relationship between schizotypal traits and performance on tasks requiring creative or unconventional thinking (e.g. Folley & Park, 2005; Green & Williams, 1999; Mohr, Graves, Gianotti, Pizzagalli, & Brugger, 2001; Schuldberg, 2001; Zanes, Ross, Hatfield, Houtler, & Whitman, 1998). Although most investigations of creative cognition have focused on tasks that tap purely divergent thinking, where there is no right or wrong solution for a given problem situation, none have addressed insight as a creative process during convergent problem solving. In the present study, insight and incremental problem solving was examined with the view that an overinclusive thinking style, which is typical of highly schizotypal individuals, would be beneficial for acquiring new perspectives and stepping out of customarily activated cognitive schemas during the approach-recognition phase of insight problem solving. Accordingly, we hypothesized that a high degree of schizotypy, as indexed by the SPQ, would be accompanied by enhanced performance on insight problem solving, but not incremental problem solving. The degree of psychoticism was also assessed in order to check for the potential association between schizotypy and psychoticism (Eysenck, 1992) in insight and incremental problem solving.

2. Methods

2.1. Participants

Participants were selected from a sample of 160 first semester undergraduates who filled out the German SPQ (Klein, Andresen, & Jahn, 1997). The SPQ total scores varied between 0 and 51 ($M = 19.29$; $SD = 0.82$). The twenty subjects with the highest ($\geqslant 32$) and lowest ($\leqslant 8$) SPQ scores were invited for further testing. The sample thus comprised forty healthy students (24 women) with a mean age of 24 years (range: 19–45) who volunteered to participate for course credits. None of the participants were taking any psychoactive drugs or medication.

2.2. Procedure and scoring

Participants were tested individually in the laboratory and instructions were given in written form for every task. They were presented with six analytical problem solving tasks of which three were insight tasks and three incremental tasks (see Fig. 1). The insight and incremental problems were presented alternately in the order shown in Fig. 1 with insight problem 1 being presented first followed by incremental problem 1, and so on. The insight and incremental problems were complementary in that each set of problems included one riddle or brainteaser, one geometrical problem and one mathematical problem (classification according to Weisberg, 1995). After completing the tasks, subjects were required to complete the short form of the German Eysenck Personality Questionnaire (EPQ-RK; Ruch, 1999).

Participants were not informed about whether any given problem was an insight or an incremental problem. A maximum of 4 minutes were allocated for the solving of each

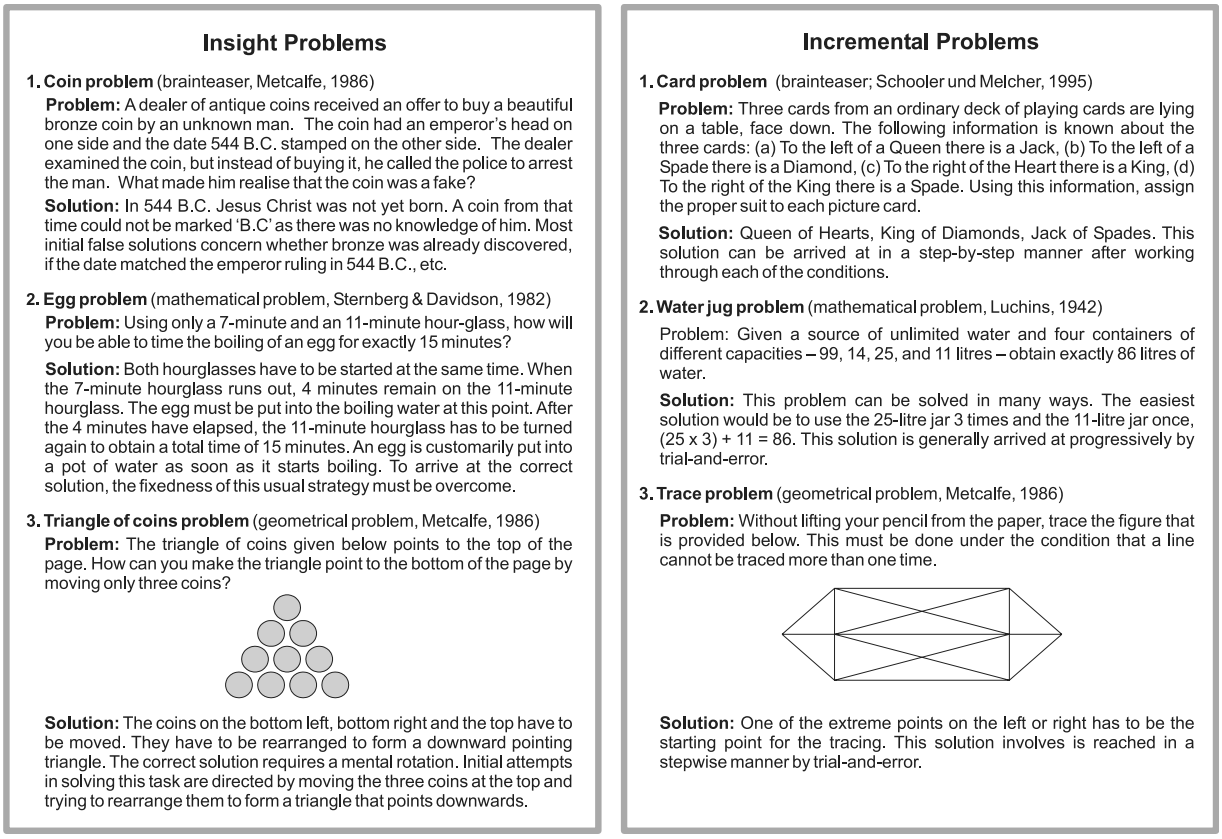

Fig. 1. Incremental and insight problem solving tasks administered to the high and low schizotypy groups. (See above-mentioned references for further information.)

problem. If a subject gave wrong solutions for the problem within this period, they were given an explanation about why the solution was wrong and were allowed to continue working on the problem till the 4-minute period had elapsed. Each problem was scored with either a 1 for the successful solving of a problem or a 0 when the problem was unsolved. Thus the total score for insight and incremental problem solving ranged from 0 to 3.

In addition to these problem solving tasks, subjects were also administered other experimental tasks assessing select facets of divergent thinking. These results will be reported elsewhere in connection with a follow-up study of a subset of the same sample.

3. Results

Using a Mann–Whitney *U* test, the schizotypy groups were found to be significantly different on the total schizotypy score, $p < .0001$, which was logical given that the subjects were recruited for the study based on their extreme schizotypy scores. Notably, however, they did not differ significantly on any of the EPQ dimensions, including psychoticism, $p = .956$, which suggests that schizotypy and psychoticism do not tap the same personality traits. The descriptive data for the schizotypy groups on the problem solving variables as well as the EPQ scales are presented in Table 1.

Due to the ordinal scaling level of the data, a nonparametric test of significance (Mann–Whitney *U* test) was employed when contrasting the two schizotypy groups on insight and incremental problem solving. The analysis showed that in comparison to the low schizo-

Table 1
Mean and standard deviation values for the high and low schizotypy groups on the dependent variables

	SPQ groups			
	High schizotypy		Low schizotypy	
	Mean	(*SD*)	Mean	(*SD*)
Total SPQ	39.45	(5.661)	4.85	(2.323)
EPQ—Psychoticism	3.55	(2.259)	3.45	(2.038)
EPQ—Extraversion	8.75	(3.385)	8.55	(3.776)
EPQ—Neuroticism	4.7	(3.342)	5.15	(3.675)
EPQ—Lie Scale	2.2	(1.281)	2.45	(1.761)
Insight problem solving—Total Score	1.95	(0.999)	1.2	(1.005)
Insight—Coin problem	0.75	(0.444)	0.45	(0.51)
Insight—Egg problem	0.6	(0.503)	0.3	(0.47)
Insight—Triangle of coins problem	0.6	(0.503)	0.45	(0.51)
Incremental problem solving—Total Score	1.9	(0.968)	1.7	(0.865)
Incremental—Card problem	0.6	(0.503)	0.45	(0.51)
Incremental—Water jug problem	0.85	(0.366)	0.75	(0.444)
Incremental—Trace problem	0.45	(0.51)	0.5	(0.513)

typy group, the high schizotypy group showed significantly better performance on insight problem solving, $p = .028$. Task by task post-hoc analyses were carried out using the Chi-Square test (due to the binary nature of the variables: solved or unsolved). These analyses revealed that the difference in insight problem solving was at the level of a strong trend for the coin problem, $\chi^2 = 3.75$, $p = .053$, as well as for the egg problem, $\chi^2 = 3.64$, $p = .055$, but not for the triangle of coins problem, $\chi^2 = .902$, $p = .264$. The discrepancy between the summation score and the single scores is due to higher statistical power of the analysis of the ordinal measures compared to the binary measures. Application of other post-hoc tests (Mann–Whitney *U* Test or Kruskal–Wallis Analysis) yielded the same dissociative pattern.

Performance of the schizotypy groups were, however, not significantly different on the incremental problem solving tasks, $p = .718$. A task by task analysis showed that the high and low schizotypy groups did not differ significantly on the card problem, $\chi^2 = .902$, $p = .264$, the trace problem, $\chi^2 = .1$ $p = .5$, or the water jug problem, $\chi^2 = .625$, $p = .347$.

As a check, correlational analyses using Spearman's rho were carried out to determine the relationship between EPQ psychoticism and the problem solving variables. The results were non-significant, insight: $r = .086$, $p = .597$; incremental: $r = .102$, $p = .529$.

4. Discussion

A number of tasks were employed in the present study to tap insight and incremental problem solving. While no significant differences resulted between schizotypal groups on the sum of solved incremental problems, the high schizotypal group was found to generate more correct solutions for insight problems than the low schizotypal group. These results indicate that a high degree of schizotypy confers advantages when solving analytical problems that require restructuring and a loose associative thinking style but not in other types of problem solving that call for a more fixed associative cognitive style in goal-directed thinking.

These findings on tasks that recruit highly complex analytical skills, as would be required for every-day life problem solving, parallel results from studies with more

rudimentary word processing and language-related tasks that have found altered semantic associations in healthy individuals with higher schizotypal traits (e.g. Duchêne, Graves, & Brugger, 1998; Mohr et al., 2001; O'Reilly, Dunbar, & Bentall, 2001). For instance, Mohr and her colleagues (2001) found that in a semantic judgment task where subjects had to judge the semantic distance of word pairs, individuals with higher scores on "magical ideation", a typical trait of positive schizotypy (Eckblad & Chapman, 1983), considered unrelated words to be more closely related than low magical ideation subjects.

Such increased semantic association effects have been proposed to arise as a consequence of enhanced spreading activation in semantic networks of the brain where the associations between concepts are represented as links (e.g. Collins & Loftus, 1975). The activation of one concept spreads through the network to associated concepts. The individual strength of the association links is determined by the activation frequency between the concepts. The stronger the links are, the faster the activation of the associated concept node.

In accordance with the semantic activation model, individuals with loose conceptual boundaries would have access to more distant information. Drawing on the same rationale, high schizotypal individuals who have been shown to exhibit wider activation of conceptual structures within their semantic networks should be able to regard an analytical problem situation from a completely new perspective with greater ease. Insight problems require that one does not adopt the most obvious strategy (as indicated by the task description), and instead benefits from approaching the problem from another less obvious course of action. Better access to wider associations could thus provide cues that help direct thought processes towards less customary paths wherein the potential solutions for the insight problems may lie. This would account for why high schizotypal individuals tend to be good insight problem solvers. This idea is directly comparable to the idea of a broader conception of relevance, or access to more remotely related concepts, which characterizes overinclusive thinking (Eysenck, 1995).

The finding of the present study that high levels of schizotypy do not particularly aid purely logical processes but is advantageous in certain types of creative processes that aid approach recognition during insight in problem solving is also consistent with earlier postulations of a positive relationship between schizotypal traits and creative divergent thinking (e.g. Mohr et al., 2001; Zanes et al., 1998). Most of these studies have assessed creativity in verbal tasks such as word association or lexical decision tasks, whereas in our study, creativity was assessed from a conceptual thinking and reasoning based domain which does not specifically reflect language bound parameters. We thereby demonstrate that the creative thinking style of individuals with high schizotypy is a more fundamental characteristic that can be beneficial to a variety of cognitive functions that exist outside the purely language domain, although perhaps to differential degrees as suggested by the differences we observed between the three insight problem tasks employed here.

Consistent with most of the literature, the present study showed that there was no significant linear relationship between the presence of schizotypy traits and the extent of psychoticism (e.g. Claridge, 1993; Kendler & Hewitt, 1992). This has been essentially attributed to the fact that both constructs try to account for different facets of mental illness. Whereas Eysenck's psychoticism dimension stems from an *Einheitspsychose* view which relates to psychosis in general, schizotypy relates specifically to schizophrenic function. Our results provide further evidence that schizotypy and psychoticism draw on different aspects of psychopathology and are not related in any simple manner. But the question of why both these personality constructs are related to better creative

performance remains unanswered. One possibility, that we are currently exploring, is that the nature of the advantage associated with these personality constructs only partially overlap. Few studies have tried to tease apart the specificity of the cognitive advantage in creativity, which is truly necessary given the highly multidimensional nature of creativity. It could be the case that schizotypy and psychoticism are accompanied by the propensity for better function on different facets of creative cognition that are not necessarily highly correlated in a straightforward manner.

In summary, the results of this study bring to light the presence of a cognitive advantage in a novel domain of complex cognition in association with schizotypy, a construct that has been associated with various types of cognitive disadvantages on mental operations such as working memory, set-shifting and attentional inhibition. It must be noted, however, that the present study included only a relatively small sample of subjects using a relatively small number of analytical problems. Although the present findings were quite consistent across problems, future research would need to address creative cognitive function not only with reference to individuals with extreme schizotypal personality scores but also with regard to schizotypy as a continuous variable. This would enable a more thorough understanding of the relationship between schizotypy with insight and other aspects of creative cognition. As in the case of several divergent thinking tasks, it would also be worthwhile to investigate if any single schizotypal trait (for instance, magical ideation) is particularly implicated with regard to enhanced performance in insight problem solving.

References

Abraham, A., Windmann, S., Daum, I., & Güntürkün, O. (2005). Conceptual expansion and creative imagery as a function of psychoticism. *Consciousness and Cognition, 14*, 520–534.

American Psychiatric Association (1987). *Diagnostic and statistic manual of mental disorders (DSM -III-R)* (revised 3. Edition). Washington, DC: APA.

Bowden, E. M., Jung-Beeman, M., Fleck, J., & Kounios, J. (2005). New approaches to demystifying insight. *Trends in Cognitive Sciences, 9*, 322–328.

Claridge, G. (1993). When is psychoticism psychoticism? And how does it really relate to creativity? *Psychological Inquiry, 4*, 184–188.

Collins, A. M., & Loftus, E. F. (1975). A spreading-activation theory of semantic processing. *Psychological Review, 82*, 407–428.

Davidson, J.E., (1995). The suddenness of insight. In: Sternberg, R.J., Davidson, J.E. (Hrsg.), *The nature of insight*, 125–157, Cambridge (MA): MIT Press.

Duchêne, A., Graves, R., & Brugger, P. (1998). Schizotypal thinking and associative processing: a response commonality analyseis of verval fluency. *Journal of Psychiatry and Neuroscience, 23*, 56–60.

Duncker, K., (1945). On problem solving. *Psychological Monographs*, 58, Whole no. 270.

Eckblad, M., & Chapman, L. J. (1983). Magical ideation as an indicator schizotypy. *Journal of Consulting and Clinical Psychology, 51*, 215–255.

Eysenck, H. J. (1992). The definition and measurement of psychoticism. *Personality and Individual Differences, 4*, 147–178.

Eysenck, H. J. (1995). *Genius: The natural history of human creativity*. NY: Cambridge University Press.

Eysenck, H. J., & Eysenck, S. B. G. (1976). *Psychoticism as a dimension of personality*. London: Hodder & Stoughton.

Folley, B. S., & Park, S. (2005). Verbal creativity and schizotypal personality in relation to prefrontal hemispheric laterality: A behavioural and near-infrared optical imaging study. *Schizophrenia Research, 80*, 271–282.

Green, M. J., & Williams, L. M. (1999). Schizotypy and creativity as effects of reduced cognitive inhibition. *Personality and Individual Differences, 27*, 263–276.

Kendler, K. S., & Hewitt, J. (1992). The structure of self-report schizotypy in twins. *Journal of Personality Disorders, 6*, 1–17.

Klein, C., Andresen, B., & Jahn, T. (1997). Erfassung der schizotypen Persönlichkeit nach DSM-III-R: Psychometrische Eigenschaften einer autorisierten deutschsprachigen Übersetzung des "Schizotypal Personality Questionaire" (SPQ) von Raine. *Diagnostica, 43*, 347–369.

Luchins, A.S., 1942. Mechanization in problem solving: The effect of Einstellung. Psychological Monographs 54, Nr. 248.

Merten, T. (1993). Word association responses and psychoticism. *Personality and Individual Differences, 14*, 837–839.

Metcalfe, J. (1986). Premonitions of insight predict impending error. *Journal of Experimental Psychology: Learning Memory and Cognition, 12*, 623–634.

Metcalfe, J., & Wiebe, D. (1987). Intuition in insight and noninsight problem solving. *Memory and Cognition, 16*, 238–246.

Mohr, C., Graves, R. E., Gianotti, L. R. R., Pizzagalli, D., & Brugger, P. (2001). Loose but normal: A semantic association study. *Journal of Psycholinguistic Research, 30*, 475–483.

O'Reilly, T., Dunbar, R., & Bentall, R. (2001). Schizotypy and creativity: An evolutionary connection? *Personality and Individual Differences, 31*, 1067–1068.

Raine, A. (1991). The SPQ: A scale for the assessment of schizotypy personality based on the DSM-III-R criteria. *Schizophrenia Bulletin, 17*, 555–564.

Rawlings, D., & Toogood, A. (1997). Using a 'taboo response' measure to examine the relationship between divergent thinking and psychoticism. *Personality and Individual Differences, 22*, 61–68.

Ruch, W. (1999). Die revidierte Fassung des Eysenck Personality Questionaire und die Konstruktion des deutschen EPQ-R bzw. EPQ-RK. *Zeitschrift für Differentielle und Diagnostische Psychologie, 20*, 1–24.

Schooler, J., Fallshore, M., & Fiore, S. (1994). Epilogue: Putting insight into perspective. In R. J. Sternberg & J. E. Davidson (Eds.), *The nature of insight* (pp. 559–587). Cambridge, MA: MIT Press.

Schooler, J. W., & Melcher, J. (1995). The ineffability of insight. In S. M. Smith, T. B. Ward, & R. K. Finke (Eds.), *The Creative Cognition Approach* (pp. 97–133). Cambridge, MA: MIT Press.

Schuldberg, D. (2001). Six subclinical spectrum traits in normal creativity. *Creativity Research Journal, 13*, 5–16.

Sternberg, R. J., & Davidson, J. E. (1982). The mind of the puzzler. *Psychology Today, 16*, 37–44.

Weisberg, R. W. (1995). Prolegomena to Theories of Insight in Problem Solving: A Taxonomy of Problems. In R. J. Sternberg & E. J. Davidson (Eds.), *The nature of insight* (pp. 157–196). Cambridge, MA: MIT Press.

Woody, E., & Claridge, G. (1977). Psychoticism and thinking. *British Journal of Social and Clinical Psychology, 16*, 241–248.

Zanes, J., Ross, S., Hatfield, R., Houtler, B., & Whitman, D. (1998). The relationship between creativity and psychosis-proneness. *Personality and Individual Differences, 24*, 879–881.