



Neuropsychological differentiation of adaptive creativity and schizotypal cognition

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ABSTRACT

Both creativity and schizophrenia-spectrum disorders have been associated with activation of remote semantic concepts, but this activation results in innovative output in one case and communication disturbances in the other. The present study examined the relationship between monitoring semantic information (which relies on executive brain function), creativity, and characteristics of schizotypy in an undergraduate population. Results indicate that executive function differentiates the use of semantic information in creativity and schizotypy. Specification of the balance between executive monitoring and activation of semantic information is important for determining how communication disturbances manifest, and for the measurement of creativity and schizotypy in the general population.

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1. Introduction

Both creativity and schizophrenia-spectrum disorders have been associated with hyperactivation of unusual or remote ideas or words (e.g., Mohr, Graves, Gianotti, Pizzagalli, & Brugger, 2001), but this activation results in innovative output in one case and communication disturbances in the other. Hyperactivation of semantic information can loosely be attributed to differences in brain-hemisphere function (e.g., Leonhard & Brugger, 1998). Normatively, the left hemisphere is important for accessing dominant meanings of words and the right hemisphere facilitates access to remote meanings (Abdullaev & Posner, 1997). Individuals with schizophrenia-spectrum characteristics rely more on right-hemisphere and less on left-hemisphere language functions than is typical (e.g., Grimshaw, Bryson, Atchley, & Humphrey, 2010; Kostova, de Loye, & Blanchet, 2011; Pizzagalli, Lehmann, & Brugger, 2001; Taylor, Zäch, & Brugger, 2002), which may lead to increased access to remote meanings and/or using semantic information in an inappropriate or unusual context (Fisher et al., 2004). Right-hemisphere activity in schizotypy has also been associated with enhanced creativity domains, such as divergent (Folley & Park, 2005) and convergent thinking (Weinstein & Graves, 2002), suggesting that schizotypy is associated with hemispheric differences in the use of semantic information.

Other than right-hemisphere involvement during activation of remote ideas, information-processing similarities and differences between creativity and schizotypy have not been specified. The lack of clarity may be due to various definitions and assessments of schizotypy and creativity leading to a lack of correlation between measures (Weinstein & Graves, 2001) and difficulty making conclusions about how schizotypy and creativity are related. This lack of clarity may also be due to incomplete assessment of skills that may mediate creative use of semantic information. For example, monitoring creative output (which requires executive function) is not often assessed in studies of creativity and schizotypy, though one study did find that measures of frontal function positively mediated better performance on aspects of creative cognition (insight problem-solving and imagery) in patients with schizophrenia and controls (Abraham, Windmann, McKenna, & Güntürkün, 2007).

The relationship of executive function to semantic associations may influence whether remote associations promote creative verbal information processing or whether they disrupt verbal information processing. Activation of remote associates may initially increase with schizotypy (especially with positive schizotypal characteristics, e.g., Weinstein & Graves, 2002) but decrease as illness and corresponding deficits in executive function (e.g., monitoring associations) increase. This pattern is similar to the suggestion that creativity increases with moderate schizotypy, but decreases with severity of psychopathology (Nelson & Rawlings, 2010), resembling an inverted U-shape. Indeed, nonlinear relationships between schizotypy and performance on verbal fluency (Tsakanikos & Claridge, 2005) and divergent thinking (Stoneham & Coughtrey, 2009) tasks have been reported. This U-shaped function can be captured by sampling three groups (rather than

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just high vs. low scorers), a strategy leveraged in the present report that has previously been effective in examining subtle relationships between schizotypy and creativity (e.g., Rhue & Lynn, 1987; Zanes, Ross, Hatfield, Houtler, & Whitman, 1998).

The Deese/Roediger–McDermott (DRM) recognition memory paradigm (Deese, 1959; Roediger & McDermott, 1995) is informative for investigating the monitoring of semantic information. Participants learn lists of words which activate semantic associates creating a gist representation. The activation–monitoring model states that activation and monitoring of highly-associated concepts determine whether false alarms (FAs) to lures are triggered (Roediger, Watson, McDermott, & Gallo, 2001). Intact maintenance of semantic gist leads to high rates of FAs. Fewer FAs can be due to poor gist maintenance that prevents activation of semantic associates. Fewer FAs can also be due to monitoring item-specific information (e.g., number of letters) to differentiate words from gist information, whereas increased FAs may be associated with lack of monitoring item-specific information. Performance on the DRM paradigm has been mixed in patients with schizophrenia (low FA rate; Huron & Danion, 2002: no difference in FAs between patients and controls; Ellevåg, Fisher, Weickert, Weinberger, & Goldberg, 2004; Lee, Iao, & Lin, 2007; Moritz, Woodard, Cuttler, Whitman, & Watson, 2004; Peters et al., 2007). In nonclinical samples, decreased FAs were associated with the cognitive-perceptual factor on the Schizotypal Personality Questionnaire (Dagnall & Parker, 2009) and with the combination of increased schizotypal positive symptoms and decreased performance on an executive function measure measuring right prefrontal function (Fisher, Heller, & Miller, 2007).

Mixed findings on the DRM task may be due to individual differences in the balance of activation and monitoring of semantic information. As outlined above, activation of semantic information may have a U-shaped relationship with creativity and schizotypy (Nelson & Rawlings, 2010). Thus, prior studies that have used the DRM paradigm to study schizophrenia-spectrum samples may have captured the two ends of the function without modeling the middle or high point of the curve, resulting in no difference between groups. In addition, exactly how monitoring semantic information is related to schizophrenia-spectrum symptoms vs. creativity has not been examined. Decreased lure accuracy in schizotypy was associated with cognitive performance (Dagnall & Parker, 2009; Fisher et al., 2007), supporting executive monitoring as important for mediating use of semantic information. Investigating how this process is similar or different in schizotypy and creativity can clarify issues about measurement of creativity and schizotypy in the general population and shed light on how communication disturbances in schizophrenia-spectrum disorders manifest.

The present study investigated (1) the relationship between schizotypy, creativity, and activation and monitoring of semantic information and (2) whether this relationship is associated with measures of executive function. It was hypothesized that the relationship between lure accuracy and schizotypy would resemble an inverted-U shaped curve (Fig. 1). FAs to lures would increase as symptoms increase, but would decrease as symptoms cross a threshold of severity and monitoring skills diminish. In addition, the balance between activation and monitoring would shift with proportion of FAs. Specifically, along the descending (right-side) arm of the inverted U, schizophrenia-spectrum symptoms would increase, and semantic activation would decrease, while item-specific information becomes more prominent. This pattern would lead to fewer FAs due to the absence of semantic gist, consistent with reduced FAs in patients with schizophrenia. Individuals near the midpoint of the U would make the most FAs, as monitoring abilities of activated semantic associates would be poor. These relationships were investigated in a subclinical schizotypy population (the left and central areas of Fig. 1).

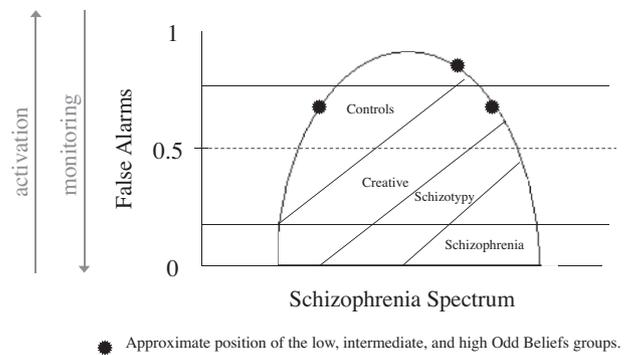


Fig. 1. The relationship between lure accuracy and schizotypy. False alarms to lures increase and decrease according to symptom severity and a corresponding balance between activation and frontal executive monitoring of semantic associates.

2. Materials and methods

2.1. Participants

Over 1000 undergraduate students participated in large-group questionnaire-testing sessions that included Perceptual Aberration and Magical Ideation scales (Chapman, Chapman, & Raulin, 1978; Eckblad & Chapman, 1983), the Schizotypal Personality Questionnaire (SPQ; Raine, 1991), and the Creative Experiences Questionnaire (CEQ; Merckelbach, Horselenberg, & Muris, 2001). A factor analysis of Chapman and SPQ scale scores yielded three factors (positive, negative, disorganized). The disorganized factor was not as reliable as the first two factors and was not used. Participants for the behavioral study were chosen according to high (≥ 65 th percentile) and low (≤ 35 th percentile) scores on the positive and negative factors and scores on the CEQ, yielding eight participant types ($2 \times 2 \times 2$): high on all three constructs, high on two (positive and negative, positive and creativity, negative and creativity), high on one (positive, negative, creativity), or low on all three. This stratified sampling method ensured a range of scores on all three relevant constructs, and was not intended to be used as a grouping strategy.

The sample consisted of 69 (39 female) right-handed, paid participants (mean age = 18.7 years, S.D. = 2.4). Due to technical difficulties, reaction time (RT) data on the computer task was not recorded for two participants, who were not included in relevant analyses. The entire sample ($n = 69$) completed all questionnaires and neuropsychological assessments. Experimenters were blind to participants' Chapman, SPQ, and CEQ scores.

To determine whether a U-shaped relationship exists between positive schizotypy and monitoring of semantic information, schizotypy scales and lure accuracy were evaluated. As Odd Beliefs (from the SPQ) and Perceptual Aberration accounted for unique variance of lure accuracy in a model with predictors of frontal executive function in our prior work (Fisher et al., 2007), three groups were created using an average of Odd Beliefs (OB) and Perceptual Aberration (PA), three groups using PA alone, and three using OB alone. In each combination, the intermediate group had fewer FAs to lures than the other two groups and the high and low groups had similar FA rates. Because the number of individuals per group was more evenly matched in the OB alone groups, analyses used this grouping. Fifteen participants were in the high group (Odd Beliefs > 2), 22 in the intermediate group (Odd Beliefs > 0 and ≤ 2), and 32 in the low group (Odd Beliefs = 0). The groups showed similar variance in lure accuracy (Levene test: $p = .65$), supporting the use of ANOVA.

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