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Decomposing perseverative errors among undergraduates scoring high on the Schizotypal Personality Questionnaire

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Abstract

Cognitive control (CC), the capacity to flexibly direct resources to a goal by selecting and integrating relevant contextual information, is impaired among persons with schizophrenia-spectrum disorders. CC is achieved, in part, through shifting one's cognitive set towards stimuli of task relevance. Set-shifting deficits typically result in perseverative errors, like those captured by the Wisconsin Card Sorting Test (WCST). However, a disadvantage of the WCST is that it confounds the potential sources of perseverative errors. The Dimensional Change Card Sorting Task (DCCS), in contrast, allows for the decomposition of perseverative errors by systematically varying the shape and/or color of stimuli across pre-switch, switch and post-switch trials. Using these techniques previous research has evaluated the separable contributions of negative priming, positive priming, and extra dimensional shifting to the production of perseverative errors. In the current study, college students scoring high on the Schizotypal Personality Questionnaire (High-SPQ; Raine, A., 1991. The SPQ: a scale for the assessment of schizotypal personality based on DSM-III-R criteria. Schizophr. Bull. 17 (4), 555–564.) and average scoring individuals (Ave-SPQ) were administered the DCCS to investigate schizotypal-related mechanisms underlying set-shifting abnormalities. Relative to Ave-SPQ, High-SPQ participants showed more perseverative responses that were restricted to the positive priming post-switch condition. Possible mechanisms of this impairment, including depletion of cognitive resources and differences in strategy commitment, are discussed.

Keywords: Set-shifting; Perseveration; Cognitive control; Schizophrenia; Task-switching

Cognitive control (CC) has been defined as the capacity to flexibly adapt behaviour to particular task demands while favoring the processing of task-relevant information (Cohen et al., 1996). Clinically, persons with schizophrenia (SCZ) are observed to have deficits in CC as reflected in symptoms such as distractibility, loosening of associations, and disorganized behaviour (Cohen et al., 1996). SCZ performance on various cognitive paradigms, thought to be mediated by CC, also suggests impairment within this population. For

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example, individuals with SCZ routinely perform poorly on the Stroop Color-Word task (Stroop, 1935). In this task, participants are slower to name the ink color of incongruent color words (e.g., blue word in red ink) than when required to name the ink color of congruent color words (e.g., blue word in blue ink) (MacLeod, 1991). In SCZ, this Stroop interference effect is enhanced and interpreted as an indication of a selective/controlled attentional deficit, and more broadly, as an impairment in CC (Cohen et al., 1992). Similarly, when performing antisaccade tasks, individuals with SCZ show greater difficulty inhibiting their prepotent response to making a saccade (as opposed to an antisaccade) to a location of the visual stimulus (Clementz et al., 1994; Radant et al., 1997). Collectively, these deficits have been interpreted to reflect abnormal CC — or reduced ability to properly maintain and update internal representations of task-relevant context information.

It is well accepted that CC is achieved, in part, through the ability to shift one's cognitive set towards stimuli of task relevance (e.g., Miyake et al., 2000). Experimentally, set-shifting deficits result in perseverative errors, such as those routinely captured by the Wisconsin Card Sorting Test (WCST; Heaton, 1981; Anderson et al., 1991). Specifically, after the card sorting rule has changed (e.g., from color to form), SCZ subjects are more likely to sort the cards by the previously reinforced dimension (i.e., color) (Gooding et al., 1999; Suhr, 1997; for a review see Laws, 1999). A disadvantage of the WCST, however, is that it confounds the potential sources of perseverative responding. That is, continuing to sort according to a previously reinforced dimension can reflect impairment in a variety of underlying cognitive operations. In particular, the current study proposes that perseverative sorting could be the result of (a) difficulties activating a previously incorrect sorting rule (i.e., difficulties overcoming negative priming of the previously incorrect sorting rule), (b) difficulties inhibiting a prepotent response to a previously correct sorting rule (i.e., difficulties overcoming positive priming of the previously correct sorting rule), or (c) difficulties shifting from sorting by one dimension to sorting by another (i.e., difficulties with extradimensional shifting *per se*).

The Dimensional Change Card Sort test (DCCS; Frye et al., 1995; Zelazo, 2006) has been used to disentangle these potential mechanisms of perseverative errors in order to investigate the development of set-shifting capabilities among preschool-aged children (Zelazo et al., 2003). Specifically, by manipulating the shapes and/or colors of sorting stimuli during switches from one dimension to another, the DCCS has been used to examine whether perseverative errors are committed under conditions that necessitate the suppression of representations of previously non-reinforced stimuli as target stimuli (negative priming condition), and the suppression of previously reinforced stimuli as non-target stimuli (positive priming condition), and extra-dimensional shifting in general (total change condition; Zelazo et al., 2003). To the degree that between-group differences in perseverative responding are modulated as a function of these conditions, the specific process(es) differentiating these conditions are implicated as mechanisms of perseveration. Using the DCCS, Zelazo et al. (2004) found age-related changes in CC between the ages of 3 and 5 years. Administering different conditions of the DCCS has revealed that the mechanism of perseveration for 3-year-olds does not reflect difficulties in the general use of abstract sorting rules but rather an inability to disengage from previously reinforced rules as well as difficulties activating and responding to previously inhibited stimulus. These results have been interpreted as reflecting developmental increases in CC, which permit 4- to 5-year-olds to use a higher order rule to determine which of the two incompatible pairs of rules to use (Zelazo et al., 1996).

The current study employed the DCCS to investigate mechanisms underlying set-shifting abnormalities associated with schizophrenia-spectrum disorders, namely college undergraduates scoring high on the Schizotypal Personality Questionnaire (High-SPQ). Notably, individuals with SPD show similar clinical and cognitive characteristics to those observed among individuals with SCZ (for review see Raine, 2006). For example, numerous studies support the existence of a three-factor structure of SPD: cognitive–perceptual, interpersonal, and disorganized (Raine et al., 1994; Bergman et al., 1996; Reynolds et al., 2000; Fossati et al., 2003). Importantly, this factor structure closely parallels current conceptualizations of SCZ, as outlined in the DSM-IV (APA, 1994) and factor analytic studies of common psychotic symptom measures (e.g., Positive and Negative Symptom Scale) in SCZ samples.

With regard to cognitive functioning, the deficits observed among individuals with SPDs are qualitatively similar to those observed among individuals with SCZ. Specifically, they often reflect deficits in executive functions such as working memory (Mitropoulou et al., 2005) and attention (Bergida and Lenzenweger, 2006). In this vein, individuals with SPD have also demonstrated perseverative responding (Gooding et al., 1999). Notably, however, the degree of cognitive impairment observed among SPDs appears intermediate between healthy controls and individuals with SCZ (Trestman et al., 1995; Mitropoulou et al., 2005). Nevertheless,