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Bipolar disorder and schizophrenia share a similar deficit in semantic inhibition: A meta-analysis based on Hayling Sentence Completion Test performance

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ABSTRACT

Bipolar disorder (BD) is associated with deficits in executive function similar to that found in schizophrenia (SZ). However, very few studies have examined whether a specific component of executive function, namely, semantic inhibition, is differentially impaired in BD and SZ. The present study reports the results of a meta-analysis of performance on a theory-driven test of semantic inhibition, namely, the Hayling Sentence Completion Test (HSCT), in patients with BD and SZ, and to examine differential group impairments. The Comprehensive Meta-Analysis Software package was used to calculate the mean effect sizes for group differences on different measures of HSCT. A total of 13 studies were included in the meta-analysis. Effect sizes for six HSCT measures were calculated. These included: Total Latency of Task A, Total Latency of Task B, Suppression Time, Total Error of Task B, Type A Error of Task B, and Type B Error of Task B. When compared with healthy controls, medium-to-large effect sizes were observed in both groups for each HSCT measure. Interestingly, the effect sizes for BD and SZ groups were comparable. These results suggest that patients with SZ and patients with BD are impaired in both task initiation and task inhibition of executive function and these impairments are similar in magnitude for both disorders.

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Abbreviations: BD, bipolar disorder; BDD, bipolar disorder in the depression phase; BDM, Bipolar disorder in the manic phase; BDR, bipolar disorder in the remitted phase; DSM, Diagnostic and Statistical Manual of Mental Disorders; HSCT, Hayling Sentence Completion Test; TD, thought disorder; SZ, Schizophrenia.

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1. Introduction

Traditionally, while bipolar disorder (BD) has abnormal emotional processes as its key feature, schizophrenia (SZ) is characterized by cognitive deficits. However, recent studies have found that patients with BD also have deficits in various cognitive functions (Arts et al., 2008; Krabbendam et al., 2005; Quraishi and Frangou, 2002). Considering that the two disorders also share many similar symptoms, these recent findings raised the question about whether the observed cognitive deficits in the two patient groups are more related to diagnosis or to pattern of symptoms.

Various definitions of executive functions have been put forward (Burgess et al., 2000; Royall et al., 1993; Stoddart et al., 2007), with the one proposed by Burgess et al. (2000) being most widely accepted. According to them, executive function refers to a wide range of cognitive processes and behavioral abilities such as problem-solving, sequencing, verbal reasoning, the ability to sustain attention, planning, resistance to interference, utilization of feedback, multitasking, cognitive flexibility and the ability to deal with novelty. Among the various cognitive deficits identified, previous studies have highlighted executive dysfunctions in BD and SZ for several reasons. First, executive functions are closely associated with everyday functioning, and are probably most impaired compared to other cognitive processes in individuals with SZ (Frangou, 2010) and BD (Arts et al., 2008). Second, executive dysfunctions are related to symptoms observed in BD and SZ. Executive functions are primarily sub-served by the frontal lobes (Andreasen et al., 1996) and frontal lobe lesions are associated with both the failure to suppress inappropriate responses and the lack of responses (Shallice, 1988). While failure to suppress inappropriate responses is associated with thought disorder and reality distortion (delusion and hallucination) in SZ and mania in BD, lack of responses is associated with psychomotor poverty in SZ and depression in BD (Kravariti et al., 2005). Third, impaired executive functions may be a common trait marker in BD and SZ (Breton et al., 2011, Frangou et al., 2005a, Morey et al., 2005).

In this study we focused on the inhibition function in individuals with BD and SZ because factorial-analytic studies have repeatedly shown that semantic inhibition is a very important factor in a battery of executive function tests, in both healthy (Chan, 2001) and patient populations (Chan et al., 2004). The Hayling Sentence Completion Test (HSCT) is a test developed to assess inhibition (Burgess et al., 2000) and it has been widely used in clinical practice. In the HSCT, individuals are presented with incomplete sentences with the final word omitted but is strongly suggested by the context. Individuals are asked to complete the sentence in either a logical (Task A, initiation section) or illogical manner (Task B, inhibition section). In Task B any word which is semantically associated with the sentence should be avoided, thus test takers have to inhibit a strongly cued and automatic response. For instance, responding with the word "ship" to the sentence "the captain went down with the sinking __" is correct when undertaking Task A, but incorrect when undertaking Task B (Type A error). Moreover, words such as 'airplane', 'bus', 'waterman' which are semantically associated with the whole sentence context are also scored incorrect for Task B (Type B error). Thus, in completing Task B, test takers are required not only to suppress a pre-potent response but also to plan and manipulate information in working memory. Shorter latency and fewer errors in Task A or Task B indicate better initiation or inhibition function.

Significant correlations between HSCT scores and self-reported measures of attentional impulsivity have been established in remitted BD patients, suggesting that poor response inhibition may be related to impulsivity in these patients (Christodoulou et al., 2006). Impaired HSCT performance has been observed in patients with different symptomatology, including patients with BD (Stoddart et al., 2007). Moreover, Dixon et al. (2004) studied the relationship between inhibition function and symptomatology by recruiting 15 manic, 15 depressed, 15 remitted patients with BD and 30 controls. Even with the modest number of participants in each group, the authors found that each of the three BD subgroups had longer latency, larger error rate in Task A, and decreased use of strategy in Task B (e.g., reporting objects in the testing environment). Similarly, compromised HSCT performance in euthymic BD patients (de Almeida Rocca et al., 2008) and remitted BD patients (Frangou et al., 2005b) have been reported. These findings, therefore, suggest that impaired performance in HSCT may be an enduring feature of BD and not a secondary deficit due to mood symptoms.

Nathaniel-James et al. (1996) first reported that patients with SZ had difficulties in performing the HSCT when compared to healthy controls. Patients with SZ showed longer response latency in Task A and more errors in Task B, indicating clear deficits in response initiation and inhibition. Since then, a large number of studies have repeatedly found that SZ patients exhibit impaired performance on the HSCT, especially in Task B where inhibition is needed (Chan et al., 2012; Chan and Chen, 2004; Chan et al., 2004, 2010; Groom et al., 2008; Joshua et al., 2009; Marczewski et al., 2001; Nathaniel-James et al., 1996, Royer et al., 2009a; Waters et al., 2003). Patients with SZ were found to either commit more errors, or had longer response latency, or both. Significant relationships between HSCT measures and symptoms in individuals with SZ have also been established (Chan et al., 2010; Waters et al., 2003). Results of previous study also suggest that patients with SZ probably showed the most severe impairment on the HSCT task in comparison with other executive function tasks such as verbal fluency and the Modified Wisconsin Card Sorting Test (Nathaniel-James et al., 2004). Average effect sizes for other executive function measures, such as verbal fluency ($d = 1.39$), the Stroop Color–Word Test ($d = 1.22$), the Trail Making Test B ($d = 1.07$) and the Wisconsin Card Sorting Test ($d = 0.95$) have been reported (Heinrichs and Zakzanis, 1998). However, the average effect size for performance on the HSCT, a task in which patients with SZ have potentially the greatest difficulty, is still not known.

A small number of studies directly compared the performance on HSCT in individuals with BD and SZ. Kravariti et al. (2005) compared the performance on HSCT in 30 BD patients and 30 SZ patients. While the performance of BD patients in the manic stage was found to resemble those of patients with SZ with thought disorder and/or reality distortion (delusion and hallucination), the performance of BD patients in the depressive stage was found to be similar to SZ patients with negative symptoms. In another study, Joshua et al. (2009) compared HSCT performance between 39 patients with SZ and 40 patients with BD (as well as a healthy control group) on several measures, including the overall scaled score (which takes into consideration both response latency and error rate), the Task A scaled score, the Task B scaled score, response suppression (subtracting Task A response latency from Task B response latency), the Task B Error scaled score, Type A Error score in Task B and Type B Error score in Task B. Results of the study suggested that the overall scaled score difference observed between the two groups was mainly due to an increase in Type B Error in the SZ group. There was no reliable difference between the two groups on other HSCT measures. Results from Kravariti et al.'s (2005) and Joshua et al.'s (2009) study seem to suggest that there are more similarities than differences between the performance of patients with SZ and BD on the HSCT. However, more evidence is needed before a firm conclusion can be drawn. Apart from further investigation on this topic using large samples, a meta-analysis can be used as a good alternative method to clarify the issue.

Using published studies which compared either/both patients with BD or SZ with healthy controls, we could compute effect sizes for the HSCT measures, and then obtain a grand effect size for each of these measures for both groups. The meta-analytic method also allows us to directly compare the effect sizes generated by comparing individuals with BD with healthy controls and those generated by comparing individuals with SZ and healthy controls. Therefore, the present meta-analysis had two aims. The first was to obtain a general profile of performance deficits on HSCT measures in patients with SZ and BD separately.