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Research report

Further evidence of a dissociation between decision-making under ambiguity and decision-making under risk in obsessive–compulsive disorder

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ABSTRACT

Background: Deficits in decision-making have been suggested as a key concept in understanding the symptoms of obsessive–compulsive disorder (OCD). However, evidence in the extant literature remains inconclusive on whether patients with OCD show inferior performance on laboratory decision-making tasks. The aims of the present study were therefore to (1) assess decision-making under ambiguity and under risk in patients with OCD and (2) study the influence of neuropsychological and clinical variables on decision-making in OCD.
Methods: The sample consisted of 65 patients with OCD and 58 controls. The Iowa gambling task (IGT) and the game of dice task (GDT) were used to examine decision-making under ambiguity and decision-making under risk, respectively. In addition, reversal learning and executive function were assessed in terms of their relationship with decision-making tasks.
Results: Patients with OCD showed impairment in the IGT, but not in the GDT. Reversal learning was neither impaired nor correlated with IGT performance. Among the clinical variables, illness severity and depression were associated with IGT scores. Executive function was impaired, but no significant relationship was found between executive function and GDT performance in OCD patients.
Limitations: Almost all OCD patients were on medication when they performed decision-making tasks.
Conclusions: Patients with OCD are impaired in decision-making under ambiguity, but not under risk. These findings demonstrate that decision-making processes are dissociated in OCD.

1. Introduction

Obsessive–compulsive disorder (OCD) is a chronic psychiatric disorder characterized by anxiety-provoking intrusive thoughts (obsession) and/or repetitive ritualistic behaviors (compulsion) aimed at reducing anxiety (American Psychiatric Association, 2000). Approaches to reveal the neural substrates of these symptoms have focused on frontal–subcortical circuits, with particular attention to increased orbitofrontal–striatal metabolism in resting state and during symptom provocation (Saxena et al., 1998; Saxena and Rauch, 2000; Whiteside et al., 2004). As the orbitofrontal cortex and ventromedial prefrontal regions are involved in reward perception and adaptation to shift in reward contingencies (Rolls, 2000), which are critical in decision-making (Krawczyk, 2002; Rolls and Grabenhorst, 2008), disrupted decision-making in OCD has been of interest, together with orbitofrontal dysfunction. In some articles, obsessive–compulsive symptoms have even been proposed as a manifestation of an underlying decision-making deficit; seeking for an immediate relief of anxiety by compulsion (short-term reward) leads to functional impairment and compromises quality of life in the long term (negative long-term consequence) (Cavedini et al., 2006; Sachdev and Malhi, 2005).

From a psychological aspect, decision-making can be classified into at least two different categories: decision-making under ambiguity and decision-making under risk (Brand et al., 2006). While ambiguous conditions provide equivocal rules for reward and punishment, risky conditions offer expected outcomes for competing alternatives. In neuropsychological research, decision-making under ambiguity and decision-making under risk are frequently examined with the Iowa gambling task (IGT) (Bechara et al., 1994) and the game

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of dice task (GDT) (Brand et al., 2005a), respectively. The IGT requires the development of implicit preference for advantageous choice under ambiguous reinforcement contingencies (decision-making under ambiguity), which is mediated by emotional learning (Bechara et al., 2000a) and relevant structures, such as the orbitofrontal/ventromedial prefrontal cortex and amygdala (Bechara, 2004; Bechara et al., 1999, 2000b; Gupta et al., 2011). In a previous study of individuals with ventromedial prefrontal lesions, poor IGT performance was also influenced by reversal learning (Fellows and Farah, 2005). On the other hand, gains and losses in the GDT are based on explicit rules and apparent winning probabilities (decision-making under risk), which are associated with executive function (Brand et al., 2007a, 2005a, 2005b, 2007b, 2008b) and activation of several brain regions, such as the dorsolateral prefrontal cortex, posterior parietal lobe, anterior cingulate cortex, and right lingual gyrus (Labudda et al., 2008).

Performance on decision-making tasks has been widely investigated in OCD, but the results remain inconclusive. In accordance with the functional alteration of orbitofrontal–striatal circuits, previous studies have frequently demonstrated reduced IGT score in patients with OCD (Cavedini et al., 2002, 2012, 2010; da Rocha et al., 2011a; Kashyap et al., 2013; Starcke et al., 2009, 2010). On the other hand, two studies reported impaired performance in only subgroups of patients with OCD (Lawrence et al., 2006; Nielen et al., 2002), and one study revealed comparable performance in medication-naïve patients with OCD (Krishna et al., 2011). As IGT taps several cognitive processes, it is unclear on which component patients with OCD principally rely to solve the IGT. Concerning the factors contributing to IGT performance, there is no agreement on whether demographic and clinical variables are involved in disadvantageous choices. The evidence for a correlation between OCD symptom severity and preference for unfavorable choices is contradictory. While three studies reported positive results (da Rocha et al., 2011b, 2008; Nielen et al., 2002), four studies did not (Cavedini et al., 2002; da Rocha et al., 2011a; Krishna et al., 2011; Lawrence et al., 2006). Furthermore, to the best of our knowledge, only two studies were conducted with the GDT (Starcke et al., 2009, 2010); patients with OCD in these studies performed similarly compared to controls. However, the small sample sizes would limit the generalizability of these results.

In this study, we aimed to obtain clearer evidence on decision-making ability in a larger sample of patients with OCD. The aims of this study were to (1) examine the properties of decision-making under ambiguity and under risk in patients with OCD compared to controls and (2) study the influence of fundamental cognitive processes and clinical characteristics on decision-making performance. Particularly, we focused on reversal learning with regard to performance on the IGT; reversal learning depends on the orbitofrontal cortex (Rolls, 2000; Rolls et al., 1994), a region of interest in OCD. We also included executive function to explore its relationship with GDT performance. In accordance with recent studies that indicate the involvement of the dorsolateral prefrontal cortex in OCD (Menzies et al., 2008; Piras et al., 2015), we hypothesized that (1) patients with OCD would perform inferiorly in both decision-making tasks and that (2) poor performance on the IGT and GDT would correlate with impairment in reversal learning and executive function, respectively.

2. Methods

2.1. Participants

Sixty-five patients with OCD were recruited from the psychiatry department of Severance Hospital, Yonsei University Health System. All participants were 19 years or older at enrollment. Diagnoses were confirmed by a trained psychiatrist with the Structured Clinical Interview for DSM-IV (SCID) (First et al., 1996). Participants with comorbid psychiatric disorder were included only when their obsessive–compulsive symptoms were the primary focus of clinical attention. Seventeen of them had comorbid psychiatric disorders, including major depressive disorder ($n=8$), panic disorder ($n=3$), bipolar II disorder ($n=2$), tic disorder ($n=2$), social phobia ($n=1$), and body dysmorphic disorder ($n=1$). Any patient with a substance-related disorder, history of psychotic symptoms, or neurological or medical disease that might influence performance was excluded. The Yale–Brown obsessive-compulsive scale (Y–BOCS) (Goodman et al., 1989) and Montgomery–Åsberg depression rating scale (MADRS) (Montgomery and Asberg, 1979) were used to assess the severity of obsessive–compulsive symptoms and depressive symptoms, respectively. Sixty-three patients were receiving medication, including selective serotonin reuptake inhibitors (SSRIs) ($n=63$), benzodiazepines ($n=43$), and atypical antipsychotics ($n=8$). Benzodiazepines on an as-needed basis were not allowed prior to and during the task. Fifty-eight age-matched controls were recruited from the local community by advertisement. Exclusion criteria for controls were current or any lifetime history of DSM-IV axis I disorder, neurological disease, and use of medications that may affect cognitive function. The study was approved by the Institutional Review Board of Severance Hospital. All participants provided written informed consent at the beginning of the study.

2.2. Neuropsychological tasks

2.2.1. Iowa gambling task

The computerized version of the IGT was conducted to examine decision-making under ambiguity (Bechara et al., 2000b). Participants were told to earn as much virtual money as possible without prior notice of when the task would end. On each trial of card selection from four decks (A, B, C, and D), a variable amount of reward was given, which was intermittently followed by unexpected loss. Decks A and B were related to high gains, but even greater losses resulted in an overall disadvantageous outcome. In contrast, decks C and D were related to small gains, but even smaller losses produced a favorable result in the long run. The outcome measure, calculated for the entire game (100 trials) and for every 20 trials (five blocks in total), was the total difference between advantageous and disadvantageous choices ($[C+D]-[A+B]$). We also drew a distinction between the first two blocks (trials 1–40) and the last three blocks (trials 41–100) according to the previous study, which reported different aspects of decision-making across trials (Brand et al., 2007b).

2.2.2. Game of dice task

The GDT (Brand et al., 2005a) was used to measure decision-making in risky situations. The goal of this game was to maximize fictitious money across 18 throws of a single die. Before each trial, participants chose between single numbers or a combination of two, three, or four numbers. Each choice was associated with specific gains or losses as well as different winning probabilities: 1/6 probability of gaining/losing $1000 (single number), 2/6 probability of gaining/losing $500 (two numbers), 3/6 probability of gaining/losing $200 (three numbers), and 4/6 probability of gaining/losing $100 (four numbers). The choices with less than 50% chance of winning (one or two numbers) were considered risky decisions while those with at least 50% chance of winning (three or four numbers) were considered non-risky decisions. The net score was calculated by subtracting the number of risky choices from that of non-risky choices.

2.2.3. Simple reversal learning task

The simple reversal learning task (SRLT) was administered to measure stimulus-reinforcement learning and reversal learning