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www.elsevier.com/locate/jocrd

PII: S2211-3649(13)00041-9
DOI: <http://dx.doi.org/10.1016/j.jocrd.2013.05.003>
Reference: JOCRD91

To appear in: *Journal of Obsessive-Compulsive and Related Disorders*

Received date: 4 December 2012
Revised date: 14 May 2013
Accepted date: 20 May 2013

Cite this article as: I. Labuschagne, S.L. Rossell, J. Dunai, D.J. Castle, M. Kyrios, A comparison of executive function in Body Dysmorphic Disorder (BDD) and Obsessive Compulsive Disorder (OCD), *Journal of Obsessive-Compulsive and Related Disorders*, <http://dx.doi.org/10.1016/j.jocrd.2013.05.003>

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A comparison of executive function in Body Dysmorphic Disorder (BDD) and Obsessive Compulsive Disorder (OCD)

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Abstract

Evidence now suggests executive dysfunction in Body Dysmorphic Disorder (BDD) which may be related to Obsessive-Compulsive Disorder (OCD). However, neurocognitive performance in the two disorders has rarely been compared. This study compared 14 BDD participants on neurocognitive tasks taken from the Cambridge Automated Neuropsychological Test Automated Battery (CANTAB) with previously published data from 23 OCD participants (Purcell et al., 1998). Effect sizes from three executive function tests (Spatial Span, Spatial Working Memory and Stockings of Cambridge), and one visual memory task (Pattern Recognition) were compared for group differences using difference and equivalence testing. Equivalence testing was used to determine whether BDD and OCD effects sizes were equivalent, non-equivalent or equivocal. Results indicated an equivocal pattern for Spatial Span, Spatial Working Memory, Pattern Recognition and most Stockings of Cambridge measures. However, results for Stockings of Cambridge accuracy measure indicated a non-equivalent pattern, with BDD but not OCD participants performing significantly worse than controls. Results suggest a number of similarities in neurocognitive function in BDD and OCD, although it was not possible to establish statistical equivalence on most study measures. The findings raise the possibility of more severe planning deficits in BDD compared to OCD.

Key words: Body Dysmorphic Disorder, Obsessive-Compulsive Disorder, Executive Function, Planning, Nosology

Introduction

Body Dysmorphic Disorder (BDD) is characterized by a preoccupation with imagined or minor defects in appearance as well as repetitive behaviors that are designed to hide or improve the supposed defects. These symptoms ultimately lead to significant distress and impairment in social and/or occupational functioning (DSM-IV-TR; APA, 2000). Individuals with BDD frequently present with comorbid Obsessive-Compulsive Disorder (OCD) (Altamura et al., 2001; Frare et al., 2004; Hollander et al., 1993), and the two disorders share many features (Phillips et al., 2010). For example, individuals with BDD experience recurrent, persistent and intrusive preoccupations about their perceived physical defects (Buhlmann et al., 2002; Perugi et al., 1997; Phillips et al., 1993) which are similar to the obsessions seen in OCD. Ritualistic behaviors in BDD such as mirror checking and hair grooming (Phillips et al., 1993; Veale et al., 2001) are similar to the compulsions of OCD. Both BDD and OCD also have a similar age at onset and course (Phillips et al., 2007), and may both respond preferentially to selective-serotonin reuptake-inhibitors (Hollander et al., 1989, 1999; Phillips et al., 1998; Soomro et al., 2008), suggesting a common neurochemical dysfunction. Based on this evidence, the APA has proposed that BDD should be classified under Obsessive-Compulsive and Related Disorders in the new DSM-V (APA, 2013; also see Phillips et al., 2010) rather than under Somatoform Disorders (DSM-IV-TR; APA, 2000). There are, however, some significant and important clinical differences between the two conditions. For instance, BDD patients are reported to have poorer insight with greater delusional endorsement (Labuschagne et al., 2010) than those with OCD (Frare et al., 2004; Phillips et al., 1995). In addition, BDD patients are more likely than OCD patients to demonstrate lifetime suicidal ideation, lifetime major depressive disorder and lifetime substance use disorder (Phillips et al., 2007).

Despite the distress and burdensome nature associated with BDD, and its relatively high prevalence (e.g., 1.7%) (Rief et al., 2006), BDD remains poorly understood and under-researched (Castle & Rossell, 2006; Phillips et al., 1993; Veale, 2004). Critically, little is known about cognitive

impairments associated with BDD. This is of concern because greater understanding of the cognitive deficits characteristic of BDD could assist in the development of more effective treatment strategies. In addition, the possibility of a relationship between BDD and OCD, suggests that these disorders may share similar neurocognitive characteristics. This in turn may indicate similar etiology and underlying neurobiological dysfunction and could inform both nosological discussions and the design of specific neurocognitive remediation packages for each disorder.

To date, there have been few published neurocognitive studies of BDD, but results of studies have generally suggested executive dysfunction. For example, Hanes (1998) compared patients with BDD ($n=14$), OCD ($n=10$), and schizophrenia ($n=14$), to a group of control participants ($n=24$) on tests of executive function, memory and motor function. This study reported similarly impaired performance on the New Tower of London and Stroop in BDD and OCD patient groups compared to controls, suggesting poor executive function in both BDD and OCD and providing support for the idea of BDD being classified under Obsessive-Compulsive and Related Disorders. Deckersbach and colleagues (2000) compared BDD patients ($n=17$) with an equal number of controls on the Rey Complex Figure Test (RCFT) and the California Verbal Learning Test (CVLT), and found deficits on both tests, suggesting both non-verbal and verbal memory impairments respectively. The authors argued that these memory deficits were mediated by poor organizational strategies, possibly resulting from executive dysfunction (Deckersbach et al., 2000). Recently, we compared BDD patients ($n=14$) with matched controls and again established executive function deficits, including problems with on-line manipulation, planning and organization of information. However, patients in this study also demonstrated intact spatial memory capacity, motor speed and visual memory (Dunai et al., 2010).

Although these studies report executive dysfunction in BDD, comparison between studies is difficult because many of the cognitive tasks used differed between studies, and conflicting results were obtained where similar tasks were used. For example, Hanes (1998) found no differences

between controls and BDD patients on the RCFT and the Rey Auditory Verbal Learning Task, whilst Deckersbach and colleagues (2000) observed deficits in immediate recall for the RCFT and CVLT in their BDD cohort. In our study (Dunai et al., 2010), tasks from the Cambridge Neuropsychological Test Automated Battery (CANTAB) battery were selected to facilitate comparison between BDD patients and an OCD sample who had completed the same tasks in a study conducted by Purcell and colleagues (1998); see below.

In contrast to BDD, neurocognitive performance in OCD patients has been well-documented (Fontenelle et al., 2006; Kuelz et al., 2004), with executive dysfunction a common finding. Examples of findings suggesting executive dysfunction in OCD include decreased cognitive flexibility and set-shifting (Henry, 2006; Lawrence, 2006) and reduced engagement in decision-making and planning activities (Shin et al., 2004; van den Heuvel et al., 2005). In addition, there is a general consensus that impaired use of implicit organizational strategies may underlie the memory impairments observed in OCD (Greisberg & McKay, 2003; Maruff et al., 2002, Savage et al., 1999, 2000). For example, Purcell and colleagues (1998) conducted a detailed investigation of neuropsychological function in OCD using a battery of tests from the CANTAB with known sensitivity to frontal and subcortical systems. They reported deficits in spatial working memory and decreased motor speed on a computerized version of the Tower of London planning task, with the performance of OCD patients being similar to that of patients with frontal excisions (Purcell et al., 1998).

Evidence from the above studies strongly suggests executive dysfunction and frontal-striatal involvement in OCD (Saxena & Rauch, 2000), and raises the possibility of similar deficits with dysfunction in similar neuroanatomical pathways in BDD. However, to date there has been only one direct comparison of neurocognitive performance in BDD and OCD (Hanes, 1998) leaving open the possibility of important differences which may have significant implications for both etiology and treatment. In our study, although not a direct comparison, we aim to statistically compare the performance of BDD and OCD patients on cognitive tasks selected from the CANTAB. This was

achieved by comparing data from the current BDD sample¹ with previously published data from an OCD sample (Purcell et al., 1998). Effect sizes for the performance of BDD (n=14) and OCD (n=23) participants compared to their respective controls were calculated and compared using both difference and equivalence testing. Only those measures common to both studies were available for comparison in this way. Based on results of previous studies of both BDD and OCD, we hypothesized that BDD and OCD participants would show an equivalent pattern of performance compared to their respective controls such that effect sizes between BDD and OCD will not be significantly different and the effect sizes will be equivalent (i.e., contained within the predetermined equivalence range).

Method

Participants

The BDD sample consisted of 14 DSM-IV BDD patients compared with 14 age-, education- and gender-matched healthy controls. The DSM-IV diagnosis for BDD was confirmed using the Body Dysmorphic Disorder Module (Phillips, 1994). The OCD sample comprised 23 DSM-IV OCD patients compared with 23 age-, education-, estimated IQ- and gender-matched healthy controls. Diagnosis of OCD was confirmed using the Anxiety Disorders Interview Schedule for DSM-IV (Brown et al., 1994). Both patients and control samples were screened for history of psychiatric illness, family history of mental illness, alcohol and/or substance abuse and head injury. Exclusion criteria for patients and controls were major medical or neurological illness and head injury. Additional exclusion criteria for control participants were current or past psychiatric illness and/or alcohol or substance abuse. For BDD patients, who have a high incidence of comorbidity, the presence of other Axis I disorders was not an exclusion criteria. For OCD participants from the Purcell et al. study (1998) the presence of other Axis I disorders (but not symptoms) was an exclusion criteria. For both

¹ Some of the data collected using this sample of BDD participants has already been published in Dunai et al., (2010).

studies, written voluntary informed consent was gained from participants; and the studies were approved by relevant ethics committees. More details of the participant groups and study designs for BDD and OCD samples can be found in the original studies (Dunai et al., 2010; Purcell et al., 1998), respectively.

CANTAB Tasks

In both studies, all participants completed three executive function tasks and one visual memory test, selected from the CANTAB (Morris et al., 1987). More procedural details for each task can be found in Dunai et al. (2010). Briefly, *Spatial Span (SS)* measures the ability to remember a sequence of squares presented on a screen in short-term memory. Possible scores range from 0 to 9, with higher scores being superior. *Spatial Working Memory (SWM)* involves searching 3-8 boxes for tokens hidden inside, and generates three scores. A between-search error involves returning to a box in which a token has previously been found. A within-search error involves searching any box more than once during a search sequence. Finally, strategy scores reflect how often search sequences are initiated from the same box within a trial, with higher scores indicating many searches starting from different boxes and poor strategy use. The *Stockings of Cambridge (SOC) planning task* assesses spatial planning ability. Participants are required to rearrange a set of balls in the bottom half of the screen to match the positions of balls presented in the top half of the screen. Accuracy measures during the copying trials consist of the total number of trials completed, the number of perfect solutions (i.e. number of trials completed in the minimum number of moves), and the total number of moves in excess of the minimum. For each copying trial, a control “following” condition is employed to provide a measure of motor initiation and subsequent execution times that are independent of thinking times. Following trials are exact replications of participants’ earlier copying moves. The measurement of initiation and subsequent execution latencies in the following condition provided estimates of motor speed. Estimates of cognitive speed are obtained by

subtracting following times from total copying times. Thus, the program provides initiation and subsequent movement (following) and thinking times, as well as the accuracy measures listed above. *Pattern Recognition (PR)* assessed visual pattern recognition memory using abstract patterns. A series of patterns are displayed after which subjects are presented with pairs of patterns, one of which has been shown previously while the other is a novel pattern. The task is to identify the pattern that was shown previously. Possible scores on this task range from 0 to 100%.

Statistical analysis

Data for BDD and OCD samples were compared using both difference and equivalence testing (Barker et al., 2002; Rogers et al., 1993). This involved three steps. First, effect sizes (Cohen's d)² were calculated for both BDD and OCD samples compared to their respective controls. Effect sizes were calculated for the following ten measures which are derived from the four experimental tasks: SS (score), SWMBSE (SWM number of between-search errors), SWMSS (SWM strategy scores), SOCPeef (number of perfect solutions on the SOC), SOCEXcess (number of excess moves on the SOC), InMt (average following/movement initiation time on the SOC³), SubMt (average subsequent following/movement time on the SOC), InTh (average thinking initiation time on the SOC), SubTh (average subsequent thinking time on the SOC) and PR (score). Second, BDD and OCD study effect sizes were compared using difference testing. This was achieved by calculating 95% confidence intervals (CIs) for the difference between BDD and OCD effect sizes. Statistically significant differences were indicated if 95% CIs did not include zero. Third, data from BDD and OCD studies were compared using equivalence testing. This was achieved by calculating 90% CIs for the difference between BDD and OCD effect sizes and comparing them to a pre-selected equivalence range of -0.2 to +0.2. This equivalence range was chosen because ± 0.2 is conventionally accepted as

$$^2 d = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{s_1^2 + s_2^2}{2}}}$$

³ For this analysis SOC latencies were transformed into logarithms (base 10) for comparison with data from Purcell et al. (1998).

a small effect size. To test our hypothesis of equivalence in performance between the patient groups, equivalence versus non-equivalence was achieved via consideration of both difference and equivalence tests. To support our hypothesis, statistical equivalence of effect sizes would result in 95% CIs showing no significant difference and 90% CIs will be entirely contained within the equivalence range. Contrary to our hypothesis, statistical non-equivalence would result in 95% CIs showing a significant difference and 90% CIs will not be entirely contained within the equivalence range. Also contrary to our hypothesis, an equivocal pattern would result in 95% CIs showing no significant difference and 90% CIs will not be entirely contained within the equivalence range (for a description of this method, see Barker et al., 2002; Rogers et al., 1993).

Results

Effect sizes with 95% CIs for BDD and OCD samples compared to their respective controls are presented in Figure 1. Confidence intervals for the difference between BDD and OCD effect sizes are shown in Figure 2. The left panel shows 95% CIs which are relevant for difference testing. The right panel shows 90% CIs superimposed over a -0.2 to +0.2 equivalence range which are relevant for equivalence testing.

SS: Effect size (ES) results showed a non-significant trend for SS scores to be lower in BDD patients compared to their controls ($ES=.83$) which was not evident in the OCD study ($ES=.44$; see Figure 1). Although this might suggest a difference between BDD and OCD SS performance, Figure 2 shows that the difference between BDD and OCD effect sizes was not significant (left panel). However, Figure 2 also indicates that the two effect sizes were not equivalent (right panel). Thus, the results of equivalence testing for the SS measure indicate an equivocal pattern.

SWM: On the SWM, effect sizes indicated significantly more between-search errors in both patient groups compared to their respective controls (BDD $ES=1.19$ and OCD $ES=.91$) and effect size confidence intervals overlapped considerably, suggesting similar performance in the two groups (see

Figure 1). This apparent similarity in performance is supported by the left panel of Figure 2 which shows that the difference between BDD and OCD SWM between search error effect sizes was non-significant. However, the right panel of Figure 2 indicates that BDD and OCD effect sizes for this measure were also non-equivalent, indicating an equivocal pattern. Effect sizes for SWM strategy scores indicated a significant difference in strategy scores for OCD but not BDD participants compared to their controls. However, Figure 2 again suggests an equivocal pattern with neither significant difference nor equivalence between BDD and OCD effect sizes.

SOC: Accuracy measures on the SOC evidenced the largest between-study differences. As can be seen from Figure 1, BDD patients achieved significantly fewer perfect solutions than control participants ($ES=1.12$) and made significantly more moves in excess of the minimum ($ES=1.48$). This contrasted with the performance of OCD patients who did not differ significantly from controls (SOCPerf $ES=.38$, SOCEXcess $ES=.35$). This is reflected in the larger effect sizes for the BDD sample, and the smaller overlap between effect size confidence intervals shown in Figure 1. Comparison of BDD and OCD effect sizes for these measures revealed an equivocal pattern for SOCPerf (effect sizes neither significantly different nor equivalent), and non-equivalence for SOCEXcess (effect sizes significantly different and non-equivalent). For SOC latency data, effect sizes shown in Figure 1 suggested the possibility of differences between BDD and OCD patients compared to their respective controls for movement initiation and subsequent thinking times. However comparison of SOC latency effect sizes failed to reveal any significant differences between the two groups, although there was again no evidence of equivalence (see Figure 2).

PR: As can be seen from Figures 1 and 2 there was little difference between the two studies for recognition of visual (abstract) patterns, with both patient groups performing similarly to control groups on the PR task. Nonetheless equivalence testing again indicated an equivocal pattern of results (see Figure 2).

Discussion

In general, the results of the present study provide support for the hypothesis that BDD and OCD participants would evidence similar differences in performance compared to controls on tasks of executive function. Examination of separate BDD and OCD analyses suggested a similar pattern of deficits or preserved function in the two patient groups for most measures, and comparison of BDD and OCD effect sizes revealed only one statistically significant difference. Although equivalence testing indicated an equivocal pattern of results and did not therefore provide statistical evidence of equivalence, the large variability evident from CIs suggests that this was due to the small sample sizes. Thus it seems likely that BDD and OCD participants have a similar pattern of performance on SS, SWM, SOC latency measures and PR. However, the results also suggested the possibility of a difference between BDD and OCD patients on SOC accuracy measures. These findings are discussed further in relation to previous studies.

The results of the present study suggest a number of similarities between BDD and OCD. Firstly, BDD and OCD patients performed similarly to their respective controls on SS suggesting a preserved ability to hold spatial information 'on-line' (i.e., in immediate/short-term memory) in both groups. This is reflected in the considerable overlap between effect size CIs for the two groups, and in the 95% confidence interval for the difference between BDD and OCD effect sizes which indicated no significant difference. However, this apparent similarity was not supported by equivalence testing which revealed an equivocal pattern of results. Secondly, results for SWM measures also suggested similar performance in the two groups. BDD and OCD participants both made significantly more between search errors than their respective controls and there was no significant difference between effect sizes for the two groups. However, equivalence testing again failed to support statistical equivalence for this measure. For SWM strategy scores, although separate BDD and OCD effect sizes suggested the possibility of a difference between the groups, statistical comparison of effect sizes indicated that this difference was not significant, although equivalence testing again

indicated an equivocal pattern. There is evidence that SWM deficits are subserved by medial dorsolateral frontal regions, so if this similarity were confirmed it would suggest frontal involvement in both BDD and OCD, and provide some support for the contention that BDD falls under the proposed Obsessive–Compulsive and Related Disorders classification (Owen et al., 1996; Phillips et al., 2010). Third, for SOC latency measures, although examination of effect sizes suggests the possibility of performance differences for movement initiation and subsequent thinking times, statistical comparison of effect sizes indicated that these differences were not significant. Thus the results of the present study indicate normal thinking initiation times and slower initiation and subsequent movement times and subsequent thinking times in both patient groups compared to their respective controls. Equivalence testing again revealed an equivocal pattern for all SOC latency measures. Finally, there were no significant differences between the performance of BDD and OCD participants compared to their respective controls on PR suggesting similarly preserved visual memory in both disorders. This was confirmed by the absence of a significant difference between BDD and OCD effect sizes although equivalence testing again indicated an equivocal pattern.

As indicated above there was also an interesting difference between the two groups: BDD participants exhibited greater performance deficits than OCD participants on SOC accuracy measures. For both ‘number of moves in excess of the minimum’ and ‘number of perfect solutions’, BDD performance was significantly worse than controls whereas OCD performance was similar to controls. For ‘number of moves in excess of the minimum’, this difference was supported by difference testing and a finding of non-equivalence. For ‘number of perfect solutions’ the difference in BDD and OCD effect sizes did not quite attain significance resulting in an equivocal pattern of results. This difference in performance on at least one SOC accuracy measure suggests that, unlike OCD patients, BDD participants were not able to plan and execute copying moves on the SOC as accurately as control participants. Deficits in accuracy on the SOC have also been observed in disorders with presumed frontal lobe dysfunction (e.g., schizophrenia) and in patients with frontal lobe lesions (Pantelis et al., 1997).

Taken together, and considered alongside the phenomenological similarities between the two disorders, the pattern of similarities between BDD and OCD patients observed in the present study is consistent with the idea of BDD as an OCSD. Data from this study and previously published work (Bailey, 2004; Buchanan et al., 2013; Deckersbach et al., 2000; Feusner et al., 2009, 2010; Hanes, 1998), suggest frontal-striatal involvement in BDD, as well as similarities in neuropsychological performance in BDD and OCD on a number of cognitive tasks. Although none of the similarities in performance of BDD and OCD participants in the present study were reflected in findings of statistical equivalence (e.g. SS, SWMBSE and PR), the large variability in effect sizes indicated by CI ranges suggests that this may have been due to low power. This argument would of course also apply to apparent differences between the two groups which failed to reach statistical significance (e.g. SWMSS, SOCPerf and possibly InMt and SubTh). Despite its low power, the present study also revealed an interesting difference between BDD and OCD performance on the SOC accuracy measure 'number of moves in excess of the minimum'. This difference may suggest more severe planning deficits in BDD compared to OCD. Some support for this suggestion comes from the finding that BDD patients, unlike those with OCD, also solved fewer SOC problems in the minimum number of moves and had significantly slower subsequent thinking times, although this was not reflected in significant differences between BDD and OCD effect sizes.

Taken together these findings suggest that detailed exploration of planning deficits in BDD and OCD may be a fruitful area for future research. The results of the present study suggest that BDD and OCD patients share some of the same deficits in executive function. This supports the proposal of frontal lobe dysfunction in BDD. However, although the data are consistent with the view that BDD and OCD share some of the same neurocognitive features, they also raise the possibility of differences between the two disorders. The present findings provide essential information for use in future studies. For example, the findings provide information on the key individual executive functioning tasks which should be researched in future studies. However, due to the nature of the present study, there are limitations to our conclusions. A major limitation to our

study is that we compared effect sizes from two separate studies with different patient and comparison group characteristics. As a result, our findings should be taken with caution. Another limitation involves the proportion of OCD comorbidity within the BDD sample (i.e., 21%) which may have confounded the findings. However, the finding of a difference between the BDD and OCD sample on the number of excess moves for the SOC task, suggest that comorbidity may not have been a significant confound in this case. It would be encouraged to exclude OCD as a comorbid axis I disorder in the BDD sample in a direct comparison study. Finally, the two studies obtained data from different time periods and thus there is a possible effect of time on the findings although the effect of this is expected to be insignificant.

Acknowledgements

The researchers thank all the volunteers for their time and Michael Fordyce for editorial assistance.

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Figure 1. Effect sizes for cognitive task measures for the BDD and OCD studies.

Black open diamonds indicate effect sizes for BDD versus Control patients. Black open squares indicate effect sizes for OCD versus Control patients. Black and open bars indicate 95% confidence intervals for BDD/Control and OCD/Control effect sizes respectively. Abbreviations: SS(spatial span); SWMBSE (number of between-search errors for SWM); SWMSS (SWM strategy score); SOCPerf (number of perfect (minimum move) solutions for SOC task); SOCExcess (number of excess moves for SOC task); InMt (average following/movement initiation time for SOC task); SubMt (average following/movement subsequent time for SOC task); InTh (average thinking initiation time for SOC task); SubTh (average thinking subsequent time for SOC task); and PR (pattern recognition).

Figure2. Differences and equivalencies for effect sizes for the BDD and OCD studies.

Horizontal bars depict confidence intervals for the differences between BDD and OCD effect sizes. Confidence intervals for statistically significant differences (95% confidence intervals) do not include zero. Confidence intervals for equivalencies (90% confidence intervals) are contained in the interval with the endpoints -0.2 and +0.2 (i.e. less than a small effect size). Abbreviations: SS (spatial span); SWMBSE (number of between-search errors for SWM); SWMSS (SWM strategy score); SOCPerf (number of perfect or minimum move solutions for SOC task); SOCExcess (number of excess moves for SOC task); InMt (average following/movement initiation time for SOC task); SubMt (average following/movement subsequent time for SOC task); InTh (average thinking initiation time for SOC task); SubTh (average thinking subsequent time for SOC task); and PR (pattern recognition).

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Title:

A comparison of executive function in Body Dysmorphic Disorder (BDD) and Obsessive-Compulsive Disorder (OCD)

Date:

2013-07-01

Citation:

Labuschagne, I., Rossell, S. L., Dunai, J., Castle, D. J. & Kyrios, M. (2013). A comparison of executive function in Body Dysmorphic Disorder (BDD) and Obsessive-Compulsive Disorder (OCD). JOURNAL OF OBSESSIVE-COMPULSIVE AND RELATED DISORDERS, 2 (3), pp.257-262. <https://doi.org/10.1016/j.jocrd.2013.05.003>.

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