The Role of Executive Functioning in Obsessive Compulsive Disorder

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Author Note

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Abstract

Ongoing literature has found that executive functioning (EF) seems to be the cognitive domain most adversely affected in the presence of obsessive-compulsive disorder (OCD). This has been particularly significant in research addressing updated treatment approaches for OCD, however, results have been inconsistent. Therefore, the purpose of this study was to explore the role of EF in the presentation of OCD using standardised subtests from the Behavioural Assessment of the Dysexecutive Syndrome (BADS, Wilson et al., 1996) and the Delis-Kaplan Executive Functioning Scale (D-KEFS, Delis, Kaplan & Kramer, 2001). A quantitative methodology was adopted for data collection and analysis. OCD-related questionnaires and five EF subtests from the mentioned batteries were administered to a sample of 50 participants. Participants were split into HIGH_OC and LOW_OC groups using the recommended cut-off score of 21 on the OCI-R. Results demonstrated an association between higher scores on the OCD-related questionnaires and subtests from the BADS. This finding revealed an association between difficulties in set shifting and inhibitory control and the presence of an inflated sense of responsibility and perceived threat of harm. It was also indicative of an association between difficulties in planning and performance monitoring and the presence of over-importance of thoughts and the need to control thoughts. No associations were found between OCD and the subtests on the D-KEFS. Moreover, no differences were found between the HIGH_OC and LOW_OC groups on the EF subtests. Findings from this study indicated that the BADS might be more sensitive in the presence of OCD, due to its high ecological validity. This implied the possibility of using domain-specific neuro-rehabilitative strategies in treatment plans.

Keywords: OCD, executive functioning, neuropsychological assessment, cognition, BADS, D-KEFS

To those suffering in silence.

Acknowledgments

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List of Abbreviations

Abbreviation	Full Name
OCD	Obsessive-compulsive disorder
APA	American Psychological Association
CBT	Cognitive behavioural therapy
EX/RP	Exposure and response prevention
EF	Executive functioning
WCST	Wisconsin Card Sorting Test
BADS	Behavioural Assessment of Dysexecutive Syndrome
D-KEFS	Delis-Kaplan Executive Function System
OCI-R	Obsessive Compulsive Inventory - Revised
HIGH_OC	High obsessive-compulsive
LOW_OC	Low obsessive-compulsive
OCCWG	Obsessive-Compulsive Cognitions Working Group
NICE	National Institute of Health and Care Excellence
WHO	World Health Organisation
DSM-V	Diagnostic and Statistical Manual for Mental Disorders – Fourth Edition
DSM-IV	Diagnostic and Statistical Manual for Mental Disorders – Fifth Edition
ICD-10	International Classification of Diseases – Tenth Edition
OBQ-44	Obsessive Beliefs Questionnaire - 44

Abbreviation	**Full Name**
OAT	Object Alteration Task
WAIS	Wechsler Adult Intelligence Scale
COWAT	Controlled Word Association Test
DASS-21	Depression, Anxiety and Stress Scale -21

Chapter 1

Introduction

1.1. Preamble

This introductory chapter presents a brief background to the present study, followed by the aims and rationale behind the topic. The theoretical frameworks supporting this study will be outlined, followed by the significance of the study and an overview of each chapter.

1.2. Background of the Study

Obsessive-Compulsive Disorder (OCD) is characterised by the presence of obsessions and/or compulsions that may cause functional impairment and distress (American Psychiatric Association [APA], 2013). Obsessions are defined as unwanted intrusive thoughts, urges or images that repeatedly enter one's mind, while compulsions are the mental actions or behaviours one feels driven to perform following obsessions (APA, 2013; NICE, 2005; WHO, 1992). Currently, the chosen non-pharmacological treatment for OCD includes cognitive behavioural therapy (CBT), particularly a branch of CBT known as exposure and response prevention (EX/RP) (Grice, 2018). Despite its common use and success in some instances, it has been argued that approximately 40 percent of individuals experiencing symptoms of OCD do not respond to the recommended treatment (Clark & Purdon, 2016). This led researchers to inquire further into the neurological understanding of OCD, in hopes of finding alternative means of understanding the pathogenesis of OCD. Research (e.g. Ducharme, Dougherty, & Drevets, 2016; Melloni et al., 2012; Pauls, Abramovitch, Rauch & Geller, 2014) has identified a close association between clinical symptoms, brain function and cognitive function in the presentation of OCD. From a neurological perspective, OCD is conceptualised as excessive activation of the

frontal cortex and subcortical structures in the brain. Cognitive impairment has also been found to be related to the frontal lobe, particularly executive functioning (EF), which consequently leads to inflexible thought and behaviour (Melloni et al., 2012; Chamberlain et al. 2005). EF is a cognitive domain encompassing a number of subdomains relating to complex thinking, planning, set-shifting[1] and response inhibition[2] (Abramovitch et al., 2015). Nevertheless, the yielded findings have been inconsistent, with some studies reporting worse performances by OCD patients in EF tasks (e.g. Shin et al., 2013), whilst others reporting no differences between clinical and non-clinical samples (e.g. Watkins et al., 2005). Such inconsistencies have been attributed to the heterogeneous nature of OCD, as well as the comorbidities commonly associated with OCD (Abramovitch et al., 2013). Most of these findings were based on the use of experimental methods of EF, for example, the Wisconsin Card Sorting Test (WCST) (e.g. Bédard, Joyal, Godbout, & Chantal, 2006). Together with inconsistent findings, a paucity in research has also been identified as findings have not yet been yielded through the use of validated and standardised neurological batteries, particularly the Behavioural Assessment of the Dysexecutive Syndrome (BADS; Wilson, Emslie, Evans, Alderman & Burgess, 1996) and the Delis-Kaplan Executive Function System (D-KEFS; Delis, Kaplan & Kramer, 2001). The mentioned batteries have been developed to assess the multifaceted aspects of EF through a number of subtests (Latzman & Markon, 2009). The use of subtests from both batteries would offer a comprehensive view of EF. This is because the D-KEFS has been found able to distinguish between fundamental and complex cognition, as well as providing both verbal and

[1] Set-Shifting is also known as cognitive flexibility.

[2] Response inhibition is also known as inhibitory control.

nonverbal tasks. Moreover, the BADS is an ecologically valid assessment, which would, therefore, provide a better understanding of the day-to-day difficulties in EF, possibly experienced by individuals with OCD.

1.3. Aims and Rationale behind the Research Topic

The aim of this study was to explore the role of EF in the presentation of OCD, using validated and standardised subtests from the BADS and the D-KEFS. Such subtests measured three main subdomains of EF, namely set-shifting, response inhibition and planning. A combination of subtests from the two batteries would provide a comprehensive picture of the EF profile of individuals with a higher likelihood of experiencing OCD symptoms. So far, the methods used to examine the role of EF in OCD in previous studies have been limited to objective measures typically used in research (e.g. WCST, Tower of London Test). These measures have yielded inconsistent results and have not measured EF from a functional perspective. Therefore, the day-to-day difficulties of EF were not addressed using these methods. Using subtests from both a laboratory-based battery and an ecologically valid battery could lead to a better understanding of the relationship between EF and the symptoms of OCD. Given the largely unsuccessful treatment options available, a neuropsychological understanding of OCD would hopefully lead to alternative treatment options.

The primary research question underlying this study was;

- What is the role of EF in the presentation of the symptoms of OCD?

The research question above branched out two main hypotheses;

- H_1: There is an association between OCD tendencies and deficits in EF.

- H_2: Individuals who are more likely to present with OCD tendencies perform significantly poorer in EF subtests than individuals who do not present with OCD tendencies.

1.4. The Chosen Methodology

In aim of answering the research question, a quantitative methodology was adopted for data collection and analysis as it allowed a more generalisable examination of the relationships between variables in a large sample. Participants were recruited using convenience sampling. Data collection took place only if participants met the necessary criteria for eligibility. Following data collection, participants were split into two groups using the recommended cut-off score of 21 on the Obsessive-Compulsive Inventory (OCI-R) total score (Foa et al., 2002). Participants who scored 21 or higher on the OCI-R were classified under the high obsessive-compulsive tendencies group (HIGH_OC), while those who scored 20 or lower on the OCI-R were classified under the low obsessive-compulsive tendencies group (LOW_OC). Participants were provided with three OCD-related questionnaires and were required to complete five subtests of EF. Data analysis was based on comparing the performances on the OCD-related questionnaires and the EF tests, as well as examining the relationship between the OCD-related questionnaires and the EF tests.

1.5. Theoretical Influences and Framework

Two main approaches serve as the main theoretical frameworks of this study; the cognitive approach proposed by the Obsessive-Compulsive Cognitions Working Group (OCCWG) and the neuropsychological understanding of OCD.

1.5.1. The cognitive approach. The heterogeneity of OCD presents a major difficulty in understanding the underlying constructs that take place in the presence of intrusive thoughts and compulsive behaviours. The cognitive understanding of OCD emphasises on three main underlying cognitive constructs: perfectionism, over-importance of thoughts and inflated responsibility (OCCWG, 2005). Individuals with OCD tend to appraise the occurrence of obsessions as meaningful, based on dysfunctional beliefs (Rachman, 1998; Salkovskis, 1989). This results in the escalation of obsessions, stemming from such intrusive thoughts which have been appraised as significant. Subsequently, the action of completing compulsive rituals is led by the failure of recognising the possibility of faulty cognitions (Salkovskis, 1996).

1.5.2. The neuropsychological approach. In recent years, there has been a growing interest in examining the cognitive deficits associated with OCD (Abramovitch et al., 2013). Several studies (e.g. Chamberlain et al. 2005; Melloni et al., 2012; Pauls et al., 2014) have been able to identify the biological links between the presentation of OCD and neurological elements. Despite the inconsistent findings emphasised by recent meta-analyses (e.g. Abramovitch et al., 2013), there seems to be a consensus that there is a presence of neuropsychological deficits in the presence of OCD symptoms, particularly in EF (e.g. Shin et al., 2013). This study attempts to explore this consensus using standardised methods that have not yet been used for this purpose. Therefore, the underlying foundations informing this study propose a neuropsychological framework, as neural systems and cognitions related to OCD have been uncovered and shall be tackled using different methods and procedures in this study.

1.6. Study Significance and Expected Contributions to the Field

Given the high occurrence of OCD within global and local populations, this study aims to provide a window leading towards better treatment. A neuropsychological perspective aids in strengthening the link between biological and psychological constructs, which in turn leads to a closer and more accurate understanding of the issue at hand. Understanding the role of EF in the presentation of OCD might shed light on the different angles of assessment and treatment one could take in order to better manage the condition. Additionally, there seems to be an apparent gap in research pertaining to this topic within the local context. Therefore, this study could possibly contribute to filling this research gap, in the aim of yielding further research for better outcomes in the future.

1.7. Chapter Overview

This introductory chapter is followed by a detailed account of the relevant literature related to the research question. Chapter 3 outlines the methodology used, in particular, the sample characteristics, data collection instruments, hypotheses and statistical tests employed. Chapter 4 then presents the results in detail, highlighting relationships between the variables involved. Subsequently, the results are analysed in view of literature in order to illuminate the findings in chapter 5. Lastly, chapter 6 concludes the study by addressing the main findings, the limitations of the study and by providing clinical implications and prospective directions for future research.

Chapter 2

Literature Review

2.1. Introduction

This chapter provides an outline of OCD and executive functioning. The first section of this chapter presents various aspects of OCD, including its definition, history, epidemiology, diagnosis, symptomatology and treatment. The second section examines into the aetiologies and theoretical underpinnings of OCD. The following section outlines executive functioning, its relation to OCD, as well as key neuropsychological measures used to detect deficits in prefrontal functioning. the final section reviews the general and cognitive measures used to assess for OCD and its symptoms. For the purposes of this study, the present review is focused on an adult population.

2.2. Defining OCD

OCD is characterised by the presence of obsessions and/or compulsions that may cause functional impairment and distress (APA, 2013; The National Institute for Health and Care Excellence [NICE], 2005; World Health Organization [WHO], 1992). Obsessions are defined as unwanted intrusive thoughts, urges or images that repeatedly enter one's mind (APA, 2013; NICE, 2005; WHO, 1992). They are involuntary and typically related to fear of contamination, fear of harm, loss of control, scrupulosity (particularly unwanted sexual thoughts) and acute perfectionism (Bloch, Landeros-Weisenberger, Rosario, Pittenger & Leckman, 2008). On the other hand, compulsions are the repetitive mental actions or behaviours one feels driven to perform following obsessions (APA, 2013; NICE, 2005; WHO, 1992). Compulsions are also referred to as physical or mental rituals, typically relating to washing and cleaning (e.g.

excessive hand washing, household cleaning to remove contact with contaminants), checking (in order to avoid inflicting harm on self or others) and repeating (routines, body movements, activities in 'multiples'). The act of compulsions is aimed at reducing the distress associated with obsessions. This is often manifested through seeking reassurance, avoiding triggering situations, and/or achieving a 'just right' feeling (APA, 2013).

2.2.1. Conceptualising OCD. Compulsions have been noted to include voluntary action, however, this is not equivalent to having full control over the compulsion (Abramowitz et al., 2009). Researchers such as Abramowitz et al. (2009) explained that control over compulsions is largely diminished in OCD, and that voluntary action should be spoken of in terms of extent. Research (e.g. Abramovitch, Abramowitz & Mittelman, 2013; Abramowitz et al., 2009; Sussman, 2003) put forward that the voluntary nature of compulsions as dependent on the chronicity of compulsions. Therefore, individuals with OCD have been found more likely to give in to chronic compulsive urges, as opposed to urges occurring on a less frequent basis. Compulsive behaviour was previously associated with a reduction in anxiety, however, more recent research (e.g. Bandelow et al., 2012) argues that anxiety following compulsions is not always reduced. According to Bandelow et al. (2012) fatigue is a more plausible reason behind unperformed compulsive urges, rather than feelings of satisfaction or reduced anxiety. In addition, Abramovitz et al. (2013) stated that all rituals performed can be categorised into four broad classifications; namely preventative (to prevent something), reparative (to repair for something), propitiatory (to ensure all goes well) and pleasure based (to achieve specific sensations).

Within the Diagnostic and Statistical Manual for Mental Disorders (DSM-V; APA, 2013), OCD symptoms are recognised through a categorical approach, which assumes that the symptom

profile of OCD is likely to be similar across different individuals. Despite addressing symptoms, the categorical approach has been criticised as neglecting to explain the underlying mechanisms behind the symptoms (Clark, 2007; Summerfeldt, 2004). Recent research (e.g. Mataix-Cols, Pertusa & Leckman, 2007; Stein et al., 2012) has therefore conceptualised OCD as a heterogenous disorder, referring to the multiple variations of symptoms dimensions that possibly overlap one another. Therefore, the symptomatology of OCD is seen as possessing different underlying neurobiological specificities, and consequently, different responses to treatment (Bloch et al., 2008). Heterogeneity made OCD a difficult disorder to conceptualise and define (Lochner, 2003; Van Schalkwyk et al., 2016). Mataix-Cols, Rosario-Campos and Leckman (2005, p. 228) explained the heterogeneity and dimensional symptomatology of OCD in one statement, which stated that "overlapping syndromes may coexist in any patient, be continuous with normal obsessive-compulsive phenomena, and extend beyond the traditional nosological boundaries of OCD". To date, the most common symptom dimensions of OCD have been broadly classified into checking symptoms, ordering symptoms, hoarding symptoms and washing / contamination symptoms (Block et al., 2008; McKay et al., 2004). Symptom dimensions may manifest differently across different individuals. Despite current research favouring the dimensional approach to better understand the varied manifestations of OCD, underlying mechanisms are still subject to ongoing debate (Block et al., 2008).

2.3. Diagnostic Criteria

It is worth noting the differences between the fourth and fifth editions of the Diagnostic and Statistical Manual of Mental Disorders [DSM-IV; DSM-V] (APA, 1994; 2013). The two editions differ in their classification of the disorder, as OCD was classified under anxiety disorders in the DSM-IV (APA, 1994). In the present edition (APA, 2013), OCD was provided its

own classification of "Obsessive-Compulsive and Related Disorders", as anxiety is no longer recognised as a symptom of the disorder. Some differences have also been made in the definition, as the DSM-IV (APA, 2013) included the recognition of obsessions and compulsions as being excessive and products of one's own mind. The DSM-V defines OCD as having persistent obsessions and/or compulsions which are time-consuming and cause significant impairment in everyday functioning, excluding the presence of mental health issues or organic causes which might explain symptoms (APA, 2013). This definition is synonymous with that of the International Classification of Diseases, 10th Edition [ICD-10] which defines OCD as characterised by persistent and intrusive obsessions and/or compulsions causing impairment in everyday functioning (World Health Organisation [WHO], 1992). The DSM-V and ICD-10 are compared in Table 1 found overleaf. The ICD-10 is currently being revised in order to establish updated diagnostic criteria in the 11th version of the ICD. So far, the recommended changes being put forward are:

"1. Clarifying the definition of obsessions;

2. Updating the definition of compulsions (i.e., not calling these "stereotyped" and clarifying that these can be behaviours or mental acts);

3. Clarifying in the text that compulsions are often performed in relation to an obsession;

4. Describing in the text that the "distress" generated by obsessions and compulsions can include a range of affective states (e.g., anxiety, disgust, feeling of incompleteness)

5. Removing the ICD-10 duration requirement" (Simpson & Reddy, 2014, p. 11).

Table 1.

Differences between the DSM-V and ICD-10 diagnostic criteria of OCD

	DSM-V	**ICD-10**
Classification	Obsessive-Compulsive and Related Disorders	Neurotic, Stress-Related and Somatoform Disorders
Obsessions	Recurring, intrusive and distressing thoughts, images, impulses or urges which one to resist or neutralise with compulsions	Recurring, intrusive and distressing thoughts, images, impulses or urges which one to resist or neutralise with compulsions
Compulsions	Performed as a prevention of distressing event	Drive a sense of completeness when performed as a response to obsessions
Impairment	Obsessions and compulsions are time consuming or cause significant impairment in everyday functioning	Obsessions and compulsions cause distress and/or interference with daily activities
Insight	Permitted range of insight	Must be recognised as one's own intrusive thoughts or compulsive urges
Exclusion criteria	OCD may be diagnosed with depressive disorders, schizophrenia and Tourette syndrome	OCD cannot be diagnosed with schizophrenia and Tourette syndrome
Specifiers	Level of insight (good or fair versus poor or absent) Tic-related	Predominantly obsessions Predominantly compulsions Mixed obsessions and compulsions

Note. Information adapted from the original systems.

2.4. Epidemiology and Clinical Features

According to the WHO (2017) the global prevalence of OCD is 2.2 percent, which translates to approximately one in 40 adults. Current research suggests that males make up the majority of earlier-onset cases, with approximately one-fourth of symptoms appearing before 10 years of age. In contrast, symptoms in females were found to peak rapidly during adolescence (Ruscio et al., 2010). Age is the strongest predictor of a lifetime prevalence of symptoms, followed by sex, with elevated odds of symptom persistence for females. Studies have also accounted parenting status as playing a role in the persistence of OCD symptoms (Lochner et al., 2004; Ruscio et al., 2010).

A longitudinal study by Pinto, Mancebo, Eisen, Pagano, Rasmussen (2006) found that approximately 90 percent of individuals diagnosed with OCD also met criteria for comorbid conditions. Anxiety disorders are the most common comorbid conditions, followed by mood disorders, disorders of impulse-control and substance use disorders (Ruscio et al., 2010). Ruscio et al. (2010) and Fogel (2003) argue that OCD emerges after underlying pre-existing mental health issues, particularly comorbid anxiety disorders (excluding separation anxiety disorder and post-traumatic stress disorder; which were both found to follow the onset of OCD), impulse-control disorders and substance-use disorders. On the other hand, comorbid mood disorders were found to equally precede as well as follow the onset of OCD, presumably due to the debilitating effects of the condition. Moreover, bipolar disorder, agoraphobia and panic disorder were found to have the highest odds of OCD onset predictions (Ruscio et al., 2010).

After examining 196 untreated individuals with OCD, Jakubovski et al. (2013) stated that earlier onset cases seemed to be associated with worse prognosis, a longer duration of symptoms and at least one comorbid mental health issue. Moreover, they concluded that prognosis is also

highly dependent on the rate of continuous treatment being implemented. Nevertheless, results could have been biased due to a drop-out of a large number of participants after being assessed (Jakubovski et al., 2013). A later study by Garnaat et al. (2015) found that prognosis is dependent on the severity of symptoms; thus, showed worse prognosis when individuals were housebound due to symptoms. However, 50 percent of diagnosed individuals seemed to show improvement after five years (Garnaat et al., 2015). A 40-year longitudinal study by Skoog and Skoog (1999) found that 83 percent of followed up diagnosed individuals exhibited improvement. 48 percent recovered, with 20 percent exhibiting complete recovery and 28 percent recovered with subclinical symptoms (Skoog & Skoog, 1999). Worse prognosis seemed to be correlated with having earlier onset, exhibiting both obsessive and compulsive symptoms, as well as low social functioning. Moreover, worse prognosis was observed in individuals exhibiting superstitious obsessions and compulsions (Skoog & Skoog, 1999).

2.4.1. Cross-cultural differences. Ongoing research has attempted to understand whether prevalence rates and prognoses are related to cross-cultural differences. OCD symptoms may include religious representations, typically through blasphemous obsessions and scrupulosity (i.e. guilt feelings and preoccupation relating to moral and religious aspects) (Nelson, Abramowitz, Whiteside, & Deacon, 2006). Several studies have accounted a relationship between religiosity, OCD symptoms and underlying cognitions (Abramowitz, Huppert, Cohen, Tolin, & Cahill, 2002; Shafran, Watkins, & Charman, 1996; Steketee, Quay, & White, 1991). The OCCWG (2005) found a strong relationship between religiosity and maladaptive beliefs, particularly elevated responsibility and importance of thoughts (Abramowitz, Deaconi, Woods, & Tolin, 2004; Nelson et al., 2006). Rachman (2006) further explained that rigid adherence to moral rules is associated with thought overvaluation,

particularly thoughts or urges involving blasphemy. Furthermore, a study by Siev and Cohen (2007) concluded that Christians have a higher tendency to view the nature and of thoughts as morally equivalent to the nature of actions (also known as thought-action fusion) when compared to Orthodox and Non-Orthodox Jews. This may have been influenced by an increased preoccupation with being 'morally just' both in thought and action, which would not undermine the weight of a thought when compared to an action. Given that the Maltese culture is predominantly Catholic (approximately 98 percent of the Maltese population, as reported by the World Population Review, 2019), rates of OCD may be influenced by a greater preoccupation with being morally just. Nevertheless, there are no existing accounts on the prevalence rates of OCD within the local context.

2.5. Approaches to Understanding OCD

The complexity of OCD has drawn the attention of different approaches aiming to understand its causes and manifestations. The sections that follow provide a brief explanation of the understanding taken by different perspectives.

2.5.1. Neuroanatomical models. Several studies (e.g. Melloni et al., 2012; Ducharme, Dougherty, & Drevets, 2016; Pauls et al., 2014) have explored the neurobiological basis of OCD and its relation to neuropsychological functioning, in order to gain further understanding of the symptoms in relation to neurology. Extant literature supports yielded findings indicating abnormal metabolic activity of the orbitofrontal cortex, anterior cingulate cortex and basal ganglia (Melloni et al., 2012; Pauls et al., 2014). Consequently, impairment in the frontal-subcortical circuit has been observed (Melloni et al., 2012; Pauls et al., 2014; Savage et al., 1998). Furthermore, a case review by Figee at al. (2013) found that compulsions are likely

induced through lesions in the cortico-striato-thalamic circuit, as well as the parietal and temporal cortices, the cerebellum and the brainstem.

The orbitofrontal cortex is primarily responsible for detecting a general sense of error or 'wrongness', as well as 'correctness' (Casale et al., 2011). In other words, this area is said to be the brain's 'error detection system' (Casale et al., 2011). This was further substantiated through behavioural studies by Schwartz (1998) which identified orbitofrontal firing in monkeys which performed tasks correctly and expected juice as reward. When performing tasks properly and receiving saltwater as reward, overactivation of the orbitofrontal cortex was noted. Following error detection, the orbitofrontal cortex signals the cingulate gyrus, which generates a sense of uneasiness until an action is performed to correct the perceived error (Schwartz, 1998). Once such error is corrected, the caudate nucleus is activated, allowing anxiety to lessen and subsequently allowing one to proceed with daily activities. Magnetic Resonance Imaging [MRI] scans of diagnosed individuals pointed to hyperactivity in the three mentioned areas, which concludes that feelings of error and the associated anxiety are abnormally strong. Functional imaging has provided evidence of the presence of a dysfunctional cortico-striato-thalamo-cortical circuitry (Casale et al., 2011). Nevertheless, functional imaging does not inform on the process that takes place in OCD, therefore, such methods cannot be fully relied on. This is mainly as pathways are too nonspecific, and processes that take place would provide better information on OCD.

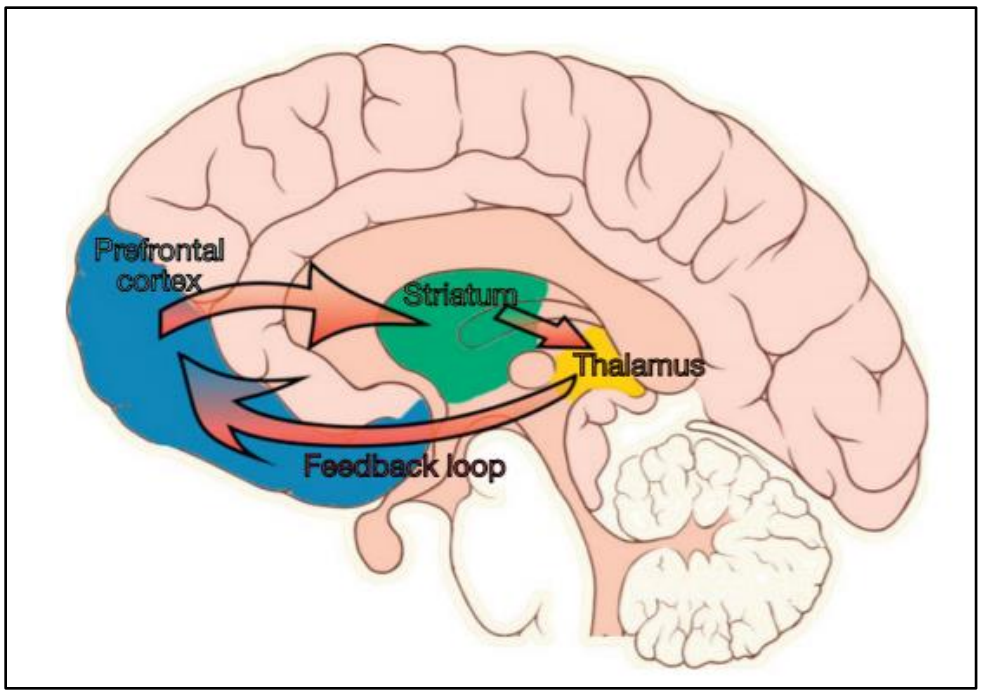

Figure 1. The neural pathway involved in OCD

Note. Image adapted from Vahabzadeh and Dougle (2014).

2.5.2. Genetic factors. Research pertaining to possible genetic associations between family members has held that strong genetic factors underpin the development of OCD (Pauls et al., 2014; Samuels et al., 2014). Twin studies (e.g. Tambs et al., 2009; Pauls et al., 2014) posited that one is four times more likely to develop OCD if the disorder is present within the family. Gene studies through animal models suggest that genetic factors are strongly linked to neurotransmitter dysregulation relating to dopamine, glutamate and serotonin (Fava et al., 2014; Pauls, 2012).

2.5.3. Environmental factors. According to Pauls et al. (2014) OCD is not necessarily developed through a genetic association. Rather, twin studies have affirmed the fact individuals with OCD do not necessarily have family members with the same disorder. Environmental risks are often linked to some form of emotional or physical trauma (Lochner et al., 2002).

Associations have been found with childhood traumatic experiences which later develops into a variation of OCD (Lochner et al., 2002). Furthermore, research has also linked OCD with acquired brain injuries, however, this is highly dependent on one's premorbid functioning as well as the nature of physical trauma (Cumming, Blomstrand, Skoog, & Linden, 2016).

2.5.4. Predominant psychological models used to understand OCD.

2.5.4.1. Psychodynamic theory. The psychodynamic viewpoint originated from Freud and has since been developed by multiple psychodynamic theorists (Swinson et al., 1998). It holds obsessions and compulsions disturb one's ego, which is the rational and conscious part of the psyche. This disturbance leads to the use of defence mechanisms to protect oneself, namely isolation, undoing and reaction formation (Fenichel, 1977). Isolation occurs due to one's appraisal of their unwanted thoughts, in that they are alien and do not belong in one's mind (Fenichel, 1977). Undoing occurs in attempt to annihilate impulses by 'undoing' such impulses, for example, cleaning oneself to remove unwanted sexual impulses (Fenichel, 1977). Similarly, reaction formation occurs in attempt to annihilate impulses by adopting an opposing lifestyle to such impulses, for example, celibacy. The underpinning conceptualisation of OCD is linked to the anal stage, where children are conflicted between wanting to soil themselves and wanting to retain such urges (Fenichel, 1977). According to Freud (1909), this happens when parents choose an authoritative stance, thus making the child feel ashamed. Such conflict is then said to possibly lead to OCD.

Nevertheless, arguments against this viewpoint stem from the lack of substantial empirical evidence to support such claims. Freud's conceptualisation of OCD is difficult to prove as there is no possible manner to measure the level of shame originating from toilet

training (Hertler, 2014). Consequently, such conceptualisation lacks scientific validity. The argument underlying cause and effect (e.g. toilet training causes OCD) is not sound as causation cannot be established, due to the array of factors which could affect toilet training as well as OCD (Hertler, 2014).

2.5.4.2. Behavioural model. The behavioural viewpoint holds that OCD stems from one's irrational fear of stimuli that are unlikely to cause harm, such as unwashed hands (Fava, 2014). Consequently, compulsive rituals are completed in attempt to reduce such fear, which in turn is reinforced by fear reduction. According to Mowrer (1960), two processes underlie the formation of obsessions and compulsions. The first relates to classical conditioning, where a neutral stimulus becomes associated with thoughts and/or experiences perceived as negative or threatening, which develops anxiety (Fava, 2014). This is followed by operant conditioning where anxiety is reduced through completion of a particular behaviour (Fava, 2014). This theory was further supported by Rachman and Hodgson (1980) who stated that anxiety was reduced whenever individuals with OCD completed compulsive rituals when exposed to triggering situations. Milad et al. (2013) proposed that obsessions could be the result of impairment in fear conditioning processes in OCD, implying that fears accompanying 'normal' intrusive thoughts are not able to be extinguished. This is further supported by impairments in extinction recall in the presence of OCD (Gillan & Sakahian, 2015). Nevertheless, this model was simultaneously challenged as the same impairments seem to be evident in post-traumatic stress disorder, which does not typically present with obsessions (Gillan & Sakahian, 2015). A study by Gillan et al. (2014) suggested that if individuals with OCD feel driven to perform a habitual act of avoidance, a fearful object must have been present in the first place. As a result, faulty beliefs about fearful threats are not extinguished due to continued habitual acts of avoidance (Lovibond et al., 2009).

In light of this, Gillan and Sakahian (2015) suggested that obsessions might actually be a by-product of compulsions, as opposed to preceding events.

On one hand, this viewpoint is supported by the success of exposure and response prevention (EX/RP) therapy, which is the treatment of choice alongside cognitive behavioural therapy (CBT) for OCD (NICE, 2005). EX/RP is based on this viewpoint, where individuals are exposed to their feared stimuli but prevented from engaging in their usual compulsions; which has been deemed highly effective (Grice, 2018). This viewpoint also consists of face validity, as compulsions do reduce anxiety, as well as scientific validity as it has been supported by empirical evidence (Grice, 2018). On the other hand, it could be argued that this viewpoint is reductionist, in that it does not take into account other factors which might predispose one to OCD. Therefore, it answers for the nurture part of development, supporting the idea that people are born as a blank slate. Ignoring the nature part of development leads to a lack of causal understanding, as behavioural theories only account for the maintenance of OCD. It could be said that this viewpoint can be deterministic, undermining individuals' abilities to control their behaviour. Additionally, there is a significant lack of explanations relating to obsessions, as cognition is not addressed in this viewpoint.

2.5.4.3. Cognitive-behavioural model. According to the cognitive perspective, compulsions are based on satiating cognitive errors (Salkovskis, 1996). This approach draws from Beck's cognitive model (1976; as cited in Salkovskis, 1996) which similarly emphasises the role of one's appraisal of perceived threat. This viewpoint holds that individuals with OCD feel the need to complete their compulsive rituals in aim of avoiding adverse consequences. This approach partly draws from the behavioural viewpoint, in that compulsions are reinforced by the immediate reduction of anxiety. Salkovskis (1996) emphasised the role of cognition in this

process, where individuals with OCD do not analyse the possibility of faulty cognitions through the action of completing compulsive rituals. Being part of the OCCWG (1997) Salkovskis developed assessment strategies to better understand OCD and its underlying process (Salkovskis, 1997). The majority of the non-clinical population has been found to experience intrusive thoughts and urges similar to those experienced by individuals with OCD (Julien, O'Connor & Aardema, 2009). However, the cognitive model postulated by the OCCWG (1997) demonstrates that the main difference between intrusive thoughts and urges in individuals without OCD and OCD patients is the appraisal of the occurrence as meaningful, based on dysfunctional beliefs (Rachman, 1998; Salkovskis, 1989). This results in the escalation of obsessions, stemming from such intrusive thoughts which have been appraised as significant. The OCCWG (1997) recognised three levels of cognitive processes underlying OCD: intrusions, appraisals and assumptions. Intrusions refer to instances when unwanted thoughts that seem to 'intrude' one's consciousness. The content of intrusions often includes doubt (e.g. "What if I did not lock the door?") and is typically appraised as negative, leading to attempts to eradicate such intrusions. When intrusions are appraised as negative experiences of particular significant, they become obsessions. Appraisals refer to how one appraises a situation, which is essentially the meaning that one gives to an occurrence. In other words, appraisals are the interpretations of specific thoughts and events. Salkovskis (1998) identified three dimensions of appraisal, namely the overestimation of the importance and responsibility of thoughts (e.g. "This thought is true because I am having it"), the probability and importance of certain events happening (e.g. "If someone breaks into my house I will be the one to blame") and the obligation to prevent such events from taking place (e.g. I have to check the door to make sure it is locked"). These are often affected by the level of perceived responsibility that one places in relation to such

occurrence and are typically responses to intrusions. Lastly, assumptions underlying appraisals are the irrational beliefs that may be specific to OCD, or general ones about oneself. As with appraisals, assumptions also elevate the level of perceived responsibility (e.g. "I am responsible for preventing bad things from happening").

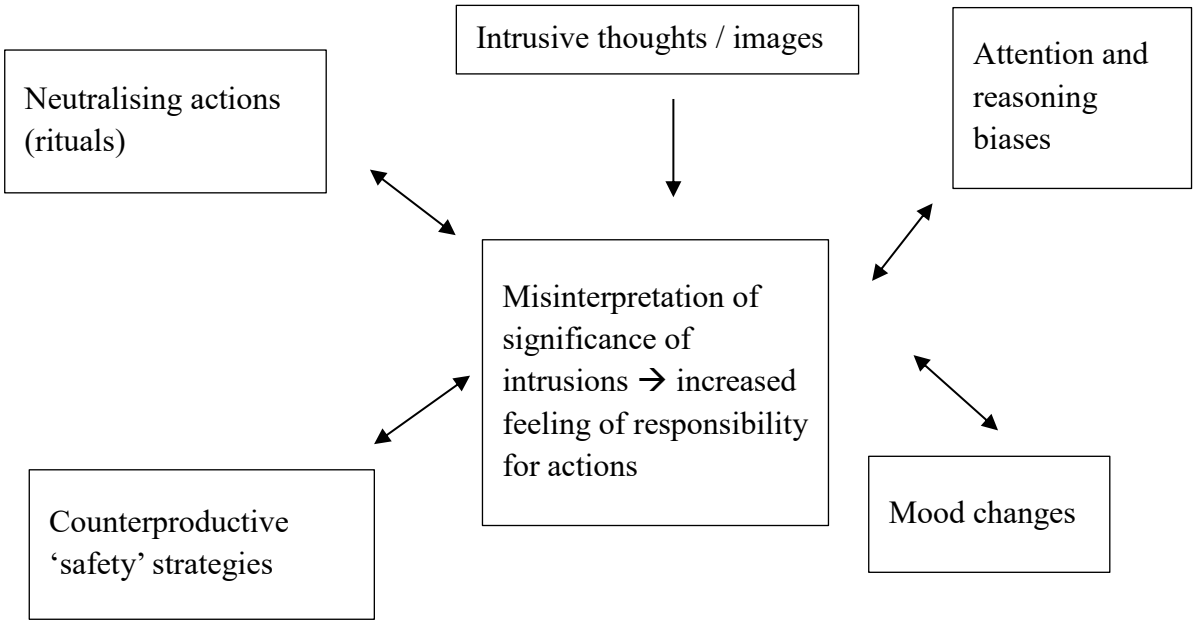

Figure 2. Salkovskis' cognitive model of OCD

Note. Model adapted from Salkovskis (1998).

2.6. Measures of OCD

There are various tools available to assess OCD, ranging from screening measures to diagnostic measures. The Yale-Brown Obsessive-Compulsive Scale (Y-BOCS) is the most common diagnostic measure of OCD. The Y-BOCS (Goodman et al., 1989) is a 10 core item questionnaire aimed at measuring symptom severity. Five items measure time, interference, distress, resistance and control of obsessions. The subsequent items measure the same aspects in relation to compulsions, yielding a global score ranging from zero to 40. It has been largely considered to be the 'gold standard' however, findings regarding its factorial structure are conflicting (Anholt et al., 2010). Following the administration of a diagnostic tool such as the Y-BOCS, determining whether an individual is presenting with OCD is dependent on the diagnostic criteria mentioned in section 2.3. The table overleaf provides a summary of additional measures of OCD.

Table 2.

Common measures of OCD

Measures	Description
Intrusive Thoughts Questionnaire (ITQ)	The ITQ (Edwards & Dickerson, 1987) is a 21-item questionnaire with a range of response formats (e.g. multiple-choice questions, open-ended questions and Likert-type scale). This questionnaire measures one's intrusive thoughts, including the rate of occurrence, duration, emotional impact, coping strategies and ability to execute cognitive control. The ITQ was found to be impractical as a typical self-report measure. Rather, it is viewed as a framework which can underlie the additional testing of intrusive cognition (Schooler, Dougall & Baum, 1999).
Cognitive Intrusions Questionnaire (CIQ)	The CIQ (Freeston et al., 1991) was developed using aspects from the Distressing Thoughts Questionnaire and ITQ. It measures six areas; health problems, embarrassing personal experiences, unacceptable sexual experiences, verbal aggression, terminal illnesses affecting significant others, and accidents involving significant others. Like the ITQ, it provides a framework for further analysis, however it also elicits relevant information on the clinical presentation of symptoms (Tallis, 1995).
Inventory of Beliefs Related to Obsessions (IBRO)	The IBRO is a 20-item questionnaire measuring cognitive beliefs (e.g. "I believe strongly that this statement is true"). This scale was developed on the basis that beliefs are central components of cognitive appraisal. This measure was found to have good internal consistency (Tallis, 1995).
Obsessive Thoughts Checklist (OTC)	The OTC (Bouvard et al., 1990) is a 28-item scale measuring the obsessional thinking style. Responses range from zero to four, the latter representing continuous troubling of the particular thought. This measure is based on the principle factor of perfectionism and pathological responsibility (Tallis, 1995).
Lucky Beliefs Questionnaire (LBQ)	The LBQ (Frost et al., 1993) is a 30-item questionnaire measuring strength of beliefs. It was generated from the superstition questionnaire by Leonard et al. (1990), and its measures reflect behaviours in response to superstitious beliefs. The LBQ has good reliability and was found to correlate with various measures of OCD (Tallis, 1995).

Measures	Description
Obsessive Compulsive Inventory – Revised (OCI-R)	The OCI-R (Foa et al., 1998) is an 18-item self-report measure assessing symptoms of OCD across six dimensions in terms of associated distress. The OCI-R shown adequate psychometric properties and was found to be a well-rounded measure to assess multiple symptom domains (Abramowitz & Deacon, 2006). It was also shown to consist of adequate validity as it was found to discriminate between OCD symptoms and symptoms of other mental health conditions (Abramowitz & Deacon, 2006). According to Abramowitz, Tolin and Diefenbach (2005) the OCI-R did not show sensitivity in terms of patients' own insight of their symptoms. Moreover, despite measuring the presence of symptoms, it was not found sensitive enough at assessing symptom severity (Storch, Benito & Goodman, 2011).
Obsessive Beliefs Questionnaire (OBQ-44)	The OBQ-44 is a self-report questionnaire, comprised of 44 statements relating to symptom severity of OCD. This questionnaire was developed by the OCCWG (2005), and thus, follows the cognitive theoretical basis of personal appraisal and beliefs. Therefore, statements target three separate domains of OCD: Responsibility / Threat, Perfectionism / Uncertainty and Importance / Control of Thoughts. A more detailed account of the OBQ-44 can be found in chapter 3.

2.7. Treatment and Management

The current utilised treatment includes both pharmacological and therapeutic intervention (NICE, 2005). Non-pharmacological treatment through psychotherapeutic interventions were found to produce better long-term benefits (NICE, 2005). As mentioned previously, CBT has been considered as the frontline approach, resulting in significant symptom reduction, particularly through the use of exposure and response prevention [EX/RP] (Capriotti, Himle & Woods, 2013; Grice, 2018; Romanelli et al., 2014). The rationale behind cognitive interventions extend to proposals by Salkovskis and Warwick (1985) as mentioned in the previous section. Such proposals stated that cognitive restructuring would help individuals realise the lack of

validity of their obsessions, and thus, increase their openness to engaging in therapeutic exposure (Abramowitz, Taylor & McKay, 2005). EX/RP involves exposing individuals to their specific feared stimuli in a gradual manner (Grice, 2018). Once exposed, individuals are encouraged to refrain from performing the rituals typically performed to reduce anxiety levels in the face of such stimuli. The rationale behind such therapy is embedded within two principles; habituation and inhibitory learning (Grice, 2018). Habituation refers to a natural process whereby individuals adjust to uncomfortable or unwanted situations (Grice, 2018). In the presence of OCD, anxiety is reduced through the habituation (or passing of time) of the uncomfortable sensations arising from intrusive thoughts (Capriotti, et al., 2013; Grice, 2018; Romanelli et al., 2014). EX/RP begins by targeting 'within trial' processes, whereby time of anxiety reduction is recorded when individuals are exposed to an anxiety-provoking situation. Subsequently, EX/RP works on 'between trial' processes, also known as 'treatment effect' (Grice, 2018; Romanelli et al., 2014; Capriotti, Himle & Woods, 2013). The aim of the latter is to reduce peak anxiety experienced when anxiety-provoking situations are repeated. In contrast, inhibitory learning follows a Pavlovian conditioning model, in which a neutral conditioning stimulus will come to elicit conditional responses if followed by aversive stimuli for a number of pairings (Craske, Treanor, Conway, Zbozinek & Vervliet, 2014). During EX/RP, individuals are repeatedly exposed to situations which would likely trigger obsessions or compulsions in the absence of aversive outcomes. This subsequently leads to extinction in the form of systematic desensitisation (Romanelli et al., 2014).

Nevertheless, it has been argued that approximately 40 percent of individuals experiencing symptoms of OCD do not respond to the recommended treatment (Clark & Purdon, 2016; Fineberg et al., 2012). Gillihan, Williams, Malcoun,Yadin and Foa (2012) proposed

possible reasons behind such shortcomings. For example, the lack of treatment response could be due to limiting one's potential to move further in exposures by refraining from further encouragement, choosing the wrong form of exposure and treating peripheral symptoms as opposed to the core issue (Gillihan et al., 2012). Moreover, the distressing nature of EX/RP was found to lead to a significant dropout of individuals undergoing treatment (Abramowitz et al., 2005). In fact, 28 percent of individuals dropped out during treatment commencement (Foa et al., 2005). Abramowitz, Taylor and McKay (2019) also pointed out that EX/RP would not be successful if individuals are unable to articulate their intrusive thoughts, particularly as it is based on exposing one to triggering situations. The highlighted limitations of the current therapeutic interventions prompt the need to explore alternatives to EX/RP (Simons, Schneider, & Herpertz-Dahlmann, 2006).

2.8. The Neuropsychological Profile of OCD

In the attempt to explore alternative treatments, ongoing neuropsychological research has been continuously aiming to understand the neuropsychological profile of OCD. As mentioned previously, functional imaging studies identifying a fronto-cortico-striatal pathway have provided a foundation on which further cognitive research could be built. However, a significant challenge presented in the neuropsychological understanding of OCD is the inconsistency in findings, and the unsuccessful attempts in reaching a common consensus on the cognitive profile of OCD (Abramovitch et al., 2015; 2013). So far, inconsistencies seem to be attributed to the heterogeneity of OCD, which increases the challenge in understanding its neuropsychological constructs (McKay et al., 2004). Results of a meta-analysis by Abramovitch et al. (2013) found that individuals with OCD performed significantly worse than healthy controls on six cognitive domains, namely attention, memory, working memory, executive functioning, visuospatial skills

and processing speed. Such results were yielded through the amalgamation of 115 studies. Out of all cognitive domains, different memory types seemed to demonstrate discrepancies in performances, thus, worse performances in nonverbal memory tasks when compared to verbal memory tasks (Abramovitch et al., 2013). Such discrepancy could be explained through the task most commonly used to assess nonverbal memory, which was the Rey-Osterreith Complex Figure Test. Such task requires executive functioning input in terms of organisational strategies to encode information. Therefore, it could be argued that nonverbal memory might not have been directly impaired, but rather, impairment could be attributed to the executive functioning skills involved in the encoding process (Abramovitch et al., 2013). This was further substantiated by Kohli, Kumar Rana, Gupta and Kulhara (2015), who similarly deducted through their results that memory dysfunction seemed to be a result of organisational deficits, thus, a frontal executive function, which made recall a difficult process. Similarly, Zitterl et al. (2001) agreed that memory impairment is likely due to executive dysfunction, however, their explanation leaned towards the lack of attention observed in performances of individuals with OCD, which could have led to low performances on memory tasks.

As mentioned, results from the meta-analysis by Abramovitch et al. (2013) highlighted significant deficits in executive functioning, which involved planning, set shifting and response inhibition. Given the neuroanatomical explanations of the frontostiatal system involved in OCD, a large number of neuropsychological studies have addressed the role of the executive functioning domain in an OCD presentation (e.g. Bedard, Joyal, Godbout, & Chantal, 2006; Chamberlain, Blackwell, Fineberg, Robbins, & Sahakian, 2005; Jang et al., 2010; Melloni et al., 2012; Nakao, Okada & Kanba, 2014; Pauls et al., 2014). Findings have associated impairment in executive functioning (particularly relating to cognitive inflexibility) with obsessions and

compulsions, thus, difficulties in inhibition, planning or attentional shifting could possibly explain intrusive thoughts and behaviours (Chamberlain et al. 2005; Melloni et al., 2012). Therefore, findings seem to concur that individuals with OCD typically demonstrate worse performances on neuropsychological measures assessing various cognitive domains (Abramovitch et al., 2013). Furthermore, EF seems to be the most adversely affected cognitive domain, which leads to further investigation into the nature of executive functioning and the possible reasons behind this phenomenon.

A meta-analysis by Snyder et al. (2014) attempted to look into the possible causal relationship between EF and OCD using a cross-sectional case-control design. The proposed three possible causal links between the two. The first relates to individual differences in prefrontal functioning. Alterations in the prefrontal cortex (including lesions through acquired brain injures) have been strongly linked to both EF deficits and OCD symptoms (Chamberlain et al., 2008; Coetzer, 2004). The second causal link proposes that OCD causes EF deficits. This link suggests that cognition is negatively affected by obsessions which interfere with maintaining goals. However, evidence has shown that deficits in EF were still present even if OCD symptoms were eliminated (Bannon, Gonsalvez, Croft, & Boyce, 2006). Similarly, Snyder et al. (2014) argue that treatment targeting symptoms of OCD would likely still be unsuccessful due to the persistent EF deficits which continue to negatively affect daily functioning. The third possible link can be understood as the opposite of the previous one, in that EF deficits contribute to the development of OCD. They explain this through anxiety models proposed by Clark (2004) which state that symptoms of OCD are a result of ineffective and maladaptive emotional-regulation strategies brought about by EF deficits. This was exemplified by avoidance-learning, which is thought to be a reinforcing strategy to reduce intrusive thoughts and compulsions. Therefore, this

hypothesis suggests that symptoms of OCD could be exasperated by the inability to engage adaptive strategies to regulate emotions due to poor EF. While this proposal may be plausible, the examples provided here could be questioned, particularly as anxiety is no longer recognised as an underlying symptom of OCD (APA, 2013).

Regardless of the nature of the causal relationship between EF and OCD, evidence suggests that EF deficits would reduce the effectiveness of therapeutic interventions targeting OCD symptoms (Mohlman & Gorman, 2005; Syder et al., 2014). This is mainly due to the executive functions required for most cognitive-behavioural therapies to work, for example, the resistance to give in to compulsive urges requires inhibitory control (Snyder et al., 2014).

2.9. Expanding on Executive Functioning

The term ‘executive’ was first used in 1973 by Pribram when referring to prefrontal functioning (Bédard et al., 2009). Baddeley and Hitch (1974; as cited in Baddeley, 1996) stated that working memory must consist of a ‘central executive’, which allows information to be manipulated in short-term memory stores. Similarly, Posner (1975; as cited in Posner, Snyder & Solso, 2004) introduced the term ‘cognitive control’, which aimed to explain that attention consists of a separate executive branch responsible for selecting specific aspects of the environment to be attended to. Shallice (1988) agreed that a ‘supervisory system’ controlled attention by overriding automatic responses. The concept of executive function (EF) underwent a number of constructs by different theorists (e.g. Barkley & Fischer, 2011; Best, Miller & Jones, 2007; Freidman et al., 2007; Lezak, 1995; Luria, 1966; Reynolds & Horton, 2006), which made the term difficult to define. Nevertheless, there seems to be a general agreement that EF is an overarching system responsible for the regulation of complex behaviour and cognition

(Anderson, 2008; Hunter & Sparrow, 2012; Purdy, 2011). By virtue of various accounts throughout history, EF has come to be known as an umbrella term encompassing numerous cognitive processes; namely planning, sequencing, attentional control, working memory, initiation, inhibition and self-monitoring and regulation (Goldstein, Naglieri, Princiotta & Otero, 2014). The most recent conceptualisations of EF contend that the processes controlled by such system correlate with a wide range of neural networks and brain regions (Hunter & Sparrow, 2012).

2.9.1. EF in the context of OCD. Table 3 and Table 4 illustrate some of the studies examining EF in the presence of OCD using clinical samples against healthy controls. As mentioned previously, OCD is characterised by perseveration and repetitive behaviours (Abramovitch et al., 2013). The main executive functions that seem to be commonly representative of this characterisation are response inhibition and set shifting (Kurt, Yildirim and Topçuoğlu, 2017; Olley et al., 2007). Associations between clinical samples and impairments in the mentioned subdomains of EF have been reported in at least six studies cognitive functioning in OCD (see Table 2). Response inhibition refers to "the suppression of actions that are inappropriate in a given context and that interfere with goal-driven behaviour" (Mostofsky & Simmonds, 2008). On the other hand, set shifting refers to the ability to switch thoughts between two stimuli (Kurt et al., 2017). When reviewing the literature, set shifting in the context of OCD seems to be commonly measured using the WCST (e.g. Kurt et al., 2017). A number of studies (e.g. Okasha et al., 2000; Purcell, Maruff, Kyrios & Pantelis, 1998) have identified deficits in diagnosed individuals through poor performances on this task. In contrast, other studies have found that OCD patients perform similarly to healthy controls (e.g. Abbruzzese et al., 1997; Kohli, Rana, Gupta & Kulhara, 2015). Despite the comparable performance shown in the latter,

OCD patients were observed to make more perseverative errors (Roh et al., 2005). In addition, they seemed to experience difficulties with learning across consecutive categories, despite the feedback provided by examiners (Bohne et al., 2005). In some studies (e.g. Abbruzzese et al., 1997; Spitznagel & Suhr, 2002) set shifting was measured using both the WCST and the Object Alternation Task (OAT), a task similar to the WCST where participants are required to alternate between different aspects of a target object whilst provided feedback (Olley et al., 2007). Results on both tasks were found to differ significantly, as the same sample of OCD patients produced comparable results on the WCST but significantly poorer results on the OAT. Such discrepancy suggests a possibility that learning could be a function more severely affected in OCD than is perseveration, due to the poor performances on the OAT and comparable results on the WCST (Olley et al., 2007). Very similar results have been reported in terms of response inhibition, which has commonly been measured by noting errors of commission[3] using the Go-No-Go test and the Stroop test (e.g. Bannon et al., 2006). Errors of commission by OCD patients were observed in studies by Bannon et al. (2006) and Aycicegi et al. (2003), both of which used computerised tasks presenting target and non-target stimuli, similar to Go-No-Go task.

Inconsistent results have also been reported in terms of planning. Studies examining planning in OCD have typically used Tower of London task. Nielen, Veltman, de Jong, Mulder and den Boer (2002) found that OCD patients performed worse on this task when compared to healthy controls. In contrast, Watkins et al. (2005) and Purcell et al. (1998) reported comparable

[3] Errors of commission refer to mistakes that should not have been made. In contrast, errors of omission refer to the exclusion of something that should have been present.

performances between the patient and control samples. Chamberlain et al. (2005) have argued that planning deficits in the context of OCD might be better explained by psychomotor slowing, where the excessive length of time taken to perform a task would be accountable for said deficits. Nevertheless, as with decision-making, additional research is required to better understand this phenomenon. Findings also varied in the meta-analyses by Abramovitch et al. (2013) and Shin et al. (2013). While both found an association between OCD and impairments in planning, response inhibition and set shifting, the effect size[4] differed in each. For example, both analyses yielded a medium effect size for response inhibition, however Abramovitch et al. (2013) yielded a smaller effect size on planning and a larger effect size on set shifting. According to Snyder et al. (2014), results were largely dependent on the manner in EF was viewed; that is, whether scores on separate subdomains of EF were viewed collectively (Abramovitch et al., 2013) or separately (Shin et al., 2013).

Cavedini et al. (2002) suggested that compulsions could possibly be explained by the deficits in decision-making. This subdomain has been measured using the Iowa Gambling test, which requires examinees to make decisions based on selecting 'good' over 'bad' cards in the aim of obtaining rewards (Chamberlain et al., 2005). Overall, there seems to be a paucity of literature addressing decision-making in OCD. Results on the Iowa Gambling Test by Cavedini et al. (2002) have indicated deficits in decision-making in OCD patients when compared to healthy controls. However, Watkins et al. (2005) and Nielen et al. (2002) failed to report

[4] An effect size refers to the magnitude of an association between two variables. In this case, the two variables are OCD symptoms and subdomains of EF.

significant results backing up possible deficits in decision-making in the presence of OCD when utilising this measure.

Similar to the inconsistencies seen in understanding the neuropsychological profile of OCD, the reason largely attributed to inconsistent results has related to the heterogeneity of OCD (Abramovitch et al., 2013). Given the vast variety in symptoms and manifestations of OCD, it is difficult to pinpoint the specific EF skills impaired, and whether any are impaired at all. In addition to the heterogenous nature of OCD, other factors could have possibly yielded inconsistent findings. Most studies have made use of small sample sizes, which could have influenced possible statistically significant differences between clinical and non-clinical samples. Furthermore, studies have not indicated the severity of OCD in clinical samples, which could also potentially affect performance on neuropsychological measures (McKay et al., 2004). Another issue pointed out by Shin et al. (2013) involves the comorbid mental health issues that might possibly confound results. Depression and anxiety seem to be the most common comorbid issues that might potentially influence cognitive functioning (Kurt et al., 2017). Nevertheless, Shin et al., (2013) argued that this aspect requires further investigation prior to reaching definite conclusions.

According to Bédard et al. (2006), research has not differentiated EF into lower and higher order skills, which could also play a role in inconsistent results. The authors explained that clearer results might be yielded if EF is viewed in this manner as opposed to a single cognitive domain. Lower order EF skills are those involving set shifting, inhibition and decision making. On the other hand, higher order EF skills are learnt over time as the brain matures, such as planning, reasoning and judging (Bédard et al., 2006). As mentioned, the majority of studies which have identified associations between EF and OCD (e.g. Bannon et al., 2006; Chamberlain

et al., 2006) have yielded specific deficits in set shifting and response inhibition, both classifying as lower-order EF skills.

Table 3.

Studies examining EF in OCD

Author(s) & Year	Sample Size	Measure(s)	Observed an association between OCD and EF	Specific EF subdomain(s) affected
Purcell et al., 1998	46	Tower of London test, CANTAB	Yes	Set shifting, response inhibition, motor initiation
Okasha et al., 2000	60	WAIS, OAT, WCST	Yes	Set shifting, response inhibition
Nielen et al., 2002	53	Tower of London test	Yes	Decision-making
Watkins et al., 2005	40	WAIS, Go-No-Go test, Tower of London test	No	N.A.
Roh et al., 2005	41	Rey-Osterrieth Complex Figure Test, Trail Making test, WCST, COWAT	Yes	Verbal fluency
Bédrad et al., 2006	60	Trail Making test, Stroop test, verbal fluency, D-KEFS 20 Question test	No	N.A.
Bannon et al., 2006	60	WCST, Go-No-Go task, Stroop test, Tower of London Test, COWAT	Yes	Set shifting, response inhibition

Note. CANTAB = Cambridge Cognition: World Leading Cognitive Assessment Tools. WAIS = Wechsler Adult Intelligence Scale. COWAT = Controlled Word Association Test.

Author(s) & Year	Sample Size	Measure(s)	Observed an association between OCD and EF	Specific EF subdomain(s) affected
Cavedini et al., 2010	66	Iowa Gambling Task, Tower of Hanoi, WCST	Yes	Set shifting, response inhibition
Kohli et al., 2015	40	Bhatia Battery of Performance tests of Intelligence, Verbal Adult Intelligence Scale, Set test, WCST	No	N.A.
Kurt et al., 2017	43	Trail Making test, COWAT, Stroop test, WCST	No	N.A.
Yun et al., 2017	58	WCST, Trail Making test, Stroop test, Rey-Osterrieth Complex Figure Test	Yes	Set shifting, response inhibition

Table 4.

Meta-analyses and reviews examining EF in OCD

Author(s) & Year	Number of studies reviewed	Observed an association between OCD and EF	Specific EF subdomain(s) affected
Chamberlain et al., 2005	23	Yes, despite inconsistencies	Planning, set shifting, response inhibition, decision making
Olley et al., 2007	N.A.	Yes, despite inconsistencies	Set shifting, response inhibition, decision making
Abramovitch et al., 2013	115	Yes, despite inconsistencies	Planning, set shifting, response inhibition
Shin et al., 2013	221	Yes, despite inconsistencies	Planning, set shifting, response inhibition
Snyder et al., 2014	110	Yes, despite inconsistencies	Set shifting, response inhibition

2.10. Assessments of EF

Assessments of EF should be able to measure the various subdomains involved. Given the complexity of EF as a cognitive domain, measuring impairments inevitably brings about

challenges. Very often, EF tasks require other cognitive domains (e.g. attention) to be performed (Diamond, 2013). Similarly, such tasks might require the integration of other areas of cognitive functioning, which makes EF measures subject to error in detecting difficulties in EF (Diamond, 2013). Therefore, low scores on EF measures might be attributable to possible impairments in other cognitive areas.

There is a vast number of available neuropsychological tools to measure EF. The following table provides a brief account of some of the more common neuropsychological measures of EF, both in clinical and research settings.

Table 5.

Common neuropsychological measures of EF

Tests	Description	EF ability measured
Trail Making Test	Consists of two sequential tasks, the using numbers and the second alternating between connecting numbers in sequence with letters in sequence.	Set shifting, visual tracking
Iowa Gambling Task	Consists of making decisions based to balance reward against penalty cards.	Decision making
Wisconsin Card Sorting Test	Consists of cards that require examinees to order them by shade, shape or number categories. The classification rules change each time 10 (out of 128) reaction cards have been arranged effectively.	Cognitive flexibility, working memory, attention
Controlled Oral Word Association Test	Consists of generating as many words within a timed limit, by category or beginning with a designated letter.	Verbal fluency
Stroop Colour-Word Test	Contains three trials; the first includes reading names of colours printed in black ink, the second naming different colour patches, and the third naming name the colour of the ink rather than reading the word.	Response inhibition, attention
Tower of London / Hanoi Test	Consists of two boards with pegs and several beads with different colours.	Problem solving, planning
Design Fluency Test	Consists of generating as many different designs by connecting dots using straight line.	Nonverbal fluency, organisation, problem solving
Go-No-Go Task	Consists of responding to the ‘Go’ signal and refraining from responding to the ‘No-Go’ signal.	Impulsivity, rule following, inhibitory control

2.10.1. Neuropsychological batteries measuring EF. In addition to the measured mentioned above, there are currently two neuropsychological batteries of EF mainly used in clinical settings.

2.10.1.1. Delis-Kaplan Executive Function System (D-KEFS). The D-KEFS is a laboratory-based assessment consisting of nine stand-alone tests, comprehensively measuring the main subdomains of executive functions believed to be mediated primarily by the frontal lobe (Delis, Kaplan & Kramer, 2001). Such components include flexibility of thinking on a visual-motor sequencing task, letter fluency, category fluency, and category switching, problem-solving, response inhibition, concept-formation skills, thinking flexibility, rule learning and spatial planning (Delis et al., 2001). The nine subtests within the D-KEFS include: Trail Making Test, Verbal Fluency Test, Design Fluency Test, Color-Word Interference Tests, Sorting Test, Twenty Questions Test, Word Context Test, Tower Test, and Proverb Test. Since the subtests within the D-KEFS are stand-alone tasks, they could be administered individually (Delis et al., 2001). The assessment distinguishes between fundamental and complex cognition and provides both verbal and nonverbal tasks. It is important to note that the development of the D-KEFS was not based on particular models or theories of executive or frontal lobe functioning. When developing the battery, Delis, Kaplan and Kramer argued that they chose to refrain from following a specific theoretical approach due to the complexity of most theories of EF (Homack, Lee & Riccio, 2005). As a matter of fact, they expressed that “in view of the still-developing understanding of frontal-lobe functioning, an attempt to develop clinical tests in accordance with an existing theoretical orientation would have been premature” (Delis et al., 2001; as cited in Homack, Lee & Riccio, 2005, p. 602). They substantiated the need of the development of further EF measures to be able to develop profiles of specific disorders by charting specific impairments in EF. The

tasks within the D-KEFS have been found sensitive to frontal-lobe dysfunction when tested on clinical versus nonclinical populations (Latzman & Markon, 2009). Moreover, it was able to distinguish between clinical groups which involved frontal lesions, Parkinson's disease, schizophrenia, foetal alcohol exposure and chronic alcoholism (Latzman & Markon, 2009). The authors also presented correlations between the D-KEFS subtests and other measures of EF to provide evidence for adequate validity (Delis et al., 2001). Moreover, the achievement scores on each subtest were found to have adequate reliability coefficients. Support was also given as clinicians were provided the opportunity to use alternate forms of EF tests (for example, the Stroop test and Trail-Making test) to minimise practice effects (Latzman & Markon, 2009). A significant strength of this battery is the cognitive-process approach which the authors utilised to interpret scores. This approach distinguishes specific EF deficits from other cognitive deficits by comparing performances on different testing conditions as well as using error analyses and contrast measure scores. Nevertheless, the D-KEFS was unable to distinguish between focal ventromedial prefrontal and non-frontal lesions when measured along with individuals presenting with dorsolateral prefrontal lesions (Keifer & Tranel, 2013). Therefore, while the D-KEFS demonstrates sensitivity associated with frontal lobe damage, the level of sensitivity is still questioned due to limited range of scores across different sample groups.

2.10.1.2. Behavioural Assessment of the Dysexecutive Syndrome (BADS). The BADS is a functional assessment, that is, specifically assesses the skills and demands involved in everyday life (Wilson et al., 1996). It is sensitive to the capacities affected by frontal lobe damage, emphasising those usually exercised in everyday situations; including one's ability to ignore a prior rule after being given a new rule to follow, problem solving, planning and organisational ability, sensible guesses and rule following (Wilson et al., 1996). The six subtests

within the BADS are: Rule Shift Test, Action Program Test, Key Search Test, Temporal Judgement Test, Zoo Map Test and Modified Six Elements Test (Wilson et al., 1996). The BADS was initially developed to counter the low ecological validity criticised against other neuropsychological measures (Norris & Tate, 2000). This was completed by developing EF tasks which parallel real-life situations, which would in turn provide a better understanding of individuals' everyday difficulties (Wilson et al., 1996). Since the BADS is specifically designed to measure dysexecutive syndrome, it could be deducted that the authors based their development on the existing knowledge of frontal lobe functioning. However, there is no specific research which addresses the theoretical basis behind the development of this battery. The BADS was standardised on 216 individuals from 16 to 64 years of age (Wilson & Chamberlain, 2003). 92 individuals had neurological disorders which included brain injuries, neurodegenerative disorders and stroke. 78 individuals were able to complete all six subtests within the battery, which is a relatively small number and thus, could affect reliability (Wilson & Chamberlain, 2003). Notwithstanding the wide clinical use of the BADS due to its ecological validity, the battery was criticised as lacking face-validity due to the inapplicability of some subtests on non-UK populations (e.g. Temporal Judgement subtest, which may be highly culture-specific). Studies (e.g. Wilson & Chamberlain, 2003; Norris & Tate, 2000) found that individuals with brain injuries presented with a worse performance than controls, however, it is not specified whether the brain injuries were frontal in nature. Therefore, it is difficult to deduct whether the BADS is sensitive enough to distinguish between frontal and non-frontal lesions.

When reviewing the literature, there was an apparent lack of research using the BADS as a measure of EF, which prompts further questioning behind such occurrence. A possible reason could include the low ceiling effect presented by the BADS, as opposed to higher ceiling effects

presented by laboratory-based measures such as the D-KEFS. The low ceiling effect could preclude researchers from utilising the BADS due to the diminished sensitivity which would otherwise be better brought out using more laboratory-based tasks. Nevertheless, it could be argued that assessing EF using a functional assessment such as the BADS in conjunction with lab-based tasks, would give a more comprehensive picture of possible EF impairments. When taking the presentation of OCD into account, one must remember that symptoms are manifested through everyday activities. Therefore, impairment in EF in the presence of OCD would likely appear in such everyday tasks, which enhances the significant of using tasks within the BADS to measure EF. Examples of EF impairment that would be highlighted through the BADS include planning abilities and efficiency, rule following and cognitive shifting. Due to the mentioned reasons, this study shall make use of subtasks from both the BADS and D-KEFS to assess for EF in the likelihood of OCD.

2.11. Conclusion

In conclusion, this chapter outlined the existing research involved in the key aspects of OCD and EF. A number of comprehensive research papers have attempted to understand EF, the presentation of OCD and the relationship between the two. Nevertheless, the review indicates that results are inconclusive, and additional research is required in order to gain a better understanding of the mentioned aspects. Moreover, no literature has been conducted on the outlined aspects within the local context, which presents an extensive lacuna in research. The following chapter details the methodology utilised study in order to meet the aims of the study.

Chapter 3

Methodology

3.1. Introduction

The current chapter describes the methodology used to address the research questions posed for this study. The first section describes the research design, procedures, research tool and the participant sample. The next section describes the primary hypotheses of this project as well as the procedures used to test the effectiveness and reliability of the research tool. Lastly, this chapter presents the ethical considerations involved in carrying out this research.

3.2. Research Paradigm and Theoretical Framework

The ontological dimension questions the nature of reality, taking into account different theoretical paradigms (Ponterotto, 2005). On the other hand, the post-positivist paradigm was also considered. Despite sharing a conviction where one true, measurable reality exists, the latter accounts for the imperfect measurement of reality, where general and human errors are inevitable. Therefore, researcher biases are considered an inevitable influence ‘true objectivity' assumed by positivism (Ponterotto, 2005). Given this, the researcher found that a post-positivist stance was more a suitable approach when completing the study, particularly as the research method utilised was susceptible to error. Therefore, the measurement of the association between symptoms of OCD and EF suggested that objective reality was somewhat present, with a degree of imperfection when the measurement of such correlation was involved.

In recent years, there has been a growing interest in examining the cognitive deficits associated with OCD (Abramovitch et al., 2013). Several studies (e.g. Chamberlain et al. 2005;

Melloni et al., 2012; Pauls et al., 2014) have been able to infer that there might be biological links between the presentation of OCD and neurological elements, particularly abnormal activity of the orbitofrontal cortex, anterior cingulate cortex and basal ganglia. The functional effects of this neurological pathway have been linked to deficits in EF (Abramovitch et al., 2015; Bedard et al., 2006; Chamberlain et al., 2005; Jang et al., 2010; Melloni et al., 2012; Nakao et al., 2014; Pauls et al., 2014). This study subsequently attempts to explore more the role of EF using standardised measures that have not yet been used for this purpose. Therefore, the underlying foundations informing this study were embedded in a neuropsychological framework, as this study looks at functional deficits related to OCD which were tackled using different methods and procedures in this study.

3.3. Research Design

This study aims to explore the role of EF in the presentation of OCD. Previous studies revealed the inconsistent information pertaining to EF deficits in such a presentation, which could highly impact the current choice of treatment methods. A quantitative methodology was adopted for data collection and analysis, as it allowed a more generalisable examination of the association between OCD and EF using a large sample. As mentioned in the previous chapter, tasks from the BADS and D-KEFS provided an ideal combination to examine EF. This is as both the BADS and D-KEFS are comprehensive measures to examine the multifactorial aspects of EF (Homack et al., 2005).

3.4. Procedures

3.4.1. Ethical approval and considerations. Commencement of the study took place after ethical approval was granted by the Faculty Research Ethics Committee (FREC; see Appendix B). Prior to agreeing on participation, participants were provided with a Participant Information Sheet (see Appendix C). Participation in this study was voluntary, therefore, individuals following the inclusion criteria for eligibility were able to choose to participate in their own free will, in addition to providing written informed consent (see Appendix D). It was ensured that potential participants possessed the capacity to make decisions regarding participation. This was determined by including only individuals who were able to communicate a choice, understand and reason (Dastidar & Odden, 2011)

Participants had the right to withdraw their participation or consent from the study at any point, in which case the information gathered from their assessment was destroyed. Additionally, this study ensured confidentiality and anonymity. The results obtained from each assessment were not shared with the participants but were solely used as data for this study. Moreover, this study did not pose any specific risks to the participants.

3.4.2. Sampling procedure. Participants were recruited through convenience sampling. Convenience sampling is a non-probability sampling method in which individuals meeting specific inclusion criteria in a target population are eligible to participate. According to Dörnyei (2007), the main criterion of this method is the researcher's convenience, such as accessibility, proximity and availability at a given time. Since this study did not require specific homogeneity apart from the inclusion criteria mentioned below, convenience sampling was deemed an ideal method to gather as many individuals as possible to cover a large sample relative to the adult

Maltese population. In line with Bezeau and Graves (2001) who examined effect sizes in neuropsychological research using Cohen's criterion, a sample of 50 participants was deemed appropriate. Moreover, participants who did not meet the inclusion criteria did not proceed with the assessment process. The inclusion criteria for eligibility of the participant sample within this study were as follows:

- Participants were required to be at least 18 years of age. The present study aimed to identify the role of EF in the presentation of OCD in an adult population.
- Participants were required to be able to read font size 12.
- Participants were required to be proficient in English.

The exclusion criteria of the participant sample were as follows:

- Participants did not have a specific learning disability (e.g. dyslexia). The presence of a learning disability would have not yielded reliable results due to the difficulties presented with reading and writing during the process of data collection.
- Participants did not have visual or hearing impairments unless corrected by a hearing aid and/or visual aids. Difficulties with visual input would have obstructed adequate results as participants were required to adequately see the tasks presented to them. Similarly, difficulties with auditory input would have also obstructed results, as specific instructions were provided by the researcher to complete each task in a standardised manner.
- Participants did not have colour blindness. This would have interfered with the Colour-Word Interference task administered as part of the data collection process, as it was imperative for colours to be seen and perceived correctly for the results to be valid.

Participants were acquired through acquaintances and referring third parties. Potential participants were contacted via phone and/or email and were provided with information about the study. If they expressed an interest in participation, an information sheet explaining the nature of the study in more detail as well as its requirements was provided. Individuals who had thoroughly read the requirements and agreed to participate were then provided with a consent form, after which the assessment process commenced.

3.4.3. Study procedure. A demographics questionnaire (described in section 3.5.1.) was initially administered in order to ensure that participants met inclusion criteria. The process of data collection took place in settings that were convenient for the participants, however, an effort was made to proceed to test in quieter settings by choosing settings with fewer distractors. The length of testing was approximately 40 minutes, however, the duration was dependent on how long each participant took to understand the instructions presented and to complete particular timed tasks.

3.5. Data Collection and Measures

3.5.1. Demographic Information. Participants' demographics were obtained using a demographics questionnaire, which was comprised of seven questions (see Appendix E). It was ensured that only relevant demographic information was obtained, in order to maintain anonymity. Participants were required to indicate their gender (question 1) and age range (question 2), as standardised scoring was dependent on these factors. Next, participants were required to indicate their highest educational level completed (question 3) and their profession (question 4). Such requirements were necessary details as they could have influenced performance. Participants were then asked to indicate whether they make use of visual aids

(question 5), particularly as difficulties with seeing tasks adequately could have interfered with performance and accuracy of results. Similarly, participants were asked whether they have colour blindness (question 6), as the Colour-Word Interference task required participants to view colours accurately in order to obtain valid results.

3.5.2. Depression Anxiety and Stress Scale (DASS-21; Henry & Crawford, 2005; Lovibond & Lovibond, 1995). The DASS-21 is a self-report questionnaire that distinguishes between symptoms of depression, anxiety and stress (see Appendix F). The DASS-21 is a shortened version of the DASS which is comprised of 42 items. The questionnaire is comprised of 21 statements which require individuals to indicate the application of each statement to them along a four-point Likert scale depending on the preceding week (0 = did not apply to me at all; 1 = applied to me to some degree or some of the time; 2 = applied to me to a considerable degree or a good part of time; 3 = applied to me very much, or most of the time). The total score for each subscale is multiplied by two as scores are based on the norms of the 42-item version, therefore, cut-off scores range from zero to 42 (see Table 6). The DASS was found consistent with the Tripartite Model of Anxiety and Depression proposed by Watson and Clark (1991), which was developed to understand the comorbidity and relationship between anxiety and depression by dividing symptoms into negative affect, positive affect and physiological hyperarousal. According to Brown et al. (1997), the depression subscale on the DASS was strongly correlated with positive affect, the anxiety subscale was strongly correlated with physiological arousal, while the stress subtest was strongly correlated with worry and negative affect. The DASS-21 was normed on a large nonclinical population of 1794 individuals (Henry & Crawford, 2005). Additionally, it demonstrated adequate internal consistency, convergent validity and discriminative validity with other scales of depression and anxiety (Gloster et al.,

2008). The reason for administering this questionnaire was to identify the possibility of an effect of either symptoms of depression, anxiety or stress on the results of the study. This questionnaire was also chosen as it is concise and easy to complete.

Table 6.

Cut-off scores for each subscale of the DASS-21

	Depression	**Anxiety**	**Stress**
Normal	0-9	0-7	0-14
Mild	10-13	8-9	15-18
Moderate	14-20	10-14	19-25
Severe	21-42	15-42	26-42

Note. Table of scores adapted from the original DASS-21 questionnaire (Lovibond & Lovibond, 1995).

3.5.3. Obsessive-Compulsive Inventory-Revised (OCI-R; Foa, Huppert, & Leiberg, 2002). The OCI-R is a shortened version of the original OCI (Foa et al., 1998). It is an 18-item self-report measure of distress levels of OCD symptoms (see Appendix G). The personal application of each statement is indicated along a five-point Likert scale of symptom distress depending on the preceding month (0 = not at all; 1 = a little; 2 = moderately; 3 = a lot; 4 = extremely). The cut-off score on this measure is 21, as most studies have found that individuals with OCD scored 21 or higher (e.g. Wootton et al., 2015; Abramowitz & Deacon, 2006). The statements of the OCI were based on the symptoms highlighted in the DSM-IV (APA, 1994), with particular associations to OCD related cognitive variables (Foa et al., 1995). The OCI-R

was found to have adequate convergent validity and it was able to discriminate symptoms of OCD from anxiety disorders (Wootton et al., 2015). Moreover, it was found to adequately distinguish cut-off scores between symptoms of OCD and the similarly presenting hoarding disorder, which accounts it as an adequate screening measure for OCD (Wootton et al., 2015; Abramowitz & Deacon, 2006; Abramowitz, Tolin & Diefenbach, 2005; Coles et al., 2005). This measure was chosen due to its adequate psychometric properties and its efficiency. The cut-off score of 21 was used to divide participants into subgroups in this study.

3.5.4. Obsessive Beliefs Questionnaire (OBQ-44; Obsessive-Compulsive Cognitions Working Group [OCCWG], 2005). The OBQ-44 is a self-report questionnaire, comprised of 44 statements relating to symptom severity of OCD (see Appendix H. It is a revised version of the original OBQ (2001) which consisted of 87 items. The rationale behind the development of this questionnaire was based on limitations presented by other measures, which included inadequate psychometric properties. The original OBQ was reduced to a 44-item questionnaire through a process of validation. Each statement in the OBQ falls under one of seven subscales which are believed to be key features of OCD. These subscales included washing, checking, doubting, ordering, obsessions, hoarding and neutralising. Such subscales were further categorised into three domains: Responsibility / Threat, Perfectionism / Uncertainty and Importance / Control of Thoughts. The personal application of each statement is indicated along a seven-point rating scale of agreement (1 = disagree very much ; 2 = disagree moderately; 3 = disagree a little; 4 = neither agree nor disagree; 5 = agree a little; 6 = agree moderately; 7 = agree very much). The subscales addressed had high internal consistency, where the level of responsibility and danger were consistent with cognitive theories of OCD relating to the overestimation of responsibility about causing or preventing harm (OCCWG, 2005; Rachman, 1997; Salkovskis, 1985, 1989).

The OBQ-44 was included in this study due to its adequate psychometric properties, as well as being brief and easy to complete.

3.5.5. Delis Kaplan Executive Function System (D-KEFS; Delis, Kaplan & Kramer, 2001). The D-KEFS is a laboratory-based assessment consisting of nine stand-alone tests, comprehensively assessing the main subdomains of executive functioning that are believed to be mediated primarily by the frontal lobe (Delis, Kaplan & Kramer, 2001). Such subdomains include flexibility of thinking on visual-motor sequencing tasks, category fluency, letter fluency and category switching, problem-solving, response inhibition, concept-formation skills, thinking flexibility, rule learning and spatial planning (Delis et al., 2001). Additionally, it was found to be able to better identify perseverative errors (Chan, Shum, Toulopoulou & Chen, 2008). Two subtests from the D-KEFS were utilised in this study.

3.5.5.1. Trail Making task. The Trail Making task measures visual search abilities, spatial skills and cognitive flexibility. This subtest is a modified version of the original Trail Making test by Partington (1938). The task within the D-KEFS consists of five conditions aimed at measuring different functions (Delis et al., 2001). The conditions relevant for this study were the second and the fourth conditions, which were Number Sequencing and Letter-Number Sequencing respectively. The second condition requires examinees to join 16 numbers sequentially, which involves attention. The fourth condition is specifically designed to measure higher cognitive abilities, as it requires examinees to switch between consecutive numbers and letters sequentially, which involves cognitive flexibility, attention and inhibition of perseveration (due to the previous condition administered). Both conditions are timed, and any errors require immediate prompting by the examiner. Scoring considers the length of time taken and the number of errors. The length of time is considered the raw score, which is subsequently

converted into an age-adjusted scaled score using the scoring conversion tables in the D-KEFS manual. Scaled scores are conversions of raw scores into consistent and standardised scales, which allows performance comparisons of individuals with same-aged peers by distributing them on a bell curve. Scaled scores ranging from eight to 12 are considered within the average range of normal ability; i.e. performance would have been as expected in accordance with one's age. Scaled scores below eight indicate a degree of impairment, while scaled scores above 12 are considered above what is expected in accordance with one's age.

3.5.5.2. Colour-Word Interference task / Stroop task. This task measures the ability to inhibit cognitive interference, which occurs when during the simultaneous processing of two stimuli (or different attributes of the same stimulus) are presented together, such as written words and colour (Stroop, 1935). As the Trail Making task, this task is divided into four conditions. The first two conditions require examinees to report the names of coloured patches presented and reading names of colours written in black ink. The third condition saying the colour of the ink presented in printed names of colours (e.g. if the word ‘green' is printed in blue ink, the correct response would be ‘blue’). Finally, the fourth condition builds upon the previous one while adding a new component which introduced a switching response. Examinees are required to switch between reading words within a box while reading the ink colour if they are not within a box. The third and fourth conditions are less automated tasks, as they require one to inhibit the interference arising from reading the word (MacLeod and Dunbar, 1988; Scarpina & Targini, 2017). Therefore, the third and fourth conditions involve cognitive flexibility and response inhibition. Each condition is timed, and errors are noted. Like the previous task, the length of time taken is considered the raw score, which is then converted into a scaled score using the scoring conversion tables in the D-KEFS manual.

3.5.6. Behavioural Assessment of the Dysexecutive Syndrome (BADS; Wilson et al., 1996). The BADS is a functional assessment, therefore, it aims to specifically measure the skills involved in everyday life. Like the D-KEFS, the BADS is sensitive to the subdomains of EF typically affected by frontal lobe damage. However, it emphasises on subdomains usually utilised in everyday situations; including one's ability to ignore a prior rule after being given a new rule to follow, problem-solving, planning and organisational ability, sensible guesses and rule following (Wilson et al., 1996). The BADS is widely used due to its ecological validity. Three subtests from the BADS have been utilised in this study.

3.5.6.1. Rule Shift task. The Rule Shift task measures cognitive flexibility, switching, rule following and inhibitory control. The task consists of 21 playing cards and is divided into two separate trials. One is first required to learn a rule, which states that one should say ‘yes' whenever a red playing card is shown and ‘no' whenever a black playing card is shown. On the second trial, the rule subsequently changes and increases in complexity, which states that one should say ‘yes' whenever the playing card matches the one shown before, and ‘no' whenever it does not match. The rules are always typed and shown to the examinee throughout the administration of the task, in the aim of reducing memory constraints. Scoring takes into account the time taken and the number of errors. A profile score is generated on the second trail of the task, depending on the number of errors as indicated in Table 7. The profile score ranges from 0 (severely deficient) to 4 (normal performance). Should the timetable be greater than 67 seconds, one point is deducted from the profile score.

Table 7.

Scoring on the Rule Shift Task

Total errors	Profile score
0	4
1-3	3
4-6	2
7-9	1
>10	0

Note. Table adapted from the original record form of the Rule Shift Task within the BADS.

3.5.6.2. Key Search task. The Key Search task measures planning abilities and performance monitoring. Examinees are provided with an A4-sized paper consisting of a square and a small black dot 50 millimeters below the square. Examinees are told that the square represents a field in which their keys have been lost. They are instructed to draw a line from the dot to show how they would walk and search the field to find their keys. Therefore, one is required to plan and draw a route taken. The strategy utilised is measured according to its functionality. Scoring depends on: entering the field, finishing the search, making a continuous line, making all parallel lines, making all vertical and/or horizontal lines, search patterns, making an obvious effort to cover all the ground, and whether using this pattern there is a 95 percent certainty they would find the keys. Each mentioned component of the examinee's route is scored according to the BADS manual. A raw score is generated by adding the points obtained on each component. The raw is subsequently turned into a profile score as indicated in Table 8. Should

the examinee take longer than 95 seconds to draw their route, one point is deducted from the profile score.

Table 8.

Scoring on the Key Search Task

Raw score	Profile score
14-16	4
11-13	3
8-10	2
5-7	1
<4	0

Note. Table adapted from the original record form of the Key Search Task within the BADS.

3.5.6.3. Zoo Map task. The Zoo Map task is a measure of planning and rule following, presented by two trials. Both trials require one to plan a route in order to visit eight locations in a zoo, without infringing any of the provided rules. Both the map and the rules provided have been constructed in a manner which makes it impossible for examinees to reach the goals if rules are infringed, however, rules allow for four possible variations of a route that could be followed without infringing rules. The first trial presents the locations to be visited, however not necessarily in the presented order. Therefore, examinees are required to create the route themselves, which involves more complex thought. The second trial requires one to follow the order in which the locations are presented. Given that the order is presented, this task should produce an error-free performance if examinees are able to follow concrete instructions. On both trails, examinees are encouraged to plan their route prior to drawing it. The planning time and

total time are recorded in both trials. A sequence score is obtained depending on whether one of the four possible routes were followed to visit all eight locations. Errors include the total number of occasions the paths were used more than once, the number of deviations from the path, the number of failures to make a continuous line and the number of inappropriate places visited. The total raw score of the first trial is generated by deducting the sequence score by the number of errors. In the second trial, the same scoring procedure is followed. A final profile score is generated by adding the total raw scores of the two trails. One point from the profile score is deducted if the planning time on the second trail is longer than 15 seconds, and/or if the total time on the second trial is longer than 123 seconds.

Table 9.

Scoring on the Zoo Map Task

Raw score	Profile score
16	4
11-15	3
6-10	2
1-5	1
<0	0

Note. Table adapted from the original record form of the Zoo Map Task within the BADS.

3.6. The Sample

Given that convenience sampling was used as a method of recruitment, individuals falling under the mentioned inclusion criteria were able to participate. The total sample consisted of 50 participants, 28 of which were females (n = 28, 56%) and 22 were males (n = 22, 44%).

Following data collection, participants were split into two groups; high obsessive-compulsive tendencies (HIGH_OC) and low obsessive-compulsive tendencies (LOW_OC) using the recommended cut-off score of 21 on the Obsessive-Compulsive Inventory (OCI-R) total score (Foa et al., 2002). It should be pointed out falling within the HIGH_OC group does not indicate the presence OCD, but rather, symptoms and/or traits of OCD would have scored at a higher level than those below the cut-off score. The HIGH_OC group consisted of 16 participants, while the LOW_OC group consisted of 34 participants.

3.7. Hypotheses and Data Analysis

The primary research question informing this study was;

- What is the role of EF in the presentation of the symptoms of OCD?

The research question above branched out two main hypotheses;

- H_1: There is an association between OCD tendencies and deficits in EF.
- H_2: Individuals who are more likely to present with symptoms of OCD perform significantly poorer in EF subtests than individuals who are less likely to present with OCD symptoms.

The data collected were analysed using the Statistical Package for the Social Sciences (SPSS Version 25.0). Firstly, a data screening for outliers was conducted, which identified 15 outliers. The analytic process was conducted with and without outliers following a process of windsorization (see Chapter 4 for a detailed explanation). When compared, no differences in results were identified, thus, outliers were left in the sample. Data were then screened for normality and homogeneity of variance using Levene's test. Descriptive analyses were conducted

to describe the demographic data of the sample. Pearson's chi-square test and Fisher's exact test were used to examine the relationship between gender and level of education on the HIGH_OC and LOW_OC groups. Following this, independent-samples *t*-tests were conducted to compare age between the HIGH_OC and LOW_OC groups, and subsequently, to compare the two groups on OCD-related questionnaires and EF tests. Pearson's correlation was then conducted between OCD-related questionnaires and EF tests in order to identify any associations between the two variables. The table overleaf illustrates the analyses conducted to address each hypothesis.

Table 10.

The statistical tests used to analyse data

Statistical Test	**Purpose**
Pearson chi square test	To examine the HIGH_OC and LOW_OC groups on gender, level of education and age.
Independent Samples t-test	To compare the HIGH_OC and LOW_OC groups on OCD-related questionnaires and EF tests (H_2).
Mann Whitney U test	As above, using the non-parametric equivalent (H_2).
One-tailed Pearson correlation coefficient	To examine the relationship between EF is and OCD symptoms (H_1).
Partial correlation	To examine the relationship between EF and OCD symptoms while controlling for possible effects of anxiety, depression and stress (H_1).

Note. H_1 = test used to address hypothesis 1; H_2 = test used to address hypothesis 2

3.8. Conclusion

The current chapter provided an outline on the research design, theoretical underpinnings and procedures adopted to achieve the aim of the study. The following chapter demonstrates the results obtained.

Chapter 4

Results

4.1. Introduction

The current chapter presents the results obtained following data collection. The aim of this study was to explore the role of EF in the presentation of OCD. OCD-related questionnaires and five EF subtests were administered to a sample of 50 participants. This chapter presents preliminary data considerations. This is followed by the statistical analyses conducted to analyse the data. The mean scores between the HIGH_OC group and LOW_OC group on OCD-related questionnaires as well as EF tests were compared by means of independent samples *t*-tests. Furthermore, Pearson's correlations were conducted to examine the associations between OCD and EF.

4.2. Screening for Outliers and Missing Values

Prior to analysis, data was screened in order to ensure that it was not skewed. The distributions of the two groups were examined independently. Box-plots and histograms were chosen to observe data, due to their clarity in organising different sets of data (see Appendices I and J). Additionally, box-plots allow clear visual observations of outliers occurring above or below the minimum and maximum values. The box-plots and histograms revealed that all variables contained the necessary scores within the possible range for each. This ensured that no errors were made during data entry. However, some variables within both groups contained extreme scores (that is; values lying outside the $\pm$3 boundary of interquartile range on the box plots or at the extreme ends of the frequency distributions). Three variables from the HIGH_OC

group contained outliers, while 12 variables from the LOW_OC group contained outliers. In the HIGH_OC group, outliers pertained to self-reports of anxiety and obsessive-compulsive tendencies, as well as an EF task (see Table 11). In the LOW_OC group, outliers pertained to self-reports anxiety, depression, stress and obsessive-compulsive tendencies, as well as EF tasks (see Table 12). Outliers are known to possibly skew results (Dancey & Reidy, 2007; Field, 2013). Given this, a number of approaches could be used to eliminate outlier bias, such as eliminating them completely or transforming them into different scores (Field, 2013). Nevertheless, it is important to consider the limitations presented by such approaches, for example, the increased likelihood of Type 1 errors if outliers are eliminated (Field, 2013). Additionally, transforming outliers might influence the estimates of the sample, which could result in inaccurate data that would favour the hypothesis (Field, 2013). Considering such limitations, it was deemed appropriate to compare findings with and without outliers in order to preserve the original data (Stevens, 2001). Winsorization was chosen as a method to adjust outliers, where each outlier was replaced with the next closest score that was not an outlier. All scores were converted to *z*-scores (using the cut-off $p < .001$) in aim of producing a standardised dataset in which outliers could be identified more closely. The analytic procedure with and without outliers was compared. Given that there were no differences between the means and standard deviations within both procedures, outliers were not ommitted. In addition, the pattern of missing data (coded '999') was examined. 50 out of 50 participants completed data on all measures, therefore, there was no missing data present.

Table 11.

List of outliers in the HIGH_OC group

Variable Name	**Outliers**	
	Raw Score	Winsorized Score
OCD-related questionnaires		
DASS-21 Anxiety Score	52	28
	48	28
OCI-R Total Score	39	25
EF tests		
BADS Rule Shift Score	2	4
	3	4
	3	4

Table 12.

List of outliers in the LOW_OC group on OCD-related questionnaires

Variable Name	**Outliers**	
	Raw Score	Winsorized Score
DASS-21 Anxiety Score	32	24
DASS Depression Score	22	16
	24	12
	24	16
	36	16
	36	16
DASS Stress Score	39	36
OBQ-44 Perfectionism / Intrelerance of Uncertainty Score	110	96
OBQ-44 Importance of Thoughts / Control Score	60	37

Table 13.

List of outliers in the LOW_OC group on EF tests

Variable Name	**Outliers**	
	Raw Score	Winsorized Score
BADS Rule Shift Score	1	4
	2	4
	3	4
	3	4
BADS Key Search Score	0	1
	0	1
	0	1
	0	1
D-KEFS Stroop Test Condition 1 Score	1	4
D-KEFS Stroop Test Condition 2 Score	13	9
D-KEFS Stroop Test Condition 3 Score	1	7
	1	7
	1	7
	1	7
D-KEFS Stroop Test Condition 4 Score	2	3
	1	3
D-KEFS Trail Making Test Condition 4 Score	4	6
	2	6
	2	6

4.3. Normality Testing of Data Distribution

The examination of normality is a necessary process to identify the manner in which data is distributed, when choosing the appropriate statistical tests. Normality can be examined visually using values of skewness and kurtosis. Normal data distribution presents a value of zero on skewness and kurtosis. Scores deviating from zero present an increased likelihood that data is not normally distributed. Statistical methods to examine normality include the Shapiro-Wilk and Kolmogorov-Smirnov tests, as well as converting scores into *z*-scores. These methods are preferred for smaller samples ($n < 30$) over larger samples, mainly due to central limit theorem which states that larger samples are more likely to be normally distributed (Field, 2013). According to Field (2013), normality in larger samples ($n > 30$) is ideally assessed through observation of the values of skewness and kurtosis. In order to follow the recommendations by Field (2013), the data within this study was initially assessed using Q-Q plots, histograms and the values of skewness and kurtosis. Additionally, the Kolmogorov-Smirnov test of normality was conducted on both the HIGH_OC and LOW_OC groups individually. In the HIGH_OC group, none of the scores on the DASS were normally distributed. In the LOW_OC group, the DASS Depression and Anxiety scores were normally distributed, however the DASS Stress score was not normally distributed. In terms of the OCI-R, scores were normally distributed in the HIGH_OC group but were not normally distributed in the LOW_OC group. On the OBQ-44, none of the scores were normally distributed in both groups. Scores on the BADS EF tasks were normally distributed in both groups, except one score in the HIGH_OC group. Scores on the D-KEFS EF tasks were normally distributed in the LOW_OC group, however, were not normally distributed in the HIGH_OC group. When looking at normality, some variables were normally distributed and thus, subjected to both parametric and non-parametric tests. On the other hand,

other variables were not normally distributed, and were therefore only subjected to non-parametric tests. For parametric test results to be considered reliable, all variables must follow a normal distribution and all sample variances are homogenous (Field, 2013). In contrast, nonparametric tests may be applied even when data is not normally distributed. As mentioned, some variables in this study were normally distributed, while others were not. In view of this, both parametric and non-parametric tests were used to analyse data.

Table 14.

Scores of skewness and kurtosis on OCD-related questionnaires and EF tests in HIGH_OC and LOW_OC groups

		HIGH_OC group (*n* = 43)				**LOW_OC group (*n* = 73)**			
	Total *N* per group	Range (-2 to +2)		All scores outside the range of (-2 to +2)		Range (-2 to +2)		All scores outside the range of (-2 to +2)	
		Skewness	Kurtosis	Skewness	Kurtosis	Skewness	Kurtosis	Skewness	Kurtosis
OCD- Related Questionnaires	7	7	7	0	0	7	7	0	0
EF Tests	9	8	8	1	1	8	7	1	2

Note. The range of -2 to +2 was deemed acceptable for skewness and kurtosis, as suggested by Field (2013). Total *N* = total number of distributions in each domain. Skewness = values of skewness, Kurtosis = values of kurtosis

4.4. Homogeneity of Variance

Homogeneity of variance refers to equal population variances, also known as the null hypothesis (Field, 2013). Parametric tests assume that the variability of scores for each group is the same (Field, 2013). In order to examine the variance between groups, Levene's test was used. If the *p*-value resulting from Levene's test is less than 0.05 ($p < .05$), it is said to be significant, and the null hypothesis is rejected. Significant results are indicative of unequal groups, and thus, homogeneity of variance cannot be assumed. If the *p*-value resulting from Levene's test is greater than 0.05 ($p>.05$), it is not significant, and the null hypothesis is accepted. If results are not significant, homogeneity of variance can be assumed. The results revealed a significant difference between the HIGH_OC and LOW_OC groups on four variables (see Table 15). Therefore, homogeneity of variance was breached as the variance of the groups was unequal.

Table 15.

Results for the statistically significant comparisons on Levene's test

	F (df1, df2)	***p***
OCD-Related Questionnaires		
Obsessive Compulsive Inventory-Revised (OCI-R)		
Total Score	.919 (31.7, 50)	.000
Obsessive Beliefs Questionnaire 44 (OBQ-44)		
Importance of Thoughts / Control Score	7.79 (21.3, 60)	.008
Perfectionism and Intolerance of Uncertainty Score	3.26 (33, 43.7)	.009
Depression Anxiety and Stress Scale (DASS-21)		
Anxiety Score	5.93 (19.1, 55)	.012

4.5 Data Analyses

4.5.1 Demographic information. The total sample size included 50 participants (*N* = 50), 28 of which were females (*n* = 28, 56%) and 22 were males (*n* = 22, 44%). The majority of the sample (*n* = 14, 28%) was between 18-24 years old, followed by 45-50 year olds (*n* = 10, 20%). 16% (*n* = 8) of the sample was represented by 35-44 year olds. 25-34 year olds, 55-64 year olds and 65-100 year olds consisted of six participants per age group (*n* = 6, 12%). In terms of educational level, 76% of the sample reached tertiary education (*n* = 38) while 16% reached secondary education (*n* = 8). Four participants from the sample reached solely primary education (*n* = 4, 8%). There seems to be an interaction between between age and level of education, as the participants who hold a primary level of education were aged between 65 and 100. This might potentially be inferring that older participants might be less likely to possess a tertiary level of education when compared to younger age groups. Participants' occupations were divided according to the fourth and current version of the International Standard Classification of Occupations [ISCO-08] (International Labour Organization [ILO], 2012). The majority of participants held a professional occupation (*n* = 18, 36%), while 26% of the sample were students (*n* = 13). 20% of the sample was either unemployed or retired (*n* = 10). Three participants held a managerial profession (*n* = 3, 6%) and two participants held a technical profession (*n* = 2, 4%). Professions consisting of clerical work, sales work, trade work and machine work comprised of one participant respectively (*n* = 1, 2%). As mentioned, participants were split into high obsessive-compulsive tendencies (HIGH_OC) and low obsessive-compulsive tendencies (LOW_OC) using the recommended cut-off score of 21 on the OCI-R (Foa et al., 2002). The HIGH_OC group consisted of 16 participants with a mean OCI-R overall

score of 26.94 (*SD* = 5.27). The LOW_OC group consisted of 34 participants with a mean OCI-R overall score of 9.71 (*SD* = 5.71).

Pearson's chi-square test was used to examine the relationship between gender and level of education on the HIGH_OC and LOW_OC groups. The expected frequencies of the data was checked using contingency tables. Pearson's chi-square test did not reveal significant difference in gender, $\chi^2 = .92$, $p = .63$) or level of education, $\chi^2 = 1.79$, $p = .40$). Moreover, Fisher's exact test was conducted in order to compare the exact probability of the chi-square statistic. Fisher's exact test revealed similar results, in that no differences were observed between the HIGH_OC ($p = .75$) and LOW_OC ($p = .67$) groups on gender and level of education. The results are illustrated in Table 16.

Table 16.

Demographic characteristics of the HIGH_OC and LOW_OC groups

Variable		**HIGH_OC Group (*n* = 16)**		**LOW_OC Group (*n* = 34)**		**Comparison**		
		n	%	*n*	%	χ^2	*df*	*p*
Gender	Male	7	43.8	15	44.1	.92[1]	2	.76[2]
	Female	9	56.3	19	55.9			
Level of Education	Primary	2	12.5	2	5.9			
	Secondary	3	18.8	5	14.7	1.76[1]	2	.67[2]
	Tertiary	11	68.8	27	79.4			

Note. [1]=Analysis conducted using Pearson's chi-square test; [2] = Analysis conducted using Fisher's exact test.

In addition to Pearson chi-square, an independent-samples *t*-test was run to compare age between the HIGH_OC and LOW_OC groups. The result on Levene's test indicated equal variances F (.524), p = .47), therefore the t statistic assuming homogeneity of variance was analysed. Such result was not significant, t(-.33), p = .74; d = 0.1) and thus, indicated that there was no difference in age between the HIGH_OC (M = 3, SD = 1.89) and LOW_OC groups (M = 3.18, SD = 1.69).

4.5.2 Comparisons between the two groups. Independent-samples *t*-tests were used to compare the two subgroups on the OCD-related questionnaires and EF tests. The results of the four variables mentioned in Table 15 indicated that the assumption of homogeneity of variance was violated. Whenever homogeneity of variance was breached, the t statistic for unequal variance was reported. In contrast, whenever homogeneity of variance was assumed, the t statistic for equal variance was reported. The mean values and standard deviations for each variable are presented in each comparison, as illustrated in Table 17. Given that median values and interquartile ranges are not influenced by outliers, they provided a more accurate measure of central tendency (Field, 2013).

4.5.2.1. OCD-related questionnaires. The two groups were compared on the DASS-21, OCD and its subdomains. The results of the independent samples *t*-tests revealed significant differences between the groups on four variables. Results from the independent samples *t*-test did not indicate a significant value on the DASS-21 Depression score. However, the Mann-Whitney U test[5] revealed a statistically significant difference between the

[5] The Mann-Whitney U test is the non-parametric equivalent of the independent samples *t*-test which compares median scores as opposed to mean scores (Field, 2013).

two groups on the DASS-21 Depression score (p = .008) and the DASS-21 Stress score (p = .050). Therefore, depression and stress could have potentially confounded results.

Results from the independent samples t-test also indicated a significant value on the DASS-21 Anxiety score, t (2.63); p = .012; d = 0.91) indicating that there was a difference in anxiety between the HIGH_OC (M = 15.25, SD = 15.55) and LOW_OC groups (M = 6.41, SD = 8.32). Therefore, anxiety could have been a confounding variable due to the higher occurrence of anxiety in the HIGH_OC sample, which could have influenced performance.

Results from the independent samples t-test indicated significant values on two subscales within the OBQ-44. Results indicated a significant value on the OBQ-44 Importance of Thoughts / Control score, t (2.89); p = .009; d = .94) indicating that there was a difference in importance of thought and control of thoughts between the HIGH_OC (M = 34.44, SD = 14.59) and LOW_OC groups (M = 22.88, SD = 9.61). Similar results were observed on the OBQ-44 Perfectionism and Intolerance of Uncertainty score, t (2.73); p = .009; d = .89) indicating that there was a difference in perfectionism and intolerance of uncertainty between the HIGH_OC (M = 72.88, SD = 11.85) and LOW_OC groups (M = 58.85, SD = 18.82). In contrast, results from the independent samples t-test did not indicate a significant value on the OBQ-44 Inflated Responsibility / Perceived Threat of Harm score, t (1.57); p = .124; d = .5) indicating that there was no difference in feelings of inflated responsibility and perceived threat of harm between the HIGH_OC (M = 63.25, SD = 14.33) and LOW_OC groups (M = 54.68, SD = 19.5).

4.5.2.2. EF tests. EF was measured using five subtests from the BADS and D-KEFS. The groups were compared on each subtest. The results of the independent-samples t-tests did not reveal significant differences between the HIGH_OC and LOW_OC groups on any of the EF tests (p >.05). Results from the independent samples t-test did not indicate statistical

significance on the BADS Rule Shift score, *t* (.076); *p* = .940; *d* = .02) indicating that there was no difference in Rule Shift subtest between the HIGH_OC (*M* = 3.75, *SD* = .58) and LOW_OC groups (*M* = 3.74, *SD* = .67). Results from the independent samples *t*-test did not indicate statistical significance on the BADS Key Search score, *t* (-.09); *p* = .933; *d* = .02) indicating that there was no difference in the Key Search subtest performance between the HIGH_OC (*M* = 2.38, *SD* = 1.54) and LOW_OC groups (*M* = 2.41, *SD* = 1.37). Similarly, results from the independent samples *t*-test did not indicate a significant value on the BADS Zoo Map score, *t* (-.23); *p* = .982; *d* = 0) indicating that there was no difference in the Zoo Map subtest performance between the HIGH_OC (*M* = 2.88, *SD* = .95) and LOW_OC groups (*M* = 2.88, *SD* = 1.09).

Performance comparisons of the two subgroups on the D-KEFS revealed similar results. Results from the independent samples *t*-test did not indicate a significant value on the D-KEFS Stroop Test Condition 1 score, *t* (-1.12); *p* = .267; *d* = .33) indicating that there was no difference in performances of the first condition of the Stroop Test between the HIGH_OC (*M* = 3.75, *SD* = .58) and LOW_OC groups (*M* = 3.74, *SD* = .67). Results from the independent samples *t*-test did not indicate a significant value on the D-KEFS Stroop Test Condition 2 score, *t* (-1.12); *p* = .355; *d* = .32) indicating that there was no difference in performances of the second condition of the Stroop Test between the HIGH_OC (*M* = 8.81, *SD* = 3.17) and LOW_OC groups (*M* = 9.68, *SD* = 2.18). Results from the independent samples *t*-test did not indicate a significant value on the D-KEFS Stroop Test Condition 3 score, *t* (-.05); *p* = .959; *d* = .02) indicating that there was no difference in performances of the third condition of the Stroop Test between the HIGH_OC (*M* = 8.06, *SD* = 3.8) and LOW_OC groups (*M* = 8.12, *SD* = 3.43). Results from the independent samples *t*-test did not indicate a significant value on the D-KEFS Stroop Test Condition 4 score, *t* (-.37); *p* = .716; *d* = .23) indicating that there was no difference in performances of the fourth condition of the

Stroop Test between the HIGH_OC (*M* = 7.69, *SD* = 3.41) and LOW_OC groups (*M* = 8, *SD* = 3.55). Results from the independent samples *t*-test did not indicate a significant value on the D-KEFS Trail Making Test Condition 2 score, *t* (-1.16); *p* = .260; *d* = .39) indicating that there was no difference in performances of the second condition of the Trail Making Test between the HIGH_OC (*M* = 9.31, *SD* = 3.17) and LOW_OC groups (*M* = 10.53, *SD* = 1.92). Finally, results from the independent samples *t*-test did not indicate a significant value on the D-KEFS Trail Making Test Condition 4 score, *t* (.11); *p* = .915; *d* = .45) indicating that there was no difference in performances of the fourth condition of the Trail Making Test between the HIGH_OC (*M* = 9.63, *SD* = 3.32) and LOW_OC groups (*M* = 10.5, *SD* = 2).

Table 17.

Comparisons between the HIGH_OC and LOW_OC groups on OCD-related questionnaires and EF tests

	HIGH_OC Group (*n* = 16)		**LOW_OC Group (*n* = 34)**		**Comparison**				
Variable	*M (SD)*	*Mdn (IQR)*	*M (SD)*	*Mdn (IQR)*	*t*	*Df*	*P*	95% CI	Cohen's *d*
OCD-Related Questionnaires									
OCI-R Total Score	26.94 (5.27)	25 (6)	9.71 (5.71)	8.50 (10)	10.19	48	0.000	[20.63]-[13.83]	3.14
DASS-21 Depression Score	13.25 (8.9)	11 (14)	7.41 (9.97)	4 (9)	1.99	48	0.052	[11.72]-[-0.05]	1.03
DASS-21 Anxiety Score	15.25 (15.55)	10 (17)	6.41 (8.32)	3 (11)	2.63	48	0.012	[15.6]-[1.07]	0.91
DASS-21 Stress Score	21 (12.67)	22 (20)	14 (11.34)	11 (17)	1.96	48	0.056	[14.17]-[-0.18]	0.58
OBQ-44 Importance of Thoughts / Control	34.44 (14.59)	29 (26)	22.88 (9.61)	21 (30)	2.89	21.4	0.009	[19.87]-[3.25]	0.94

Note. M = Mean; *SD* = Standard Deviation; Mdn = Median; IQR = Interquartile Range

	HIGH_OC Group (*n* = 16)		**LOW_OC Group (*n* = 34)**		**Comparison**				
Variable	*M (SD)*	*Mdn (IQR)*	*M (SD)*	*Mdn (IQR)*	*t*	*Df*	*P*	95% CI	Cohen's *d*
OBQ-44 Inflated Responsibility / Perceived Threat of Harm	63.25 (14.33)	63 (18)	54.68 (19.5)	54.5 (24)	1.57	48	0.124	[19.57]-[-2.42]	0.5
OBQ-44 Perfectionism / Intolerance of Uncertainty	72.88 (11.85)	75 (19)	58.85 (18.82)	53.5 (11)	2.73	48	0.009	[24.36]-[3.69]	0.89
EF Tests									
BADS Rule Shift Profile Score	3.75 (0.58)	4 (0)	3.74 (0.67)	4 (0)	0.076	48	0.940	[0.4]-[-0.38]	0.02
BADS Key Search Profile Score	2.38 (1.54)	3 (3)	2.41 (1.37)	3 (1)	-0.09	48	0.933	[0.83]-[-0.9]	0.02
BADS Zoo Map Profile Score	2.88 (0.95)	3 (2)	2.88 (1.09)	3 (2)	-0.23	48	0.982	[0.63]-[-0.65]	0

	HIGH_OC Group (*n* = 16)		**LOW_OC Group (*n* = 34)**		**Comparison**				
Variable	*M (SD)*	*Mdn (IQR)*	*M (SD)*	*Mdn (IQR)*	*t*	*Df*	*P*	95% CI	Cohen's *d*
D-KEFS Stroop Test Condition 1 Profile Score	6.88 (2.91)	7.5 (4)	7.74 (2.33)	8 (3)	-1.12	48	0.267	[0.68]-[-2.4]	0.33
D-KEFS Stroop Test Condition 2 Profile Score	8.81 (3.17)	9.5 (5)	9.68 (2.18)	10 (2)	-1.12	48	0.355	[0.95]-[-2.68]	0.32
D-KEFS Stroop Test Condition 3 Profile Score	8.06 (3.8)	8 (7)	8.12 (3.43)	9 (3)	-0.05	48	0.959	[2.11]-[-2.22]	0.02
D-KEFS Stroop Test Condition 4 Profile Score	7.69 (3.41)	8.5 (5)	8 (3.55)	8.5 (3)	-0.37	48	0.716	[1.4]-[-2.03]	0.23
D-KEFS Trail Making Test Condition 2 Profile Score	9.31 (3.97)	9.5 (7)	10.53 (1.92)	9.53 (3)	-1.16	18.4	0.260	[0.98]-[-3.41]	0.39
D-KEFS Trail Making Test Condition 4 Profile Score	9.63 (3.32)	9.5 (5)	11 (2.74)	10.5 (2)	0.11	48	0.915	[1.88]-[-1.69]	0.45

4.5.3. Associations between OCD-related questionnaires and EF tests. A correlation matrix was conducted to examine the associations between the OCD-related questionnaires versus EF tests on the whole sample, using Pearson's correlation coefficient. The Pearson's correlation coefficient (also referred to as bivariate correlation) measures the linear correlation between two variables (Field, 2013). The value of a correlation coefficient ranges from -1.0 to 1.0. A positive correlation would indicate that the values on the two variables are greater than zero and moving in the same direction. In contrast, a negative correlation is indicative of values less than zero and thus, variables would be moving in the opposite direction. A value of zero indicates no association between variables (Field, 2013). In this study, a negative association was expected between OCD and EF tests, particularly higher scores on OCD-related questionnaires and lower scores on EF tests. Spearman's correlation, the nonparametric equivalent of the Pearson's correlation coefficient, was also conducted and yielded the same statistically significant results.

Significant negative correlations were observed between two subscales within the OBQ-44 and all three subtests on the BADS. A significant association (p <.0001) was found between the OBQ-44 Inflated Responsibility / Perceived Threat of Harm Score and BADS Rule Shift subtest (r = -.281). This suggests that a higher score on the OBQ-44 Inflated Responsibility / Perceived Threat of Harm subscale is associated with worse scores on the BADS Rule Shift subtest. A significant association (p <.0001) was found between the OBQ-44 Importance of Thoughts / Controlling Thoughts Score and BADS Zoo Map subtest (r = -.294). This suggests that a higher score on the OBQ-44 Importance of Thoughts / Controlling Thoughts subscale is associated with worse scores on the BADS Key Search subtest. Additionally, a significant association (p <.0001) was found between the OBQ-44 Importance of Thoughts / Controlling Thoughts Score and BADS Key Search subtest (r = -.330). This suggests that a higher score on the OBQ-44 Importance of Thoughts /

Controlling Thoughts subscale is associated with worse scores on the BADS Zoo Map subtest. The results are presented in Table 17.

Partial correlations were conducted to examine possible influences of the DASS-21 anxiety, depression and stress scores on the statistically significant results obtained when using Pearson's correlation coefficient. A partial correlation is a measure of the association between two variables when removing effects of potential confounding variables (Field, 2013). This was done to ensure that the statistically significant correlations obtained were not misleading due to variables that might be numerically related to the OBQ-44 scores and BADS subtest scores. The association between the OBQ-44 Inflated Responsibility / Perceived Threat of Harm Score and BADS Rule Shift subtest remained significant (r = -.333). The association between the OBQ-44 Importance of Thoughts / Controlling Thoughts Score and BADS Zoo Map subtest also remained significant (r = -.410). Similarly, the association between the OBQ-44 Importance of Thoughts / Controlling Thoughts Score and BADS Key Search subtest (r = -.311) remained significant. Therefore, results following partial correlations indicated that significant correlations were still present, even when controlling for potential confounders.

Table 18.

Results of the correlations between OCD-related questionnaires and EF tests

	1	**2**	**3**	**4**
BADS				
BADS Rule Shift	-.102	**-.281***	-.276	-.277
BADS Key Search	-.064	-.144	-.125	**-.294***
BADS Zoo Map	-.049	.029	-.023	**-.330***
D-KEFS				
D-KEFS Stroop Condition 1	-.135	.100	-.044	-.157
D-KEFS Stroop Condition 2	-.102	-.004	.219	-.009
D-KEFS Stroop Condition 3	.006	.194	.153	.034
D-KEFS Stroop Condition 4	-.111	-.011	.024	-.025
D-KEFS Trail Making Condition 2	-.185	-.181	-.125	-.174
D-KEFS Trail Making Condition 4	-.112	-.070	-.035	-.055

Note. Significant negative correlations are indicated in bold. 1 = OCI-R Total Score, 2 = OBQ-44 Inflated Responsibility / Perceived Threat of Harm, 3 = OBQ-44 Perfectionism / Intolerance of Uncertainty, 4 = OBQ-44 Importance of Thoughts / Controlling Thoughts.

4.6. Conclusion

The present chapter provided an outline of the results obtained using independent samples *t*-tests and Pearson's correlation coefficient. The following chapter discusses these findings against extant literature. Results from the independent samples *t*-tests indicated significant differences between the HIGH_OC and LOW_OC groups on the DASS-21 Anxiety score, the OCI-R total score and on two subscales of the OBQ-44. Nevertheless, no differences were indicated on any of the EF tests. The Mann-Whitney U test revealed similar results, however also indicated significant differences on the DASS-21 Depression score and the DASS-21 Stress score. In contrast with the results on the independent samples *t*-test, the Mann-Whitney U test did not indicate a significant difference on the DASS-21 Anxiety score. Results from the Pearson correlation revealed significant correlations between OCD-related questionnaires and the BADS subtests. Nevertheless, it did not report significant correlations between the OCD-related questionnaires and the D-KEFS subtests. The following chapter shall discuss the findings against extant literature.

Chapter 5

Discussion

5.1. Introduction

The previous chapter outlined the findings obtained following analysis. The aim of this study was to understand the role of EF in OCD. This was done using OCD- related questionnaires and five subtests from the BADS and D-KEFS. The current chapter discusses the findings in light of literature on OCD and EF. This chapter is divided into three sections. The first section outlines a brief summary of the results obtained. The second section explores the comparisons between the two groups on OCD-related questionnaires and EF tests. Finally, the third section discusses the associations between OCD and EF.

5.2. Summary of Results

The findings indicated differences between the HIGH_OC and LOW_OC groups on the DASS-21 Anxiety score, the OCI-R total score and on two subscales of the OBQ-44. Moreover, no differences were indicated on the EF tests. When looking at the whole sample, significant associations were found between the OBQ-44 Inflated Responsibility and Perceived Threat subscale, the Importance of Thought and Control of Thought subscale and the three subtests administered from the BADS. No differences were identified on EF measures and no associations were found between OCD-related questionnaires and subtests from the D-KEFS between groups. The two hypotheses branching out from the main research question were:

- H_1: There is an association between OCD tendencies and deficits in EF.
- H_2: Individuals exhibiting OCD tendencies perform significantly poorer in EF tests than individuals who do not present with OCD tendencies.

Given that significant correlations were found between EF and OCD, the first hypothesis was accepted. In contrast, the second hypothesis was refuted considering that there were no differences in performance of the EF tests between the two groups.

5.3. Exploring Comparisons between HIGH_OC and LOW_OC Groups on EF Tests

The HIGH_OC and the LOW_OC groups were compared on the OCD-related questionnaires and EF tests. The differences between the groups were significant between groups on three variables on the OBQ-44 Importance of Thoughts / Control score and the OBQ-44 Perfectionism / Intolerance of Uncertainty score. No differences were found between groups on the EF tests.

The HIGH_OC group was expected to yield lower scores on EF tests than the LOW_OC group. When compared, no differences in performances were found between the two groups. This finding supports the lack of differences in recent research examining EF deficits in OCD (e.g. Kurt et al., 2017; Bédard et al., 2006) both of which utilised a similar methodology to this study. For example, both studies consisted of similar sample sizes to the present study ($N = 60$; Bédard et al., 2006; $N = 43$; Kurt et al., 2017) and both used the Trail Making test and the Stroop test as part of their data collection. In addition to these tests, Kurt et al. (2017) administered the WCST and the COWAT, while Bédard et al. (2006) administered the 20 question subtest within the D-KEFS. Nevertheless, findings did not yield significant differences. It should also be noted that both studies examined individuals diagnosed with OCD against controls, as opposed to this study where the individuals in the HIGH_OC group were not diagnosed formally with OCD. A possible reason behind lack of differences in EF between clinical and non-clinical samples in literature (e.g. Bédard et al., 2006; Kurt et al., 2017) is the comorbid issues that may manifest together with OCD. For example, Kurt et al. (2017) argued that EF impairments in the presence of OCD might be

brought about by the high rates comorbid symptoms of depression, rather than by OCD itself. In support of this claim, the authors cited studies by Basso, Bornstein, Carona and Morton (2001), Moritz et al. (2001) and Aycicegi, Dinn, Harris and Erkman (2003); all of which found that EF between clinical and non-clinical samples appeared similar when controlling for the influence of depression. When comparing diagnosed individuals against controls on the WCST and Trail Making test, Basso et al. (2001) claimed that differences between performances were only found when the depression levels were not excluded. When the administration process was repeated controlling for depression, no significant differences were found between the two groups (Basso et al., 2001; as cited in Kurt et al., 2017). Moritz et al. (2001; as cited in Kurt et al., 2017) did not identify significant differences in performances on the WCST and verbal fluency test between individuals with OCD with low levels of depression and controls. Similarly, Aycicegi et al. (2003; as cited in Kurt et al., 2017) only found differences in EF tests between diagnosed individuals and controls when levels of depression were not controlled for. This finding was further substantiated when the same study did not yield differences when depression was controlled. In this study, depression was statistically significant when the two groups were compared. Therefore, this significant result could have potentially affected the lack of differences between groups on EF tests. In line with findings by Kurt et al. (2017), Bédard et al. (2006) hypothesised that typical EF measures (e.g. WCST, Tower of London test) are more likely affected by the typical comorbid issues present in OCD (anxiety and / or depression) than by OCD itself. Consistent with these findings, anxiety was significant when comparing the HIGH_OC and LOW_OC groups in this study, which could also have had a potential effect on the lack of differences.

A challenge that has been found to potentially yield inconsistent findings for other researchers in this regard is the operationalisation of EF; that is, how the subdomains within

EF are defined (Snyder et al., 2014). For example, when comparing results of meta-analyses by Abramovitch et al. (2013) and Shin et al. (2013), effect sizes on EF measures differed because of the manner in which EF was viewed. Shin et al. (2013) found much larger effects on planning, smaller effects on set shifting and similar effects on response inhibition. Abramovitch et al. (2013) grouped particular subdomains with others (e.g. set shifting tasks were grouped with fluency tasks and consequently, were scored together resulting in a composite score), (Snyder et al., 2014). On the other hand, Shin et al. (2013) viewed EF tasks independently. Subtests and scores in this study were also viewed independently, similar to the method used by Shin et al. (2013). Nevertheless, results could have still been subject to inconsistencies as suggested in the literature.

McKay et al. (2004) also pointed out possible reasons which could have yielded inconsistent results in studies examining EF in OCD. For instance, they put forward that most studies have made use of small sample sizes, which could have influenced possible statistically significant differences between clinical and non-clinical samples. They also explained that severity of OCD is not usually indicated in clinical samples, which could also potentially affect performance (McKay et al., 2004). While the participants within the HIGH_OC group were not clinically diagnosed with OCD, it is possible that the severity between tendencies ranged significantly[6].

Another possible explanation for lack of differences between performances could be due to the method which was used to split the groups. First, it is important to note that the

[6] The scores on the OCI-R of participants classified within the HIGH_OC group could have ranged from 21 to 72.

OCI-R is a screening tool as opposed to a diagnostic tool (Foa et al., 2002). The HIGH-OC group did not consist of individuals who were diagnosed with OCD, but rather, individuals who were more likely to experience OCD symptoms. The participants in this study potentially did not reach the diagnostic levels required to reach a clinical diagnosis of OCD, despite the higher likelihood of exhibiting tendencies if scores on the OCI-R exceeded the cut-off. This in itself would have precluded any potential results supporting the second hypothesis proposed in this study. Moreover, while a number of studies supported the cut-off score recommended by Foa et al. (2002) on the OCI-R (e.g. Abramowitz & Deacon, 2006; Wootton et al., 2015), other researchers (e.g. Williams et al., 2013) have argued against it. Researchers in favour of this cut-off claimed that individuals with OCD tended to score 21 or higher on the mentioned questionnaire (Wootton et al., 2015). However, Wootton et al. (2015) highlighted that other studies (e.g. Abramowitz & Deacon, 2006; Williams et al., 2013) recommended different cut-off scores for different populations, which is said to be related to the heterogeneous nature of different samples. Therefore, the cut-off score of 21 could have not been appropriate for the sample in this study, however, this is only a tentative explanation as there is no empirical evidence to support this claim.

In addition to the points mentioned above, self-report questionnaires are subject to inaccurate results. This is mainly due to questionnaire bias, which is “a result of unanticipated communication barriers between the investigator and respondents that yield inaccurate results” (Choi & Pak, 2005, p. 1). Inaccuracies in self-report questionnaires could be brought by a number of factors, including the design of the questions or statements and the manner in which questionnaires are administered and completed (Choi & Pak, 2005). Two salient elements that might bring about bias are social desirability and response bias (Rosenman, Tennekoon & Hill, 2011). Social desirability occurs when respondents tend to favour responding in a manner which they perceive as more desirable to the researcher, while

response bias is the tendency to respond in a particular manner (Rosenman et al., 2011). More specifically, participants may respond positively only in statements which describe situations occurring frequently in their experience. In contrast, they could have tendencies to respond positively with minimal information or evidence to back up a positive response (e.g. answering 'yes' or choosing a high score on a Likert-type scale even if an experience being inquired did not occur regularly). These elements could have potentially influenced scores on the OCI-R. Given that the majority of participants in this study were classified under the LOW_OC group, some might have been more likely to choose lower scores on the Likert-type scale if they wanted to appear as they did not experience OCD tendencies. They might also have been more likely to choose lower scores if they felt that the experiences explored by the statement did not happen regularly. Further, participants could have over or under intEX/RPreted their behaviours relating to the statements presented on the questionnaire. Alternatively, they could have possibly misunderstood some statements, which would have potentially affected their overall score and thus, the group they were classified under.

The lack of differences in performance could have also been brought about by the fact that the BADS was not standardised on a non-clinical population, but rather, was standardised on individuals who presented with neurological disorders which included brain injuries, neurodegenerative disorders and stroke (Wilson & Chamberlain, 2003).

5.4. Associations between OCD and EF

A correlation matrix was created to examine the associations between the OCD-related questionnaires and EF tests. Three significant correlations were yielded, which remained significant even when controlling for potential confounders. While this finding is contradictory to the previous lack of differences found between the HIGH_OC and LOW_OC

groups, associations were yielded when the sample was viewed collectively as opposed to separately.

5.4.1. Exploring statistically significant associations between OCD and BADS subtests. Findings indicated a significant negative correlation between the BADS Rule Shift subtest and the OBQ-44 Inflated Responsibility and Perceived Threat of Harm score. A significant negative correlation is representative of poorer performances on the Rule Shift subtest by individuals who scored higher on the OBQ-44 Inflated Responsibility and Perceived Threat of Harm subscale. The Rule Shift subtest specifically measures set shifting (also known as cognitive flexibility), rule following and inhibitory control (also known as response inhibition). Therefore, this finding is indicative of difficulties in set shifting and inhibitory control in the presence of an inflated sense of responsibility and perceived threat of harm. Thus, this study replicates the presence of impairments in set shifting and inhibitory control in OCD, as suggested by a number of studies (e.g. Yun et al., 2017; Cavedini et al., 2010; Olley et al., 2007). Studies examining the presence of EF impairment in OCD have often measured set shifting using the WCST (e.g. Cavedini et al., 2010). Literature (e.g. Cavedini et al., 2010; Okasha et al., 2000; Purcell er al., 1998) has identified poor performances on the WCST in clinical samples, particularly due to increased perseverative errors (Roh et al., 2005). Errors due to perseveration occur when one repeats certain responses despite instructions. This repetitive and perseverative behaviour could possibly explain the repetitive symptoms involved in OCD. According to Beck's cognitive model of OCD (1976) one's appraisal of perceived threat is central in the presence of OCD (Salkovskis, 1996). Additionally, the cognitive behavioural model purports that compulsions are based on satiating cognitive errors, which in turn increases perseveration (Salkovskis, 1996). More recent literature (e.g. Ferrão et al., 2012; Wahl et al., 2008) has also related repetitive behaviours to an internal sense of incompleteness, a sensory phenomenon which

keeps occurring repetitively, causing repeated compulsive behaviours. In this study, errors due to perseveration were observed during the second trial of the Rule Shift subtest, where participants were required to follow a different and more complex rule than the one provided in the first trial. Although verbal and visual instructions were provided, some participants noticeably struggled with shifting their thinking to the more complex rule.

Common tests measuring response inhibition include the Go-No-Go test (e.g. Bannon et al., 2006; Watkins et al., 2005) as well as the Stroop test (e.g. Shin et al., 2013). Literature has yielded inconsistent results, which have been attributed to various reasons. For example, Shin et al.'s (2013) meta-analysis consisting of 88 studies examining cognitive functioning in OCD identified that the computerised formats of assessments were more sensitive in identifying difficulties in individuals with OCD when compared to the classic hands-on formats. While no reason was formally provided behind this occurrence, it could be postulated that computerised formats might be more accurate and less likely subject to human error. The authors also pointed out that the small sample sizes utilised by most studies examined require additional research prior to reaching definite conclusions (Shin et al., 2013). Findings in this study have also yielded inconsistencies. Despite the significant association found using the Rule Shift subtest, the Stroop test[7] within the D-KEFS was not associated with the OCI-R or any subscale on the OBQ-44 in the present study. When exploring possible reasons behind this specific finding, it is possible that the Stroop test was perceived as a harder task, while the Rule Shift was perceived as an easier task. While there is no existing evidence behind this, the fourth condition of the Stroop test within the D-KEFS is more cognitively demanding. When comparing the Stroop test with the Rule Shift test, the

[7] The Stroop test is also known as the Colour-Word Interference test in the D-KEFS.

latter requires a similar level of set shifting abilities as the third condition on the Stroop test. However, the fourth condition on the Stroop test requires set shifting with the added element of working memory and increased attention (Homack et al., 2005). This could have led participants to increase their focus on the Stroop test, and in contrast exert less attention on the Rule Shift subtest, which in turn could have yielded lower scores on this measure. While lower scores were observed within the HIGH_OC group on the first, second and fourth conditions of the Stroop test, results were not significant and thus, not generalisable.

Interestingly, the Key Search and Zoo Map subtests within the BADS (both measuring planning and performance monitoring) where significantly negatively correlated with the OBQ-44 Importance of Thoughts and Control of Thoughts score. Despite measuring a common subdomain within EF, the Zoo Map subtest has been regarded as a harder task due to its increased cognitive demands (Norris & Tate, 2000). As discussed in the previous section, the significant negative correlation is representative of poorer performances on the Key Search and Zoo Map subtest by individuals who scored higher on the OBQ-44 Importance of Thoughts and Control of Thoughts subscale. Therefore, difficulties in planning and performance monitoring seem prevalent in individuals who regard intrusive thoughts as important and uncontrollable. The sense of increased importance of thoughts coincides with the dimensions of thought appraisal proposed by Salkovskis (1998). Similarly, Clark and Purdon (2016) have highlighted importance of thoughts as an underlying cognitive mechanism in the presence of reccurring intrusive thoughts. So far, there is no evidence to support the direct association between impairments in planning, performance monitoring and overestimation of thought importance and control. However, a large body of research agrees on the presence of planning deficits in OCD (e.g. Abramovitch et al., 2103; Melloni et al., 2012; Olley et al., 2007). Planning and performance monitoring have mostly been measured using the Tower of London and the Tower of Hanoi tests

(e.g. Rao et al., 2008; Shin et al., 2013). Both measures have been found senstive to identifying planning deficits, however, Oosterman, Wijers and Kessels (2013) have argued that these measures require additional cognitive functions for the tasks to be executed. More specifically, the Tower of London test was found to be associated with fluid intelligence, while the Tower of Hanoi test included set shifting in addition to planning (Oosterman et al., 2013). Hence, the authors argued that it is unclear whether the Tower of London and the Tower of Hanoi tests solely measure planning. When taking these aspects into account, the Zoo Map test was argued to be a better measure of planning ability, as other cognitive domains do not interfere with (Oosterman et al., 2013). Nevertheless, there is no research comparing the sensitivity of the Key Search subtest with common measures of planning thus far.

Chamberlain et al. (2005) attributed planning deficits on these tests to abnormal psychomotor slowing, where individuals with OCD seemed to take longer to think about their plans and execute them. In this study, slower processing in terms of planning was observed, especially in the first version of Zoo Map test which required participants to create their own route within the confinements of rules. Most participants who achieved lower scores on this subtest were observed to execute either one of two behaviours: (1) spent a long time planning the route and subsequently a long time executing the route, or alternatively, (2) did not spend a long time planning the route but spent a long time executing the route as they realised they did not plan their route appropriately.

Melloni et al. (2012) attributed planning deficits with the neural circuit involved in the OCD. This was supported by functional imaging studies that claimed that OCD patients performed worse than controls on the Tower of London and Tower of Hanoi tests and simultaneously showed impairments in the dorsolateral prefrontal cortex and

orbitofrontal cortex, two areas within the frontal lobe. Consistent with findings in the present study, results using these methods have yielded significant differences in performances between clinical and non-clinical samples. However, there is paucity of research targeting the direct association between deficts in planning and the overestimation of the importance of thought. Therefore, future studies are required to examine this association further.

Along with the operationalisation of EF, Bédard et al. (2006) postulated that inconsistencies might also be explained by the dichotomous nature of EF, which differentiates EF into lower and higher order skills. Lower order EFs refer to more primitive executive skills involving set shifting, inhibition and decision making. In contrast, higher order EFs refer to newer executive skills that are learnt over time, such as planning, reasoning and judging (Bédard et al., 2006). Interestingly, a number of studies examining EF in OCD found differences specifically in lower order EF (e.g., Bannon et al., 2006; Chamberlain et al., 2006; Aycicegi et al., 2003). Neurological findings have also suggested that higher order EFs are associated with the dorsolateral prefrontal cortex, while lower order EFs are more associated with the ventromedial and orbitofrontal areas within the prefrontal cortex (Stuss & Knight, 2002). Growing evidence has identified the orbitofrontal cortex as being the main area responsible for detecting a general sense of error as well as ‘correctness’ (Casale et al., 2011). This could possibly explain the higher likelihood of impairments in lower order EFs in the presence of OCD, where the need to feel ‘just right’ or ‘complete’ is prevalent. Bédard et al. (2006)’s findings consisted of a medium effect on set shifting and inhibitory control, however, they postulated the possibility of a Type II error. When unpacking the findings in this study, deficits were similarly found in set shifting and response inhibition, both of which are considered as lower order EF. However, significant associations were also found between OCD and two subtests measuring planning. Although planning is considered a high order EF,

it could be argued that the planning abilities measured by the Key Search and the Zoo Map subtests on the BADS tap onto a more basic planning ability. This could also be due to ecological nature of the two subtests, which lend themselves to more basic and functional abilities as opposed to more complex abilities usually measured a more laboratory-based approach. Given that in this study, planning abilities were measured solely by the Key Search and Zoo Map subtests, results cannot be compared with different tests. Future research comparing higher and lower order EF in OCD might uncover this phenomenon further.

Another interesting observation was that the OBQ-44 Perfectionism and Intolerance of Uncertainty score was not associated with lower scores on the EF measures. The cognitive model of OCD has regarded perfectionism as a factor maintaining OCD symptoms (OCCWG, 1997). Nevertheless, research presents inconsistencies in terms of the association between perfectionism and OCD (Moretz & McKay, 2009). Moretz and McKay (2009) identified trait anxiety as a mediator between perfectionism and OCD, while Taylor et al. (2005) argued that perfectionism only contributed a small amount of variance in the presence of OCD symptoms. Taking these inconsistencies into account, the lack of a significant association between perfectionism and intolerance of uncertainty and EF could be explained by the small contribution in OCD symptoms, as suggested by Taylor et al. (2005).

5.4.2. Exploring the lack of associations between OCD and D-KEFS subtests.

Current research (e.g. Kurt et al., 2017; Snyder et al., 2014; Shin et al., 2013) has highlighted the inconsistencies in findings when looking at the relationship between EF and OCD, as explored in the second chapter. Findings from this study have also presented a level of inconsistency, particularly due to the unexpected lack of association between OCD-related questionnaires and subtests from the D-KEFS. It was interesting to note that significant correlations were obtained on the BADS and not the D-KEFS. Two subtests from the D-

KEFS were administered to the sample: the Colour-Word Interference test (also known as the Stroop test) which measured response inhibition, and the Trail Making test that measured visual search abilities, spatial skills and cognitive flexibility. As mentioned in the literature review, the BADS measures EF using a functional approach, as opposed to the D-KEFS which measures EF using a laboratory-based approach. While both measure the same cognitive domain, the BADS targets the use of EF in everyday functioning. This could explain the significant association between the BADS subtests and the two of the OBQ-44 subscales. The high ceiling of the D-KEFS was expected to be more sensitive towards EF deficits (Latzman & Markon, 2009). Nevertheless, symptoms of OCD are typically manifested through everyday activities, therefore, potential EF deficits in the context of OCD could possibly be more visible in everyday functional tasks. Taking this into account, the BADS could have been more sensitive towards functional deficits. On the Trail Making test, participants did not seem to experience difficulties with shifting from the second to the fourth condition. Albeit minor errors, most participants performed within the average range of normal ability, as expected in accordance to individuals within the same age group. While this subtest was found valid and reliable (Latzman & Markon, 2009), the nature of the task could have been less cognitively demanding when compared to a possibly more complex set shifting test like the Rule Shift within the BADS.

Another potential reason behind the lack of results from the D-KEFS could include the nature of objective measures of EF, which have been criticised. Critics (e.g. Chaytor, Schmitter-Edgecombe, & Burr, 2006; Manchester, Priestley, & Jackson, 2004) have argued that objective measures might not be reflective of the true extent of one's difficulties. Standardised measures are typically performed in clinical settings, which do not present the same environmental stimuli as in real-life settings. This could be a compensatory advantage due to the lower number of distractors, which allow examinees to attend to the assessment.

However, this could equally present a disadvantage as particular difficulties might go unnoticed. Lloyd (2010) also highlighted the effect of the game-like format utilised in most measures of EF, which introduces novel and intriguing tasks, making them overall easier to attend to. Hence, such measures could potentially be measuring one's maximum cognitive capability as opposed to true, typical and regular daily experiences. Thus, results following administration could potentially be underestimating the nature of true potential difficulties in EF. Keifer and Tranel (2013) explained that despite its sensitivity towards identifying frontal lobe damage, the D-KEFS might not be as sensitive in distinguishing between frontal and non-frontal damage. This was supported by its inability to distinguish between focal ventromedial prefrontal and non-frontal lesions when measured along with individuals presenting with dorsolateral prefrontal lesions (Keifer & Tranel, 2013). Therefore, while the rationale behind using the D-KEFS was adequate, results might have not been yielded due to this reason.

Another issue which is pertinent to the local context and which could have affected results in this study includes the lack of measures normed on the Maltese population. To date, there is no neuropsychological measure of EF which has been strandardised on a local population. This in itself presents a challenge when interpreting quantitative scores yielded from objective measures. Such challenges were also experienced during data collection. For example, language sometimes presented a barrier in understanding, particularly in older participants. While an effort was made to administer each subtest in a standardised manner, translation to Maltese was sometimes required. Rivera Mindt et al. (2008) EF in bilingual individuals forces the inhibition of the frequency of use of one language (typically the mother tongue which the assessment is not standardised on) which could influence result accuracy.

In addition to the explanations above, it is also important to consider that performances on standardised tests are dependent on a number of factors. These include physical and mental wellbeing, the level of attention and environmental factors. Additionally, examinees could present with a higher probability of performance anxiety, which could potentially influence results. Since assessments are typically performed once, they are highly exposed to the possibilities of these factors (Watson & Clark, 1991). These factors are inevitable in any administration setting, however, participants in this study could have possibly been more at risk to some. For example, level of attention could have easily been diminished as participants were aware that the purpose of administration was not diagnostic.

5.5. Conclusion

In conclusion, the HIGH_OC sample did not exhibit a worse performance in EF tests when compared to the LOW_OC sample. Nonetheless, OCD and EF were associated when looking at the whole sample as opposed to when the sample was split into HIGH_OC and LOW_OC groups. Associations were found between OCD subscales and ecologically valid EF measures, which is indicative of a relationship between the two. In particular, deficits in set-shifting, response inhibition and planning were linked to the overestimation of importance of thoughts and controlling thoughts, as well as a sense of inflated responsibility and perceived threat of harm.

Chapter 6

Conclusion

6.1. Introduction

The current chapter concludes this study. First, a brief summary of the findings of this study is outlined, followed by its clinical implications. The limitations of this study are discussed thereafter, followed by recommendations for future research and a concluding note.

6.2. Summary of the Study

The purpose of this study was to explore the role of EF in the presentation of OCD. The rationale behind this study was motivated by the large percentage of individuals with OCD who do not respond to the treatment currently available (Clark & Purdon, 2016; Fineberg et al., 2012). Ongoing research has been attempting to look at OCD from a neuropsychological standpoint, particularly since functional imaging showed a neurological circuit involved in the presentation of OCD. Following a comprehensive literature review on OCD and EF, two hypotheses were tested. The first hypothesis expected to find a correlation between EF deficits and the likelihood of experiencing OCD tendencies. The second hypothesis expected to find that individuals who are more likely to experience OCD tendencies exhibit poorer performances on EF tests than individuals who were not likely to exhibit OCD tendencies. A quantitative methodology was adopted for data collection and analysis. Data was obtained by administering OCD-related self-report questionnaires, which included the OCI-R, the OBQ-44 and the DASS-21 to test for potential confounders. Additionally, five EF subtests were administered, which included the Rule Shift test, Key Search test and Zoo Map test from the BADS, as well as the Colour-Word Interference test and the Trail Making test from the D-KEFS.

The sample consisted of 50 participants ($N = 50$) which were divided into HIGH_OC and LOW_OC groups using the cut-off score of 21 on the OCI-R (Foa et al., 2002). The HIGH_OC group consisted of 16 participants (n = 16) while the LOW_OC group consisted the majority of the participants ($n = 34$). Results from the OCD-related questionnaires and EF tests were viewed separately and collectively. Following a number of statistical analyses, findings indicated that OCD and EF were associated when looking at the whole sample as opposed to when the sample was split into HIGH_OC and LOW_OC groups. More specifically, significant negative correlations were found between OCD subscales and the three subtests from the BADS, where higher scores on the OBQ-44 subscales were related to lower scores on the BADS subtests. The Rule Shift subtest was strongly negatively correlated with the OBQ-44 Inflated Responsibility and Perceived Threat of Harm subscale. Therefore, this finding was indicative of specific difficulties in set shifting and inhibitory control in the presence of an inflated sense of responsibility and perceived threat of harm. The Key Search and Zoo Map subtests were both strongly negatively correlated with the OBQ-44 Importance of Thoughts and Control of Thoughts subscale. Consequently, this indicates specific difficulties in planning and performance monitoring in the presence of over-importance of thoughts and the need to control thoughts. Contrary to these findings, there were no associations between OCD and the subtests on the D-KEFS.

When examining the HIGH_OC and LOW_OC groups separately, statistically significant differences were found on the OBQ-44 Importance of Thoughts and Control of Thoughts subscale and the OBQ-44 Perfectionism and Intolerance of Uncertainty subscale. Therefore, the HIGH_OC group demonstrated a higher likelihood of overestimating the importance of their thoughts and controlling their thoughts. Moreover, this group demonstrated higher tendencies to exhibit perfectionist behaviour and to be intolerant of uncertainty. The HIGH_OC group was also found to exhibit higher rates of anxiety, which

could have potentially confounded results. In contrast, the HIGH_OC and LOW_OC groups did not exhibit significant differences between their performances on the EF tests.

6.3. Implications for Clinical Practice

The current study was the first to examine the role of EF in OCD within the local context. It was also the first of its kind using the combination of subtests from the BADS and D-KEFS which, until the present study, have not been used to examine the role of EF in OCD. Although results cannot be generalised to the entirety of the Maltese population, this study contributed to the field of neuropsychology, where it demonstrated a correlation between OCD and EF. A salient finding of this study highlighted that OCD was significantly associated with subtests from the BADS, however, there was a lack of association with the subtests from the D-KEFS. This inferred that OCD symptomatology could potentially be better identified using ecologically valid measures, like the BADS. Despite the low ceiling effect of the BADS which potentially inhibits sensitivity to EF impairment, it is possible that the manifestation of OCD symptoms in everyday life is highlighted in functional EF impairments. This poses significant clinical implications, where functional methods of assessment might yield better results in identifying EF impairments in OCD.

Furthermore, this would imply that treatment for OCD could possibly be provided through a neuropsychological perspective, where the specific EF deficits present in individuals' OCD symptomatology could be targeted. As mentioned in previous chapters, treatment for OCD is currently based on pharmacological and cognitive behavioural approaches, utilising CBT and EX/RP (NICE, 2005). When considering the heterogeneity of OCD, it is possible that the current available treatment does not cater for the diverse variety of symptoms exhibited by diagnosed individuals (Bloch et al., 2008). A number of researchers (e.g. Abramowitz et al., 2019; Gillihan et al., 2012) have proposed different

reasons behind the lack of treatment success using these methods, including the distressing nature of EX/RP, the inability to verbalise particular intrusive thoughts and choosing the wrong form of exposure. Findings in this study imply that domain-specific neuro-rehabilitative strategies targeting EF could possibly provide treatment outcomes without the presented limitations. As suggested by D'Esposito and Gazzaley (2006), such strategies would employ:

1. Environmental manipulation: this would include making the necessary changes in one's environment (e.g. decreasing distractions, increasing time to complete certain tasks that are cognitively demanding).
2. Compensatory skills: these are novel strategies that one learns to compensate for specific impaired skills (e.g. writing sequences of particular tasks down).
3. Direct interventions: as opposed to compensatory skills, these interventions are aimed at restoring one's impaired functions (e.g. administering continuous cognitive training using exercises targeting specific EF impairments). Such interventions are usually repetitive in nature as they attempt to increase one's insight into their own difficulties.

The combination of the three categories is typically employed in the presence of impairments in EF (D'Esposito & Gazzaley, 2006). Therefore, the association of OCD symptoms with subtests from the BADS might be indicative of a greater need to employ such strategies in treatment plans, particularly as they are largely based on restoring and / or compensating for impaired functional skills. While this area of research is still at its infancy, neuro-rehabilitative treatment approaches might yield promising results.

6.4. Limitations of the Study

The findings reported in this study should be evaluated in light of several limitations. Firstly, convenience sampling was used. A significant limitation of this sampling method is the increased likelihood of a biased sample (Farrokhi, 2012). Whilst effort was made to diversify the sample as much as possible, one cannot eliminate the fact that this sampling method was based on convenience and reaching participants who fit into the inclusion criteria. Therefore, some groups within the general population were over-represented (younger age groups and higher educational levels were more represented than older age groups and individuals with lower educational levels) as they were easier groups to reach. This led to a biased sample in terms of age and level of education, which could have influenced results. On a similar note, the total sample of this study was small when compared to the Maltese adult population. Therefore, the results of this study cannot be generalised to the whole population as the sample was not representative of the general population.

Another limitation is that the BADS and D-KEFS are not standardised on a Maltese population. This could have potentially affected both performances and scoring due to cultural and / or language bias. Furthermore, the BADS and D-KEFS were not administered as whole batteries, but rather, subtests measuring different subdomains of EF were selected. While such subtests were carefully selected to represent the major EF subdomains, using whole batteries might have yielded more accurate results.

Furthermore, participants who were classified under the HIGH_OC group were not formally diagnosed with OCD. Rather, this classification was solely based on the clinical cut-off score of 21 on the OCI-R, which is a screening tool as opposed to a diagnostic tool. Findings are based on individuals who are more likely to exhibit OCD tendencies, rather than individuals diagnosed with OCD. It is also possible that participants in the HIGH_OC group

did not reach the required diagnostic levels of OCD, which could have led to the lack of comparable differences between group performances. In addition, the OCI-R is a self-report questionnaire, which in itself could have been subject to inaccurate results. Tentative reasons behind possible inaccuracies were put forward in the previous chapter, such as social desirability and response bias. Further, such over or under interpreting behaviours relating to the statements presented on the questionnaire or misunderstanding statements, which would have potentially affected the overall score.

6.5. Recommendations for Future Research

This study helped shed light on various areas requiring further research. First, the present study could be replicated using a larger sample of participants. In this way, findings would be more generalisable to the whole adult population within the local context. It would also be useful if this study is replicated using the BADS and D-KEFS as whole batteries, rather than selecting specific subtests from each. This could perhaps lead to more accurate results, particularly if specific subtests that were not utilised in this study are associated with OCD.

Findings were viewed in terms of obsessive-compulsive tendencies as opposed to OCD, as participants were not clinically diagnosed with OCD. It would be beneficial to conduct a case-control study where individuals diagnosed with OCD are compared with a non-clinical sample on EF tests. Additionally, examination of whether the severity of OCD is linked with greater deficits in EF. McKay et al. (2004) similarly identified this area as a gap within the literature. Findings could potentially shed further light on the role of EF in OCD, which could provide greater implications for alternative treatment.

Linking with the clinical implications of the present study, examining treatment outcomes of neuro-rehabilitative strategies targeting EF in clinical samples is strongly recommended. A comparative study comparing cognitive behavioural treatments with neuro-rehabilitative treatment would potentially identify the effectiveness of both treatments.

A significant finding reported by Bédard et al. (2006) suggested that the lower order EFs are markedly more impaired than higher-order EFs in the presence of OCD. The authors also suggested that this could potentially be a reason behind inconsistent results, as EF skills are not being viewed dichotomously (Bédard et al., 2006). Findings from this study highlighted associations between two lower-order EFs: set shifting, response inhibition; and one higher-order EF: planning. Therefore, it would be useful to conduct a study examining the differences between higher-order EFs and lower order EFs in OCD, as this is still an area of ongoing debate.

Moreover, findings identified a specific association between the over-importance of thoughts, the need to control thoughts and deficits in planning. Both neuropsychological and neuroimaging studies have identified planning difficulties in the presence of OCD (e.g. Shin et al., 2013; Melloni et al., 2012; Rao et al., 2008). However, research does not seem to address the direct association between deficits in planning and the overestimation of the importance of thoughts. Therefore, a study exploring this association could potentially provide a better understanding of the reasons behind this phenomenon.

This study also brought to light the various gaps in local research pertaining to this topic. A significant gap within local research includes the lack of prevalence rates of OCD within the Maltese adult population. While rates of mental health issues are provided, there are no current rates examining the rates different disorders separately. This study revealed a number of findings which were speculated to be brought about by cultural norms specific to

the local context. For example, findings indicated significant differences between the HIGH_OC and LOW_OC groups on over-importance of thoughts, the need to control thoughts, perfectionism and intolerance of uncertainty. However, no differences were indicated on inflated responsibility and perceived threat of harm, which is also a key underlying mechanism of OCD. Therefore, findings could shed light on the underlying mechanisms of OCD specifically within the Maltese population. On a similar note, it would be interesting to examine whether the underlying mechanisms of OCD and religiosity are associated within the Maltese population.

6.6. Concluding Note

This study provided a unique contribution towards the field of neuropsychology as it was the first of its kind to examine the role of EF in OCD using the BADS and D-KEFS. This study revealed relationships between increased OCD tendencies and deficits in EF, particularly in set shifting, response inhibition and planning. These findings were specific to the BADS, and thus, findings indicate that functional and ecologically valid measures might be more sensitive to OCD. This shed further light on ongoing research within this area, with the aim of providing alternative effective treatment for OCD.

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Appendix A

Neurochemical and Genetic Models of OCD

Extant literature (e.g. Fava et al., 2014; Soomro, Altman, Rajagopal & Browne, 2008; Hu et al., 2006) seems to hold that serotonin plays significant role in the onset and maintenance of OCD. Serotonin exhibits both excitatory and inhibitory effects in the brain, particularly in the hippocampus, cerebral cortex and neostriatum; the same locations involved in OCD movement disturbances (Soomro et al., 2008). Research has confirmed the occurrence of genetic polymorphism in regions encoding 5-HT transport and reuptake proteins (5_HTTLPR), both which are linked to anxiety traits and personality differences (Fava et al., 2014). Drugs acting on blocking 5-HT reuptake have been found to improve OCD symptoms, as opposed to drugs that did not act through this mechanism. Such drugs exhibit both agonist and antagonist effects.

The agonist effect occurs through;

a. the blocking of presynaptic receptors, thus increasing neurotransmitter availability,
b. activating postsynaptic receptors, thus simulating serotonergic effects, and
c. deactivating the enzymes tryptophan hydroxylase (Tph1) and tryptophan hydroxylase-2 (Tph2), resulting in a higher level of available serotonin (Fava et al., 2014).

Conversely, the antagonist effect occurs by blocking the post-synaptic receptors (Fava et al., 2014).

Studies examining the genetic components of OCD have attempted to provide a clearer understanding of the pathophysiology of OCD. Most results extracted from gene studies have been derived through animal models (Fava et al., 2014; Pauls, 2012).

Levels of dopamine transporter (o carrier) (DAT). A study by Berridge, Aldridge, Houchard & Zhuan (2005) identified reduced levels of DAT in transgenic mice who showed patterns of grooming behaviour. Additionally, Karagiannidis et al. (2013) suggested that an

impairment of DAT levels impacted on working memory tasks performed by mice, thus, suggesting possible indicators of cognitive impairment in OCD.

The Hoxb8 mRNA expression. The Hoxb8 gene (located on chromosome 17) forms part of the Homebox B complex which provides positional information along the anteroposterior axis (Fava et al., 2014). Hox8 mice examined in animal models exhibited excessive grooming, which consequently led to hair removal and deep skin lesions. This behaviour seemed to correlate with some manifestations seen in OCD.

The SAP90/PSD95 associated protein 3. The SAP90/PSD95 associated protein 3 is responsible for mediating excitatory postsynaptic action in the striatum (Fava et al., 2014). In a study by Welch Rodriguiz and Trotta (2007), SAP mice exhibited lesions as a result of over grooming as well as increase in anxiety in the open field test, elevated plus maze test and the light and darkness test.

NR2B (glutamate) receptor antagonist. Extant research holds that particular glutamatergic systems play a significant role on psychiatric disorders. Riluzole (a glutamatergic modulator) has been found to inhibit marble-burying behaviour in mice by acting as an antagonist of the NR2B (glutamate) receptor (Fava et al., 2014; Wu, Hanna, Rosenberg, & Arnold, 2012).

Functionality of the 5-hydroxytryptamine (HT) 2c receptors. Various studies (e.g. Fava et al., 2014; Pytliak, Vargová, Mechírová & Felsöci, 2011; Boulougouris, Glennon & Robbins, 2007) hold that symptoms of OCD are typically exacerbated in the presence of piperazine, a 5-HT2c receptor agonist. 5-HT2 receptors are serotonergic receptors responsible for modulating the release of a number of excitatory and inhibitory neurotransmitters.

Neurotransmitter dysregulation. Treatment of OCD includes medication such as selective serotonin reuptake inhibitors (SSRIs) which has been found effective in alleviating

symptoms in 40 percent to 60 percent of diagnosed individuals (Snyder et al., 2014; Bloch et al., 2010; Soomro et al., 2008). Nevertheless, Snyder et al. (2014) argue that this is not necessarily indicative of serotonergic abnormalities, but rather, a level of dysregulation in neurosteroids.

Current research takes into account allopregnanolone, the neurosteroid attributed to obsessive compulsive behaviour (Snyder et al, 2014; Umathe, Vaghasiya, Jain & Dixit, 2009; Bigos et al., 2008). Its affect is mostly due to its action in the central dopaminergic transmission in the nucleus accumbens affecting GABA receptors, as well as its action in increasing the firing rate of serotonergic neurons (Snyder et al, 2014; Umathe, Vaghasiya, Jain & Dixit, 2009; Bigos et al., 2009). When administering allopregnanolone to mice exhibiting 'marble-burying' behaviour, Umathe et al. (2009) found that such behaviour was significantly reduced. In addition to allopregnanolone imbalance, Bigos et al. (2009) pointed out alterations in adrenocorticotropin, corticotropin releasing hormone and cortisol in diagnosed individuals. Their study specifically examined levels of dehydroepiandrosterone, dehydroepiandrosterone sulfate and cortisol in 15 controls and one diagnosed individual. While no differences in cortisol levels were reported, results indicated accelerated levels of dehydroepiandrosterone and dehydroepiandrosterone sulfate in the diagnosed individual. Bigos et al. (2009) posited that the likelihood of such occurrence could be explained by the high levels of anxiety experienced by diagnosed individuals, which produces the same concentrations of the mentioned hormones in occurrences of panic disorder and anorexia nervosa.

d'Angelo et al. (2014) further substantiated results from studies by Umathe et al. (2009) and Bigos et al. (2009), whilst also pointing out differences in neurosteroid dysregulation levels depending on sex in 8-hydroxy-2-(di-n-propylamino)-tetralin hydrobromide (8-OHDPAT) animal model. Moreover, a study by Alonso, López-Solà, Real,

Segalàs, and Menchón (2015) reexamined the accuracy neurosteroids in animal models of OCD against those within the condition as manifested in humans. The study noted that the 8-OHDPAT animal model seemed to be modulated by dehydroepiandrosterone, dehydroepiandrosterone sulfate, cortisol, and corticotrophin-releasing factor, as pointed out by previous studies.

Appendix B

FREC Permission to Commence with Research

SWB FREC <research-ethics.fsw@um.edu.mt> 4 Oct 2018, 12:18

to me

Dear Ms Caruana,

Your Form A was received with thanks. Your reference number is FRECSWB_1819_157.

As indicated in the *UM Research Ethics Review Procedures* (RERP), Form As are kept for record and audit purposes and the research may commence.

Please note that FREC will not issue any form of approval as the responsibility for Form A lies exclusively with the principal investigator (PI).

Regards,

Charmaine Agius

Faculty Research Ethics Committee (FREC)
Faculty for Social Wellbeing
Room 113
Humanities A Building (Laws & Theology)
University of Malta
Msida MSD 2080

Appendix C

Participant Information Sheet

PARTICIPANT INFORMATION SHEET

You have been invited to take part in this academic study. Kindly take your time to read the information provided below. Should you wish to further clarify the information provided or would like further information, do not hesitate to ask on the email provided below.

Dear Participant,

My name is Martina and I am currently reading for a Master of Psychology degree in Neuropsychology at the University of Malta. In part fulfilment of this course, I am carrying out a study entitled: **The Role of Executive Functioning in Obsessive Compulsive Disorder,** supervised by Dr Kristina Bettenzana and Dr Fiona Ambery. This study is aiming to explore the role of executive functioning in relation to the key features involved in the presentation of OCD.

Participation

You have been invited to participate in this study as you are 18 years of age or older, and do not have a diagnosis of a learning difficulty (for example, dyslexia). Your participation in this study is voluntary. You name will not be used, in order to maintain anonymity and confidentiality. You have the right to withdraw your participation or consent from the study at any point, without the need of an explanation. Should you decide to withdraw, the information gathered from the assessment will be destroyed.

Should you decide to take part, you will be invited to fill in short questionnaires. You will then be invited to complete verbal and pen and paper tasks, with provided instructions. This procedure will not be audio or video recorded, and you will not be asked to divulge any personal information. The results obtained from the assessment will be solely used for data analysis and will be destroyed following study completion. You will not have access to your results following the procedure, however, you have the right to ask for a summary of the overall results of the study. The session will take approximately one hour.

Risks or Disadvantages of Taking Part

This study does not involve any clinical risks or changes to your care. When filling in questionnaires, you might come across questions which you may find unpleasant or upsetting

(for example, thinking about how you are feeling). Please note that you are not obliged to answer questions that you find upsetting.

Contact Information

Should you decide to participate, kindly email me on **martina.m.caruana.13@um.edu.mt**. A date and time for the assessment will be provided via email shortly after you express your wish to participate. The procedure will take place in a mutually convenient setting. Should the provided date and time be inconvenient, alternative dates and times will be given. Should you wish to ask questions or gain further information regarding the study and/or the assessment procedure, please do not hesitate to contact me. Should you prefer to contact my main supervisor, kindly send an email on **kristina.vella.um.edu.mt**.

Thank you for taking the time to read the provided information. Your contribution to this study would be greatly appreciated.

Respectfully yours,

Martina Caruana

Neuropsychology Trainee

Appendix D

CONSENT FORM

I confirm that I have thoroughly read and understood the information that was provided, and I accept to participate in the study entitled: The Role of Executive Functioning in Obsessive Compulsive Disorder (OCD), under the conditions mentioned in the Participant Information Sheet.

I am aware that:

1) My participation in this study is voluntary.
2) I have the right to withdraw my participation from this study without the need of an explanation.
3) Information from my participation be anonymised.
4) My name will be replaced by a number.
5) I will not be asked to divulge any personal information.
6) The assessment procedure shall take approximately one hour to complete.
7) The results obtained in this study shall only be used for the academic purposes of data analysis.
8) The raw data will be destroyed following the completion of the study.
9) I will not have access to my results from the assessment.
10) I have the right to ask for a summary of the overall results of the study.
11) Any questions or queries were answered satisfactorily.
12) I am able to ask the researcher for further information at any point.
13) I have the right to stop from or refuse to answer any of the questionnaires mentioned i the information sheet.

_____ _____

Date Signature of Researcher

Tutors: Dr Kristina Bettenzana; Dr Fiona Ambery

Appendix E

Demographics Questionnaire

DEMOGRAPHICS QUESTIONNAIRE

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1. Please indicate your gender.

    □ Male

    □ Female

    □ Other

2. Please select the category that includes your age.

    □ 18-24

    □ 25-34

    □ 35-44

    □ 45-54

    □ 55-64

    □ 65+

3. Please indicate the highest educational level that you have completed.

    □ Primary

    □ Secondary

    □ Tertiary

4. Please state your current profession.

    _____

5. Do you use glasses or contact lenses?

    □ Yes

    □ No

6. Do you have colour blindness?

    - Yes
    - No

Thank you for taking the time to fill in this questionnaire.

Appendix F

Dass-21 Questionnaire

Depression, Anxiety and Stress Scale (DASS21)

For each statement below, please circle the number in the column that best represents how you have been feeling in the last week.

Statement	Did not apply to me at all	Applied to me to some degree or some of the time	Applied to me a considerable degree or a good part of the time	Applied to me very much or most of the time
1. I found it hard to wind down	0	1	2	3
2. I was aware of dryness of my mouth	0	1	2	3
3. I couldn't seem to experience any positive feeling at all	0	1	2	3
4. I experienced breathing difficulty (eg, excessively rapid breathing, breathlessness in the absence of physical exertion)	0	1	2	3
5. I found it difficult to work up the initiative to do things	0	1	2	3
6. I tended to over-react to situations	0	1	2	3
7. I experienced trembling (eg, in the hands)	0	1	2	3
8. I felt that I was using a lot of nervous energy	0	1	2	3
9. I was worried about situations in which I might panic and make a fool of myself	0	1	2	3
10. I felt that I had nothing to look forward to	0	1	2	3
11. I found myself getting agitated	0	1	2	3
12. I found it difficult to relax	0	1	2	3
13. I felt down-hearted and blue	0	1	2	3
14. I was intolerant of anything that kept me from getting on with what I was doing	0	1	2	3

15. I felt I was close to panic	0	1	2	3
16. I was unable to become enthusiastic about anything.	0	1	2	3
17. I felt I wasn't worth much as a person	0	1	2	3
18. I felt that I was rather touchy	0	1	2	3
19. I was aware of the action of my heart in the absence of physical exertion (eg, sense of heart rate increase, heart missing a beat)	0	1	2	3
20. I felt scared without any good reason.	0	1	2	3
21. I felt that life was meaningless	0	1	2	3

Lovibond, S.H. & Lovibond, P.F. (1995). Manual for the Depression Anxiety Stress Scales. (2nd. Ed.) Sydney: Psychology Foundation

DASS21 SCORING

1) For questions numbered 3, 5, 10, 13, 16, 17, 21 add up the numbers circled then multiply that number by 2 and enter it here: __

2) For questions numbered 2, 4, 7, 9, 15, 19, 20 add up the numbers circled then multiply that number by 2 and enter it here: __

3) For questions numbered 1, 6, 8, 11, 12, 14, 18 add up the numbers circled then multiply that number by 2 and enter it here: __

Refer to the chart below and for each numbered question above, refer to the same number in the table below to determine how mild or serious each condition may be.

Rating	Depression #1	Anxiety #2	Stress #3
Normal	0-9	0-7	0-14
Mild	10-13	8-9	15-18
Moderate	14-20	10-14	19-25
Severe	21-27	15-19	26-33
Extremely Severe	28+	20+	37+

Provided to you by Depression-Test.net for educational purposes only. If there is an indication that you might be depressed, please check out the site for additional information, tools and support. If there is an indication that It might be serious then please see the help of a mental health professional.

Appendix G

OCI-R Questionnaire

OCI-R

The following statements refer to experiences that many people have in their everyday lives. Circle the number that best describes **HOW MUCH** that experience has **DISTRESSED or BOTHERED you during the PAST MONTH.** The numbers refer to the following verbal labels:

0 Not at all	1 A little	2 Moderately	3 A lot	4 Extremely

1.	I have saved up so many things that they get in the way.	0 1 2 3 4
2.	I check things more often than necessary.	0 1 2 3 4
3.	I get upset if objects are not arranged properly.	0 1 2 3 4
4.	I feel compelled to count while I am doing things.	0 1 2 3 4
5.	I find it difficult to touch an object when I know it has been touched by strangers or certain people.	0 1 2 3 4
6.	I find it difficult to control my own thoughts.	0 1 2 3 4
7.	I collect things I don't need.	0 1 2 3 4
8.	I repeatedly check doors, windows, drawers, etc.	0 1 2 3 4
9.	I get upset if others change the way I have arranged things.	0 1 2 3 4
10.	I feel I have to repeat certain numbers.	0 1 2 3 4
11.	I sometimes have to wash or clean myself simply because I feel contaminated.	0 1 2 3 4
12.	I am upset by unpleasant thoughts that come into my mind against my will.	0 1 2 3 4
13.	I avoid throwing things away because I am afraid I might need them later.	0 1 2 3 4

14. I repeatedly check gas and water taps and light switches after turning them off.	0	1	2	3	4
15. I need things to be arranged in a particular way.	0	1	2	3	4
16. I feel that there are good and bad numbers.	0	1	2	3	4
17. I wash my hands more often and longer than necessary.	0	1	2	3	4
18. I frequently get nasty thoughts and have difficulty in getting rid of them.	0	1	2	3	4

Appendix H

OBQ-44 Questionnaire

RT	1. I often think things around me are unsafe.	1	2	3	4	5	6	7
PC	2. If I'm not absolutely sure of something, I'm bound to make a mistake	1	2	3	4	5	6	7
PC	3. Things should be perfect according to my own standards.	1	2	3	4	5	6	7
PC	4. In order to be a worthwhile person, I must be perfect at everything I do.	1	2	3	4	5	6	7
RT	5. When I see any opportunity to do so, I must act to prevent bad things from happening.	1	2	3	4	5	6	7
RT	6. Even if harm is very unlikely, I should try to prevent it at any cost.	1	2	3	4	5	6	7
ICT	7. For me, having bad urges is as bad as actually carrying them out.	1	2	3	4	5	6	7
RT	8. If I don't act when I foresee danger, then I am to blame for any consequences.	1	2	3	4	5	6	7
PC	9. If I can't do something perfectly, I shouldn't do it at all.	1	2	3	4	5	6	7
PC	10. I must work to my full potential at all times.	1	2	3	4	5	6	7
PC	11. It is essential for me to consider all possible outcomes of a situation.	1	2	3	4	5	6	7
PC	12. Even minor mistakes mean a job is not complete.	1	2	3	4	5	6	7
ICT	13. If I have aggressive thoughts or impulses about my loved ones, this means I may secretly want to hurt them.	1	2	3	4	5	6	7
PC	14. I must be certain of my decisions.	1	2	3	4	5	6	7
RT	15. In all kinds of daily situations, failing to prevent harm is just as bad as deliberately causing harm.	1	2	3	4	5	6	7
RT	16. Avoiding serious problems (for example, illness or accidents) requires constant effort on my part.	1	2	3	4	5	6	7
RT	17. For me, not preventing harm is as bad as causing harm.	1	2	3	4	5	6	7
PC	18. I should be upset if I make a mistake.	1	2	3	4	5	6	7

RT	19. I should make sure others are protected from any negative consequences of my decisions or actions.	1	2	3	4	5	6	7
PC	20. For me, things are not right if they are not perfect.	1	2	3	4	5	6	7
ICT	21. Having nasty thoughts means I am a terrible person.	1	2	3	4	5	6	7
RT	22. If I do not take extra precautions, I am more likely than others to have or cause a serious disaster.	1	2	3	4	5	6	7
RT	23. In order to feel safe, I have to be as prepared as possible for anything that could go wrong.	1	2	3	4	5	6	7
ICT	24. I should not have bizarre or disgusting thoughts.	1	2	3	4	5	6	7
PC	25. For me, making a mistake is as bad as failing completely.	1	2	3	4	5	6	7
PC	26. It is essential for everything to be clear cut, even in minor matters.	1	2	3	4	5	6	7
ICT	27. Having a blasphemous thought is as sinful as committing a sacrilegious act.	1	2	3	4	5	6	7
ICT	28. I should be able to rid my mind of unwanted thoughts.	1	2	3	4	5	6	7
RT	29. I am more likely than other people to accidentally cause harm to myself or to others.	1	2	3	4	5	6	7
ICT	30. Having bad thoughts means I am weird or abnormal.	1	2	3	4	5	6	7
PC	31. I must be the best at things that are important to me.	1	2	3	4	5	6	7
ICT	32. Having an unwanted sexual thought or image means I really want to do it.	1	2	3	4	5	6	7
RT	33. If my actions could have even a small effect on a potential misfortune, I am responsible for the outcome.	1	2	3	4	5	6	7
RT	34. Even when I am careful, I often think that bad things will happen.	1	2	3	4	5	6	7
ICT	35. Having intrusive thoughts means I'm out of control.	1	2	3	4	5	6	7
RT	36. Harmful events will happen unless I am very careful.	1	2	3	4	5	6	7
PC	37. I must keep working at something until it's done exactly right.	1	2	3	4	5	6	7
ICT	38. Having violent thoughts means I will lose control and become violent.	1	2	3	4	5	6	7
RT	39. To me, failing to prevent a disaster is as bad as causing it.	1	2	3	4	5	6	7

Appendix I

Normality Testing

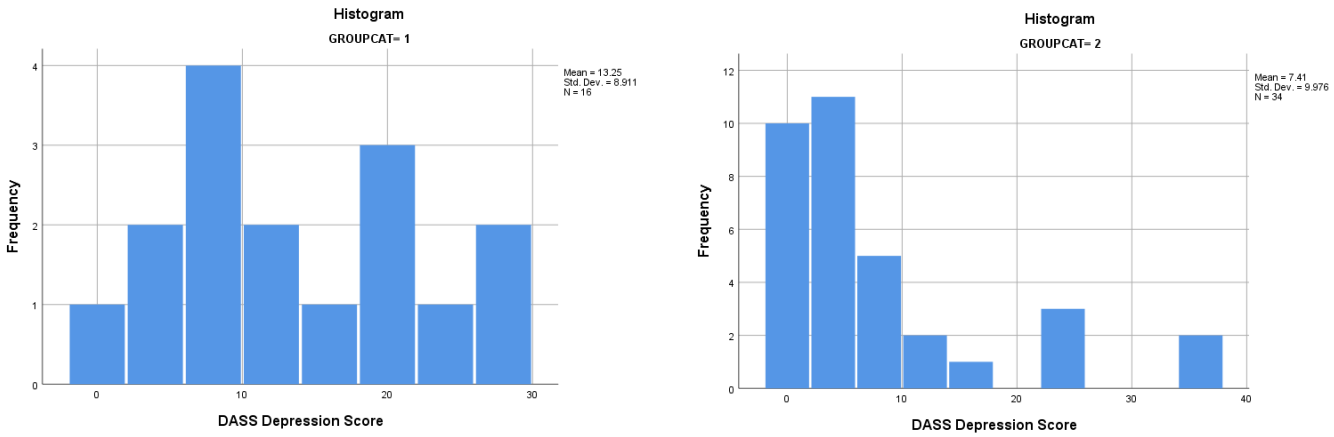

Figure 3. Histograms illustrating distributions of DASS-21 depression scores on the HIGH_OC (left) and LOW_OC (right) groups respectively.

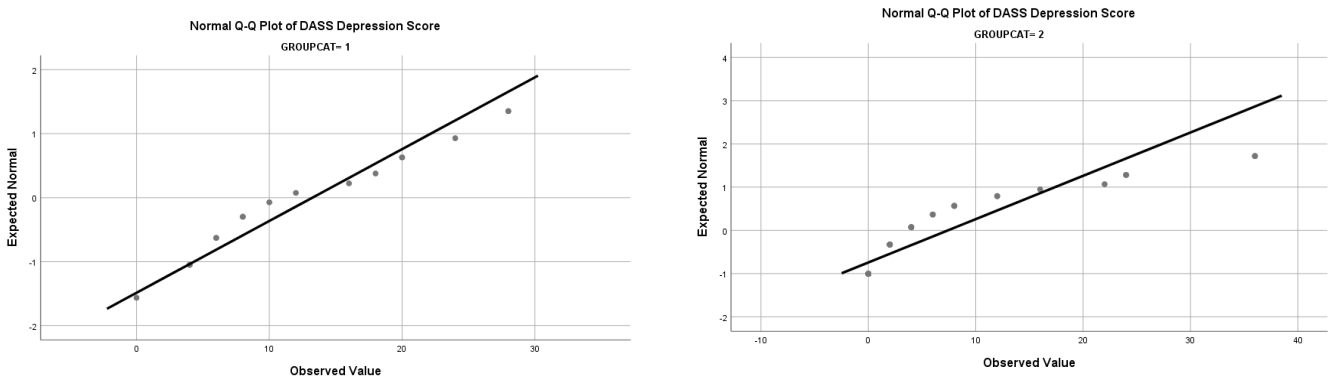

Figure 4. Normal Q-Q plots of the DASS-21 depression scores on the HIGH_OC (left) and LOW_OC (right) groups respectively.

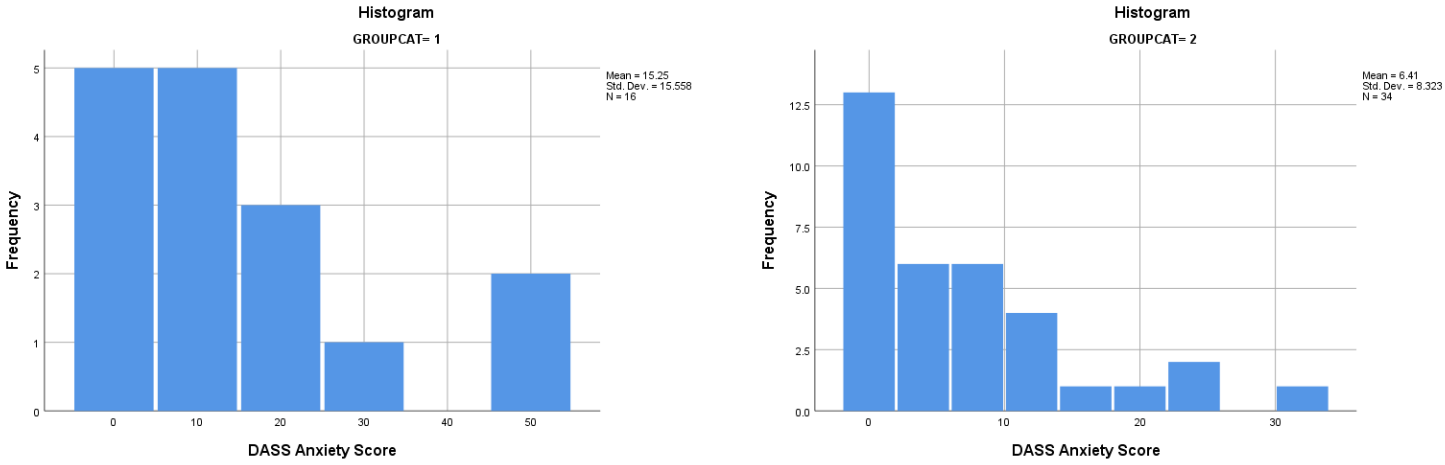

Figure 5. Histograms illustrating distributions of DASS-21 anxiety scores on the HIGH_OC (left) and LOW_OC (right) groups respectively.

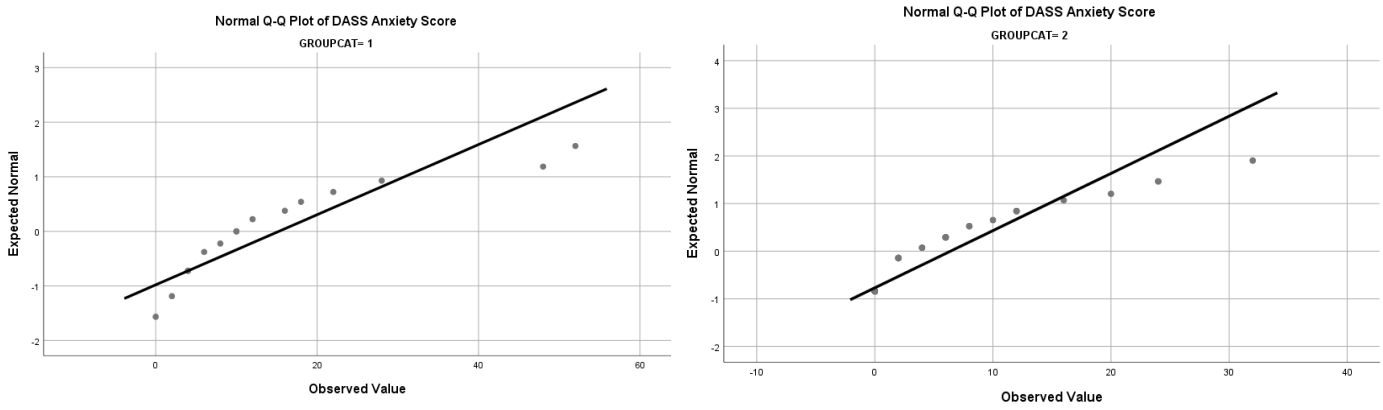

Figure 6. Normal Q-Q plots of the DASS-21 anxiety scores on the HIGH_OC (left) and LOW_OC (right) groups respectively.

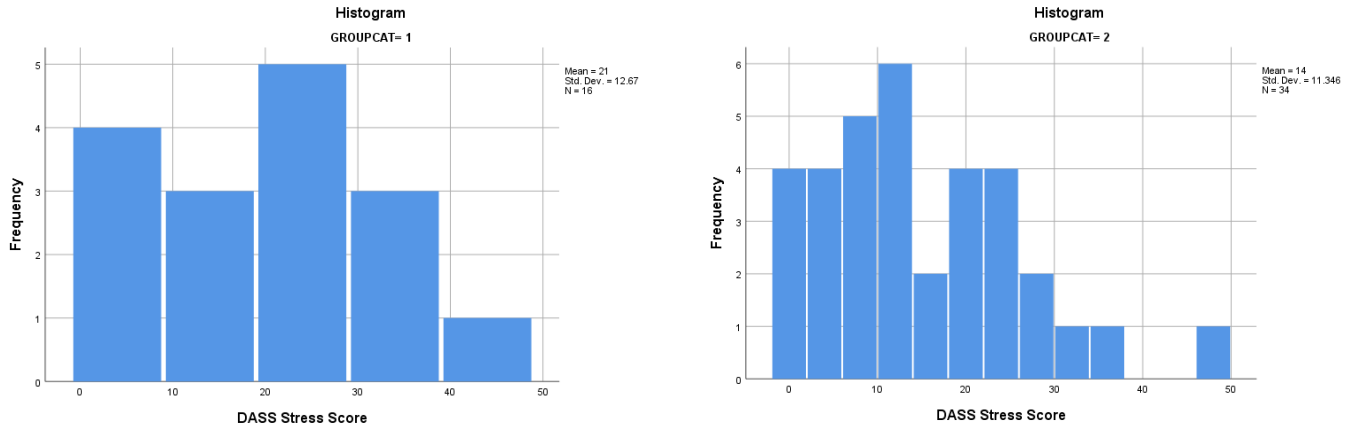

Figure 7. Histograms illustrating distributions of DASS-21 stress scores on the HIGH_OC (left) and LOW_OC (right) groups respectively.

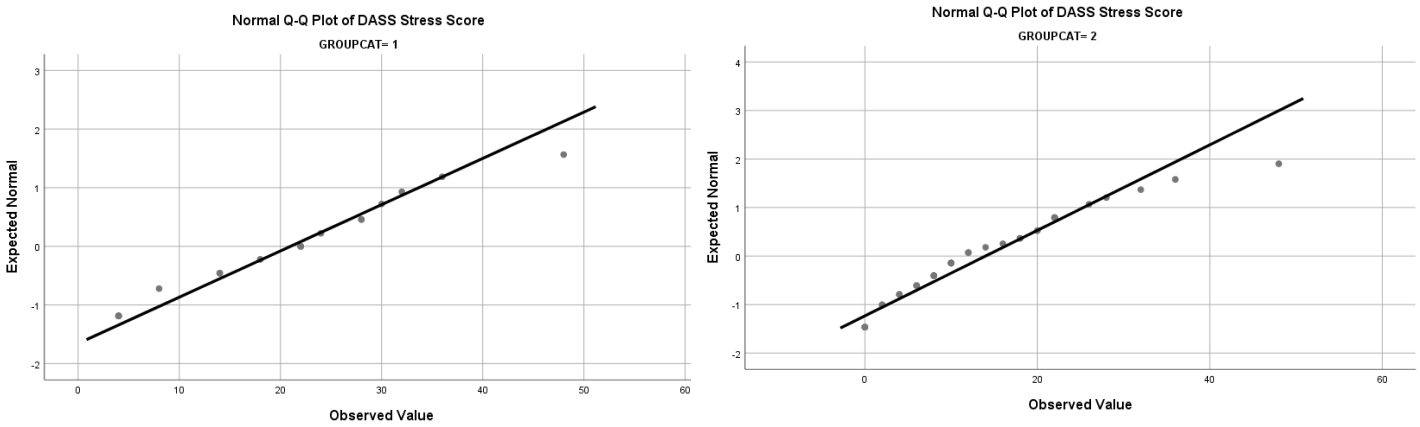

Figure 8. Normal Q-Q plots of the DASS-21 stress scores on the HIGH_OC (left) and LOW_OC (right) groups respectively.

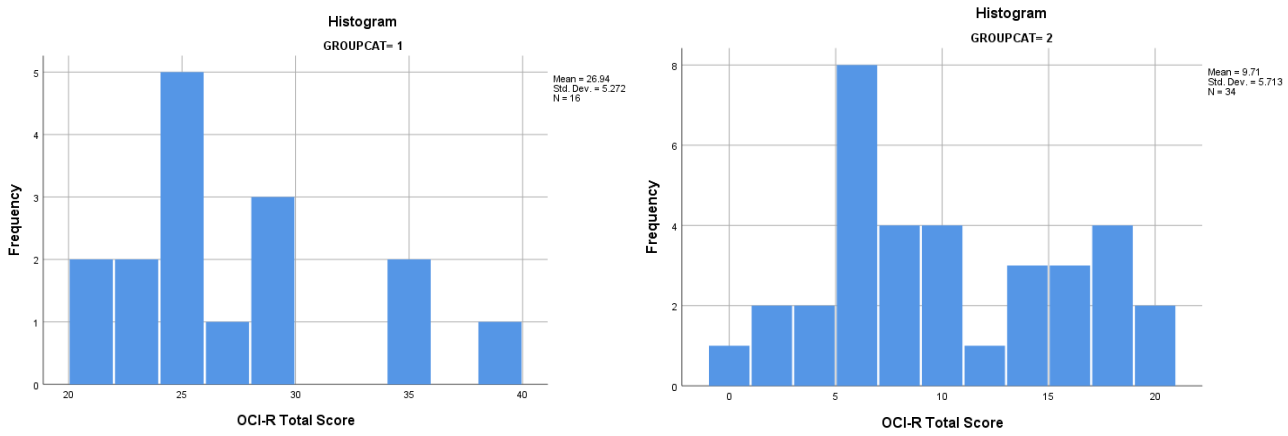

Figure 9. Histograms illustrating distributions of OCI-R total scores on the HIGH_OC (left) and LOW_OC (right) groups respectively.

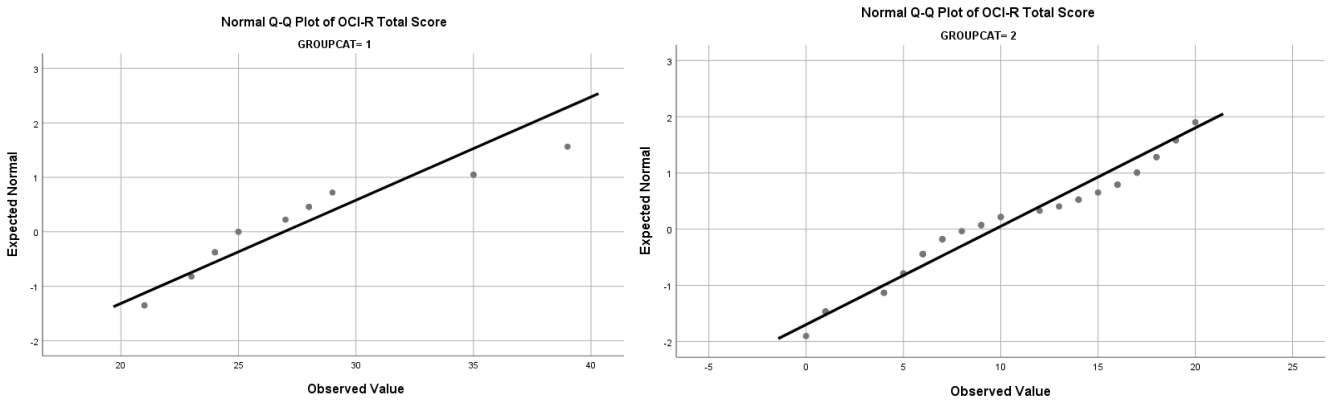

Figure 10. Normal Q-Q plots of the OCI-R total scores on the HIGH_OC (left) and LOW_OC (right) groups respectively.

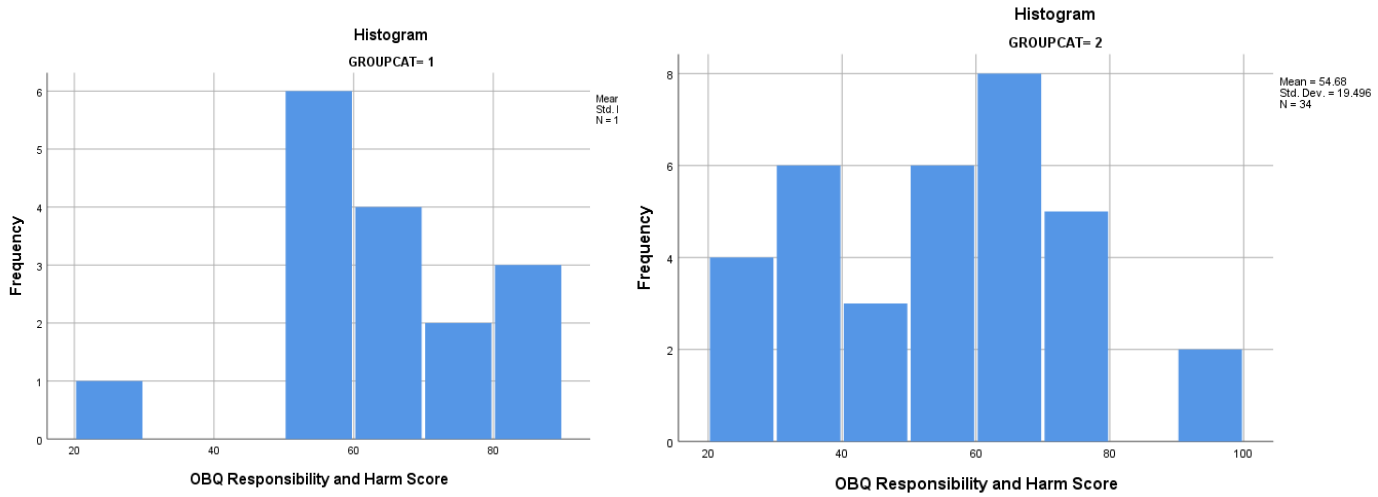

Figure 11. Histograms illustrating distributions of the OBQ-44 responsibility and harm scores on the HIGH_OC (left) and LOW_OC (right) groups respectively.

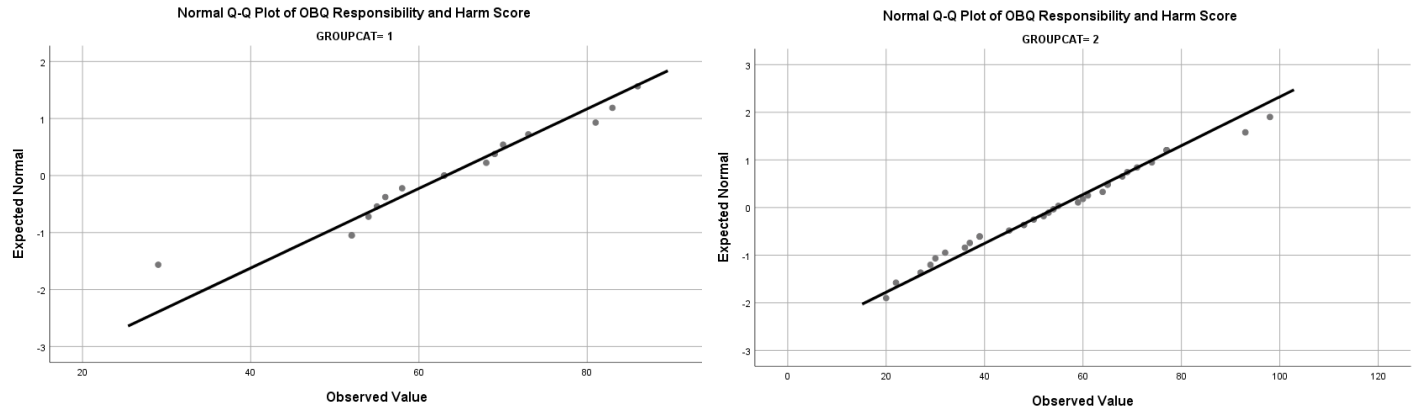

Figure 12. Normal Q-Q plots of the OBQ-44 responsibility and harm scores on the HIGH_OC (left) and LOW_OC (right) groups respectively.

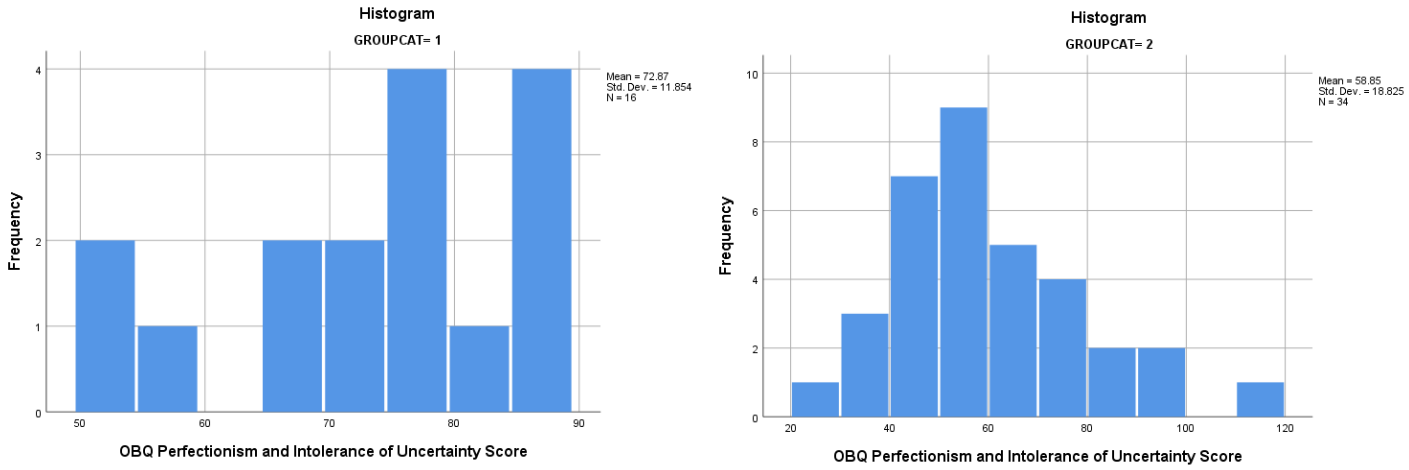

Figure 13. Histograms illustrating distributions of the OBQ-44 perfectionism and intolerance of uncertainty scores on the HIGH_OC (left) and LOW_OC (right) groups respectively.

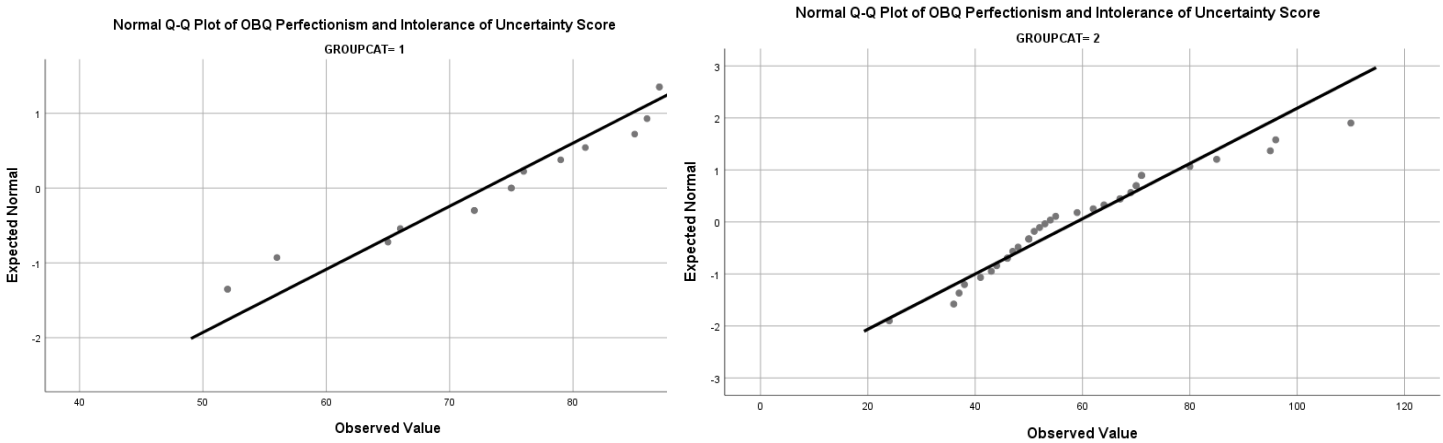

Figure 14. Normal Q-Q plots of the OBQ-44 perfectionism and intolerance of uncertainty scores on the HIGH_OC (left) and LOW_OC (right) groups respectively.

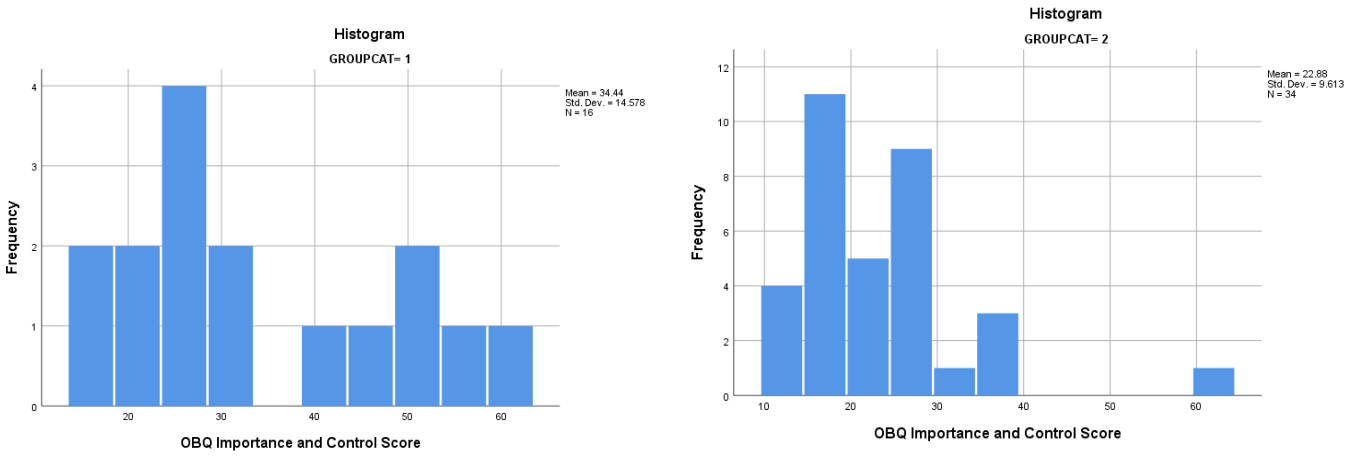

Figure 15. Histograms illustrating distributions of OBQ-44 importance of thought and control of thought scores on the HIGH_OC (left) and LOW_OC (right) groups respectively.

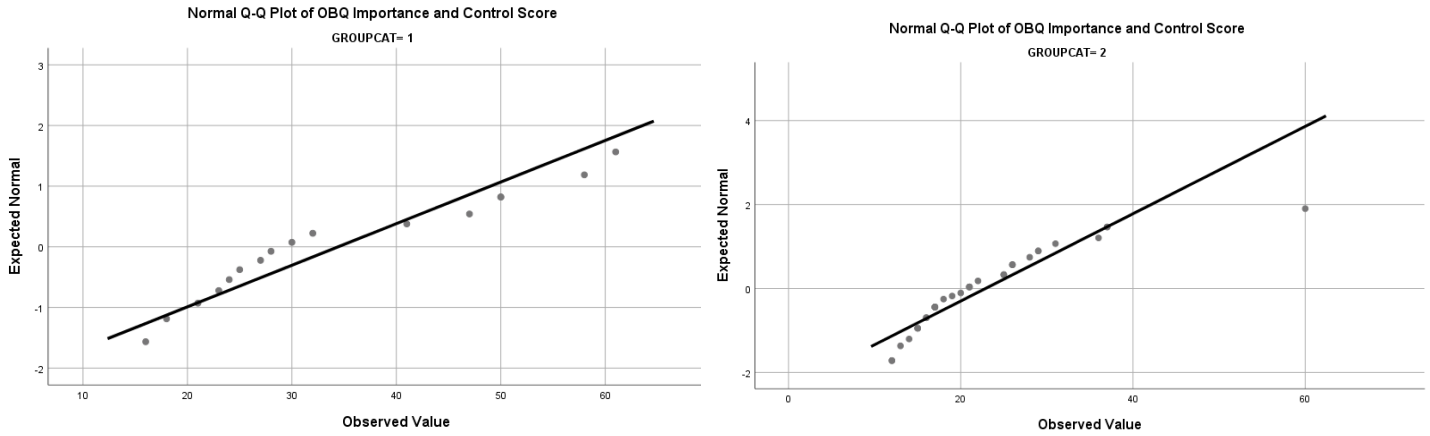

Figure 16. Normal Q-Q plots of the OBQ-44 importance of thought and control of thought scores on the HIGH_OC (left) and LOW_OC (right) groups respectively.

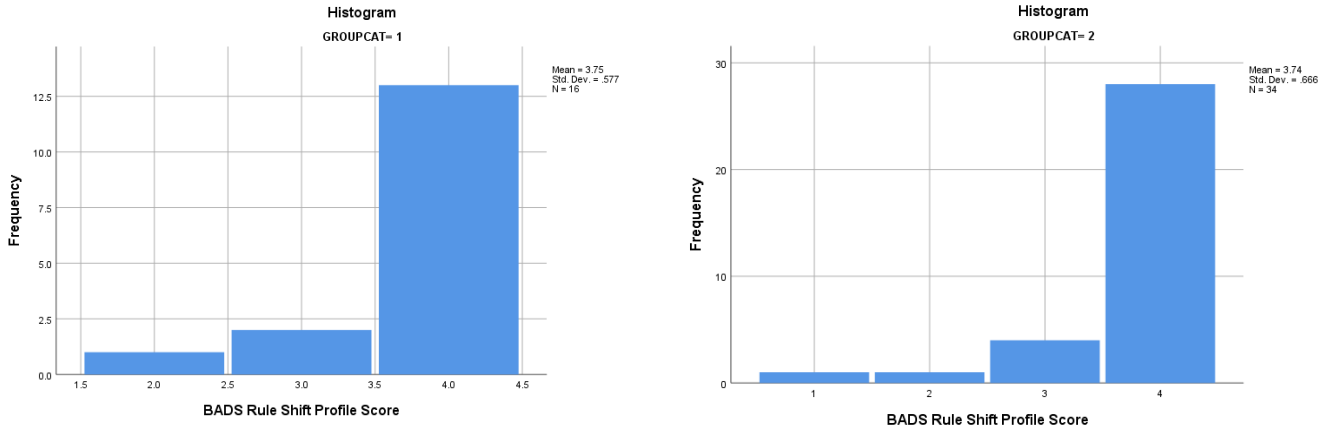

Figure 17. Histograms illustrating distributions of the BADS Rule Shift profile scores on the HIGH_OC (left) and LOW_OC (right) groups respectively.

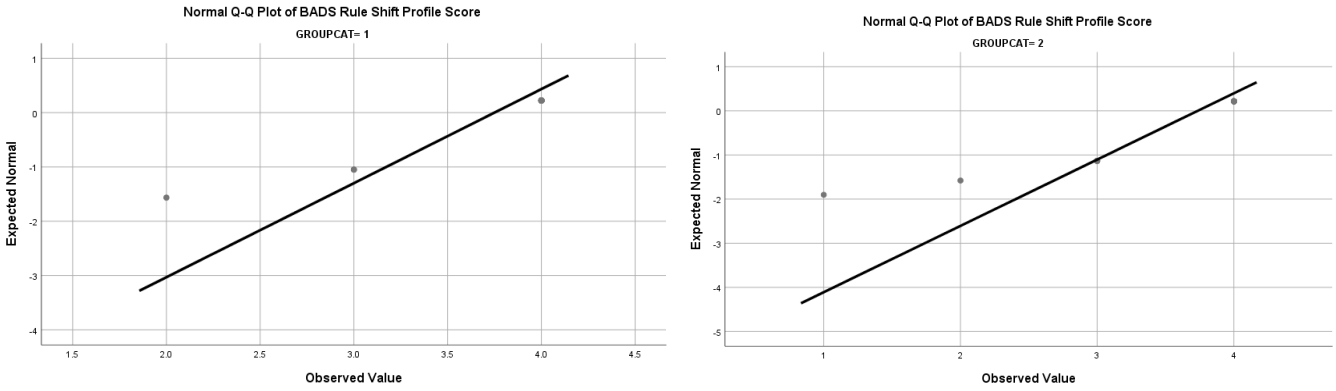

Figure 18. Normal Q-Q plots of the BADS Rule Shift profile scores on the HIGH_OC (left) and LOW_OC (right) groups respectively.

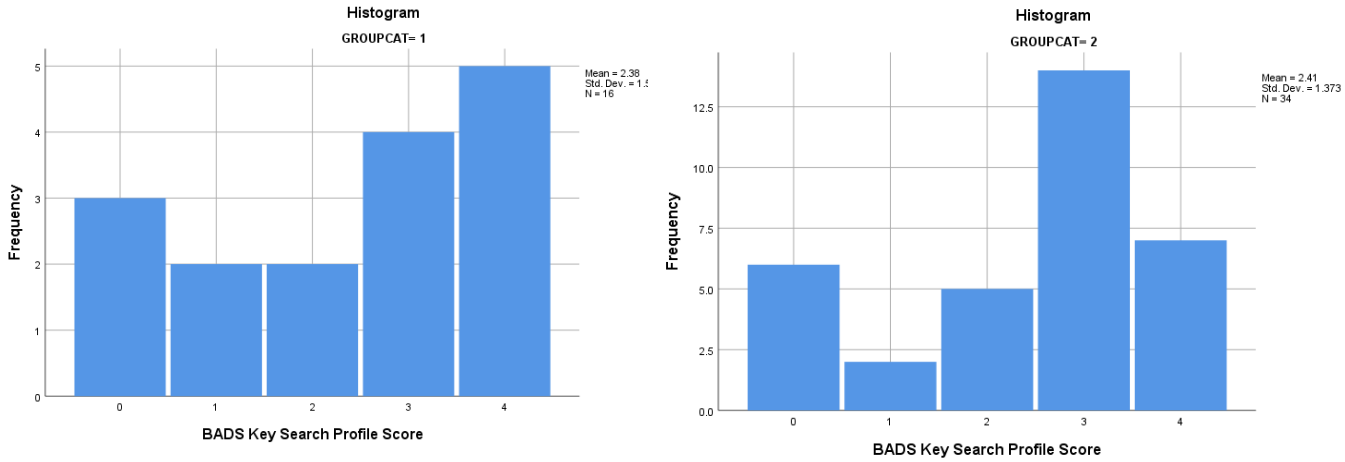

Figure 19. Histograms illustrating distributions of BADS Key Search profile scores on the HIGH_OC (left) and LOW_OC (right) groups respectively.

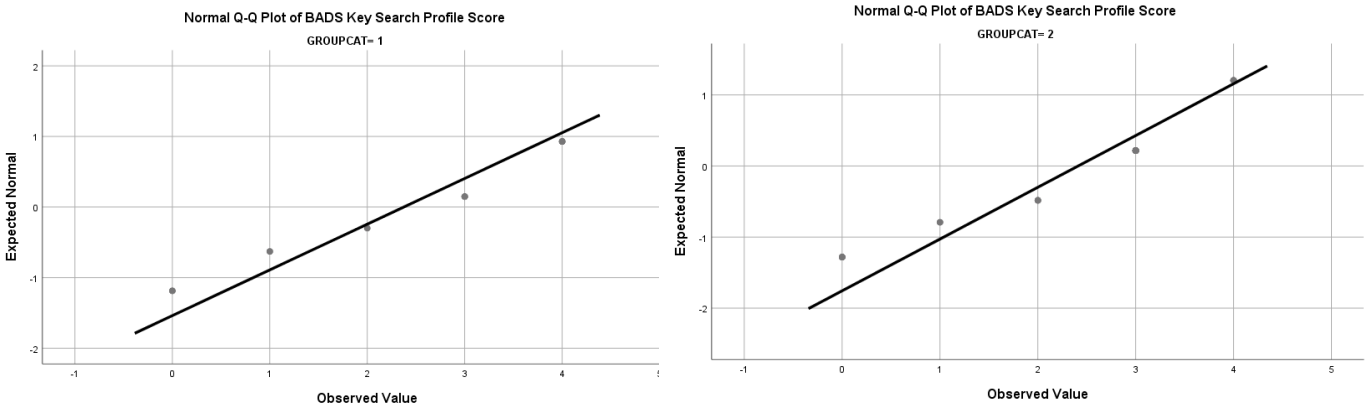

Figure 20. Normal Q-Q plots of the BADS Key Search profile scores on the HIGH_OC (left) and LOW_OC (right) groups respectively.

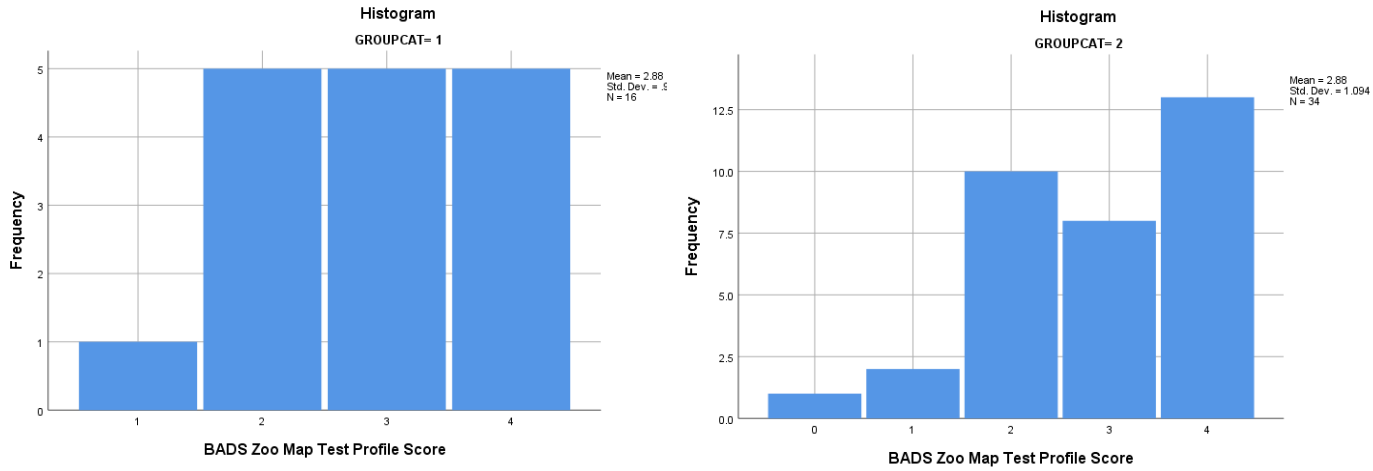

Figure 21. Histograms illustrating distributions of the BADS Zoo Map profile scores on the HIGH_OC (left) and LOW_OC (right) groups respectively.

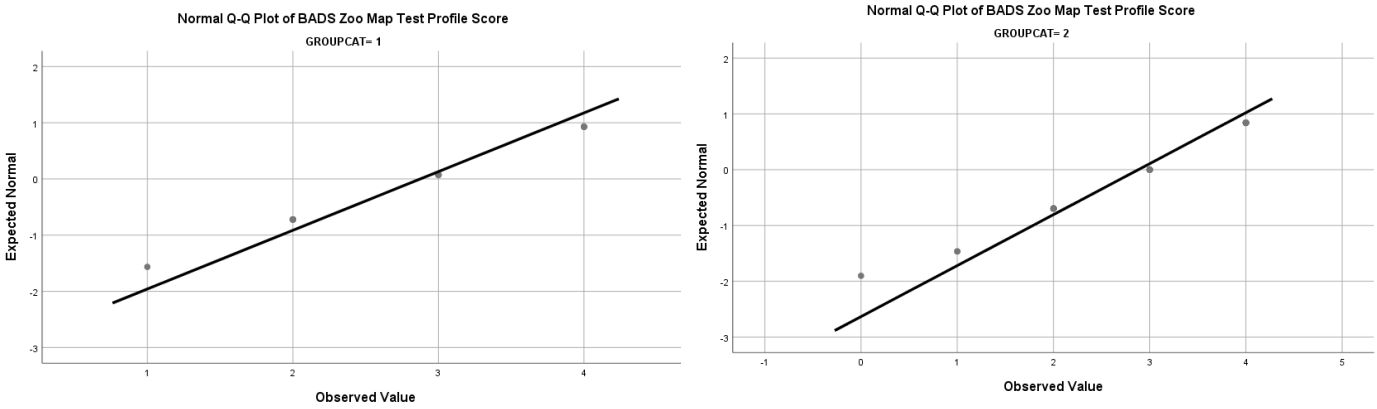

Figure 22. Normal Q-Q plots of the BADS Zoo Map profile scores on the HIGH_OC (left) and LOW_OC (right) groups respectively.

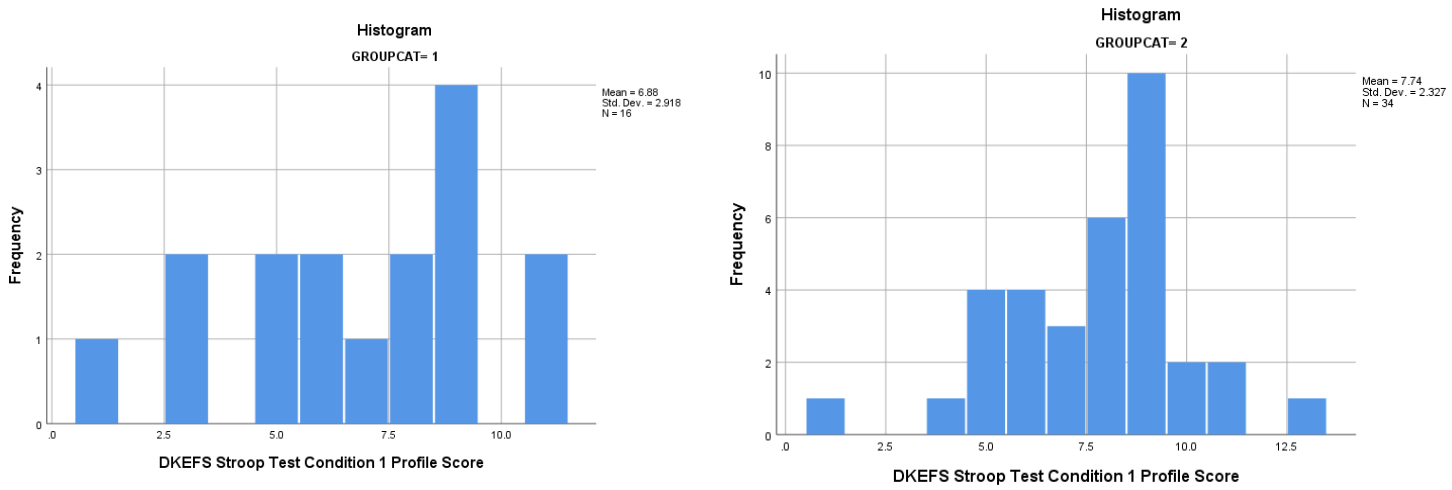

Figure 23. Histograms illustrating distributions of the D-KEFS Stroop Test Condition 1 profile scores on the HIGH_OC (left) and LOW_OC (right) groups respectively.

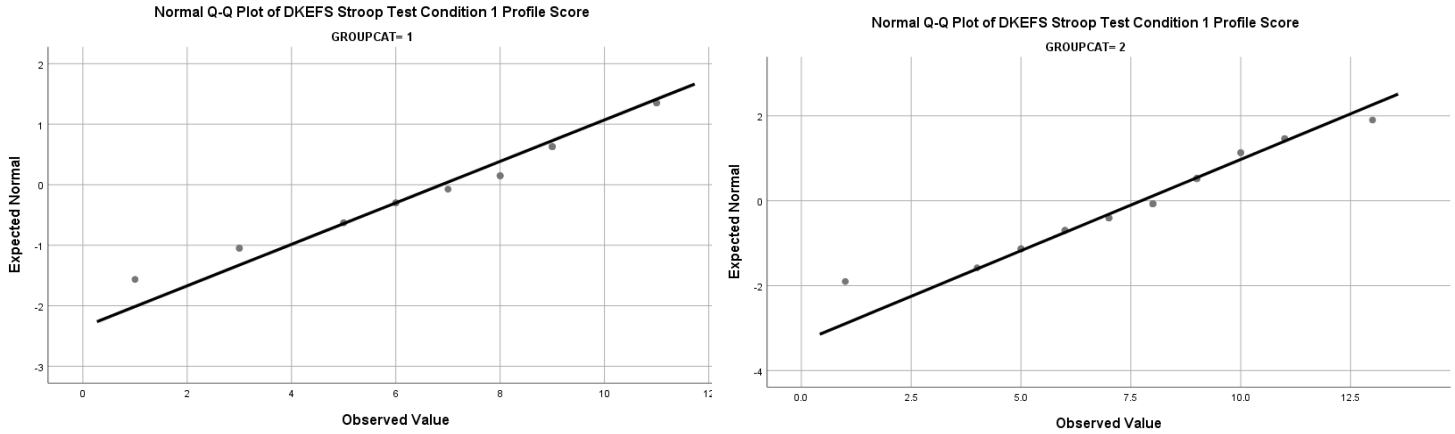

Figure 24. Normal Q-Q plots of the D-KEFS Stroop Test Condition 1 profile scores on the HIGH_OC (left) and LOW_OC (right) groups respectively.

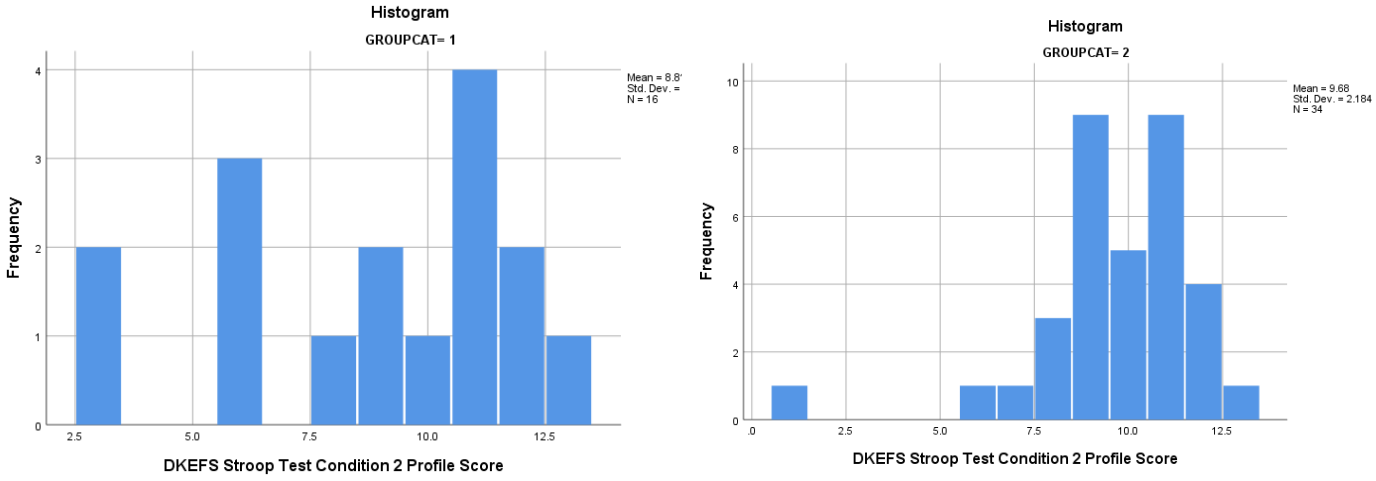

Figure 25. Histograms illustrating distributions of the D-KEFS Stroop Test Condition 2 profile scores on the HIGH_OC (left) and LOW_OC (right) groups respectively.

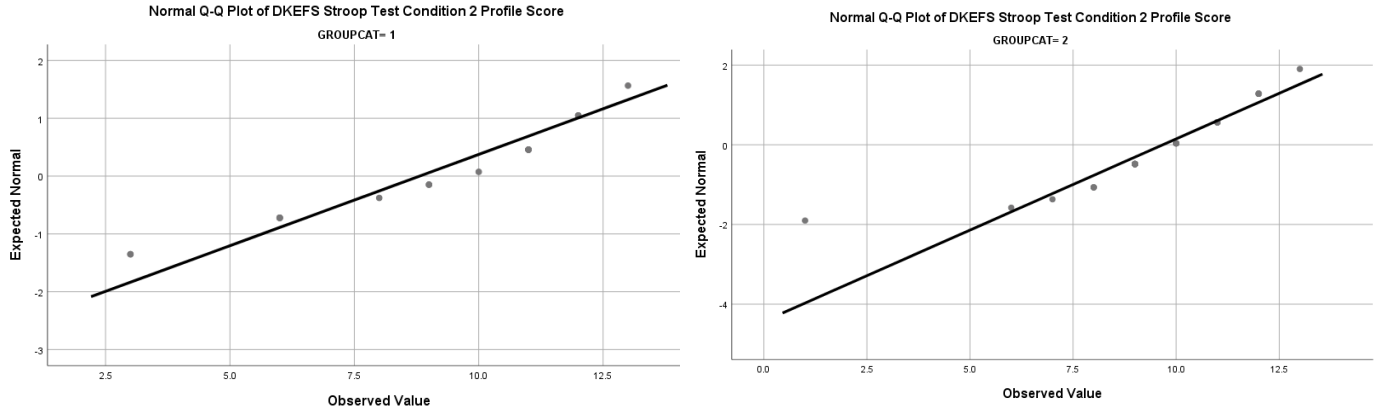

Figure 26. Normal Q-Q plots of the D-KEFS Stroop Test Condition 2 scores on the HIGH_OC (left) and LOW_OC (right) groups respectively.

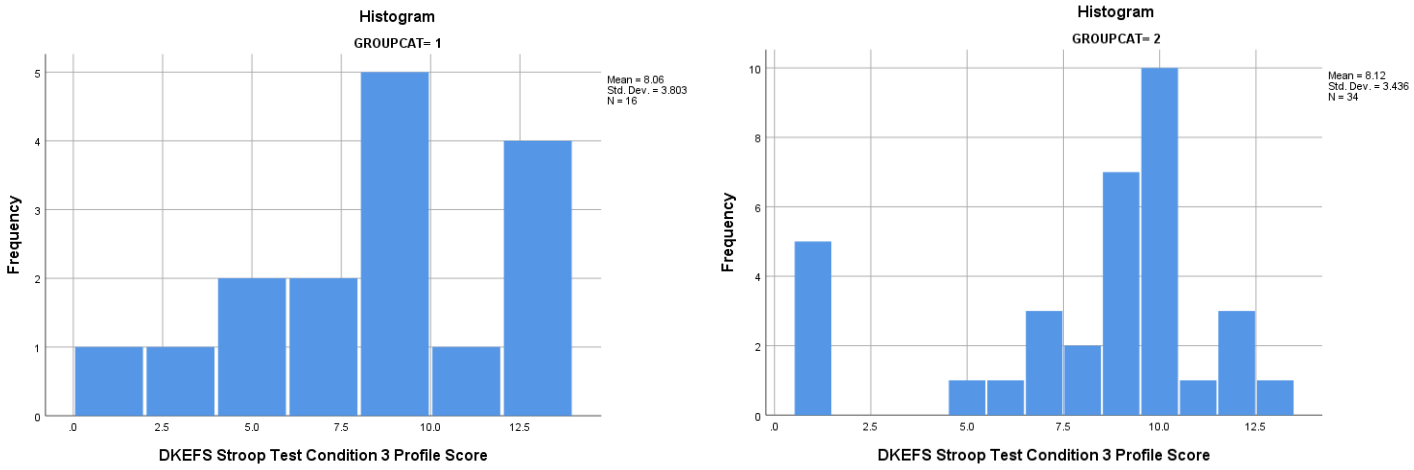

Figure 27. Histograms illustrating distributions of the D-KEFS Stroop Test Condition 3 profile scores on the HIGH_OC (left) and LOW_OC (right) groups respectively.

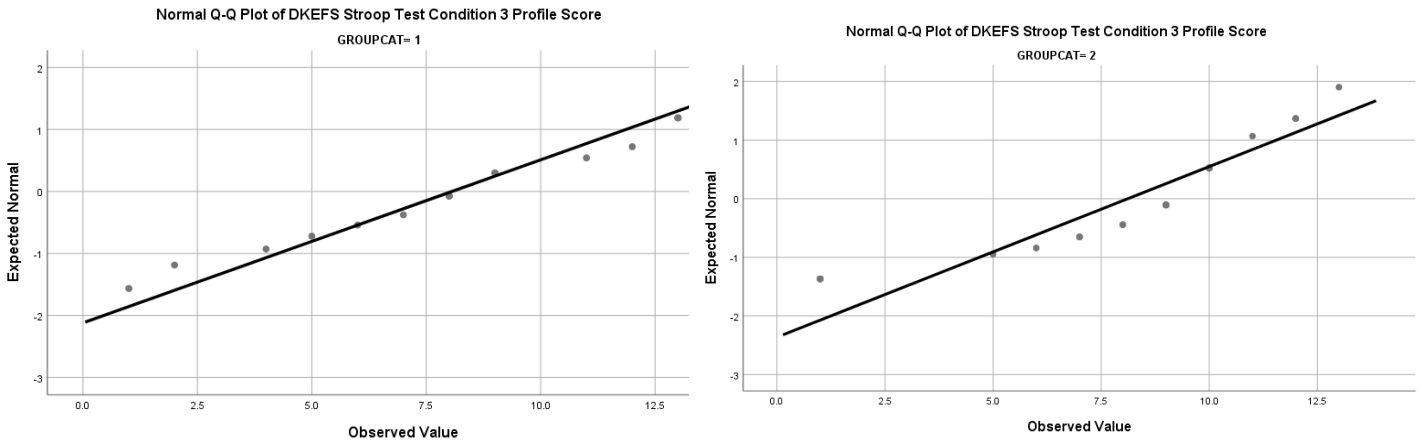

Figure 28. Normal Q-Q plots of the D-KEFS Stroop Test Condition 3 profile scores on the HIGH_OC (left) and LOW_OC (right) groups respectively.

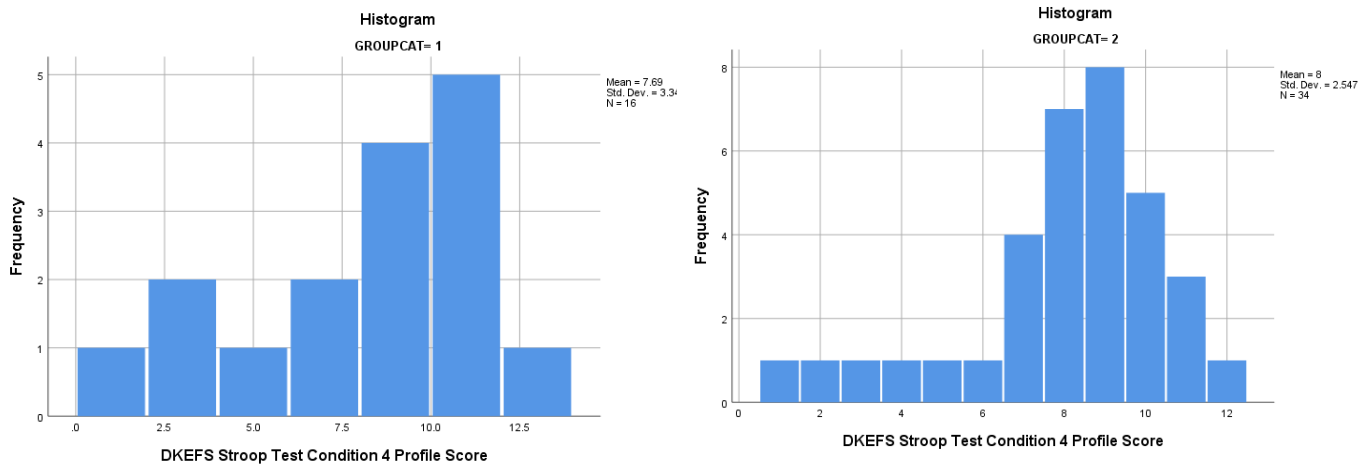

Figure 29. Histograms illustrating distributions of the D-KEFS Stroop Test Condition 4 profile scores on the HIGH_OC (left) and LOW_OC (right) groups respectively.

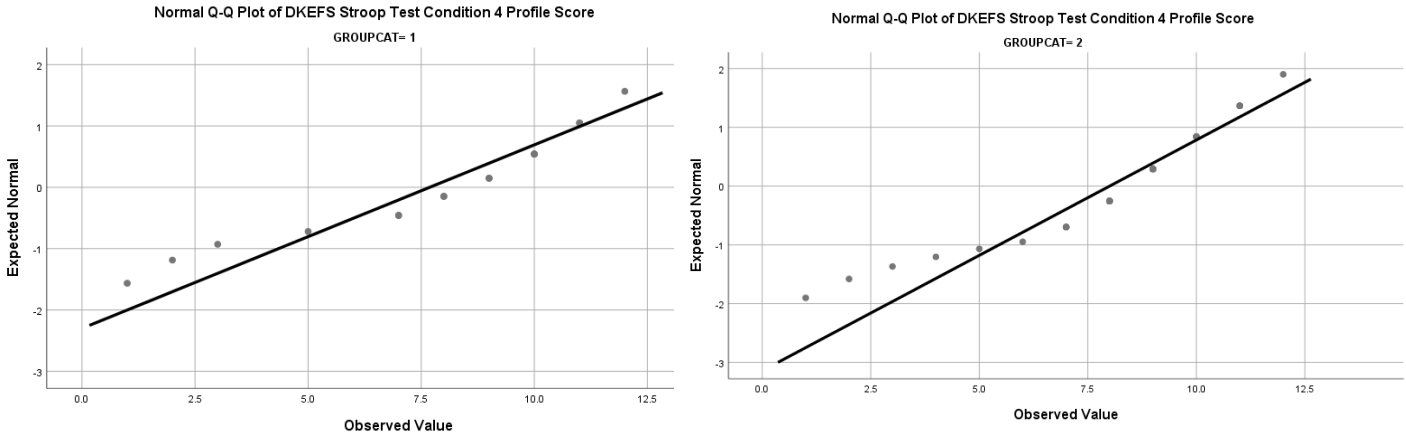

Figure 30. Normal Q-Q plots of the D-KEFS Stroop Test Condition 4 profile scores on the HIGH_OC (left) and LOW_OC (right) groups respectively.

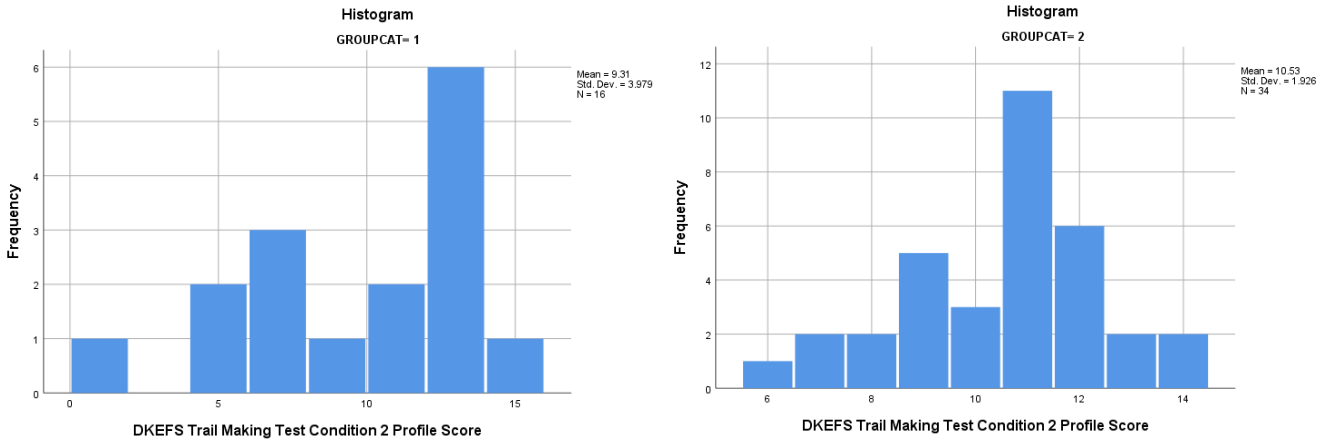

Figure 31. Histograms illustrating distributions of the D-KEFS Trail Making Test Condition 2 profile scores on the HIGH_OC (left) and LOW_OC (right) groups respectively.

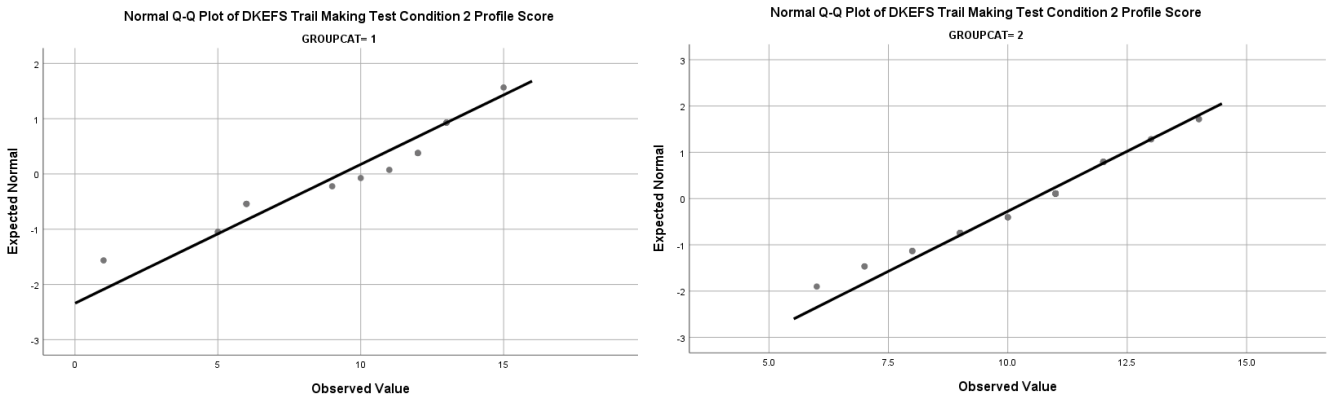

Figure 32. Normal Q-Q plots of the D-KEFS Trail Making Test Condition 2 profile scores on the HIGH_OC (left) and LOW_OC (right) groups respectively.

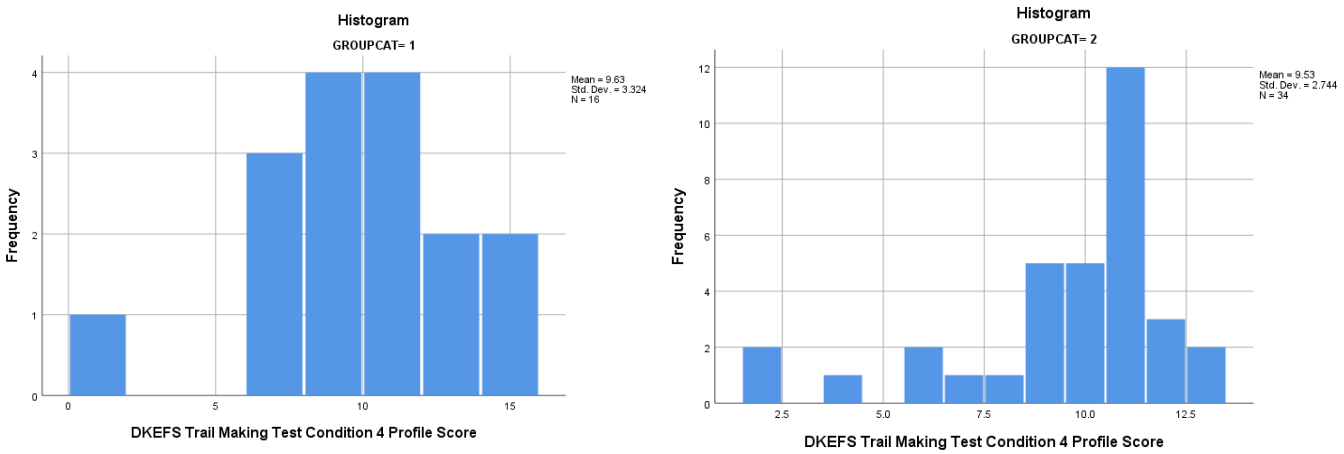

Figure 33. Histograms illustrating distributions of the D-KEFS Trail Making Test Condition 4 profile scores on the HIGH_OC (left) and LOW_OC (right) groups respectively.

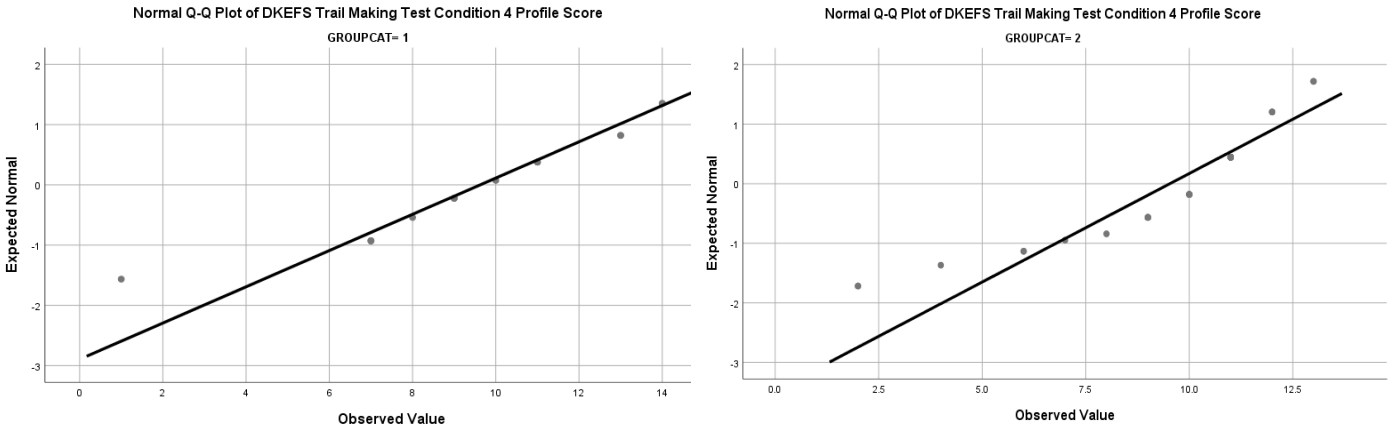

Figure 34. Normal Q-Q plots of the D-KEFS Trail Making Test Condition 4 profile scores on the HIGH_OC (left) and LOW_OC (right) groups respectively.

Appendix J

Dealing with Outliers

As mentioned in Chapter 4, outliers were transformed by reducing them to the next highest value within the sample through the process of windsorization. The box-plots below demonstrate the distribution of the data before and after the process of winsorization. Despite this process, analysis with and without outliers yielded the same results.

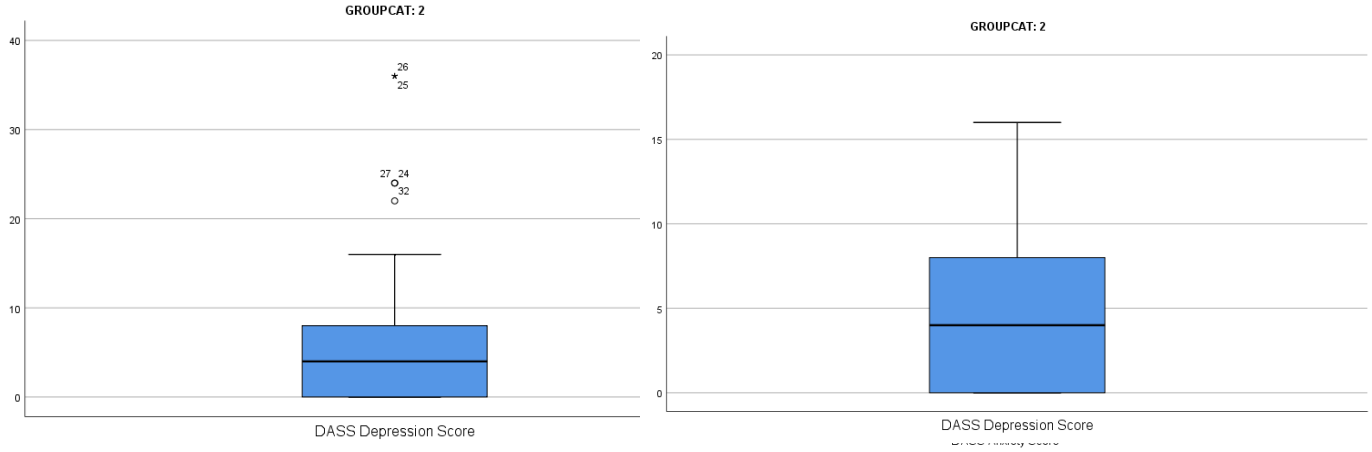

Figure 35. Box-plots illustrating data distribution within the HIGH_OC group of the DASS-21 Anxiety scale with outliers (left) and without outliers (right) following winsorization.

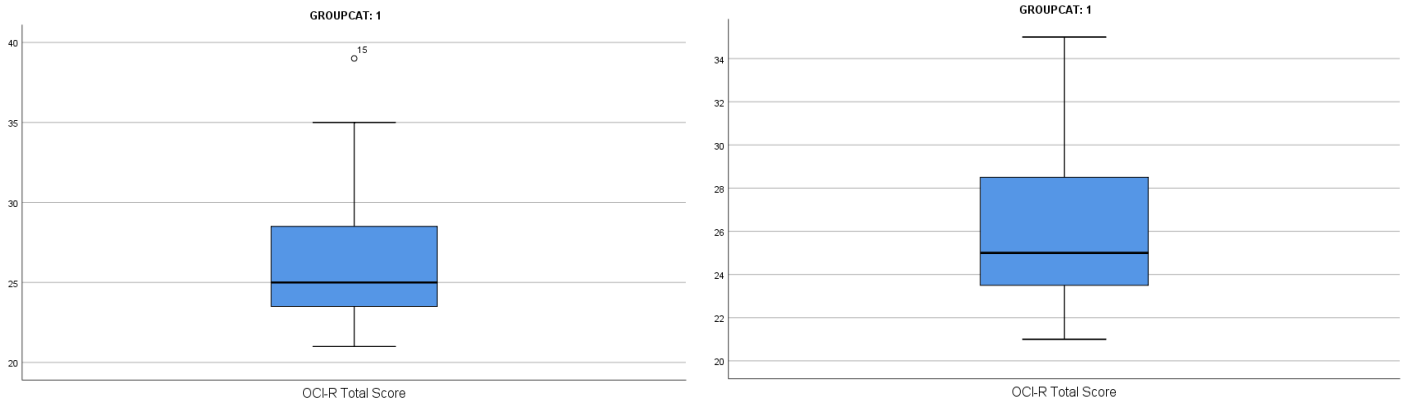

Figure 36. Box-plots illustrating data distribution within the HIGH_OC group of the OCI-R with outliers (left) and without outliers (right) following winsorization.

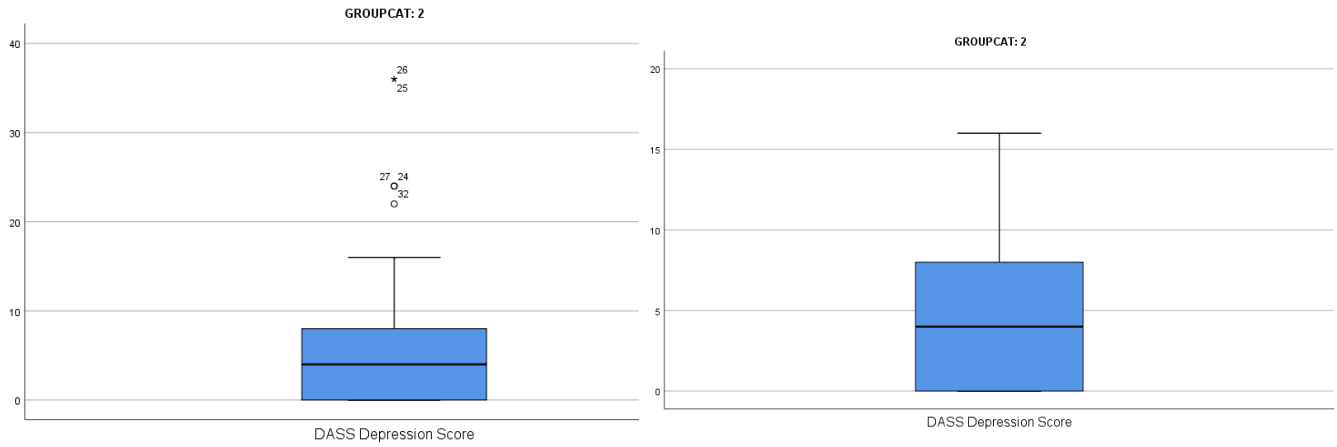

Figure 37. Box-plots illustrating data distribution within the LOW_OC group of the DASS-21 Depression scale with outliers (left) and without outliers (right) following winsorization.

Figure 38. Box-plots illustrating data distribution within the LOW_OC group of the DASS-21 Anxiety scale with outliers (left) and without outliers (right) following winsorization.

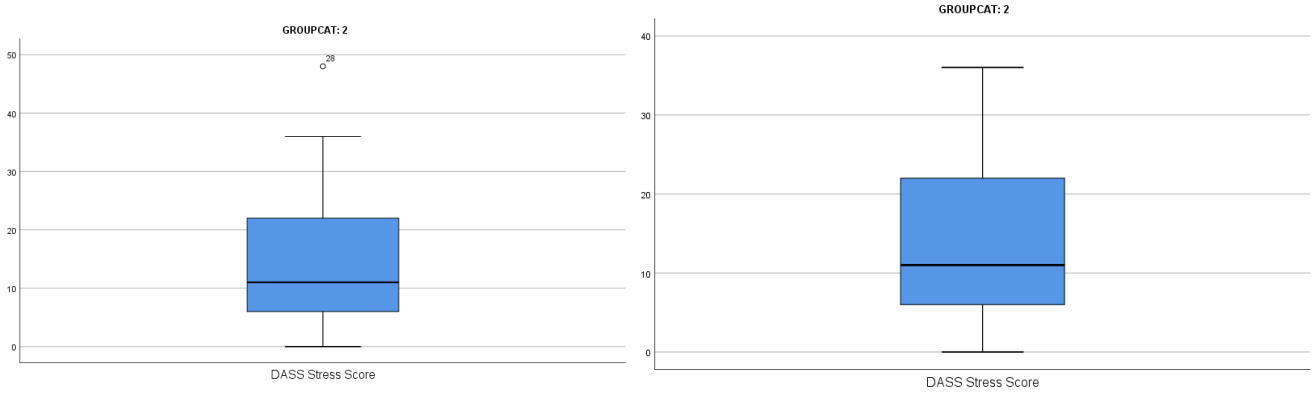

Figure 39. Box-plots illustrating data distribution within the LOW_OC group of the DASS-21 Stress scale with outliers (left) and without outliers (right) following winsorization.

Figure 40. Box-plots illustrating data distribution within the LOW_OC group of the OBQ-44 Importance of Thought and Control of Thought scale with outliers (left) and without outliers (right) following winsorization.

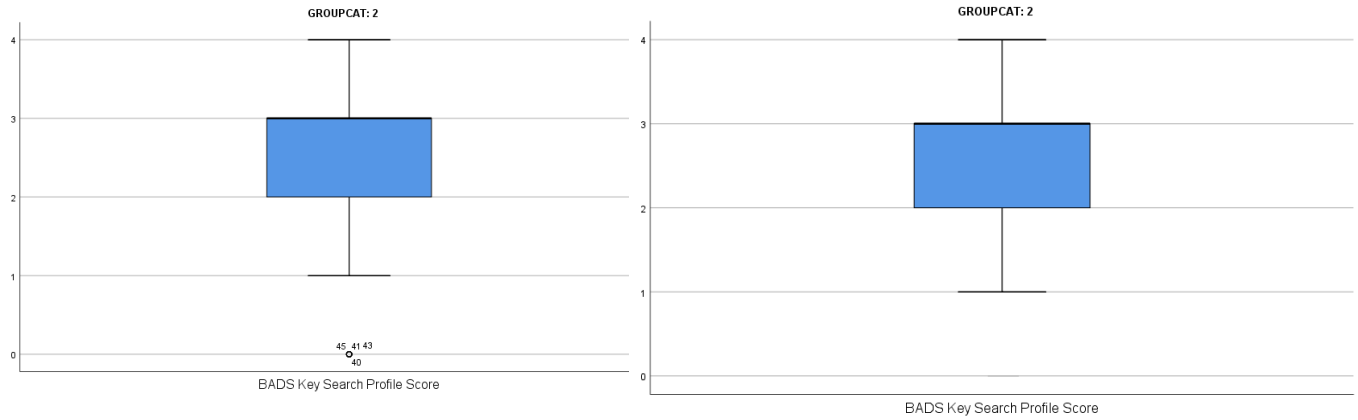

Figure 41. Box-plots illustrating data distribution within the LOW_OC group of the BADS Key Search subtest with outliers (left) and without outliers (right) following winsorization.

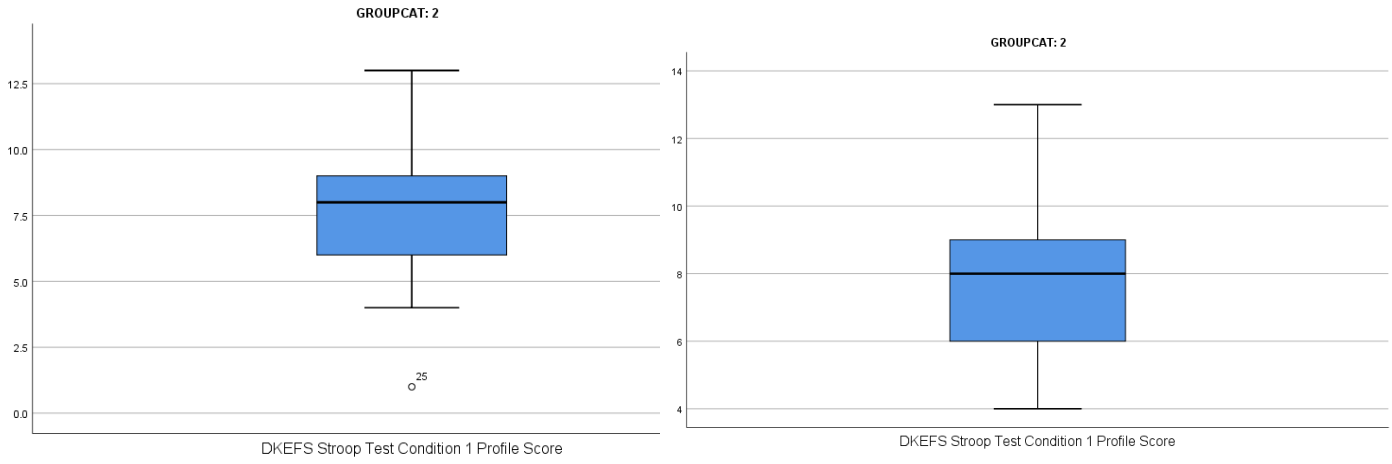

Figure 42. Box-plots illustrating data distribution within the LOW_OC group of the D-KEFS Stroop Test with outliers (left) and without outliers (right) following winsorization.

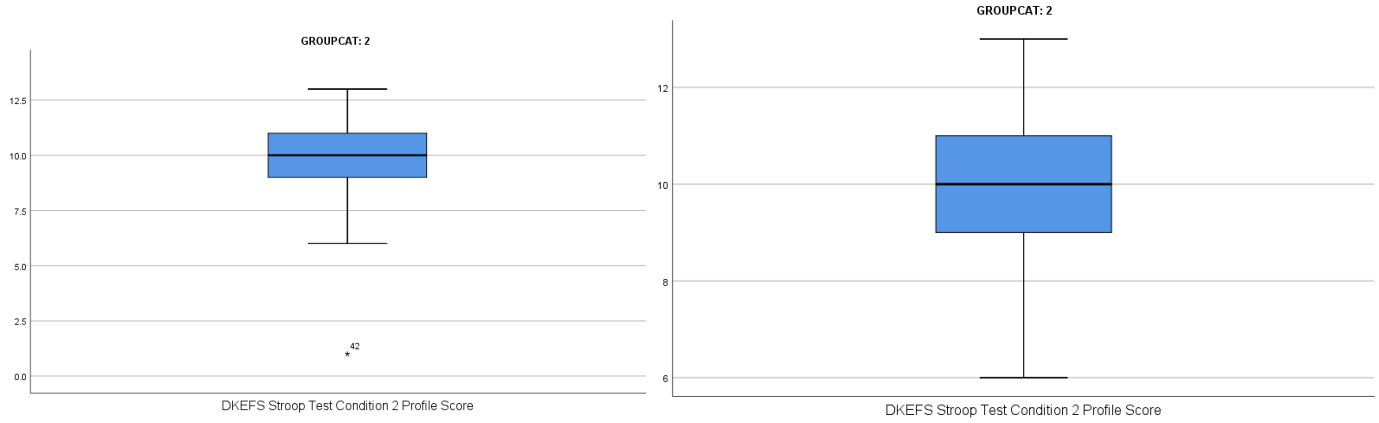

Figure 43. Box-plots illustrating data distribution within the LOW_OC group of the D-KEFS Stroop Test Condition 2 with outliers (left) and without outliers (right) following winsorization.

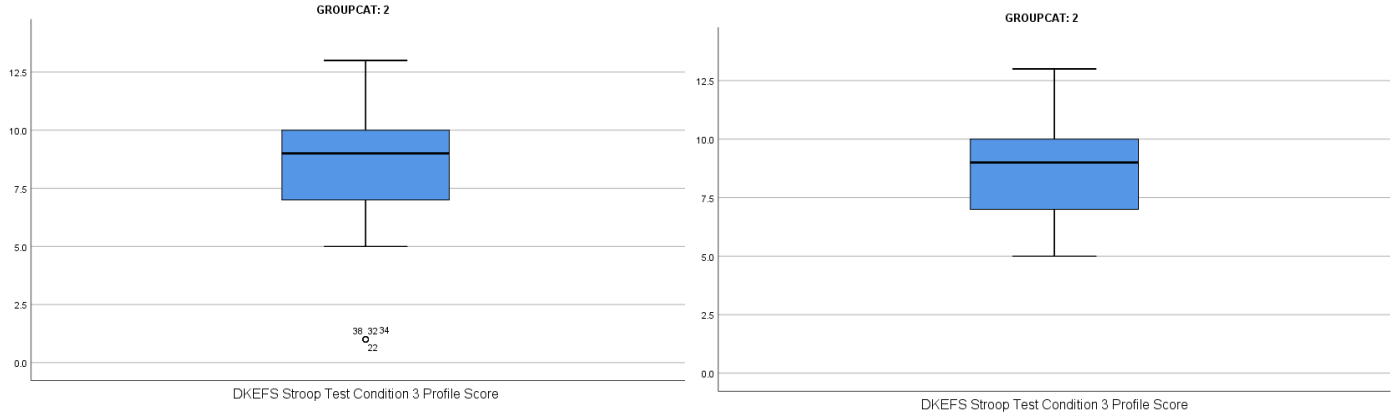

Figure 44. Box-plots illustrating data distribution within the LOW_OC group of the D-KEFS Stroop Test Condition 3 with outliers (left) and without outliers (right) following winsorization.

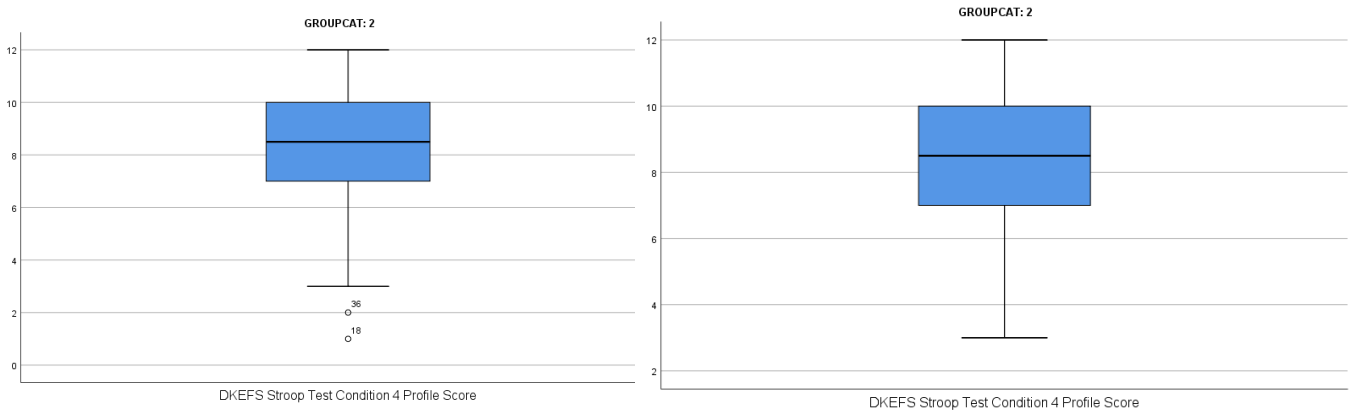

Figure 45. Box-plots illustrating data distribution within the LOW_OC group of the D-KEFS Stroop Test Condition 4 with outliers (left) and without outliers (right) following winsorization.

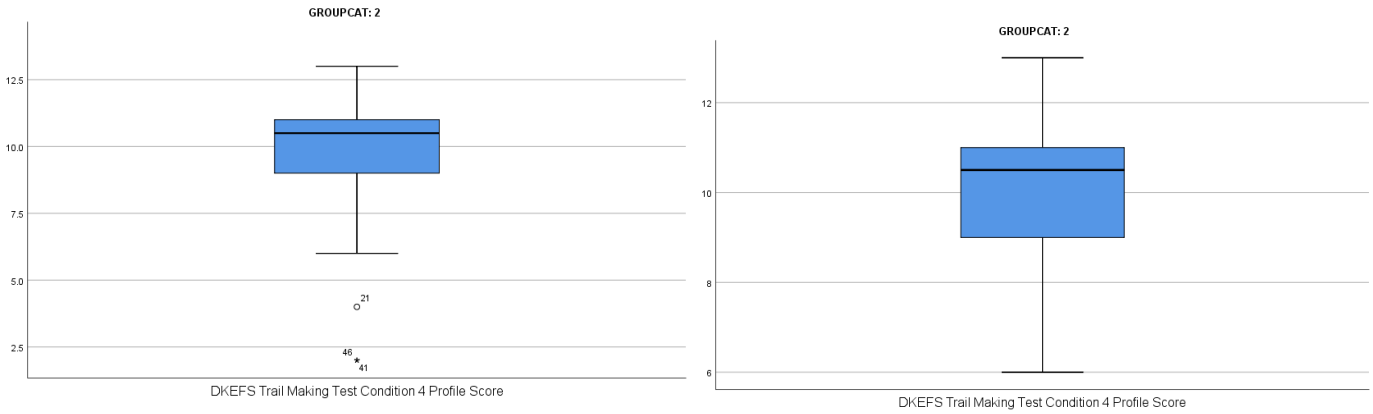

Figure 46. Box-plots illustrating data distribution within the LOW_OC group of the D-KEFS Trail Making Test Condition 4 with outliers (left) and without outliers (right) following winsorization.

Appendix K

Extended Discussion

The first part of the analytic process involved examining the relationship between gender and level of education. Results revealed no significant differences between the two groups, indicating that no significant differences in gender were observed in the likelihood of experiencing OCD symptoms. Past studies (e.g. Ruscio et al., 2010; Lochner et al., 2004) suggested that males make up the majority of earlier-onset cases and seem to experience a worse overall outcome, while symptoms in females were found to peak rapidly during adolescence. The distribution of males and females within both subgroups was very similar, and thus, do not match with extant literature.

Similarly, results revealed no significance differences in education levels and the likelihood of experiencing OCD symptoms. Literature (e.g. Nogardy, 2017; Cath, van Grootheest, Willemsen, van Oppen, Boomsma, 2008) have linked a higher likelihood of OCD symptoms in individuals with lower educational levels. Cath et al. (2008) argued that the neuropsychological impairments linked with OCD might be mediated by a lower educational level. Interestingly, despite the lack of significant differences, findings from this study revealed a higher percentage of participants possessing a tertiary level of education in the LOW_OC group (n = 27, 79.4%) when compared to the HIGH_OC group (n = 11, 68.8%). While the majority of participants in both groups possessed a tertiary educational level, the larger percentage in the LOW_OC group does not match previous literature. Nevertheless, it is important to consider that participants with higher educational levels were more willing to participate in the study, which could have affected the results.

In terms of age, it is unclear whether particular age ranges are more likely to experience OCD symptoms. Extant literature (e.g. Ruscio et al., 2010; Millet et al., 2004) seems to address the ages of onset of OCD symptoms. Therefore, it is difficult to conclude

whether OCD symptoms are present at higher rates in particular age ranges. This could be due to the lifetime prevalence of OCD as reported by Ruscio et al. (2010), which makes it difficult to measure higher rates in particular ages. In this study, results from the independent samples *t*-test revealed no significant differences in age between the two subgroups.

Within the local context, a larger number of participants was expected in the HIGH_OC group. The sample from this study showed otherwise, as the majority of participants fell under the LOW_OC group (n = 34). Such expectation was mainly due to the higher rates of Catholic individuals within the Maltese culture, as reported by the World Population Review (2019). Literature (e.g. Nelson et al., 2006; Abramowitz et al., 1996) has linked religion with OCD, and has suggested that individuals who need to feel morally just are more likely to show OCD symptoms. Additionally, the OCCWG (2001) linked religiosity with maladaptive beliefs, which are a strong cognitive underpinning in schemas of individuals with OCD.

Comparisons between HIGH_OC and LOW_OC Groups on OCD Questionnaires

Independent-samples *t*-tests were used to compare HIGH_OC and the LOW_OC groups on the OCD-related questionnaires and EF tests. Findings reported statistically significant differences between groups on three variables on the OBQ-44 Importance of Thoughts / Control score and the OBQ-44 Perfectionism / Intolerance of Uncertainty score. No differences were found between groups on the EF tests.

Results indicated that the HIGH_OC group demonstrated a higher likelihood of overestimating the importance of their thoughts and controlling their thoughts. They also seem to exhibit higher tendencies of perfectionism and intolerance of uncertainty. These findings are consistent with past literature (e.g. Nelson et al., 2006; Abramowitz et al., 2004; OCCWG, 2001) where the overestimation of importance of thoughts and perfectionism were

found to be key subscales of OCD. In these studies, both the overestimation of importance of thoughts and perfectionism in the context of OCD was linked to religiosity. Scrupulosity and acute perfectionism are also regarded as key features in the definition of obsessions (Bloch et al., 2008). As mentioned in the previous section, the local context consists of higher rates of religious individuals, which could possibly explain these findings. Additionally, statements related to religiosity within measures of importance of thoughts and thought control have been strongly associated with symptoms of OCD (Sica et al., 2012). Furthermore, the cognitive model postulated by the OCCWG (1997) regards the appraisal of intrusive thoughts as being the main difference between intrusive thoughts and urges in clinical and non-clinical samples (Rachman, 1998; Salkovskis, 1989). This finding is also consistent with Clark and Purdon (2016), which similarly regarded importance of thoughts and mental control as a key feature within the pathogenesis of OCD.

Interestingly, the HIGH_OC sample did not report experiencing an inflated sense of responsibility and perceiving threat of harm. This contrasts the cognitive theory by Salkovskis (1985) which links obsessions with one's appraisal of their own responsibility to prevent harm from occurring. When observing these findings, it seems that the HIGH_OC group exhibited internalised symptoms which were unrelated to others. Both over-importance of thoughts and perfectionism do not involve the possible harm to others, as having a sense of responsibility to prevent harm would. Research (e.g. Wheaton et al., 2010; Mataix-Cols et al., 2005) has increasingly recognised OCD as a dimensional disorder, where symptoms of OCD "can be distilled down to a smaller number of symptom dimensions" (Wheaton et al., 2010, p. 949). Another possible reason could relate to the local culture, where OCD symptoms might not be manifested through a sense of responsibility for others. Given that there is no clear evidence to support this finding, future studies on this topic may be better suited to explore this aspect.

Statistically significant differences were also indicated in the DASS-21 anxiety scores, with higher levels of anxiety reported in the HIGH_OC group. The most recent definition of OCD excludes anxiety from its list of symptoms (APA, 2013) anxiety symptoms in OCD are heterogenous (Stein et al., 2012). The fifth edition of the DSM has removed OCD from its prior classification within the anxiety disorders and has since been provided its own classification (APA, 2013). However, the finding in this study questions whether a level of anxiety is in fact present in individuals with a higher likelihood of having OCD. Stein et al. (2012) pointed out the overlapping symptoms in terms of cognitive-emotional processing in OCD and anxiety disorders. The most prominent similarity seems to be based on the excessive attention to threat, which in OCD extends to thought–action fusion leading to an excessive sense of personal responsibility (Stein et al., 2012). In this study, the DASS-21 was administered to detect symptoms of depression, stress or anxiety as possible confounders. Therefore, anxiety could have possible acted as a confounding variable which could have affected the overall results.