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Investigación | Research

Cognitive Load and Attentional Control in Puerto Ricans with Obsessive-Compulsive Disorder

Carga cognitiva y control atencional en puertorriqueños con trastorno obsesivo-compulsivo

Carga cognitiva e controle atencional em porto-riquenhos com transtorno obsessivo-compulsivo

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Resumen

The executive control of attention involves problem solving and voluntary action and has been implicated in emotion regulation. Some researchers have reported that attentional control is impaired in individuals with obsessive-compulsive disorder (OCD). However, influence of cognitive load and distraction on task performance has not been considered, which may have an impact on the control of attention. In this study, we evaluated if low and high cognitive load influences attentional control in individuals with OCD, compared to healthy controls. Methods: A total of 41 Puerto Rican adults participated in the study, 15 with OCD (M=31.60, SD=10.70) and 26 healthy controls (M=28.42, SD=10.73). A psychological evaluation was completed using structured interviews and self-reports. The Attention Network Test and a cognitive load task were performed to assess attentional control. Results: No significant differences in alerting, orienting, and attentional control scores were observed between groups (p>0.05). A significant difference was only observed in the attentional control of OCD (z= -1.99, p=0.047) and healthy participants (z= -2.83, p=0.005) between low and high cognitive load conditions. Conclusions: OCD and healthy participants experienced decreased interference from distractors under high cognitive load, suggesting increased attentional control during this condition. It is possible that increasing cognitive load can reduce distraction in OCD and healthy Puerto Ricans. Considering load may facilitate cognitive training for the control of attention and increase cognitive flexibility, enhancing treatment response

Abstract

El control ejecutivo de la atención implica la resolución de problemas y la acción voluntaria y se ha implicado en la regulación de las emociones. Algunos investigadores han informado que el control de la atención se ve afectado en personas con trastorno obsesivo-compulsivo (TOC). Sin embargo, no se ha considerado la influencia de la carga cognitiva y la distracción en el desempeño de la tarea, lo que puede tener un impacto en el control de la atención. En este estudio, evaluamos si la carga cognitiva baja y alta influye en el control atencional en individuos con TOC, en comparación con controles sanos. Métodos: Un total de 41 adultos puertorriqueños participaron en el estudio, 15 con TOC (M=31.60, SD=10.70) y 26 controles sanos (M=28.42, SD=10.73). Se completó una evaluación psicológica mediante entrevistas estructuradas y autoinformes. Se realizó el Test de Red de Atención y una tarea de carga cognitiva para evaluar el control atencional. Resultados: No se observaron diferencias significativas en las puntuaciones de alerta, orientación y control atencional entre los grupos (p>0,05). Solo se observó una diferencia significativa en el control atencional de TOC (z= -1,99, p=0,047) y participantes sanos (z= -2,83, p=0,005) entre condiciones de baja y alta carga cognitiva. Conclusiones: Los participantes con TOC y sanos experimentaron una disminución de la interferencia de los distractores bajo una alta carga cognitiva, lo que sugiere un mayor control atencional durante esta condición. Es posible que el aumento de la carga cognitiva pueda reducir la distracción en el TOC y en los puertorriqueños sanos. Considerar la carga puede facilitar el entrenamiento cognitivo para el control de la atención y aumentar la flexibilidad cognitiva, mejorando la respuesta al tratamiento

Resumo

O controle executivo da atenção envolve resolução de problemas e ação voluntária e tem sido implicado na regulação emocional. Alguns pesquisadores relataram que o controle atencional é prejudicado em indivíduos com transtorno obsessivo-compulsivo (TOC). No entanto, não foi considerada a influência da carga cognitiva e da distração no desempenho da tarefa, o que pode ter impacto no controle da atenção. Neste estudo, avaliamos se a carga cognitiva baixa e alta influencia o controle atencional em indivíduos com TOC, em comparação com controles saudáveis. Métodos: Participaram do estudo 41 adultos porto-riquenhos, 15 com TOC (M=31,60, SD=10,70) e 26 controles saudáveis (M=28,42, SD=10,73). Uma avaliação psicológica foi completada por meio de entrevistas estruturadas e auto-relatos. O Teste de Rede de Atenção e uma tarefa de carga cognitiva foram realizados para avaliar o controle atencional. Resultados: Não foram observadas diferenças significativas nos escores de alerta, orientação e controle atencional entre os grupos (p>0,05). Uma diferença significativa foi observada apenas no controle atencional de TOC (z= -1,99, p=0,047) e participantes saudáveis (z= -2,83, p=0,005) entre condições de baixa e alta carga cognitiva. Conclusões: TOC e participantes saudáveis experimentaram diminuição da interferência de distratores sob alta carga cognitiva, sugerindo maior controle atencional durante essa condição. É possível que o aumento da carga cognitiva possa reduzir a distração em TOC e porto-riquenhos saudáveis. Considerar a carga pode facilitar o treinamento cognitivo para o controle da atenção e aumentar a flexibilidade cognitiva, melhorando a resposta ao tratamento

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Introduction

Obsessive-Compulsive Disorder (OCD) is a chronic illness characterized by checking or doing things repeatedly or having thoughts that cause significant distress and alter an individual's functionality (Fenske et al., 2015, National Institute of Mental Health, 2019). Individuals with OCD use compulsions to avoid perceived threat or situations that might activate their obsessions. OCD affects approximately 1-3% of the general population and the cause of this psychiatric illness is unknown (Abramovitch et al., 2015; Pallanti et al., 2011; Nestadt et al., 2010). Recently, Canino et al. (2019) reported a 12-month prevalence rate of **22.5%** of Puerto Ricans with a psychiatric disorder living in Puerto Rico, suggesting an increased incidence of psychopathology on the island. Studies in Latin America revealed a lifetime prevalence rate of **3.2%** of OCD in Puerto Rico (Canino et al., 1987), compared to **1.4%** in Mexico City and **1.2%** in Chile (Williams & Steever, 2015). The data shown in these studies suggest higher lifetime and annual prevalence rates of OCD in Puerto Rico, compared to other Latin American countries, highlighting the increase of individuals with this disorder in a small island with approximately 3.337 million people.

OCD can significantly impair academic, social, and occupational functioning – quality of life (Ruscio et al., 2010; Eisen et al., 2006), as well as neurological activity (Pauls et al., 2014). This psychiatric illness is little understood and often misdiagnosed. The symptoms of this disorder are commonly confused with personality characteristics that may be informally catalogued as habits. In a review, Ociskova et al. (2013) found that perceived stigma affects how individuals with OCD experience the disorder and search for help and it also increases their anxiety, particularly because they anticipate rejection and are afraid of the reaction of others when they perform compulsive acts or rituals in public.

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Previous research suggests that decision-making and executive functioning are impaired in individuals with OCD, although studies on their neuropsychological performance have reported inconsistent findings (Abramovitch & Cooperman, 2015; Abramovitch et al., 2015; Dittrich & Johansen, 2013; Greisberg & McKay, 2003). Attention has a major role in learning and many constructs are involved in its processing. The attentional system involves several networks, including alerting, orienting, and executive control of attention (Fan et al., 2002). According to Fan et al. (2009), the ***alerting system***, which focuses on maintaining an alert state and preparing the individual to respond to a particular target, is related to frontal and parietal regions of the right hemisphere of the central nervous system, which are activated by vigilance and constant performance on tasks. The ***orienting system***, which involves selecting specific information from specific sensory inputs, is related to areas in the frontal and parietal lobes and is activated by presenting a cue that indicates where an individual should direct their attention to. The ***executive control of attention (attentional control)***, which involves more complex mental operation and conflict resolution, is related to midline frontal areas and the lateral prefrontal cortex and it is mostly activated by tasks associated to conflict. The executive control of attention involves problem solving and voluntary action control and has been implicated in the process of emotion regulation (Najmi et al., 2015). Research studies have shown that anxiety reduces the attentional focus of an individual while performing a cognitive task, thus having an impact on their attentional control or their capacity to selectively use cognitive resources to inhibit certain stimuli (Amir et al., 2009; Armstrong et al., 2011; Derryberry & Reed, 2002; Najmi et al., 2015). This effect of anxiety on attentional control may be present when there are both, task-irrelevant and threat-related stimuli. Several studies have provided support for the influence of cognitive load, which is the load or mental effort imposed by a particular task, on attentional control and emotion (Najmi et al., 2015; Paas et al., 2003; Pacheco-Unguetti et al., 2012). Some researchers argue that different types of load may affect the performance of cognitive tasks (Engstrom et al., 2017; Park et al., 2011), which can lead to difficulties in academic, occupational, and social functioning, and activities of daily living. Most of the limited research examining the interaction between cognitive load and attentional control have focused on individuals with non-clinical high and low anxiety and findings have demonstrated that working memory load or cognitive load influences attentional control and emotion processing, although these effects vary across studies (Berggren et al., 2013; MacNamara & Proudfit, 2014; Najmi et al., 2015). Although the literature suggests impairments in the neurocognitive functioning of individuals with OCD, most have not considered the effects of cognitive load and distraction on attentional control in this population (Armstrong et al., 2011; Dittrich and Johansen, 2013).

Armstrong et al. (2011) examined the influence of obsessional thoughts and perseverative worry in attentional control of patients with and patients with Generalized Anxiety Disorder (GAD) using self-reported assessments and found diminished attentional control in OCD patients and in those with GAD, compared to healthy controls. However, these deficits were associated with perseverative worry only in patients with GAD. On the contrary, the authors found that attentional control deficits were not related to perseverative worry or obsessional thoughts in patients with OCD. Additionally, rumination was not associated to these deficits in the attentional control of both OCD and GAD patients. They suggest that it is possible that trait anxiety may be mediating the relation between attentional control and perseverative worry in GAD and that obsessional thoughts may be developed and maintained the same way as other habits in OCD patients, for they may not be regulated by attention. Nonetheless, this study was limited by using self-reports. Moreover, they did not take into consideration other factors, such as cognitive load, that can be associated to attentional control (Berggren et al., 2013; Najmi et al., 2015; Vytal et al., 2013). In another study, Najmi et al. (2015) assessed the effect of cognitive load on attentional control by using the Attention Network Test (ANT), a computerized test that measures the different attention components: alerting, orienting, and executive control of attention. Individuals with subclinical anxiety and a clinical sample with GAD performed this task twice, under a low load condition (i.e., counting backward from 100 by 1's while completing the ANT) and under a high load condition (i.e., counting backward from 100 by 3's while completing the ANT). Results showed that subjects with subclinical high anxiety and those with GAD showed increased attention control, but only under high cognitive load. These findings highlight the importance of considering the influence of cognitive load when attentional control is measured, since attentional control deficits can negatively impact daily life activities, particularly in areas such as academic achievement and job performance.

Variations in OCD symptoms may exist based on cultural factors, since an individual's cultural background and the content of obsessions and compulsions can have an influence in the manifestation of OCD (Nicolini et al., 2017). The heterogeneity of the disorder and the lack of inclusion of Latino clinical samples in OCD studies suggests the importance of innovative research focused on the minority population. To our knowledge, research in OCD is limited in Puerto Rico and although there are evidence-based treatments for this disorder, the underrepresentation of minority groups in research studies brings inquiries about the effectiveness of validated treatments for this population (Williams et al., 2010).

Low participation of Latinos with OCD on research studies in the United States and their limited use of mental healthcare services may reduce the reliability of research findings. Wetterneck et al. (2012) reviewed studies on the use of mental healthcare and the inclusion of Latinos with OCD in clinical studies and results revealed that Latinos were included in only 11 **(12.2%)** of the 90 studies evaluated from the United States and Canada. The heterogeneity of OCD and the insufficient representation of Latinos with this disorder in previous literature demands more research to develop effective culturally adapted evidence-based treatments for this population.

In view of the increased prevalence rates of Puerto Ricans affected by OCD and the need of research including this population, in the current study, we evaluated the effects of cognitive load on the different components of attention: alerting, orienting, and executive control of attention, in a Puerto Rican sample with OCD and a healthy control group. First, we hypothesized that the group with OCD would have increased alerting and orienting functions while performing an attention task under high cognitive load condition but not under low cognitive load, compared to healthy subjects, who would have increased alerting and orienting functions under both low and high cognitive load conditions. Second, our central hypothesis was that participants with OCD would show increased attentional control under high cognitive load, but not under low cognitive load, compared to healthy individuals, who would show increased attentional control under both low and high cognitive load. In other words, we hypothesized that individuals with OCD would show increased interference from distractors under low cognitive load, but not under high cognitive load, while healthy controls would show decreased interference from distractors in both cognitive load conditions. Understanding the circumstances in which attentional control is affected is essential given the importance of the executive control of attention in emotion regulation. This study can bring important contributions regarding the neurocognitive functioning of Puerto Ricans with OCD that could lead to effective evidence-based treatments for this underrepresented population.

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Methods

Design

This research was non-experimental, since no variables were manipulated, only observed. An observational, cross-sectional exploratory design was used. With a cross-sectional exploratory design, data was obtained in a particular moment, on a specific time with the purpose of evaluating the variables in a specific context, event, or situation (Hernández-Sampieri et al., 2010).

Participants

Healthy subjects and participants with OCD were recruited via local advertising and were selected by availability. Individuals that had received services at the Center for the Study and Treatment of Fear and Anxiety (CETMA, for its Spanish acronym) and that met the inclusion criteria for the study were invited to participate via telephone after the review of records, which was the only method of contact. The following inclusion criteria was required to participate in the study: aged 21-60, able to provide informed consent, Puerto Rican, Spanish-speaking, OCD diagnosis (for the OCD group), and no psychiatric diagnosis (for the healthy control group). The exclusion criteria included the following: complicating medical conditions (e.g., heart complications), history or active drug, alcohol or substance dependence in the last 6 months, history of a neurological disorder, and history of **Attention Deficit Disorder with or without Hyperactivity (ADD or ADHD).**

Participants received some benefits for participating in this study. They obtained educational information about **OCD** and mental health services at **CETMA**, if needed. In addition, subjects participated in a raffle to win one of three $50 Amazon gift cards. The raffle took place after the recruitment of all participants was completed and was done using the Random Picker application (https://www.randompicker.com). They were contacted through telephone or e-mail and were asked to meet in CETMA to receive the gift card.

Ethical Considerations

This study was approved by the **Institutional Review Board (IRB)** at the University of Puerto Rico, Medical Sciences Campus and was handled in accordance with the University of Puerto Rico's policy on confidentiality. The information obtained was kept anonymous and was safeguarded based on the regulations of the **Health Insurance Portability and Accountability Act (HIPAA)**.

The personal information obtained from the records of individuals who meet the inclusion criteria for the study and that have received services in CETMA (name, telephone number, and diagnosis) was immediately destroyed after their invitation to participate. All subjects had an ID code to adhere to confidentiality agreements. A master database was created with the assigned ID codes and data collected for analysis. The assigned ID codes were matched in all data collected as part of the study.

During the study, subjects may have felt discomfort by answering some sensitive questions about stressful life events, symptoms of psychiatric disorders (i.e., OCD), and other questions assessed by the Structured Clinical Interview for DSM-IV – TR Axis I Disorders, Research Version (SCID-I, 2002), an interview performed to assess psychiatric symptomatology. This interview explored symptoms of mental disorders, personality traits, medications, and history of substance use during the past 12 months. Additionally, females were asked to identify their last menstrual period to control for hormonal variations. Participants could refuse to answer any questions that might cause them discomfort and their responses were kept confidential.

Measures/Instruments

Demographics sheet

The demographic sheet was designed to obtain the following information: age, sex, race/ethnicity, education level, occupation, marital status, telephone number, and e-mail.

Psychological Assessments

Beck Anxiety Inventory – Spanish Version (BAI).

The Beck Anxiety Inventory (BAI) was created by Beck et al. (1988) to measure the severity of anxiety. This instrument is a self-report that takes approximately 5-10 minutes to complete and it is administered to individuals with 17 years or older. It is composed of 21 items, rated from 0 (not at all) to 3 (severely, bothered me a lot). The scores on the items are added. Scores 0-7 indicate very low anxiety symptoms, scores 8-15 indicate mild anxiety symptoms, scores 15-25 indicate moderate anxiety symptoms, and scores 26-63 indicate severe anxiety symptoms. The psychometric properties of the English and Spanish version of the BAI are very similar, which increases the reliability of the self-report (Novy et al., 2001).

Obsessive-Compulsive Inventory – Revised (OCI – R).

The Obsessive-Compulsive Inventory – Revised (OCI-R) was elaborated by Foa et al. (2002). The OCI-R is a self-report questionnaire that takes approximately 5-10 minutes to complete and can be administered to adults. It consists of 18-items in which patients rate the amount of distress they have experienced by 18 common OCD symptoms during the last month. The symptoms are rated on a scale ranging from 0 (not at all) to 4 (very much). The self-report contains 18 items rated on two 5-point Likert scales: one measuring symptom frequency and another measuring distress caused by the symptoms. The items form six subscales based on the following categories: washing, checking, ordering, obsessing, hoarding, and neutralizing. According to the authors, people with OCD typically have a score of 21 points and higher. The revised OCI is an improved version by eliminating improves the redundant frequency scale, simplifying the scoring of the subscales, and reducing the overlap across subscales (Foa et al., 2002). Moreover, the OCI-R has shown good to excellent internal consistency (alpha coefficients above .70), test-retest reliability, and convergent validity, according to Foa et al (2002).

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Interview Assessments

Structured Clinical Interview for DSM-IV – TR Axis I Disorders, Research Version (SCID I).

The Structured Clinical Interview for DSM-IV–TR Axis I Disorders, Research Version (SCID-I) was designed by First et al. (2002). It takes approximately 1 hour to complete, it is administered to adults 18 years or older, and it is a clinician rated report. This interview explores symptoms of mental disorders (including OCD), personality traits, medications, and history of substance use during the past 12 months. Additionally, females are asked to identify their last menstrual period to control for hormonal variations. Participants could refuse to answer any questions that might have cause them discomfort and their responses were kept confidential.

Yale-Brown Obsessive Compulsive Scale (Y-BOCS).

The Yale-Brown Obsessive Compulsive Scale (Y-BOCS) is a semi-structured interview-based rating scale that was created by Goodman et al. (1989). According to Goodman et al. (1989), the alpha coefficient was 0.89 for the internal consistency of the Y-BOCS. The Spanish version was validated by Vega-Dienstmaier et al. (2002). It takes approximately 15-30 minutes to complete, it is administered to adults and it is a clinician rated report. It is used to evaluate the severity and type of symptoms in individuals with OCD. It is composed of two parts: (1) the Severity Scale and (2) the Symptom Checklist. The Y-BOCS includes a 10-item scale, rated from 0 (no symptoms) to 4 (extreme symptoms) (total range, 0 to 40). The interviewer explores past and present symptomatology and may ask additional questions for clarification. It includes questions based on the amount of time the individual spends in obsessions and compulsions and how much distress and impairments they have experienced.

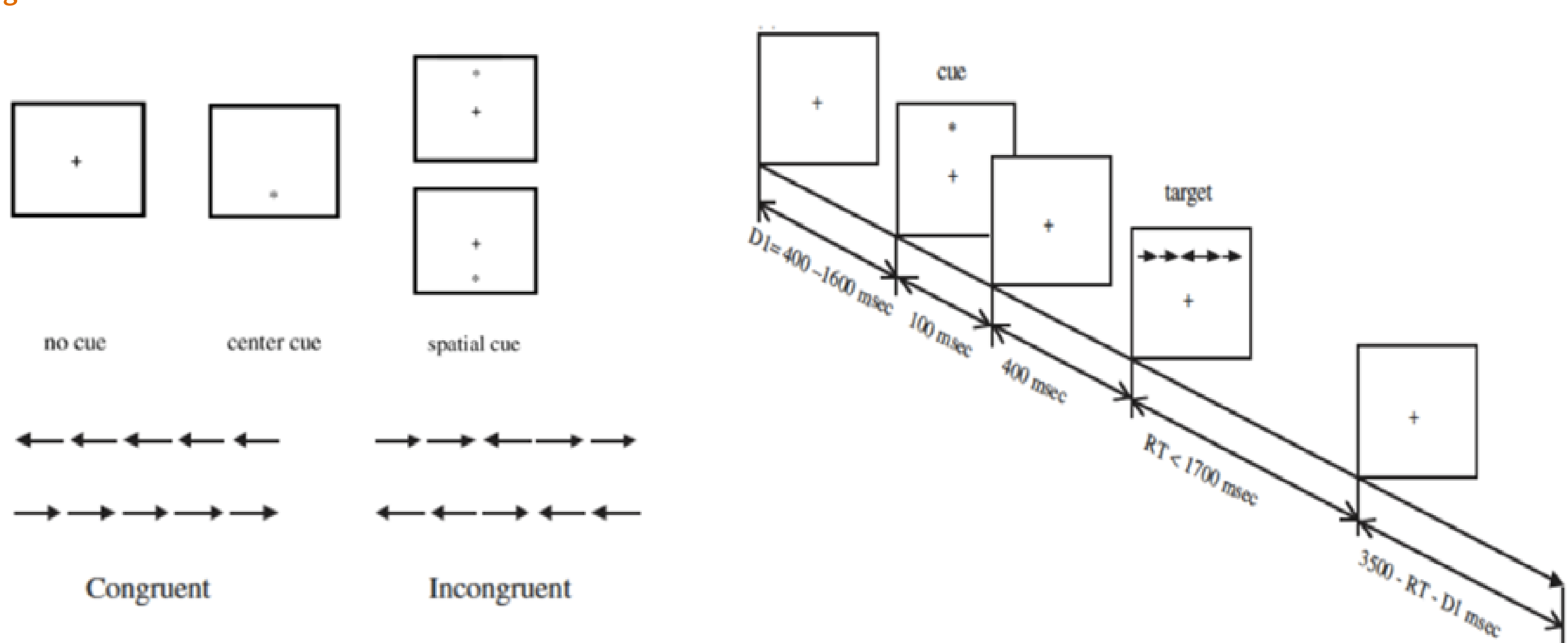
Attentional Control and Cognitive Load Assessment

Attention Network Test.

The Attention Network Test (ANT) was designed by Fan et al. (2002) and can be administered to children and adults, ages 6 to 85, to assess three attentional networks: (1) alerting, (2) orienting, and (3) executive control of attention. In the current study, we assessed the three attentional networks, but mostly focused on the executive control of attention, given that attentional control is included in this system.

The original ANT is computerized and it comprises of 288 trials. We used the short version of the ANT that comprised two blocks of 96 trials, see Figure 1. First, a fixation cross (+) was presented for about 400 to 1,600 msec. Then, the fixation cross was replaced by one of three possible cues represented by asterisks (*). The three cuing conditions are: no cue, center cue, and spatial cue. The center cue appears directly in the middle of the screen, alerting the participant that the target will appear soon. The spatial cues direct participants to the correct location of the target (i.e., where the target will be presented). The asterisk cues (*) can appear at the center, above, or below the location of the cross for 100 msec, followed again by the fixation cross for 400 msec. Later, a row of arrows appears above or below the location of the fixation cross. The center arrow is flanked by arrows that could either be congruent or incongruent. There two flaker conditions are: congruent (e.g., →→→→→) and incongruent (e.g., →→←→→). Participants are required to identify the direction of the central arrow (left or right) and the screen remains for 1,700 msec or until the participant responds. Finally, the fixation cross is presented again during each trial. They complete 12 practice trials with feedback and then two blocks of 96 test trials with no feedback, which were counterbalanced considering cueing and flanker conditions. The test was run on a Dell computer with a 15.6 computer screen using E-Prime 3.0 software and participants' response times (RT) were recorded.

Figure 1 Attention Network Test Procedure



Note. The ANT procedure adapted by Fan et al. (2002, 2009). (a) The three cue conditions. (b) The two flanker conditions including the four stimuli. (c) An example of the procedure.

Cognitive Load Task

For the current study, we used the cognitive load task procedure described by Najmi et al. (2015). Participants completed the ANT task twice, under low cognitive load and high cognitive load conditions. Under the low load condition, participants counted backward from 100 by 1's and at the same time, they completed the ANT. Under the high load condition, participants counted backward from 100 by 3's, completing the ANT at the same time. The order of the load conditions was counterbalanced.

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The alerting index was calculated by subtracting the mean RT of no-cue trials from the mean RT of center-cue trials. The orienting index was calculated by subtracting the mean RT for center-cue trials from the mean RT for spatial-cue trials. The attentional control index was obtained by subtracting the mean RT for incongruent trials from the mean RT for congruent trials. A higher score for the conflict index –conflict scores between low and high cognitive load conditions– implies lower attentional control.

Procedure

The study was performed at CETMA and took approximately 3 hours on a single day to complete, including breaks, which were given between assessments in order to prevent exhaustion in participants. During the initial telephone contact, candidates were screened for OCD symptoms. If they qualified, they were given an appointment for the formal evaluation. During the day of evaluation, a written informed consent was obtained from participants before beginning the study. They were informed that participation was voluntary and that they may withdraw from the study at any time. First, after participants signed the consent form, demographic information was obtained and participants were then interviewed using the SCID-I (2002) to identify and confirm a clinical diagnosis of OCD. Second, all participants were asked to complete psychological questionnaires to assess anxiety severity. Third, the attentional control assessment was administered. Finally, participants with OCD were interviewed using the Y-BOCS to assess obsessive-compulsive symptoms and severity. Healthy controls were screened to exclude a psychiatric diagnosis and other exclusion criteria and followed the same protocol as the OCD subjects except for the OCD symptom severity interview using the Y-BOCS. After data collection, test scores were analyzed and compared between the OCD sample and healthy controls. The results that were statistically significant (***p***<0.05) were considered to shed light into understanding the mechanisms of OCD and further enabling the modification and development of treatment programs for this population.

Statistical analyses

Frequency distributions and descriptive analyses were used for demographic variables and sample description. Non-parametric statistical analyses were used given the small sample size. We conducted a Wilcoxon signed-rank test to assess if high cognitive load was characterized by slower speed and lower accuracy, compared to the low cognitive load condition. Mann-Whitney U tests were conducted to assess mean RT and accuracy differences between groups under low and high cognitive load. We used the Mann-Whitney U test to assess OCD and healthy control group differences in alerting, orienting, and conflict scores (attentional control) scores under low cognitive load. The Mann-Whitney U test was also used to examine OCD and healthy control group differences in alerting, orienting, and conflict scores (attentional control) under high cognitive load. Additionally, a Wilcoxon signed-ranks test was conducted to evaluate the effect of low and high cognitive load in alerting, orienting, and executive control networks of OCD and healthy groups. Statistical significance was set at p<0.05. Data was analyzed using SPSS software package, version 22.

Results

Demographic Data

All analyses were based on 41 participants (**48.8%** female) with a mean age of 29.59 (***SD=10.70***), divided into OCD and healthy control (***mean age=28.42, SD=10.73***) groups (Table 1). The OCD group included 15 participants (***mean age=31.60, SD=10.70***) that included **46.7%** females (n=7) and **53.3%** males (n=8) and 26 healthy controls that included **50%** females (n=13) and **50%** males (n=13). In terms of the education levels of the participants, the number of subjects that had completed graduate studies was the highest in the OCD group (**53.3%**) and the number of subjects that had completed a bachelor's degree (**30.8%**) and part graduate studies were the highest in the healthy controls group (**30.8%**). Significant differences were observed in education level, psychological history, and use of psychiatric medication during the last month by groups; the OCD group had more education years compared to the healthy group. Diagnostic characteristics of the OCD group as reported by the OCI-R are shown in Table 2.

Table 1 Demographic Characteristics by Group **(OCD vs HC)**

	OCD (n=15)		HC (n=26)		
	Total (%)	Mean (SD)	Total (%)	Mean (SD)	*p*
Sex					**0.862**
Male	8 (53.3)	-	13 (50)	-	-
Female	7 (46.7)	-	13 (50)	-	-
Age	-	**31.60 (10.71)**	-	**28.42 (10.73)**	**0.174**
Education Level (yrs)		**18.13 (2.56)**		**16.73 (2.10)**	**0.043***
High School Diploma	1 (6.7)		0 (0)		
Associate Degree	0 (0)		1 (3.8)		
Part College	1 (6.7)		5 (19.2)		
Bachelor's Degree	2 (13.3)		8 (30.8)		
Part Graduate Studies	3 (20.0)		8 (30.8)		
Completed Graduate Studies	8 (53.3)		4 (15.4)		
Marital Status					**0.164**
Single	10 (66.7)		22 (84.6)		-
Married	4 (26.7)		4 (15.4)		-
Divorced	1 (6.7)		0 (0)		-
Occupation					**0.301**
Yes	12 (80.0)		26 (100)		-
No	3 (20.0)		0 (0)		-
Medical History					**0.758**
Yes	6 (40.0)		12 (46.2)		
No	9 (60.0)		14 (53.8)		
Psychological History					**0.000***
Yes	13 (86.7)		0 (0)		-
No	2 (13.3)		26 (100)		-
Psychiatric Medication					**0.000***
Yes	8 (53.3)		0 (0)		
No	7 (46.7)		0 (0)		

Note. OCD=Obsessive-Compulsive Disorder; HC=Healthy Controls.*p<0.05
Source: Elaboration

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Table 2. Diagnostic Characteristics of the OCD group **(n =15)**

Characteristic	Total (%)
OCD Severity	
Mild	2 (13.3)
Moderate	8 (53.3)
Severe	4 (26.7)
Extreme	1 (6.7)
Types of Obsessions	
Aggressive	9 (60.0)
Contamination	8 (53.3)
Sexual	4 (26.7)
Hoarding/Saving	3 (20.0)
Religious	3 (20.0)
Symmetry	7 (46.7)
Miscellaneous	11 (73.3)
Somatic	6 (40.0)
Types of Compulsions	
Cleaning/Washing	8 (53.3)
Checking	12 (80.0)
Repeating	10 (66.7)
Counting	6 (40.0)
Ordering	5 (33.3)
Hoarding	2 (13.3)
Miscellaneous	9 (60.0)
Comorbidity	
PTSD	3 (20.0)
MDD	3 (20.0)
Dysthimia	1 (6.7)
Social Anxiety	1 (6.7)
Social Phobia	3 (20.0)
GAD	7 (46.7)
Panic	2 (13.3)

Note. OCD=Obsessive-Compulsive Disorder; PTSD=Post-Traumatic Stress Disorder; MDD=Major Depressive Disorder; GAD=Generalized Anxiety Disorder

Source: Elaboration

Self-Report Data

A Mann-Whitney U was conducted to examine anxiety severity between OCD and healthy control groups, as assessed by Beck Anxiety Inventory (BAI). The test showed a significant difference in anxiety severity between groups (**z= – 4.46, p=0.000**), suggesting increased symptoms of anxiety in the OCD group (**M=16.4, SD=10.56**), compared to healthy controls (**M=3.96, SD=4.94**).

Cognitive Load Manipulation Check

Only correct trials were included in the RT analyses. **2.85%** of the trials were removed due to incorrect answers. A Wilcoxon signed-rank test was conducted to evaluate if high cognitive load was characterized by slower speed and lower accuracy, compared to the low cognitive load condition. Significant differences were observed in mean RT (***z= – 4.10, p=0.000***) and accuracy (***z= – 4.00, p=0.000***) under low and high cognitive load when both **OCD** and healthy control groups were considered. After splitting analyses by group, mean RT of the OCD group did not differ significantly between low cognitive load and high cognitive load conditions (***z= – 1.85, p=0.065***). However, mean accuracy in the **OCD** group differed significantly between low cognitive load compared to the high cognitive load condition (***z= – 2.56, p=0.01***), suggesting lower accuracy under the high cognitive load condition. Moreover, significant differences were observed in mean RT (***z= – 3.67, p=0.000***) and mean accuracy (***z= – 3.02, p=0.002***) of the healthy control group under low cognitive load compared to high cognitive load condition, suggesting slower RT and lower accuracy under the high cognitive load condition.

Mann-Whitney U tests were conducted to assess mean RT and accuracy differences between groups under low and high cognitive load. No significant differences were observed in mean RT between groups under low cognitive load (**z= – 1.46, p=0.144**) or high cognitive load (**z= – 1.19, p=0.234**) conditions. Furthermore, no significant differences were observed in mean accuracy between groups under low cognitive load (**z= – 1.07, p=0.283**). However, significant differences were observed in mean accuracy between OCD and healthy control groups under the high cognitive load condition (**z= – 2.43, p=0.015**), with a medium effect size of 0.37 (Cohen, 1988), suggesting lower accuracy by the OCD group, compared to the healthy control group, under the high cognitive load condition.

These results show that the high cognitive load condition is characterized by slower speed, although the difference between RT under low and high cognitive load was only significant in the healthy control group. These results also suggest that the high cognitive load condition is characterized by lower accuracy in both OCD and healthy control groups, compromising working memory more than the low cognitive load condition. In addition, significant differences in mean accuracy between groups were observed during the high cognitive load condition, suggesting lower accuracy by the OCD group.

Attention Network Test Measures: Attentional Networks

Attention network (alerting, orienting, executive control of attention) calculations by means under low and high cognitive load for the OCD group are shown on Tables 3-4.

Table 3 ANT Mean RT by Flanker, Cue, and Index in OCD group under Low Cognitive Load (***n*** =15)

	Cue Type				
Flanker Type	No-cue	Center-cue	Spatial-cue		Flanker Mean
Incongruent	745.41	742.68	671.85		**719.98**
Congruent	659.52	627.28	597.74		**628.18**
Cue Mean	**702.47**	**684.98**	**634.80**		
	CueType	Cue Type		Index	
Alerting	**No-cue**	**Center-cue**		**Alerting**	
	702.47	684.98		17.49	
Orienting	**Center-cue**	**Spatial-cue**		**Orienting**	
	684.98	634.80		50.18	
Executive Control of Attention	**Incongruent**	**Congruent**		**Control**	
	719.98	628.18		91.80	

Source: Elaboration

Table 4 ANT Mean RT by Flanker, Cue, and Index in OCD group under High Cognitive Load (***n*** =15)

Flanker Type	Cue Type No-cue	 Center-cue	 Spatial-cue		Flanker Mean
Incongruent	747.85	759.72	706.78		**738.12**
Congruent	715.79	678.11	636.55		**676.82**
Cue Mean	**731.82**	**718.92**	**671.67**		
	Cue Type	Cue Type		Index	
Alerting	**No-cue**	**Center-cue**		**Alerting**	
	731.82	718.92		12.9	
Orienting	**Center-cue**	**Spatial-cue**		**Orienting**	
	718.92	671.67		47.25	
Executive Control of Attention	**Incongruent**	**Congruent**		**Control**	
	738.12	676.82		61.3	

Source: Elaboration

Alerting and orienting under **low** cognitive load between OCD and healthy control groups

We used the Mann-Whitney U test to assess OCD and healthy control group differences in alerting and orienting scores under low cognitive load. There were no significant differences between OCD and healthy control groups in alerting scores (***z= – 0.70, p=0.482***) and orienting (***z= – 0.22, p=0.829***) scores under the low cognitive load condition.

Alerting and orienting under **high** cognitive load between OCD and healthy control groups

The Mann-Whitney U test was conducted to evaluate OCD and healthy control group differences in alerting and orienting scores under high cognitive load. There were no significant differences between OCD and healthy control groups in alerting (***z= – 1.68, p=0.093***) and orienting (***z= – 0.33, p=0.745***) scores under the high cognitive load condition.

Attentional control under **low** cognitive load in OCD between healthy control groups

We conducted a Mann-Whitney U test to assess OCD and healthy control group differences in attentional control under the low cognitive load condition. No significant differences were observed between OCD and healthy control groups in conflict scores (***z= – 0.41, p=0.685***) under the low cognitive load condition.

Attentional control under **high** cognitive load in OCD between healthy control groups

A Mann-Whitney U test was used to evaluate **OCD** and healthy control group differences in attentional control under the high cognitive load condition. No significant differences were observed between OCD and healthy control groups in conflict scores (***z= – 0.70, p=0.482***) under the high cognitive load condition.

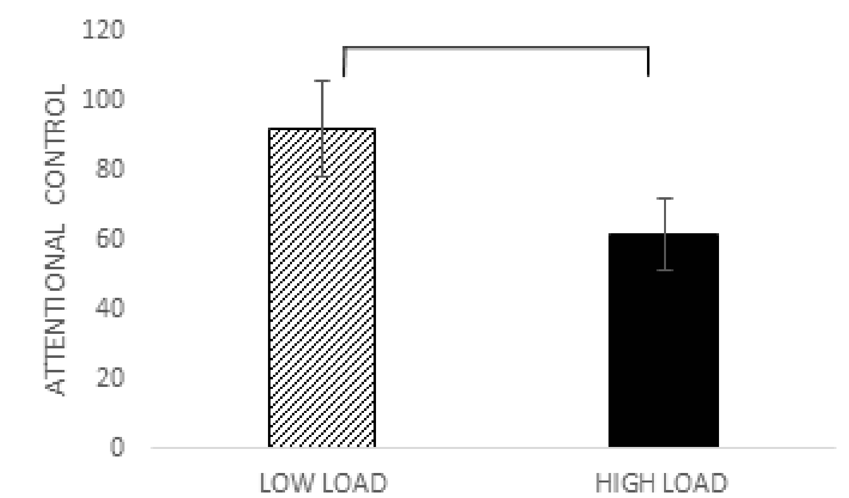
Effect of low and high cognitive load in alerting and orienting networks

A Wilcoxon signed-ranks test was conducted to evaluate the effect of low and high cognitive load in alerting and orienting networks of OCD subjects and healthy controls. There were no significant differences in alerting (***z= – 0.23, p=0.821***) nor orienting (***z= – 0.14, p=0.887***) scores in both groups between low and high cognitive load conditions. After splitting analyses by group, no significant differences were observed in alerting scores of the OCD group (***z= – 0.28, p=0.776***) and healthy control group (***z= – 0.06, p=0.949***) between low and high cognitive load conditions. In addition, no significant differences were observed in orienting scores of the **OCD** group (***z= – 0.28, p=0.776***) and healthy control group (***z= – 0.20, p=0.839***) between low and high cognitive load conditions.

Effect of low and high cognitive load in the attentional control network

A Wilcoxon signed-ranks test was conducted to examine the effect of low and high cognitive load in the attentional control network of OCD subjects and healthy controls. The results indicated a significant difference in conflict scores between low and high cognitive load (***z= – 3.35, p=0.001***) when both groups (OCD and healthy groups) were considered. After splitting analyses by group, a significant difference was observed in the conflict scores of the healthy group (***z= – 2.83, p=0.005***) and OCD group (***z= – 1.99, p=0.047***) between low and high cognitive load. The effect sizes were large, with 0.55 in the healthy group and 0.51 in the OCD group (Cohen, 1988), showing that 30.8% of the difference in conflict scores (i.e., attentional control) can be explained by cognitive load in the healthy group and 26.3% of the difference in conflict scores can be explained by cognitive load in the OCD group. These findings suggest that conflict scores of both groups were faster during the high load condition, compared to the low load condition. The effects of low and high load on attentional control in the OCD group are shown on Figure 2 and the effects of low and high load on attentional control in the healthy control group are shown on Figure 3.

Figure 2 Effect of low and high load on attentional control in the OCD group



Note. A significant difference was observed in the conflict scores of the OCD group ($p<0.05$) between low and high cognitive load.
Source: Elaboration

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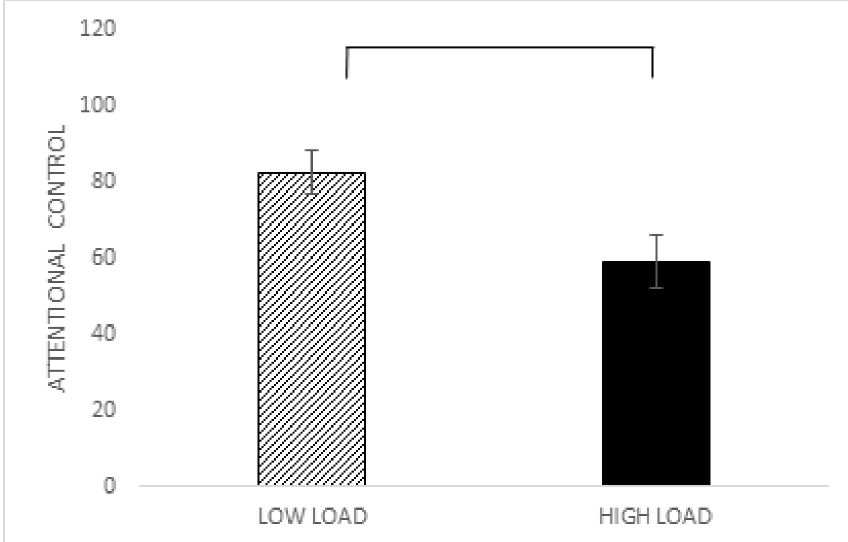
Figure 3 Effect of low and high load on attentional control in the HC group



Note. A significant difference was observed in the conflict scores of the healthy group ($p<0.05$) between low and high cognitive load.

Discussion & Conclusions

The current study evaluated the effects of cognitive load in different components of attention, such as alerting, orienting, and executive attention (i.e., attentional control), as measured by the ANT, of a Puerto Rican sample with OCD, compared to a healthy control group. The cognitive load manipulation showed that the high cognitive load condition was harder to perform compared to the low cognitive load condition, resulting in slower RT in the healthy control group and lower accuracy in both groups. Lack of differences in mean RT under low and high cognitive load in the OCD group suggests that, generally, their speed to respond in a task with neutral distractors is similar under both cognitive load conditions. Our first hypothesis was that the OCD group would have increased alerting and orienting functions only under the high cognitive load condition, compared to healthy subjects who would have increased alerting and orienting under both low and high cognitive load conditions. Contrary to our hypothesis, no differences were found between groups in alerting and orienting networks under low and high cognitive load. Our second hypothesis was that participants with OCD would show increased attentional control under high cognitive load but not under low cognitive load, compared to healthy controls, who would show increased attentional control under both low and high cognitive load conditions. Also contrary to our hypothesis, no differences were found between groups in attentional control. However, when analyzing the attentional control network, we found that participants with OCD, as well as healthy controls, experienced decreased interference from distractors under the high cognitive load condition, but not under the low cognitive load condition. This suggests that alerting, orienting, and the ability to control attention is similar in both groups. These findings propose that Puerto Ricans with OCD and healthy individuals show increased attentional control under high cognitive load. They reveal the influence that cognitive load imposes in the attentional control of healthy individuals and those with OCD from Puerto Rico. These results do not support our hypothesis that attentional control is only increased under high cognitive load in individuals with OCD, given that we also found these same effects in healthy participants. In other words, it seems that increasing cognitive load reduces distraction in OCD and healthy Puerto Ricans.

Literature on the neuropsychological functioning of OCD has been inconsistent and conflicting, as some studies suggest neurocognitive underperformance in attention, executive function, and memory, while others have not observed these deficits, after comparing with healthy undiagnosed individuals (Abramovitch & Cooperman, 2015; Fungueirino et al., 2020; Nakao et al., 2014). Furthermore, previous studies have shown self-reported attentional control deficits in OCD (Armstrong et al., 2011; Behzadpoor et al., 2016; Moradi et al., 2014). A study found that deficiency in attentional control increases rumination, or recurrent inner thoughts about a certain topic, in OCD patients (Behzadpoor et al., 2016). However, less research has directly assessed the effect of cognitive load in attentional control in individuals with OCD.

Many studies examining the influence of cognitive load in attentional control in anxious individuals have been contradictory, hampering the understanding of deficits in attentional control abilities (Berggren & Derakshan, 2012; Najmi et al., 2015; Stefanopoulou et al., 2014). The results of the current study are partially consistent with previous findings that reveal increased attentional control and decreased interference from neutral distractors under high cognitive load in a clinical sample consisting of patients with Generalized Anxiety Disorder (GAD), but not in undiagnosed healthy individuals while using the ANT (Najmi et al., 2015). Our results are also in agreement with a study by San Miguel et al. (2008) that assessed the effects of working memory load on distraction in healthy subjects that performed a visual classification task, while ignoring irrelevant auditory stimuli, suggesting that increasing working memory load decreases or prevents distraction. SanMiguel et al. (2008) concluded that distraction is reduced because load takes control over the mechanisms of involuntary attention. Vytal et al. (2013) also support the idea that although anxiety has an impact on working memory, it depends on the influence of cognitive load. They used spatial and verbal ***n***-back tasks to observe the effect of cognitive load on working memory when anxiety was induced (i.e., threat of shock), which was measured using acoustic startle reflex (eye blink). During the 1-back, 2-back, and 3-back tasks participants had to identify if the stimulus was "same" or "different" and during the view task, they only attended to the stimuli without responding. There were four experimental runs and each of them alternated threat and safe blocks, and participants were reminded if they were in the threat (at risk for shock) or safe condition (no shock). The results of their study showed that induced-anxiety impaired both verbal and spatial working memory, but low-load verbal working memory was more susceptible to be affected by anxiety, compared to high load, and spatial working memory was disrupted despite task difficulty or cognitive load.

Nevertheless, the findings of the present study are in contrast with some previous research on cognitive load and attentional control, suggesting that increasing cognitive or working memory load increases distraction in individuals with high levels of anxiety (Berggren et al., 2013; Lavie & Dalton, 2014). The also contradict previous studies examining the effect of working memory load in attentional control when emotional stimuli were taken into account (Judah et al., 2013; MacNamara & Proudfit, 2014). For example, MacNamara and Proudfit (2014) used late positive potentials (LPP), which show electrical activity during attentional processing, under the presentation of emotional stimuli, to measure attention toward task-irrelevant and unpleasant pictures using a high-load and low-load working memory task in participants with GAD and healthy controls. During the working memory task, participants were asked to memorize the letters (2 – or 6-letter string) that were presented during the beginning of each trial and after the presentation of unpleasant or neutral pictures, they typed the letters in the same order as they were displayed. Their results showed that all participants had larger LPPs to unpleasant pictures. Specifically, participants with GAD elicited larger LPPs during the presentation of unpleasant pictures under high working memory load (6-letter string), which suggests reduced attentional control when load is high. These results support the idea that attention to unpleasant or threatening stimuli is more likely in individuals with GAD (i.e., with anxiety) than in healthy individuals (Bishop, 2008; Eysenck et al., 2007). MacNamara and Proudfit's (2014) findings are inconsistent with the results of the current study since cognitive load is playing a different role on attentional control in anxious individuals, although the influence of emotional stimuli and the fact that a different clinical population (i.e., participants with GAD and not OCD) was assessed should be considered. Our results also contradict the Load Theory of Attention and Cognitive Control, which proposes that attention improves under high perceptual load, but deteriorates under high cognitive or working memory load (Lavie et al., 2004). However, this idea has received less empirical support as it does not consider anxious or clinical populations, such as those diagnosed with OCD. Furthermore, our results seem to disagree with the Attentional Control Theory, which posits that anxiety affects attentional control and increased worry is associated with underperformance in tasks (Eysenck et al., 2007). Our findings indicate that high cognitive load may be competing with worry, anxiety, or obsessional thoughts for attention in the participants with OCD of this study, while low cognitive load may be susceptible to distraction and greater impact of these emotional factors (Vytal et al., 2013). They are supported by the idea that cognitive load can reduce the effect of processing emotional information on cognitive processes that include the control of attention. This is in agreement with a previous study using functional magnetic resonance imaging (fMRI) while participants viewed neutral and negative stimuli and performed an attention arithmetic task, which revealed that increased cognitive load can modulate emotional brain response, increasing activation in brain regions that are implicated in cognitive processing (right dorsolateral frontal cortex, right superior parietal cortex, and left dorsal occipital cortex) and decreasing brain activity involved in emotional processing (bilateral amygdalae and right insula) (vanDillen et al., 2009). Another explanation for our findings may be related to alterations in the orbitofrontal cortex (OFC) in OCD subjects, given that decision making, which is mediated by the OFC, is influenced by emotions and during high cognitive load individuals with OCD may choose to obtain a reward by focusing on the performance of the task, thus challenging their disengagement from a task that can lead to their perceived reward. OCD may be seen as a behavioral addiction, where individuals could be depending on their compulsions due to the effects of the reward, which could be performing the task correctly and reducing anxiety (Grassi et al., 2015).

Additionally, these results show that the impact of cognitive load on attentional control in the OCD group is similar to that of the healthy control group. Although significant differences in anxiety severity were observed between the OCD and healthy control groups in this study, healthy participants also reported anxiety symptoms, which may have influenced their performance in the ANT. Anxiety sensitivity or fear of anxiety-related sensations is thought to be increased in the Puerto Rican population, predisposing individuals to experience anxiety and making them vulnerable to develop anxiety disorders and ***ataques de nervios***, which is a cultural syndrome characterized by experiencing distress and a sense of being out of control (Cintron et al., 2006; Hinton et al., 2008; Nogueira et al., 2015; Santiago-Mejias et al., 2019). Santiago-Mejias et al. (2019) examined the neurocognitive functioning of Puerto Ricans with anxiety disorders and comorbid ***ataques de nervios***, who showed decreased attention, concentration, and immediate memory, compared to individuals without comorbid ***ataques de nervios***, although the influence of cognitive load in attention was not assessed. If some of the healthy subjects in the current study were experiencing ***ataques de nervios***, this may support why healthy and OCD participants performed the ANT similarly, given that both OCD and ***ataques de nervios*** are characterized by anxiety sensitivity. However, definite conclusions cannot be drawn, as we did not assess the experience of ***ataques*** in the sample. Another possibility that can explain why healthy individuals reacted similarly to OCD subjects under high cognitive load may be related to working memory capacity. Working memory capacity is about the ability to control attention and inhibit interference from distractors and it has been proposed that high working memory capacity increases top-down attentional control (Luo et al., 2017). Redick and Engle (2006) used the ANT to examine the three attention networks (alerting, orienting, executive control of attention) in healthy individuals with high compared to low working memory span and found that group differences were only found in the executive control network, revealing increased attentional control in the high working memory capacity group. It can also be possible that OCD and healthy participants of the current study have high working memory capacity, which can thus increase their attentional control under high cognitive load. The fact that our sample was highly educated (i.e., most with bachelor's and graduate studies) supports this idea.

Previous research has found that improving attentional control can also improve the ability to suppress worry-related thoughts and the control and prevention of rumination (Behzadpoor et al., 2016; Fox et al., 2015). Our findings suggest that cognitive training for the control of attention can be facilitated by conditions of high cognitive load, allowing individuals to inhibit involuntary attention to unwanted or threat-related distractors. This can also be useful in the implementation of the most effective evidence-based treatments for OCD (i.e., cognitive behavioral therapy and exposure with response prevention), in which cognitive flexibility or the ability of the mind to be flexible when adjusting behavior in view of the demands of an environment that is constantly changing (Gruner & Pittenger, 2017) is required. Thus, considering cognitive load in attentional control training along with exposure response prevention may enhance cognitive behavioral treatment response in OCD. For example, increasing cognitive load during exposure and response prevention could help OCD patients expose themselves to perceived threat while performing other complex tasks that require attention. Complex tasks that involve cognitive load can include occupational, academic, social, or daily living activities, which OCD patients intend and are motivated to perform but have difficulty accomplishing given their intrusive thoughts and compulsions. Specifically, if attentional control training considers cognitive load, it could enable exposure to perceived threat in OCD patients by performing common activities that require attention during exposure. Wilson (2016, pp.139-144) specifies that when OCD patients drop resistance upon intrusive thoughts, they free up space in awareness, increasing their capacity to focus and control their attention. If cognitive load can increase attentional control, it may also facilitate their ability to push out unwanted thoughts and focus on what is important to them.

Taken together, the findings of this study provide useful knowledge that can facilitate the modification and design of treatment programs that target the development of top-down processing abilities, as well as expand current knowledge about OCD, which has been understudied in Puerto Rico.

Limitations

The current study has several limitations that must be noted. First, the small sample size may limit the generalization of results. Second, OCD subjects had psychiatric comorbidities and approximately half **(53.3%)** of them were taking a psychiatric medication, which may have had an influence on their performance. Difficulty to identify individuals with OCD without psychiatric comorbidities may be the reason for this situation. Finally, the sample was highly educated (most with graduate

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studies), thus it is possible that performance would differ in a less educated sample.

Future Research

Future studies should include a larger sample and a sample with all levels of education. Studies should also aim to include subjects without psychiatric comorbidities to control for confounding variables. Additionally, they should consider within-group differences in OCD subtypes and symptom severity. Although we assessed OCD subtypes and symptom severity in the current study, we were not able to perform within-group analyses given the small sample size. Moreover, given that the healthy control group in this study also reported anxiety symptoms, we recommend future studies to use anxiety self-reports as a screening tool to include healthy controls with none to mild anxiety symptoms.

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Declaration of Interest

All authors approved this manuscript and its submission to this journal. None of the authors has any financial conflicts of interest to disclose.

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