Original Article

Study of behavioral inhibition in compulsive washing: Stop signal paradigm

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Abstract

Introduction: Behavioral inhibition deficit is considered probable in compulsive washing symptoms. Go-No Go and stop signal paradigms are the frameworks used for studying behavioral inhibition. As in stop signal paradigm it is necessary for participants to inhibit triggered response, we aimed to investigate behavioral inhibition in clinical compulsive washing in this paradigm.

Materials and Methods: The cases of this clinical trial were participated among obsessive-compulsive patients who referred to psychiatrists clinics in Mashhad. Number of 30 cases with washing compulsion and 30 cases without disorder were selected. Beck Depression Inventory - version II, Obsessive Compulsive Inventory- Revised (OCI-R) and Stop it test were fulfilled for all cases in the Psychology Clinic of Ferdowsi University of Mashhad. Data analyzed by MANCOVA and SPSS software version 20.

Results: The analysis showed that the effect of group factor (F=4.37, $P<0.05$). The results of MANCOVA analysis showed that there is a significant difference in Stop-Signal Reaction Time (SSRT) between compulsive washing patients and the control group (F=4.298, $P<0.05$). There is no difference between the two groups in Stop-Signal Delay (SSD) (F=1.265, $P=0.18$).

Conclusion: Significant differences in stop-signal reaction time between the two groups indicated a deficiency in behavioral inhibition in the compulsive washing group. Inability to inhibit triggered response (behavioral inhibition) in compulsive washing patients is consistent with the symptoms of disorder.

Keywords: Inhibition, Obsessive-compulsive disorder, Signal

Introduction

The core of the Obsessive Compulsive Disorder (OCD) symptomology is formed by distressing recurring thoughts that cause anxiety (1). Compulsions are compulsive tendencies to perform mental or behavioral rituals so as to mitigate the anxiety and stress. The recurring and compulsive nature of OCD symptoms could be considered the failure to inhibit such actions. Wang and Klein clarified this point in their description of inhibition: "A mechanism, which keeps attention away from a previous object or targeted situation, is ecologically important for living in a world full of visual stimuli. Without such a mechanism, the individual has to return to a previously prominent stimulus over and over again (2)."

Inhibition is defined in the wide context of the brain's executive control functions (3,4), which form "a set of cognitive skills responsible for planning, starting, continuing, and reflecting behaviors focused on complex objectives (4)." Attention, targeting (goal-setting), changing focus of attention, memory storage and retrieval, perception, and motor functions become efficient and accurate provided that the inhibition coordinating role, as an executive function, is not impaired (5,6). Inhibition failure has actual consequences. A part of studies on inhibition covers a wide spectrum of psychological disorders (i.e. a range of neurotic and psychotic disorders) (7).

Among the disorders analyzed with an emphasis on the inhibition mechanism, the Obsessive-Compulsive Disorder, with its specific symptomology, is of

special importance. The studies on the relationship of OCD disorders with the role of inhibition deficits first of all analyze the special nature of this disorder at the symptomology level. Different studies have somehow referred to inhibition deficits in OCD (8-14). Many investigations have introduced the overall deficit in the ability to pay selective attention to the related stimuli and ignore other competing stimuli in the environment, as a major etiology in OCD (9,15,16).

Behavioral inhibition is a form of inhibition (17). As an executive function, behavioral inhibition is the repression of an inappropriate action to create a flexible focused behavior in an ever-changing environment (18). In the field of experimental psychology, the following two paradigms are commonly used in examinations of behavioral inhibition: go/no I go paradigm and stop-signal paradigm (19,20). The behavioral inhibition deficit has been one of the concerns of researchers in the field of psychopathology. Some of these studies include the research on ADHD (Attention-Deficit/Hyperactivity Disorder) (21-23), autism (24), and schizophrenia (25). Manifestation of behavioral inhibition deficit in OCD has been proved via the aforementioned two paradigms: a) the go/no-go paradigm (26-29), and b) the stop-signal paradigm (30,31).

The stop-signal paradigm is a more precise form of the go/no-go paradigm (32). In the stop-signal paradigm, the interval between the outbreak of a stimulus and the stop signal (or the stop-signal delay/SSD) is modified. However, in the go/no-go paradigm, this interval is normally zero. Regardless of the issues associated with developing the tests for these paradigms, these two paradigms also differ in inhibition processes and neurological fundamentals. In the go/no-go paradigm, a very powerful non-triggered response is inhibited. However, in the stop-signal paradigm, the participant has to inhibit a triggered motor response in a very short moment (20). Investigations into the cerebral fundamentals involved in these two tasks have also indicated that different circuits are involved in the accomplishment of these two tasks (i.e. stopping a triggered response and stopping incidence of the response or withholding the response) (33,34). The index examined in the stop-signal trial is the stop-signal reaction time (SSRT), which is calculated using the horse-race model (19). In this model, the respondent's performance is considered a race between the go and stop processes (35).

Chamberlin (30) analyzed behavioral inhibition in patients with OCD and trichotillomania and concluded that these patients deal with behavioral inhibition problems in the stop-signal task. The problem was more intense in patients with trichotillomania. Besides the lack of a normal control group, one of the limitations of this research was the low number of OCD patients as claimed by the researchers (36). Menzis (31) also reported the same deficit in OCD patients as well as in their first-degree relatives. In the recent studies, researchers have tried to study the possible behavioral inhibition deficit in one of the subgroups of OCD (i.e. compulsive washing disorder) as compared to the non-OCD group.

Materials and Methods

The present research was carried out as a causal-comparative study using the descriptive research method. The statistical population for this study included all of patients with compulsive washing disorder who visited the psychotherapy clinics of Mashhad City. The study sample was selected using the convenience sampling method and included 60 participants. The sample size was estimated in GPower based on the hypothesis test methods and effect sizes reported by previous studies (37). The research hypotheses were examined using the Multivariate Analysis of Covariance (MANCOVA) method. In addition to the statistical model, the following parameters were taken into account to estimate the required number of participants: a) Effect sizes obtained in former similar studies (30,31); b) Number of groups in the proposed research ("OCD and non-OCD individuals"). Considering the expected effect size (f=0.433), number of groups (g=2), and statistical power (0.85) in the multivariate analysis of variance method, 60 participants (30 participants in each group) had to be examined for two variables (SSD and SSRT) and two groups.

The selected sample was included in the study after receiving the psychiatrist's diagnosis results and doing primary interviews. The interview included a detailed explanation of the research goals and the principle of confidentiality. Moreover, in this interview the paper-based questionnaires were completed by the patients. The participants' basic knowledge of computers was assessed in the interview, and patients who did not have the experience of working with computers were excluded from the research. Scores of the compulsive washing disorder group from the Yale-Brown Obsessive Compulsive Scale (Y-BOCS), with a minimum score of 16 and maximum of 37 (which show moderate and severe symptoms), were

used as the inclusion criteria in this study. In the second session, after describing the "Stop it" test to the participants, they took this test. The test was taken in the psychology clinic of the Faculty of Educational Sciences and Psychology of Ferdowsi University of Mashhad.

Research instruments

- Beck Depression Inventory-Second edition (BDI-II): This scale is the revised version of the Beck Depression Inventory, which was meant to assess the severity of depression (38). It is a self-report 21-item instrument designed for measuring severity of depression and its symptoms. Items of this inventory are scored based on the five-point Likert scale (from 0 to 3), and higher scores reflect more severe forms of depression. The psychometric characteristics of this inventory with a 94-member sample in Iran were as follows: alpha coefficient: 0.91; split-half correlation coefficient: 0.98; and re-test alpha coefficient=0.94 (39).

- Obsessive-Compulsive Inventory-Revised (OCI-R): This inventory was designed by Fao et al. (1998) to assess the severity of obsessive-compulsive symptoms in clinical and non-clinical populations (40). This 18-item inventory was revised in 2002 (41). Based on a 5-point scale (from 0=not at all to 4=too much) the respondent expresses his/her agreement with the distress each option has caused him/her over the past month. In the research by Mohamadi, Zamani, and Fata the internal consistency of this inventory was reported to be satisfactory in Iran with a Cronbach's alpha coefficient of 0.72 (42).

- Yale-Brown Obsessive Compulsive Scale (Y-BOCS): It is used to determine the severity of OCD. This scale contains 10 items and ranks obsessions and compulsions from 0 to 4 based on the following factors: duration, interference, distress, resistance, and controllability. Y-BOCS has demonstrated satisfactory reliability and validity in assessments of severity of symptoms. This scale quickly turned into a tuned method of assessing medicinal and behavioral examinations of OCD (43). In Iran, the reliability of the scale among interviewers was r=0.98. It had a reported internal consistency coefficient of 0.98, and its reliability coefficient using the re-test method with a two-week interval was 0.84 (44).

- Stop-It Test: This test was developed by Verbruggen, Logan and Stevens (2008) and is publicly available (GNU) (45). Above all, this task calls for distinguishing a circle from a square. In the no-signal trials (75%) only the stimulus is shown, and the respondent (subject) is asked to respond to the stimulus as quickly and accurately as possible. In the stopping trials (25%), following the go stimulus an auditory signal is broadcast as a sign of stopping and the respondent (participant) is asked to stop (withhold) the response.

The circle and square stimuli and the (+) sign are displayed at the center of the screen on a black background. The stimuli's size depends on the screen size, and the stop signal is heard for 75 seconds at 750 HZ. The loudness of this signal depends on the system's Windows settings.

The program begins with entering the participant's number. Then the instruction is displayed on the screen. The experiment consists of two phases: the practice phase (which contains 32 trials), and the experiment phase (which is composed of three 64-trial segments). In both phases, the presentation starts with a (+) sign in the middle of the screen. This sign is replaced with the test stimulus after 250ms. The "z" key is pressed for responding to the square stimulus, while "/" is pressed for the circle stimulus. The stimulus remains on the screen (for 1250 ms) until the participant responds. If no response is given, this stimulus is replaced by the next trial. The interval between the stimuli is 2000ms regardless of the recorded reaction time (RT). In the stop-signal trials, the stop signal is displayed after variable SSDs (stop-signal delays). The primary SSD is set to 250ms and occurs as follows: If the inhibition is successful the SSD exceeds 250ms, and if the inhibition is not successful SSD drops below 250ms. It is believed that the probability of response inhibition declines with an increase in SSD (32). Responses are recorded as the trials are displayed. There is a 10-min pause every three blocks. During this break, the participants take a rest and a report of the participants' performance (including the number of wrong responses and the number of non-answered trials) is provided. After execution of this program, raw data is expressed as mean SSD and SSRT values using the ANALYZE-IT Program.

To perform the above test, a Sony laptop (VGN-Z31MN) was used. The laptop was placed on the ground at a 40 to 60 cm distance from the participant's eyes.

At the descriptive level, the research data was analyzed through measurements of central tendencies and variability, and at the hypotheses level it was analyzed using the multivariate analysis of covariance (MANCOVA) method.

Results

The data obtained from 60 participants, which

included 30 patients with compulsive washing disorder (80% female) and 30 participants without OCD or any other clinical disorder (73.33% female), was examined first based on self-rating questionnaires and then using the stop-signal test. The average age of respondents in the compulsive washing disorder group and control group was 26.07 years (SD=5.52) and 23.03 years (SD=3.55), respectively.

Table 1. Scores of self-measures in obsessive compulsive and control groups

Group	BDI M±SD	OCI-R M±SD	YBOCS M±SD
Washing	22.03±9.55	32.00±11.06	22.63±5.44
Control	17.90±7.55	17.00±8.77	6.97±5.37

Beck Depression Inventory: BDI, Obsessive-Compulsive Inventory-Revised: OCI-R, Yale-Brown Obsessive Compulsive Scale: Y-BOCS

Concerning the self-rating scales, a review of the data revealed that there was a significant difference between the Y-BOCS (t=11.21; $P<0.01$) and OCI-R (t=5.823; $P<0.01$) scores of the compulsive washing disorder group and the normal group. However, no significant difference was observed between BDI-II scores of the two groups (t=1.860; $P>0.05$).

The data resulted from the primary analysis of the Stop-it test in ANALYZE-IT is presented in the following.

Table 2. Scores of behavioral inhibition index in obsessive compulsive and control groups

Group		SSRT M±SD	SSD M±SD
Washing	Female	287.25±33.91	434.37±157.74
	Male	261.55±66.08	383.75±181.49
	Total	274.91±41.37	424.24±160.74
Control	Female	230.16±33.88	459.30±134.01
	Male	232.16±42.67	520.23±180.96
	Total	230.70±35.66	475.55±147.17

To carry out the multivariate analysis of covariance, two variables (SSD and SSRT) were used as the dependent variables in the analysis. The group variable (OCD and non-OCD) and gender were used as independent variables, and Beck scores were introduced into the analysis as the covariate.

The insignificance of the Box test results is a sign of approval of the analysis assumption (F=0.72, P=0.68). The multivariate analysis of covariance revealed that the group factor was significant. Hence, there was a significant difference between average values of dependent variables in the OCD and non-OCD groups (F=4.37; $P<0.05$; Wilk's Lambda=0.861; Partial η^2=0.139). Examination of results of the post hoc tests on the effects observed

on the participants indicated that there was a significant difference between SSRT mean values (F=8.90; $P<0.05$; Partial η^2=0.13). However, the difference between the SSD mean values was not significant (F=1.83; $P=0.18$; Partial η^2=0.03).

Discussion

OCD is characterized as an impulse control disorder by the following characteristics: constant mental preoccupation, impulsivity, and repetitive actions (rituals) (1). All of these three notions reflect the probable inhibition function deficit. The classic symptoms of OCD (which include persistent obsessive thoughts) are characterized by the inability to inhibit repetitive compulsive behaviors. Accordingly, people with the compulsive washing disorder are less likely to be able to inhibit their behavioral responses. Moreover, such patients demonstrate a longer reaction time when inhibiting stimuli.

Based on the paradigm used for the behavioral inhibition assessment (i.e. the stop-signal paradigm), motor inhibition deficit manifests as the inability to suppress a triggered motor response. People with OCD have demonstrated their disorder in a wide range of inhibitory function tests (such as the go/no-go test) (46). Therefore, people with OCD not only suffer motor response selective inhibition deficit (as seen in the go/no-go test), but also demonstrate inhibition deficits in suppressing a triggered motor response (the stop-signal test). The available data suggests that response inhibition, which is denoted by SSRT, is abnormal in OCD patients.

In addition to theoretical implications of compulsive washing disorder, confirmation of behavioral inhibition deficit in patients with symptoms of this disorder sets the scene for development of computer retraining programs, as supplements for the clinical and in-person therapeutic methods. One of the limitations on this research was that all of the obsessive-compulsive disorder types were not studied. Although one of the strengths of this study was to determine the type of the subgroup under study, simultaneous examination and comparison of other subgroups may contribute to more clarification of findings. On the other hand, it seems that if prominent disorder-related emotional stimuli are used in the making of the stop-signal test, more clear results will be obtained from such studies.

The significance of the difference between SSRT values reflects a motor inhibition deficit (18). The lack of significance of the difference between SSD values in the two groups signals a lack of difference

between the delays (SSDs) in the test. That is to say, the difference between the performances of the two groups did not result in a shorter significant SSD in the OCD group. However, in view of the research background, SSRT calculations involve other indices besides SSD to estimate the imperceptible latency in the stop-response process. Therefore, SSRT is considered the main index for examination of inhibition deficits (35).

The results of this research comply with the results of related similar research (30,31). In the study by Chamberlin et al. (30) the number of participants was low. In Menzies' research (31) an unclear spectrum of OCD subgroups was analyzed. The present research was, however, an attempt to examine patients with compulsive washing disorder, as the most common compulsion (47).

Conclusion

Significant differences in stop-signal reaction time between the two groups indicated a deficiency in behavioral inhibition in the compulsive washing group. Inability to inhibit triggered response (behavioral inhibition) in compulsive washing patients is consistent with the symptoms of disorder.

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