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Are Nonclinical Obsessive-Compulsive Symptoms Associated With Bias Toward Habits?

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Abstract: In a sample of student volunteers ($N=93$), we found that obsessive-compulsive symptoms (although not hoarding) were associated with overreliance on stimulus-response habits at the expense of goal-directed control during instrumental responding. Only checking symptoms were associated with bias toward habits after negative affect was controlled for. Further research is warranted to examine if

overreliance on habits represents an aberrant learning process that confers risk for obsessive-compulsive psychopathology.

Keywords: Obsessive-compulsive disorder; Habit learning; Checking

1. Introduction

An influential neurobiological model of obsessive-compulsive disorder (OCD) identifies dysfunctions in frontal-striatal circuits as critical pathophysiological underpinnings of the disorder ([Burguière et al., 2015](#)). These circuits have a significant overlap with two interacting brain systems thought to control instrumental behavior: a goal-directed system that encodes action-outcome associations (prefrontal cortex/dorsomedial striatum), and a habit system that encodes stimulus-response associations (dorsolateral striatum) (for a review see [Yin and Knowlton \(2006\)](#)). According to the habit hypothesis of OCD ([Graybiel and Rauch, 2000](#); [McDonald et al., 2004](#); [Robbins et al., 2012](#)), compulsive symptoms are caused by deficits in goal-directed learning, which lead to excessive reliance on stimulus-response habits. In support of this hypothesis, [Gillan et al. \(2011\)](#) found that OCD patients, compared to healthy volunteers, underutilized goal-directed action control and relied excessively on habits during instrumental responding.

Given suggestions that aberrant habit learning may represent a vulnerability to obsessive-compulsive psychopathology ([Robbins et al., 2012](#)), we examined if OC symptoms would be associated with underutilization of goal-directed action control/overreliance on habits among student volunteers. Also, given evidence for partly distinct neurobiological underpinnings of different OC symptoms ([Burguière et al., 2015](#)), we examined if a bias toward habits would be more prominent in certain symptom dimensions.

2. Methods

2.1. Participants and procedure

One hundred and five college students participated in a study session to complete a battery of questionnaires and the Fabulous Fruit Game (see below) in exchange for extra credit. Twelve (11.4%) students who were currently taking serotonergic medication were excluded because evidence indicates that reduction in central serotonin neurotransmission influences goal-directed action control in healthy volunteers ([Worbe et al., 2015](#)). In the

final sample ($N=93$), 80 were females and 65 identified as Caucasian (mean age=22.9 years; $SD=6.9$).

2.2. Measures

2.2.1. Self-report measures

Participants were asked to complete the Depression Anxiety and Stress Scales-21 item version (DASS-21; [Antony et al., 1998](#)), which includes Depression, Anxiety and Stress subscales, and the Obsessive-Compulsive Inventory-Revised (OCI-R; [Foa et al., 2002](#)), which includes six subscales: Washing, Obsessing, Ordering, Hoarding, Checking and Neutralizing.

2.2.2. The Fabulous Fruit Game

(FFG; see [Worbe et al. \(2015\)](#), for a more complete task description). The FFG is a three-stage computerized task designed to measure the extent to which participants rely on habitual versus goal-directed action control during instrumental responding.

Stage 1: Instrumental Training. Six closed boxes were presented on the screen one at a time. Participants had to learn by trial and error which response (left or right) would lead to a rewarding outcome (i.e., open box with fruit inside=gain points) and which response would not (i.e., open an empty box=gain no points). Fruit pictures on the outside of the boxes served as discriminative stimuli. The training included eight blocks during which each of the six boxes were presented twice in random order.

Stage 2: Slips-of-Action Test. The test included nine testing blocks. For each block, the closed boxes from Stage 1 were presented one at a time. However, in each block, two of the six fruit rewards were devalued (did not yield points anymore). Participants were instructed not to respond to boxes that contained the devalued fruit inside because it would deduct points. Failure to withhold responses to stimuli linked with devalued outcomes (i.e., 'slips of action') reflects stimulus-response habits, whereas selective inhibition of responding reflects goal-directed control.

Stage 3: Baseline Test. This stage is identical to the slips-of-action phase except that the discriminative cues (fruits on the outside of the boxes) are devalued rather than the outcomes (fruits inside the boxes). Thus, this phase allows us to control for general test demands of the slips-of-action test (e.g., working memory and response inhibition).

2.3. Statistical analysis

We created a Devaluation Sensitivity Index (DSI) for the slips-of-action test and the baseline test by subtracting the percentage of responses to cues linked to devalued outcome from the percentage of responses to cues linked to valued outcomes. Thus, higher scores reflected greater sensitivity to devaluation (i.e., goal-directed responding). We conducted hierarchical linear regression with the slips-of-action DSI as a dependent variable. The baseline DSI was entered into Step 1 to control for general test performance variables. Age, gender and DASS-21 were also entered into Step 1 given that research has shown that gender, age and negative affect may influence habit learning ([Schwabe and Wolf, 2011](#); [Worbe et al., 2015](#)) and OC symptoms. All the OCI-R subscales were entered simultaneously in Step 2 to examine their unique contribution to the slips-of-action DSI.

3. Results

There was a significant main effect of block in the instrumental learning stage [$F(4.75, 432.46)=114.28, p<0.001$] confirming that participants' discriminative performance gradually improved with training ([Fig. 1](#)). There was no interaction between the effect of block and OCI-R or DASS-21.

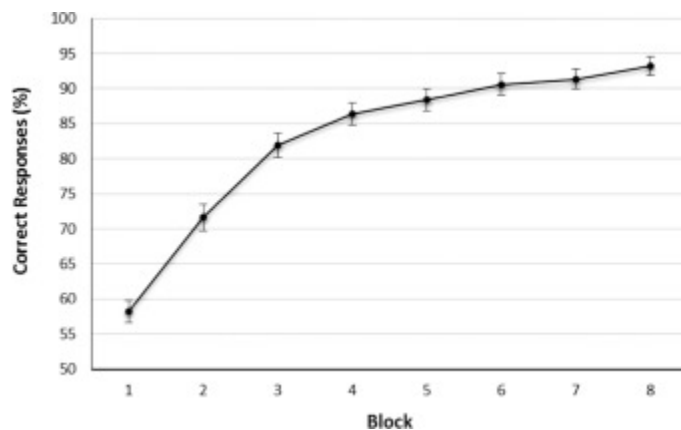


Fig. 1. Mean levels of correct responses across eight consecutive instrumental training blocks. Y-axis starts at 50% reflecting chance level of correct responding. Error bars represent standard error of the mean.

[Fig. 1](#) As would be expected, participants responded more often to stimuli related to valued outcome than stimuli related to devalued outcome, in both the slips-of-action test [87.3% vs. 34.8%; $F(1, 91)=215.19, p<0.001$] and the baseline test [93.2% vs. 18.2%; $F(1, 91)=676.14, p<0.001$]. All the DASS-21 scales, and all the OCI-R subscales with the

exception of Hoarding, had significant negative zero-order correlations with the slips-of-action DSI (Table 1). In contrast, none of the symptom scales correlated with the DSI in the baseline test (Table 1). Hierarchical linear regression showed that only Checking remained a significant predictor of the slips-of-action DSI after the other variables were controlled for ($Beta = -.23$, $t = -2.03$, $p < 0.05$).

Table 1. Descriptive Statistics for the Symptom Measures and Correlations between the Symptom Measures and Devaluations Scores from the Baseline and Slips-of-Action Tests.

Measures	<i>M</i> (<i>SD</i>)	Minimum-maximum score	Baseline DSI	Slips-of-action DSI
DASS total score	8.4 (9.4)	0–42	–0.139 ^{ns}	–0.259*
Stress	4.1 (3.9)	0–15	–0.080 ^{ns}	–0.231*
Anxiety	1.9 (2.9)	0–13	–0.118 ^{ns}	–0.247*
Depression	2.4 (3.8)	0–19	–0.172 ^{ns}	–0.217*
OCI-R total score	8.1 (8.5)	0–48	–0.104 ^{ns}	–0.261*
Washing	1.1 (2.2)	0–12	–0.062 ^{ns}	–0.241*
Checking	1.3 (1.5)	0–6	–0.173 ^{ns}	–0.328**
Neutralizing	0.7 (1.4)	0–5	–0.051 ^{ns}	–0.209*
Ordering	2.4 (2.8)	0–12	–0.115 ^{ns}	–0.216*
Obsessing	1.1 (1.8)	0–9	–0.188 ^{ns}	–0.242**
Hoarding	1.6 (2.0)	0–8	–0.016 ^{ns}	–0.017 ^{ns}

Note. ns=not significant; DASS=Depression Anxiety Stress Scale; OCI-R=Obsessive-Compulsive Inventory-Revised; DSI=Devaluation Sensitivity Index.

* $p < 0.05$.

** $p < 0.01$.

4. Discussion

The results showed that OC symptoms were associated with overreliance on habits at the expense of goal-directed control in a sample of student volunteers. These findings extend previous research documenting a bias toward habits among OCD patients (Gillan et al., 2011). However, these correlational data cannot determine the causal role of bias toward habits in OC symptoms, and longitudinal research examining aberrant habit learning as a risk factor for OCD are warranted.

It should be noted that we also found a significant association between negative affect and bias toward habits, which is consistent with a large body of literature showing that anxiety/stress-reactions promote reliance on the habit system (Schwabe and Wolf,

[2011](#)). It has been theorized that the association between dysfunctional habit learning and OCD may be at least partially attributable to negative affect (e.g., [Goodman et al., 2012](#)). Thus, we opted to control for stress, anxiety and depression to explore unique relations between reliance on habits and different OC symptom domains. Notably, Checking remained a significant predictor of slips-of-action after negative affect was controlled for.

Some previous studies have also indicated that dysfunction in goal-directed processes may be relatively more strongly associated with checking symptoms than other OC symptoms. For example, a detailed behavioral analysis of OCD patients showed that checking compulsions involved more repetitions of non-functional acts (appeared less goal-directed) than washing compulsions ([Zor et al., 2001](#)). Additionally, a large literature has compared OCD patients with healthy comparison groups on tasks that assess cognitive functions related to goal-directed control (e.g., planning/problem solving and inhibition). Even though results have been somewhat inconsistent across studies, on balance evidence suggest OCD patients show relatively poor performance on these tasks, and a larger and more robust effect has been found among those with primary checking symptoms (for meta-analysis see [Leopold and Backenstrass \(2015\)](#)).

Importantly, however, the mechanism underlying poor performance on these tasks remains unclear. For example, the current results cannot determine whether bias toward habits is due to excessive reliance on habits or to weak goal-directed control (although neuroimaging data from another habit-learning paradigm suggest the deficit may stem from weak goal-directed control; [Gillan et al., 2015](#)). Tasks that more specifically tap habit formation independent of goal-directed control are needed to better address this issue. Also, future researchers may want to examine other hierarchical models of goal-directed dysfunctions and their relation with habit formation ([Barahona-Corrêa et al., 2015](#)), or explore the role of interfering emotional experiences ([Dittrich and Johansen, 2013](#)).

Finally, according to the habit hypothesis of OCD, excessive habit formation results in a discrepancy between the individual's behavior (stimulus-driven compulsions) and his or her rational reflections, which may explain the ego-dystonic nature of OC symptoms ([Robbins et al., 2012](#)). It is therefore interesting that hoarding, which tends to be less ego-dystonic than other OC symptoms, was the only OC symptom that did not have zero-order correlation with the slips-of-action DSI. It will be an interesting avenue of future research to investigate more directly whether aberrant habit learning is associated with ego-dystonicity of OC symptoms.

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