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Ethical sensitivity in obsessive-compulsive disorder and generalized anxiety disorder: The role of reversal learning

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ABSTRACT

Background and objectives: In obsessive-compulsive disorder (OCD), amplified moral sensitivity may be related to the orbitofrontal–striatal circuit, which is also critical in reversal learning. This study examined three questions: (1) What aspects of ethical sensitivity is altered in OCD?; (2) What is the relationship between ethical sensitivity and reversal learning?; (3) Are potential alterations in ethical sensitivity and reversal learning present in generalized anxiety disorder (GAD)?
Methods: Participants were 28 outpatients with OCD, 21 individuals with GAD, and 30 matched healthy controls. Participants received the Ethical Sensitivity Scale Questionnaire (ESSQ), rating scales for clinical symptoms, a reversal learning task, and the Wisconsin Card Sorting Test (WCST).
Results: We found higher ethical sensitivity scores in OCD compared with healthy controls in the case of generating interpretations and options and identifying the consequences of actions. Individuals with OCD displayed prolonged reaction times on probabilistic errors without shift and final reversal errors. Participants with GAD did not differ from healthy controls on the ESSQ, but they were slower on reversal learning relative to nonpatients. In OCD, reaction time on final reversal errors mediated the relationship between ethical sensitivity and compulsions. WCST performance was intact in OCD and GAD.
Limitations: Small sample size, limited neuropsychological assessment, self-rating scale for ethical sensitivity.
Conclusion: Prolonged reaction time at switching reinforcement contingencies is related to increased ethical sensitivity in OCD. Slow affective switching may link ethical sensitivity and compulsions.

1. Introduction

The resurgence of the increased moral sensitivity theory of obsessive-compulsive disorder (OCD) emerged as a fruitful meeting between psychodynamic and neurocognitive approaches (Freud, 1905/1955; Kempke & Luyten, 2007). Current cognitive theories posit that potentially harmful and immoral intrusive thoughts, images, or impulses elicit an inflated sense of personal responsibility, leading to compulsive behaviors, such as checking, ordering, or counting, to prevent unfavorable consequences (Salkovskis, 1985; Salkovskis, Forrester, & Richards, 1998). Mancini and Gangemi (2004) proposed that OCD is dominated by a feeling of fear of guilt that would stem from behaving irresponsibly. Patients with OCD often display dysfunctional appraisal about the power of their internal representations, believing that the mere appearance of an intrusive thought is morally the same as actions and behaviors driven by that thought (moral thought–action fusion) (Rachman, 1997; Shafran & Rachman, 2004).

Recent progress in social neuroscience may provide a direct link between these theories and the neuronal mechanisms of OCD symptoms. Harrison et al. (2012) used functional magnetic resonance imaging (fMRI) in order to measure brain activation in OCD during the processing of moral dilemmas. Relative to controls, patients with OCD displayed increased activation of the medial orbitofrontal cortex, left dorsolateral prefrontal cortex, and middle temporal gyrus. Critically, the global severity of OCD symptoms predicted the extent of activation in the orbitofrontal–striatal system during the processing of moral dilemmas, which is broadly consistent with the common pathophysiological and functional neuroanatomical models of the illness (Evans, Lewis, & Iobst, 2004; Harrison et al., 2012; Menzies et al., 2008).

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From a neuropsychological point of view, reversal learning is one of the most promising tools to investigate the functional integrity of the orbitofrontal–striatal system in OCD (Chamberlain et al., 2008; Freyer et al., 2011; Remijnse et al., 2006, 2009; Valerius, Lumpp, Kuelz, Freyer, & Voderholzer, 2008). Remijnse et al. (2006) used fMRI to study brain responses during reversal learning and “affective switching”, when participants changed their behavior by reversing reward-punishment contingencies in a simple visual discrimination task (i.e., choosing a cartoon tie over a bus and vice versa). When decisions were followed by reward, patients with OCD exhibited decreased activation of right orbitofrontal cortex and caudate nucleus compared with controls. Similarly, lower activations were found during reversal in the left orbitofrontal cortex, dorsolateral prefrontal cortex, and insula. Chamberlain et al. (2008) demonstrated reduced activation of the lateral orbitofrontal cortex not only in OCD patients, but also in their healthy biological relatives, providing evidence that changes during reversal learning may be an endophenotype. At the behavioral level, results are mixed with varying degrees and types of accuracy and reaction time deficits on reversal learning tasks in OCD (Freyer et al., 2011; Remijnse et al., 2006, 2009; Valerius et al., 2008).

The consideration of external contingencies and corrective feedback from the social environment, as it is modeled in reversal learning and affective switching, have a vital role in moral behavior, and this process is linked to different regions of the prefrontal cortex (Sinnott-Armstrong, 2008). For example, individuals with moral deficiency and antisocial traits consistently show reversal learning impairments and abnormal ventromedial prefrontal cortex functions during the task (Budhani, Richell, & Blair, 2006; Finger et al., 2008). Braun, Léveillé, and Guimond (2008) reported neurological patients with lesions to the orbitofrontal and striatal regions who exhibited either antisocial or OCD-like symptoms. Altogether, these results suggest that the orbitofrontal–striatal system may play a role in disorders associated with altered moral sensitivity, including antisocial personality disorder at one extreme, and perhaps OCD at the other.

Despite the fact that the results cited above revealed that responses to moral dilemmas, reversal learning, and OCD symptoms might share a common neuronal circuit in the orbitofrontal–striatal system (Harrison et al., 2012; Remijnse et al., 2006), and this neuronal network is important in moral sensitivity in general (Braun et al., 2008; Budhani et al., 2006; Finger et al., 2008), there has been no attempt to examine the relationship between basic neuropsychological functions and different aspects of ethical sensitivity in OCD. In addition, the definition of moral and ethical functions is less exactly delineated in the clinical and neuropsychological literature.

According to Narvaez’s concept (Narvaez, 2005; Narvaez & Endicott, 2009), moral behavior is based on four domains of skills and attitudes: ethical sensitivity, ethical judgment, ethical motivation, and ethical action. The first of these domains, ethical sensitivity, refers to the ability to recognize and understand ethical problems, to deal with conflicts empathically, and to evaluate the consequences of actions. Ethical sensitivity is therefore not a uniform construct, including at least seven areas of skills: (1) *Reading and expressing emotions* means understanding and identifying emotional expressions, as well as learning how to appropriately express emotions and manage aggression in different contexts. (2) *Taking the perspectives of others* refers to the ability to use an alternative perspective, for example, that of other persons from a distinct cultural group or with a different socioeconomic status. (3) *Caring by connecting to others* involves transcending self-interests and providing care to others. (4) *Working with interpersonal and group differences* includes perceiving and adjusting to diversity and multicultural adaptation. (5) *Preventing social bias* involves identifying and countering interpersonal biases. (6) *Generating interpretations and options* refer to skills to re-evaluate routines and to find another way to act. (7) *Identifying the consequences of actions and options* refers to our abilities to reflect to the outcome of actions and behaviors and to create alternative options (Narvaez & Endicott, 2009).

The purpose of this study was to investigate Narvaez’s ethical sensitivity dimensions in OCD and to compare that with reversal learning performance. We hypothesized that, relative to healthy controls, patients with OCD would not show a homogeneously increased ethical sensitivity; instead, we expected higher values in ethical sensitivity dimensions that require enhanced monitoring and controlling capacity (generating interpretations and identifying the consequences of actions). We also hypothesized a relationship between ethical sensitivity and reversal learning. This hypothesis was based on the similarity of brain activation patterns during moral dilemma processing and reversal learning in OCD (Harrison et al., 2012; Remijnse et al., 2006), the fact that individuals with moral deficiency and antisocial traits show abnormal reversal learning and ventromedial prefrontal cortical activation (Budhani et al., 2006; Finger et al., 2008), and the finding that damage to the orbitofrontal–striatal system may be associated with both antisocial traits at one extreme and OCD at the other (Braun et al., 2008). The prediction was that higher ethical sensitivity would be associated with a tendency to less readily change response contingencies in the reversal learning task in OCD, a sign of behavioral rigidity and indecisiveness. Perfectionism, concern about mistakes, and indecisiveness are significantly associated (Taylor, 1998).

In order to evaluate the specificity of the findings, we also included a group of individuals with generalized anxiety disorder (GAD) and examined the possibility that the expected alterations in OCD were mere consequences of anxiety and depressive symptoms.

2. Materials and methods

2.1. Participants

We enrolled 28 outpatient individuals with OCD (obsessions with checking compulsions: $n = 11$; contamination obsessions with washing and cleaning compulsions: $n = 9$; symmetry obsessions with ordering, arranging, and counting compulsions: $n = 8$), 21 outpatients with GAD, and 30 matched healthy controls at the National Psychiatry Center, Budapest, Hungary. Individuals with OCD and GAD were outpatients who received treatment and regular follow-up at the Center coordinated by A.N. The main type of OCD symptoms, as enlisted above, was defined by the treating clinician. Full medical records were available from all patients. Controls were enrolled via email and community networks, or they were acquaintances of the hospital staff. Healthy controls did not meet the diagnostic criteria of Axis I mental disorders as revealed by structured interviews (SCID-CV, see later at assessments) and medical history obtained during a screening interview. All patients received antidepressant medications (selective serotonin reuptake inhibitors and clomipramine). The demographic and clinical characteristics are summarized in Table 1. We used the following psychological and clinical instruments to characterize the participants: the Structured Clinical Interview for DSM-IV Axis I Disorders – Clinician Version (SCID-CV) (First, Spitzer, Gibbon, & Williams, 1996), the Yale-Brown Obsessive Compulsive Scale (YBOCS) (Goodman et al., 1989), the Hamilton Depression Rating Scale (HAM-D) (Hamilton, 1960), the Hollingshead Four-Factor Index for socioeconomic status (Hollingshead, 1975), the Wechsler Abbreviated Scale of Intelligence (WASI) (Wechsler, 1999), and the Wisconsin Card Sorting Test (WCST) (Heaton, Chellune, Talley, Kay, &

Table 1
Clinical, demographic, and neuropsychological characteristics of the participants.

	Obsessive compulsive ($n = 28$)		Generalized anxiety ($n = 21$)		Healthy controls ($n = 30$)	
	Mean	SD	Mean	SD	Mean	SD
Age (years)	41.2	8.3	45.6	11.3	41.1	9.0
Education (years)	13.2	4.5	14.0	5.2	13.8	4.7
IQ	110.4	10.1	111.6	10.5	109.5	11.0
WCST						
Categories completed	5.4	1.2	5.7	1.1	5.6	1.1
Number of perseverative errors	8.9	5.7	8.3	6.4	8.5	5.4
Number of non-perseverative errors	7.5	6.0	7.2	6.3	7.4	5.9
Conceptual responses	78.3	16.9	79.6	17.1	79.0	16.3
Social-economic status	34.6	5.4	36.4	7.2	35.0	6.0
Duration of illness (years)	21.4	7.2	14.3	9.6	–	–
YBOCS obsessions	10.3	3.2	–	–	–	–
YBOCS compulsions	10.1	2.2	–	–	–	–
HAM-D	7.8	3.8	8.3	5.2	–	–

Note. The groups were matched for age, education, IQ, and social-economic status ($ps > .1$). Gender ratio and handedness were similar (gender: 18 female/10 male in the obsessive-compulsive group, 13 female/8 male in the generalized anxiety group, 19/11 in the healthy control group; handedness: 24 right handed and 4 left handed in the obsessive-compulsive group, 29/2 in the generalized anxiety group, 25/5 in the control group; chi-square tests, $ps > .1$). All patients with obsessive-compulsive disorder received antidepressant treatment (22 patients received selective serotonin reuptake inhibitors, 6 patients received clomipramine) and participated in psychotherapy. All patients with generalized anxiety disorder received selective serotonin reuptake inhibitors. HAM-D = Hamilton Depression Rating Scale; WCST = Wisconsin Card Sorting Test; YBOCS = Yale-Brown Obsessive Compulsive Scale.

Curtiss, 1993) (Table 1). All scales and tests were administered by trained and regularly supervised experts who were naïve to the data obtained from the neuropsychological experiments. Clinical interviews and cognitive testing were performed in the same week. Patients with co-morbidity, including current major depressive disorder, other anxiety disorders, and substance abuse, were not included in the study. After a complete description of the study, all participants gave written informed consent. The study was done in accordance with the Declaration of Helsinki and was approved by the institutional ethics committee.

2.2. Ethical Sensitivity Scale Questionnaire (ESSQ)

The ESSQ is based on Narvaez's theory of ethical sensitivity (Narvaez & Endicott, 2009). The self-rating questionnaire consists of 28 items using a four-level Likert scale (1 = totally disagree, 5 = totally agree). The items are statements describing personally important ethical values and attitudes. The statements were selected to be suitable for individuals with different cultural and socioeconomic backgrounds. The 28 items are classified into seven dimensions (4 items/dimensions) according to theory of Narvaez and Endicott (2009): (1) Reading and expressing emotions (e.g., "In conflict situations, I am able to identify other persons' feelings."); (2) Taking the perspectives of others (e.g., "I also get along with people who do not agree with me."); (3) Caring by connecting to others (e.g., "In conflict situations I do my best to take actions that aim at maintaining good personal relationships."); (4) Working with interpersonal and group differences (e.g., "I try to consider another person's position when I face a conflict situation."); (5) Preventing social bias (e.g., "I realize that I am tied to certain prejudices when I assess ethical issues."); (6) Generating interpretations and options (e.g., "I ponder on different alternatives when aiming at the best possible solution to an ethically problematic situation."); (7) Identifying the consequences of actions and options (e.g., "I notice that there are ethical issues involved in human interaction."). The reliability ranged between $\alpha = .63$ (preventing social bias) and $\alpha = .79$ (working with interpersonal and group differences). The overall reliability was $\alpha = .81$, which is similar to previous reports using factor analyses and reliability measurements in different cultures (Gholami & Tirri, 2012). The dependent measures were the mean scores for each dimension of the ESSQ.

2.3. Reversal learning task

We used the method of Remijnse, Nielen, Uylings, and Veltman (2005) because of the substantial clinical and neuroimaging experience with this task (Remijnse et al., 2005, 2006, 2009). The task was presented on a MacBook laptop, programmed in SuperCard language. On each trial, two stimuli appeared on the screen: cartoons of a bus and a tie (exposure time: 3 s). The stimuli appeared at either side of the screen with randomized locations. We asked the participants to select one of the stimuli by pressing keys with left or right arrows on the computer keyboard. We informed them that the choice of the right object lead to winning points, whereas wrong answers are associated with point loss. The aim of the game was to win as many points as possible. After each response, either positive or negative feedback was provided by gaining or losing points, respectively. Positive and negative feedback was administered in a probabilistic schedule with an 80/20 ratio. The range of points to win or lose was 80–250. The number of points won or lost and the number of total points was presented for 2 s after each response. This feedback phase was followed by an interval of 1 s during which a fixation cross was presented. The task consisted of 400 trials (Fig. 1).

We defined distinct types of responses. A correct response that was probabilistically followed by negative feedback (20% of the trials) could result in a shift to the other stimulus (probabilistic error with shift) or the participant maintained the original response (probabilistic error with no shift). We did not inform the participants on the reversal of the contingency. After reversal, a wrong response not resulting in a shift to the other stimulus was called preceding reversal errors, whereas the last false response before the shift was the final reversal error. The criterion for reversal was 6–10 consecutive correct responses. During the task, we also administered baseline trials with two different stimuli (cartoons of a car and a pair of trousers). Participants were

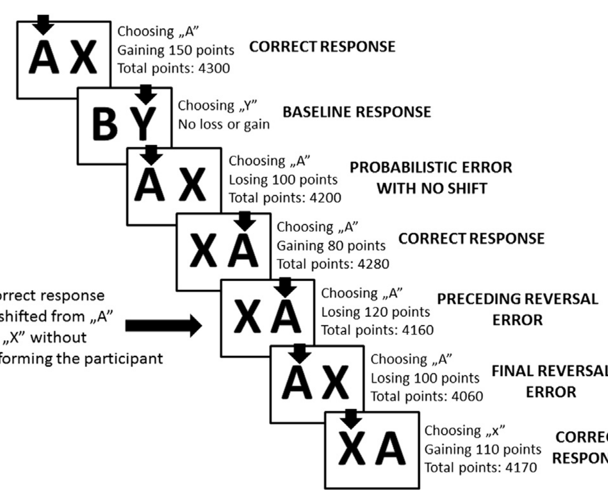

Fig. 1. Schematic illustration of the reversal learning task. Consecutive trials are depicted from top left to bottom right. Two stimuli were presented (A = cartoon tie; X = cartoon bus). Either stimulus was correct, and positive or negative feedback was provided after the choice (gaining or losing points). In baseline trials, participants were told which of the stimuli to choose. After 6–10 correct responses, a reversal occurred without informing the participant (Remijnse et al. 2005, 2006, 2009).

informed in advance which of the two baseline stimuli to select. Responses after baseline trials were not followed by gains or losses. For each type of responses, in addition to the number of the specific response or error, we also measured reaction time, which served as a dependent measure in the statistical analysis.

2.4. Data analysis

We used STATISTICA 11 software (StatSoft Inc., Tulsa) for data analysis. After checking the normal distribution of the data with Kolmogorov–Smirnov tests, individuals with OCD, GAD, and healthy controls (nonpatients) were compared with one-way analyses of variance (ANOVAs), followed by Tukey Honestly Significant Difference (HSD) tests. Cohen's effect size values (d) were determined for critical comparisons. We calculated Pearson's product moment correlation coefficients between ESSQ scores and reversal learning results, which was followed by multiple regression analyses. The threshold of statistical significance was $\alpha < .05$.

3. Results

3.1. ESSQ

Table 2 depicts the ESSQ scores and the statistical comparisons. Relative to healthy controls, patients with OCD achieved higher scores on generating alternative interpretations, $d = .85$, and identifying the consequences of actions, $d = .94$. Patients with GAD did not exhibit significant differences in ESSQ scores compared to healthy controls.

3.2. Reversal learning

Table 3 depicts behavioral results from the reversal learning task. Overall, individuals with OCD and GAD performed well on the task, exhibiting no significant differences in the number of different types of errors and responses, as well as the overall score won at the end of the game. Regarding response latencies, there were two cases when individuals with OCD showed longer reaction time than did the nonpatients: probabilistic errors without shift, $d = .75$, and final reversal errors, $d = .79$. In the case of GAD, we observed more generalized slowness during the reversal learning task (Table 3). First, in the case of probabilistic errors without shift and final reversal errors, individuals with GAD were slower than nonpatients ($d = 1.3$ and $d = 1.1$, respectively), but they did not differ significantly from individuals with OCD ($d = .46$ and $d = .28$, respectively). There were two additional cases when individuals with GAD, but not individuals with OCD, were significantly slower than nonpatients: probabilistic errors with shift ($d = .88$) and preceding reversal errors ($d = 1.3$) (Table 3).

3.3. Correlations

We calculated correlation coefficients between ESSQ scores and reversal learning test results (reaction time) in order to test the hypothesis that ethical sensitivity and reversal learning are associated. In addition, we calculated correlation coefficients between the clinical symptoms of OCD, ESSQ, and reversal learning test results in order to explore potential associations with obsessions and compulsions.

In OCD, the reaction time on final reversal errors positively correlated with two ESSQ dimensions: generating alternative interpretations, $r = .53$, $p < .05$, and identifying the consequences of actions, $r = .60$, $p < .05$. All other correlations between ESSQ scores and reversal test results remained below the threshold of statistical significance, $-.2 < rs < .2$, $ps > .1$. There were significant correlations between ESSQ scores on generating alternative interpretations and compulsions, $r = .43$, $p < .05$, as well as between identifying the consequences of actions and compulsions, $r = .42$, $p < .05$. The reaction time on final reversal errors also correlated with YBOCS compulsions, $r = .56$, $p < .05$. The HAM-D scores did not correlate significantly with either reversal test results or ESSQ measures, $rs < .3$, $ps > .1$.

In the case of GAD and nonpatient controls, ESSQ scores did not correlate with reversal learning, $rs < .2$, $ps > .1$.

In individuals with OCD, we also investigated the predictors of the two significant OCD-related ESSQ dimensions (generating alternative interpretations and identifying the consequences of actions) using multiple regression analyses. In these analyses, the potential predictor from the reversal learning task was the reaction time on final reversal errors because only this measure fulfilled three key criteria: significant alteration in OCD, correlation with ESSQ dimensions, and correlation with OCD symptoms. The probable predictors were therefore reaction time on final reversal errors, clinical symptoms (YBOCS and HAM-D scores), IQ, and Hollingshead scores. In the case of ESSQ generating alternative interpretations, the sole significant predictor was reaction time on final reversal errors, $b^* = .46$, $t\,(21) = 2.24$, $p < .05$; all other potential predictors: $ps > .1$; full model: $F\,(6, 21) = 2.76$, $p < .05$, $R^2 = .28$. In the case of ESSQ consequences of actions, again, the significant predictor was reaction time on final reversal errors, meanwhile the other potential predictors were not significant (final reversal errors: $b^* = .60$, $t\,(21) = 3.11$, $p < .05$; all other potential predictors: $ps > .1$; full model: $F\,(6, 21) = 3.76$, $p < .05$, $R^2 = .38$).

3.4. Mediation analysis

We conducted a formal mediation analysis (Baron & Kenny, 1986) in the OCD group with the assumption that reversal learning mediates the relationship between OCD-related ESSQ

Table 2
Ethical Sensitivity Scale Questionnaire (ESSQ) scores in individuals with obsessive-compulsive disorder and healthy controls.

	Obsessive compulsive ($n = 28$)		Generalized anxiety ($n = 21$)		Healthy controls ($n = 30$)	
	Mean	SD	Mean	SD	Mean	SD
Reading and expressing emotions[a]	3.3	.6	3.5	.8	3.7	.6
Taking the perspectives of others	3.9	.5	4.0	.6	3.9	.5
Caring by connecting to others	3.7	.5	3.9	.7	3.8	.7
Working with interpersonal and group differences	4.1	.5	4.2	.7	4.0	.5
Preventing social bias	4.0	.5	3.7	.5	3.8	.4
Generating interpretations and options[b]	4.3	.5	3.8	.6	3.8	.6
Identifying the consequences of actions and options[b]	4.4	.5	4.0	.5	3.9	.5

Note. The table depicts means and standard deviations (SD).
[a] One-way ANOVA: $F > 3$, df = 2,76, $p < .05$; healthy controls > obsessive compulsive ($p < .05$, Tukey HSD test).
[b] One-way ANOVA: $Fs > 3$, df = 2,76, $ps < .05$; healthy controls < obsessive compulsive ($p < .05$, Tukey HSD test).

Table 3
Results from the reversal learning task.

Event	Obsessive compulsive ($n = 28$)				Generalized anxiety ($n = 21$)				Healthy controls ($n = 30$)			
	Number		Reaction time		Number		Reaction time		Number		Reaction time	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Baseline trials	48.1	4.1	.72	.21	49.0	5.0	.70	.23	47.8	3.9	.68	.19
Correct responses	223.5	22.3	.63	.22	225.6	20.8	.60	.19	222.4	19.4	.62	.20
Probabilistic errors with shift[a]	18.9	8.3	.68	.23	18.7	9.1	.76	.16	19.0	8.9	.60	.21
Probabilistic error without shift[b]	24.6	9.7	.72	.16	23.7	10.7	.79	.15	22.5	8.5	.60	.13
Preceding reversal error[a]	13.0	9.1	.67	.17	14.1	10.0	.78	.13	15.1	9.5	.59	.12
Final reversal errors[b]	24.3	10.0	.71	.14	24.9	11.3	.75	.15	23.7	9.6	.60	.12
Spontaneous errors	56.7	24.7	.70	.22	55.3	25.9	.71	.20	54.8	23.7	.69	.21
Accumulated points	15,347 (SD = 8010)				15,466 (SD = 8095)				15,456 (SD = 7369)			

Note. The table depicts the mean number of events and reaction time.
[a] One-way ANOVA on reaction time: $Fs > 5.0$, df = 2,76, $ps < .005$, generalized anxiety > healthy controls = obsessive compulsive ($ps < .05$, Tukey HSD test).
[b] One-way ANOVA on reaction time: $Fs > 5.0$, df = 2,76, $ps < .005$, obsessive compulsive = generalized anxiety > healthy controls ($ps < .05$, Tukey HSD test).

dimensions and clinical symptoms, with a special relevance to compulsions, which showed significant correlations in preceding analyses described above. First, YBOCS compulsion scores were regressed on generating alternative interpretations scores, $b^* = .43$, $t\,(26) = 2.42$, $p < .05$, and reaction time at final reversal errors, $b^* = .56$, $t\,(26) = 3.47$, $p < .05$. Generating alternative interpretations scores were regressed on reaction time at final reversal errors, $b^* = .53$, $t\,(26) = 3.17$, $p < .05$. In the critical interaction analysis, both reaction time and compulsions were entered as possible predictors of generating alternative interpretations, which revealed a significant effect of reaction time, $b^* = .41$, $t\,(26) = 2.08$, $p < .05$, but not compulsions, $p = .35$.

The same analyses were performed in the case of ESSQ consequences of actions (regression of YBOCS compulsions: $b^* = .42$, $t\,(26) = 2.33$, $p < .05$). In the interaction analysis, when both reaction time and compulsions were entered as possible predictors of ESSQ consequences of actions, only reaction time at final reversal errors retained significance, $b^* = .54$, $t\,(26) = 2.81$, $p < .05$; compulsions: $p = .56$.

4. Discussion

Individuals with OCD differed from matched healthy controls on the ESSQ regarding generating interpretations and options and identifying the consequences of actions in social scenarios; as hypothesized, we found elevated self-rating scores in OCD relative to healthy controls. In addition, participants with OCD scored slightly lower than healthy controls at reading and expressing emotions. These results suggest that ethical sensitivity is not uniformly changed in OCD: dimensions that are related to monitoring and controlling are amplified, whereas those related to some emotion-laden interpersonal interactions might be mildly constricted. This is consistent with some results from cognitive and affective neuroscience (e.g., Grisham, Henry, Williams, & Bailey, 2010; Reuven-Magril, Dar, & Liberman, 2008; but see Bozikas et al., 2009). The findings cannot be explained by general anxiety and depressive symptoms in OCD, because patients with GAD did not show altered ethical sensitivity relative to healthy controls.

From a methodological point of view, it is necessary to emphasize that we used a self-rating scale instead of the evaluation and interpretation of moral dilemmas. Consistent with our results, others found that individuals with OCD scored higher than controls on the Responsibility Attitude Scale, which is a self-rating instrument consisting of 26 items (e.g., "I often feel responsible for things which go wrong." – totally agree/totally disagree on a 7-step scale) (Franklin, McNally, & Riemann, 2009; Salkovskis et al., 2000). Interestingly, individuals with OCD and healthy controls did not differ in the evaluation of moral dilemmas (Franklin et al., 2009). Moritz, Kempke, Luyten, Randjbar, and Jelinek (2011) reported that people with OCD displayed higher social responsibility than controls, but they were also characterized by more latent aggression and interpersonal distrust. According to Lind and Boschen (2009), lessened ability to tolerate uncertainty in OCD mediated the relationship between responsibility beliefs and compulsive checking behavior. The level of responsibility may play a causal role in symptom development: in experimentally manipulated high responsibility conditions, individuals with OCD experience more severe subjective symptoms and checking behavior (Arntz, Voncken, & Goosen, 2007). Increased checking behavior was also observed in children when a high responsibility condition was experimentally induced (Reeves, Reynolds, Coker, & Wilson, 2010). In non-clinical individuals, threats to moral self-perceptions lead to contamination-related concerns and behavioral tendencies (Doron, Sar-El, & Mikulincer, 2012).

There is evidence that the orbitofrontal cortex and its connections with the basal ganglia play an important role in both OCD and moral behavior (Braun et al., 2008; Harrison et al., 2012; Menzies et al., 2008). Therefore, we predicted that reversal learning alterations, with a special reference to poor shifting of affective sets and contingencies, might be related to altered ethical sensitivity in OCD. We found a specific correlation: prolonged reaction time at trials immediately before contingency shifting (reversal) was associated with higher ESSQ scores for generating interpretations and options and identifying the consequences of actions. Reaction time on final reversal errors mediated the relationship between ethical sensitivity and compulsions. In other words, indecisiveness to reverse the previously acquired contingency might be related to higher subjective ratings of ethical sensitivity associated with monitoring and controlling. This is consistent with the findings of Lind and Boschen (2009) who reported that low ability to tolerate uncertainty mediated the relationship between responsibility beliefs and compulsive checking. In the present study, ESSQ measures may correspond to responsibility beliefs and uncertainty may be related to hesitation before reversal. Further studies are necessary to test this hypothesis, with a special reference to the relationship between indecisiveness, hesitation, and reversal learning.

Individuals with the diagnosis of OCD performed surprisingly well on the reversal learning task: they did not differ from healthy controls in the total number of accumulated points or the number of errors. We observed prolonged reaction time only in two conditions (probabilistic errors without shift and final reversal errors), but only reaction time on final reversal errors had a specific role as it correlated with ESSQ scores and mediated the relationship between ESSQ and compulsions. However, it should be noted that people with OCD show generally higher monitoring and controlling tendencies, which may be against the specificity of our findings. Patients with OCD have been found to be slower than controls on various tasks including error-related events (Remijnse et al., 2009; Valerius et al., 2008). To tackle the issue of specificity, we included patients with GAD with anxiety, enhanced need of control and monitoring related to worries, and depressive symptoms without obsessions and compulsions. These patients with GAD displayed slowness that was even more extensive on some parameters of the reversal learning task relative to OCD, but in their case there was unaltered ethical sensitivity. Critically, individuals with GAD showed a significant increase in reaction time on probabilistic errors without shift and final reversal errors, which was similar to that observed in individuals with OCD. A potential explanation may be that the underlying mechanism of increased reaction time in reversal learning may be different in OCD and GAD. In OCD, it may be specifically related to ethical sensitivity, whereas in GAD it may be a part of general slowness; ethical sensitivity is not altered and reaction time on reversal learning does not correlate with it in GAD. However, both OCD and GAD are characterized by enhanced control and monitoring. Altogether, these are against the possibility that our findings in OCD are entirely non-specific. The results also indicate that reversal learning is not a specific index of ethical sensitivity.

The general slowness of patients with GAD was unexpected and unusual. Given the strong relationship between GAD and major depressive disorder (MDD), a possible explanation is that some of these patients later developed comorbid MDD associated with psychomotor slowness (Mennin, Heimberg, Fresco, & Ritter, 2008; Watson, 2005), although we have no evidence for that because we did not follow-up our patients. Similarly, it is unknown whether in the future patients with OCD will develop comorbid MDD or not.

Behavioral performance on reversal learning tasks may vary across OCD populations. In the Remijnse et al. (2006) study, patients gained less total points and had more errors relative to controls. In a second group of OCD patients, however, the same research group did not find impaired accuracy on this test, although the patients responded slower than the controls in several conditions (baseline trials, correct responses, probabilistic errors without shift, preceding reversal errors, and probabilistic errors with shift) (Remijnse et al., 2009). The most plausible explanation for the different findings may be the exclusion of OCD patients with comorbidity (e.g., major depressive disorder and non-OCD anxiety disorders) and the principal symptom-dimensions of the patients, which may be associated with different neuropsychological profiles (Hashimoto et al., 2011).

Using a similar reversal learning task with different stimuli (triangles and squares) and reinforcement signals (sad and smiling cartoon faces), Valerius et al. (2008) found flawless performance in OCD regarding accuracy and reaction time. However, the severity of compulsions was positively associated with reaction time at hits, response changes after a probabilistic error, and final reversal errors. This latter is consistent with the findings of the present study.

Our study is not without limitations. First, executive functions were assessed only with the WCST, in which we found no dysfunctions in this group of people with OCD. Evidence suggests that attentional set-shifting, as investigated by the WCST, and reversal learning are linked to the dorsal vs. ventral regions of the prefrontal cortex (Dias, Robbins, & Roberts, 1996; Fellows & Farah, 2003; Hornak et al., 2004). Executive functions are often found to be impaired in OCD, although it depends on the task used, clinical characteristics of patients, generalized cognitive dysfunctions, and medication status (Demeter, Csigó, Harsányi, Németh, & Racsmány, 2008; Henry, 2006; Kuelz, Hohagen, & Voderholzer, 2004; Lawrence et al., 2006; Olley, Malhi, & Sachdev, 2007). In this respect, it is noteworthy that we enrolled highly functioning outpatients and a healthy control group strictly matched for education, IQ, and socioeconomic status, which all may diminish neuropsychological differences. Second, all individuals with OCD received serotonergic medications at the time of testing, which may affect both neuropsychological performance (Robbins & Arnsten, 2009) and moral judgment (Crockett, Clark, Hauser, & Robbins, 2010). Third, the sample size was small and therefore we were not able to explore the relationship between OCD symptom-dimensions, reversal learning, and ethical sensitivity. Fourth, controlling and monitoring functions were not assessed with specific tests, and therefore it cannot be excluded that these functions mediate the changes in ethical sensitivity. Further studies are needed to explore these limitations and potential confounding factors and to address the question how altered ethical sensitivity may be relevant to psychosocial interventions in OCD.

Declaration of interest

The authors declare no conflict of interest.

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