Skin conductance responses of OCD washers to masked obsession-related pictures

Abstract

Patients with Obsessive-Compulsive Disorder (OCD) usually become very frightened when confronted with the object of their obsession. It is possible that these excessive fear responses are due to a hyperreactive fear system, that generates arousal responses even before the object is consciously perceived. Therefore, the aim of this study was to investigate whether OCD patients generate stronger arousal responses to masked obsession-relevant pictures, as compared to neutral and generally fearful (i.e. snakes and spiders) pictures. Fifteen OCD patients with washing compulsions viewed masked and unmasked versions of these stimulus types while their skin conductance responses (SCRs) were measured. The results demonstrate that OCD patients did not react with stronger SCRs to washer-relevant stimuli, regardless whether they were masked or unmasked. However, there was some evidence that patients did not habituate to the masked OCD pictures, whereas they did to the other pictures. Taken together, these data suggest that automatically elicited fear responses do not play a vital role in the pathogenesis of obsessive-compulsive washing. This conclusion can be validated by future neuroimaging studies investigating neural responses to masked emotional stimuli in OCD.
Introduction

Patients with Obsessive-Compulsive Disorder (oCD) usually generate extreme arousal responses when confronted with the object of their obsession. Clinically, these responses are rather similar to those observed in other anxiety disorders, such as simple phobias. Although autonomic arousal is presumed to play an important role in the etiology and maintenance of these disorders (Öhman and Soares, 1994), its role in the pathogenesis of oCD remains far from clear. This study tried to clarify this role, by examining the nature of automatic arousal responses in oCD washers.

Emotional arousal responses are usually elicited after the stimulus is consciously identified. However, there is growing evidence that these responses can be elicited automatically (i.e. prior to awareness) when biologically fear-relevant stimuli are present. This is possible because the human brain is able to identify threatening stimuli by recognizing certain key sensory features, upon which an immediate arousal response is elicited (Lang et al., 2000). This ‘pre-attentive’ detection of threat would be controlled by the amygdala and thalamic pathways (LeDoux, 1998; Morris et al., 1999; Williams et al., 2001). Support for the pre-attentive elicitation of fear comes from studies in healthy volunteers who had been aversively conditioned to pictures of angry faces. These subjects showed discriminatory skin conductance responses (SCRs) to the angry faces, even when the pictures were backwardly masked in order to prevent conscious perception (Esteves et al., 1994, Morris et al., 1996). Other studies found that phobic and subjects with post-traumatic stress disorder (PTSD) display exaggerated fear responses to masked phobic objects and facial stimuli respectively (Öhman and Soares, 1994; Rauch et al., 2000).

Taking a lead from this, it would be interesting to see whether obsession-relevant information can elicit automatic fear responses in oCD patients as well. This could shed light on the issue whether the fear system involved in oCD is similar to the one implicated in other anxiety disorders. In addition, it may also broaden our understanding of the processes underlying obsessive-compulsive washing behaviour. For instance, there is evidence that autonomic feedback influences a range of cognitive processes, including memory (Cahill, 1997) and decision making (Damasio, 1994). The experience of peripheral arousal responses may also increase the expectancy of aversive events (Öhman and Soares, 1998). This suggests that pre-attentive fear responses in oCD patients may interfere with cognitive processes needed to evaluate the ‘safeness’ of the situation at hand, thereby reinforcing the urge to perform compulsive actions.
In sum, the current study examined whether OCD patients generate stronger skin conductance responses to masked OCD-relevant stimuli than to masked neutral stimuli. We decided to include only OCD patients with washing symptoms, since the anxiety of these OCD patients is most similar to phobic fear (Rasmussen and Eisen, 1998). In order to study the specificity of the automatic fear responses to washer-relevant stimuli, we also added generally fearful stimuli (that is, pictures of snakes and spiders) to the stimulus set.

**Methods**

**Subjects**

Sixteen patients with Obsessive-Compulsive Disorder (OCD) with predominantly washing symptoms were included in this study. The nature of OCD symptoms was rated with the Yale Brown Obsessive Compulsive Symptom Checklist and symptom severity with the Yale Brown Obsessive Compulsive Scale (Y-BOCS, Goodman et al., 1989). Of the 16 patients we included, fourteen presented with fear of bodily products, germs and dirt. Two patients presented specifically with fear of chemical waste and toxics. The Hamilton Depression Rating Scale was used to assess the severity of comorbid depressive symptoms (HDRS, Hamilton, 1960). Premorbid verbal intelligence was estimated by the Dutch translation of the National Adult Reading Test (NARL; Schmand et al., 1991). Eleven OCD patients used anti-depressive medication (SSRIs) at the time of testing; two patients combined this medication with either beta blockers or benzodiazepines. Due to a technical failure, recordings of one female patient were lost, leaving the final sample to 15 subjects. Demographic and clinical characteristics of the subjects are given in table 1.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>36.6 (6.41)</td>
</tr>
<tr>
<td>Estimated verbal IQ</td>
<td>107.3 (8.99)</td>
</tr>
<tr>
<td>Y-BOCS obsessions</td>
<td>10.67 (3.96)</td>
</tr>
<tr>
<td>Y-BOCS compulsions</td>
<td>10.73 (4.73)</td>
</tr>
<tr>
<td>Y-BOCS total</td>
<td>21.40 (8.40)</td>
</tr>
<tr>
<td>HDRS</td>
<td>6.86 (4.45)</td>
</tr>
</tbody>
</table>

Table 1 — Clinical and demographic characteristics of OCD washers (n = 15). Standard deviations are given between parentheses.
Apparatus and stimulus material

Patients were tested in a sound-isolated, dimly lit room at the Department of Psychology of the University of Groningen. The testing apparatus was situated outside the experimental chamber. During the experiment, subjects were able to communicate with the experimenter by means of an intercom. Stimuli were presented on a 15 inch computer monitor (resolution 60 Hz) that was situated in front of the subject on a distance of 1 meter. The actual size of the pictures displayed on this monitor was 28 x 21 cm. We used three categories of stimuli: neutral pictures (flowers), generally fearful pictures (spiders and snakes) and washer-relevant pictures (e.g. dirty toilet). For every stimulus category there were 5 different stimuli (examples of the stimuli are depicted in figure 1). Most of the stimuli were derived from the International Affective Picture System (IAPS; Lang et al., 1997). Some stimuli were derived from a recent PET study in OCD (Van den Heuvel et al., unpublished results) or were photographs taken by the authors and validated in a subset of OCD patients (n = 4), who did not participate in the SCR experiment. Masking stimuli were scrambled pictures consisting of small parts of the original OCD, fearful or neutral pictures. As a result, the five different masks used in this study were highly similar to the target stimuli with respect to color and texture.

Target stimuli were flashed on the screen for 33 ms and immediately followed by the masking stimulus which was presented for 100 ms. Stimulus presentation was controlled by an in-house developed software program. The time between two successive presentations of stimuli ranged between 21 and 25 seconds (mean 23 sec). Skin conductance responses (SCRs) were measured during all four stages of the task (see Procedure) using the constant voltage method (0.5 V). Two Ag-AgCl electrodes were filled with isotonic gel (Oxford Instruments Medical Inc.) and attached to the middle phalanges of the first and second finger of the subject’s nondominant hand. A 486 PC sampled physiological signals with 1000 Hz. A visual warning signal, consisting of a white asterisk appearing for 500 ms in the center of the screen, was given 1500 ms before presentation of the stimulus.

Procedure

Before the start of the experiment, subjects were told that their physiological responses to different kind of pictures were measured. They were aware that the pictures could be related to their obsession, however, subjects were not exposed to the actual pictures that were used in the experiment. Subjects were told that,
as soon as they saw the warning signal (asterisk) on the screen, they had to sit quiet and fixate on the center of the screen. Subjects were explained that following each warning signal, two pictures would be flashed. The first could be either a neutral stimulus, a fearful stimulus or a washer-relevant picture, the second would be a nonsense picture (mask). The experimental procedure comprised of four consecutive stages. In the first stage, masked stimuli of the three different categories (5 for each category) were presented twice. Stimuli were presented in random order, with the restriction that only two successive exposures of each stimulus type were allowed (cf. Öhman and Soares, 1998). This stage was followed by a forced choice recognition procedure. Fifteen new stimuli derived from the same three categories were mixed with the target stimuli and presented once to the subject. After each stimulus, subjects had to make a forced categorization of the (unseen) target stimulus. In the third stage, each target was presented twice
and unmasked to the subject (presentation time 1000 ms). This stage consisted of passive looking at each stimulus. In the final stage, unmasked target stimuli were presented once (1000 ms). This time, subjects rated both valence and arousal of each stimulus on the Self-Assessment Manikin (SAM) rating scales (Bradley & Lang, 1994). Valence ratings ranged from 1 (very unpleasant) to 9 (very pleasant) and arousal ratings ranged from 1 (very calm) to 9 (very excited).

Data reduction and analysis

Skin conductance responses were measured in mVolt and analyzed off line by means of an in-house designed computer program. A skin conductance response was defined as the maximal continuous deflection in conductance starting in the 1–4 seconds interval after onset of the stimulus (Dawson et al., 1990). In addition to computing the absolute SCR amplitude, we also computed the relative change in skin conductance with respect to baseline, which was defined as the SC level in the 500 ms preceding the onset of the target stimulus. SCR amplitudes were converted to microSiemens by correction for the gain of the amplifier that was set individually for each patient. A square-root transformation was used to normalize SCRs.

Statistical analysis

Emotional rating of stimuli
Ratings of valence and arousal of unmasked OCD, fearful and neutral pictures were averaged across stimuli. Emotional ratings for each stimulus category were compared using nonparametric Friedman’s tests. In addition, we used the Wilcoxon signed ranks test to evaluate the nature of the differences between valence and arousal ratings.

Forced Choice Recognition
Data from the forced choice recognition procedure was used to test whether the masking had been effective. For each subject, we calculated the mean percentage of hits and false alarms. An one-sample t-test was used to test whether mean accuracy was different from 10 (which was the chance level of being correct; namely 30% of 30 trials). Further, in order to detect a potential response bias, we performed a 3 (Picture: OCD vs neutral vs fearful) × 2 (Awareness: percentage hits vs percentage false alarms) ANOVA with repeated measures on both factors.
In case of significant interaction effects, paired t-tests were used to compare percentage hits/false alarms for each stimulus category.

**Skin Conductance Responses (SCRs)**
Both relative and absolute SCRs were subjected to analysis of variance. In order to test for habituation effects, we averaged SCRs for the first and second block of five trials per type of picture. Data were analyzed with a three-way univariate analysis of variance with repeated measures, using a 2 (Mode: masked or unmasked) × 2 (Block: first or second presentation) × 3 (Pictures: OCD vs fearful vs neutral) design. In case of significant interaction effects, post-hoc paired t-tests were used to investigate the nature of these effects.

**Correlations between symptoms and skin conductance responding**
Spearman’s rho was used to test whether emotional ratings of the OCD, fearful and neutral stimuli correlated with both absolute and relative SCR amplitude under either masked and unmasked conditions. Pearson’s product moment correlations were computed between total scores on the Y-BOCS symptom scale and SCR amplitudes in both the masked and unmasked condition.

**Results**

**Emotional ratings of stimuli**
Ratings of valence and arousal for the different picture types are shown in table 2. OCD patients rated OCD stimuli as significantly more arousing and less pleasant than either the fearful (valence: Z = -2.78, p = 0.005; arousal: Z = -3.24, p = 0.001) or neutral stimuli (valence: Z = -3.41, p = 0.001; arousal Z = -3.41, p = 0.001). Neutral stimuli were rated as significantly more pleasant (Z = -3.41, p = 0.001) and less arousing (Z = -3.24, p = 0.001) than fearful stimuli.

**Table 2** — Mean emotional ratings of stimuli by OCD washers (n = 15). Valence: high numbers correspond to positive ratings. Arousal: high numbers correspond to increased arousal. Standard deviations are given between parentheses.

<table>
<thead>
<tr>
<th>Picture</th>
<th>Valence</th>
<th>Arousal</th>
</tr>
</thead>
<tbody>
<tr>
<td>OCD</td>
<td>1.76 (1.04)</td>
<td>6.91 (1.63)</td>
</tr>
<tr>
<td>Fearful</td>
<td>4.27 (2.04)</td>
<td>4.03 (2.21)</td>
</tr>
<tr>
<td>Neutral</td>
<td>7.83 (0.87)</td>
<td>1.21 (0.47)</td>
</tr>
</tbody>
</table>
Forced Choice Recognition

Table 3 depicts mean percentage of hits and false alarms for OCD patients. Mean percentage of total hits (20.26%) was significantly lower than the percentage that could be expected on chance alone (i.e. 30%) ($t_{12} = -3.27; p = 0.007$). When we looked at the percentage of hits for the individual stimulus types, only the mean hit score for neutral pictures was at chance probability (see table 3). One-way ANOVA with repeated measures revealed a significant interaction between Condition and Awareness ($F_{2,11} = 12.49; p < 0.005$). This interaction effect was due to OCD patients making more incorrect assignments to the neutral category than to either the OCD or fear category ($t_{12} = -6.24; p < 0.001$ and $t_{12} = -6.38; p < 0.001$ respectively). Apparently, OCD patients tended to categorize a stimulus as ‘neutral’ when they were uncertain. This conservative response bias explains the relatively high percentage of hits in the neutral category.

<table>
<thead>
<tr>
<th>Picture</th>
<th>% correct</th>
<th>% false alarms</th>
<th>$t(12)$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>OCD</td>
<td>3.59 (4.40)</td>
<td>9.23 (11.23)</td>
<td>-5.25</td>
<td>0.001</td>
</tr>
<tr>
<td>Fearful</td>
<td>5.90 (4.55)</td>
<td>8.46 (8.45)</td>
<td>-3.26</td>
<td>0.001</td>
</tr>
<tr>
<td>Neutral</td>
<td>10.77 (10.47)</td>
<td>60.00 (22.65)</td>
<td>0.265</td>
<td>0.796</td>
</tr>
</tbody>
</table>

Relative SCRs to masked and unmasked stimuli

Exploratory analysis with Shapiro-Wilks statistic revealed that the square-root transformation was successful in normalizing the distribution of SCR data. These analyses also revealed that one subject consistently presented elevated SCRs to the masked stimuli. During intake, this subject had indicated that she was treated for hyperthyroidism. This disorder has been associated with abnormalities in the HPA-axis, which may lead to significantly elevate skin conductance levels (Dolu et al., 1997). Therefore, data were analyzed both with and without this subject. In case this caused significant differences in the results, this will be reported explicitly. Mean relative SCRs of OCD patients to masked and unmasked OCD, fearful and neutral stimuli are depicted in figures 2ab.

The omnibus ANOVA with Mode (2), Picture (3) and Block (2) did not reveal a significant main effect of Mode ($F_{1,14} < 1$) or Picture ($F_{2,13} < 1$), although there was a trend towards a significant effect of Block ($F_{1,14} = 4.41; p = 0.054$). In addition, none of the interaction effects (Mode × Picture, Mode × Block, or Mode
× Block × Picture) was significant. Together, these results indicate that the SCR pattern displayed in the masked condition was similar to the one observed in the unmasked condition.

Next, we analyzed mean SCRs for the masked and unmasked condition separately. In the unmasked condition, there was no effect of Picture (F_{1,14} < 1) or Block (F_{1,14} < 1) and the interaction between Picture and Block did not reach significance either (F_{2,13} < 1) (see figure 2a). Apparently, the unmasked washer-

**Figure 2a** — Mean √SCRs to unmasked washer-relevant (OCD), neutral and generally fearful pictures.

**Figure 2b** — Mean √SCRs to masked washer-relevant (OCD), neutral and generally fearful pictures.
relevant pictures did not evoke stronger or more persistent arousal responses in the patients than neutral or fearful pictures. For the masked condition, the ANOVA yielded only a significant effect of Block (F_{1,14} = 6.35; p < 0.05) demonstrating an overall habituation effect to the masked pictures. The lack of an effect of Picture (F_{1,14} = 2.88; p = 0.09) or Picture × Block (F_{1,14} < 2; p = 0.18) demonstrates that OCD patients did not generate larger or more persistent SCRs to the masked OCD stimuli either. However, when we repeated this ANOVA with two instead of three picture types, the comparison of OCD and neutral stimuli revealed a significant effect of Picture (F_{1,14} = 5.76; p < 0.05). Remarkably, SCRs to masked OCD stimuli were smaller than those elicited by masked neutral pictures (see figure 2b). In addition, comparison of OCD with fearful stimuli revealed a significant Block × Picture interaction: F_{1,13} = 4.74; p < 0.05 (outlier removed). This effect was due to the fact that patients did not habituate to masked OCD stimuli (t_{14} = 0.825; p = 0.423) whereas they did to masked fearful stimuli (t_{14} = 2.47; p < 0.05) (see figure 2b).

**Absolute SCR to masked and unmasked stimuli**
Replacing relative changes in SCRs by absolute SCR values did not change the significance of the results of the ANOVA. There was one exception to this, however. When we used absolute SCRs, the Block × Picture interaction effect, that was found comparing masked fearful and masked OCD pictures, was no longer significant.

**Correlations between symptoms and SCR**
Mean SCRs to masked or unmasked OCD stimuli did not correlate with severity of either obsessions or compulsions. In addition, there was no significant association between SCRs and symptoms of depression in the OCD sample. Finally, emotional ratings of the stimuli were not related to SCR amplitudes.

**Discussion**

To our knowledge, this is the first study on emotional responses to masked stimuli in OCD washers. Previous work in phobic subjects and healthy controls has found evidence for discriminatory SCRs to covert aversive stimuli, which supported the notion that autonomic states can be triggered automatically. This theory may also have explanatory power for the presence of emotional disregulations as they are observed in OCD. For instance, the pre-attentive activation of
Somatic states may interfere with cognitive processes involved in the evaluation of danger and the subsequent selection of behaviour. In the current study, we investigated whether covertly presented washer-relevant pictures elicited arousal responses in OCD patients with washing symptoms. We specifically predicted that SCRs elicited by masked OCD stimuli could be differentiated from those elicited by masked neutral or generally fearful pictures.

Behavioural data of the forced recognition test revealed that OCD patients did not have a higher than chance probability of recognizing the target stimuli. This suggests that the backward masking procedure was effective in preventing conscious perception of the stimuli. In addition, OCD washers rated the unmasked washer-relevant pictures as significantly more aversive and more arousing than either neutral and fearful pictures, which confirms the validity of our stimulus material.

Despite these facts, our psychophysiological data clearly indicate that OCD washers did not react with stronger SCRs to masked contamination pictures. In fact, there was even evidence that SCRs to masked OCD stimuli were smaller than SCRs elicited by masked neutral stimuli. We also found (and this was rather unexpected) that OCD washers did not habituate to masked washer-relevant pictures, whereas they did to masked fearful pictures. We should note, though, that this interaction effect was rather small and only present when we considered the relative, but not the absolute, changes in skin conductance.

One possible explanation for our negative findings may lie within the validity of the washer-relevant stimuli. That is, we found that OCD washers did not generate stronger SCRs to these pictures when they perceived them consciously. This suggests that our OCD stimuli were not capable of eliciting SCRs in OCD washers at all. We think, however, that the SCRs to the unmasked pictures have been confounded by factors that are inherent to the design and the nature of our patient group. First, stimuli were presented in random order, meaning that subjects never knew which stimulus would be the next one. After debriefing, some OCD patients reported that they were actually relieved when the presented picture was not related to their obsession. These feelings of relief may have induced variations in skin conductivity that are difficult to discriminate from those elicited by negative emotions. In addition, a number of patients noted that they could not help thinking back of the washer-relevant pictures, and these thoughts may have enlarged SCRs to either neutral or fearful pictures. Thirdly, some patients used cognitive strategies to deal with the emotions that were induced by the OCD pictures, for instance, they told themselves ‘it is only a picture and not real’. Finally, SCRs to neutral pictures may have been enhanced by a cognitive bias that...
is present in many OCD patients. For instance, some subjects rated pictures of flowers as ‘aversive’, because ‘a dog could have urinated on them’. Together, these factors may have obscured genuine differences in SCRs to the different picture types, and this implies that the unmasked condition has not been as an adequate control for the masked condition. Although the random-order design was successfully applied in previous studies with phobic subjects (Van den Hout et al., 2000; Öhman and Soares, 1994), we think it is less suited for use in OCD.

Therefore, the most straight-forward interpretation of the main findings of this study seems to be the following. First, the fact that OC washers did not react stronger to washer-relevant stimuli suggests a minor role for the automatic fear system in OCD, and this differentiates OCD from other anxiety disorders such as simple phobia and PTSD. In fact, our data indicate that the excessive fear response of OCD patients, when confronted with the object of their obsession, is elicited after the stimulus has been semantically processed. This supports the view that OCD is first and foremost mediated by distorted cognitive processes (Rachman, 1997). However, we also found some evidence for decreased habituation to washer-relevant stimuli in our patients. Although this effect may have occurred because SCRs to OCD stimuli were already quite small in the first block, it still remains worthwhile to investigate whether these findings reflect some kind of abnormal emotional processing in OCD.

As a final point, we emphasize that the validity of our conclusions awaits further testing. This seems warranted as there is a possibility that the relatively small sample size has decreased the power of our study. Since it appears rather difficult to obtain a large homogeneous sample consisting of OCD washers only, we are currently replicating our study with Positron Emission Tomography (PET) to validate our findings. With this method, we can determine whether OCD washers have abnormalities in the neural network that underlies the processing of masked washer-relevant stimuli. This may also clarify the meaning of the specific lack of habituation to OCD-relevant stimuli shown by the patients in the present study.

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References


