Obsessive–compulsive disorder patients display enhanced latent inhibition on a visual search task

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Abstract

Latent inhibition (LI) is a phenomenon that reflects the ability to ignore irrelevant stimuli. LI is attenuated in some schizophrenic patient groups and in high schizotypal normal participants. One study has found enhanced LI in patients with obsessive–compulsive disorder (OCD) [Swerdlow, N. R., Hartston, H. J., & Hartman, P. L., 1999. Enhanced visual latent inhibition in obsessive–compulsive disorder. \textit{Biological Psychiatry}, 45, 482–488]). The present experiment replicated this finding using a within-subject visual search LI task, with OCD patients displaying more LI than healthy controls. The contrasting LI effects in schizophrenia and OCD are discussed in terms of how these groups differentially process relevant and irrelevant stimuli, and how that outcome affects subsequent behavior.

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Introduction

Obsessive–compulsive disorder (OCD) has been extensively studied at the biological, genetic and psychological levels (for reviews, see Aouizerate et al., 2004; Kuelz, Hohagen, & Voderhozer, 2004; Wilson, 1998). In the past two decades, cognitive psychologists have explored the relationship between OCD and information processing variables, particularly those that index attentional processes. However, a recent review of the literature (Kuelz et al., 2004), covering studies of visual reaction time, speed of information processing, attention span, sustained attention, set shifting, and selective attention, concluded that, “There is little evidence…for dysfunctional basic attention (abilities) in OCD patients”.

Of the various attentional processes that have been studied in OCD, selective attention is particularly relevant, as distractibility by irrelevant stimuli is often observed in these patients (Kuelz et al., 2004). Whereas
in Kuelz et al.’s review, selective attention is indexed only by the Stroop paradigm, several studies have examined selective attention in OCD using other methodologies. Enright and Beech (1990, 1993a) combined the Stroop task with a negative priming task (NP; Tipper, 1985). Patients with OCD displayed reduced NP effects compared to non-patients and to patients with other anxiety disorders. In another study, OCD patients displayed no evidence of NP while showing facilitation, rather than inhibition, on a semantic NP task (Enright & Beech, 1993b).

Enright and Beech interpreted these findings as indicating reduced cognitive inhibition in OCD. They contended that patients with OCD are deficient in their ability to selectively attend to relevant stimuli while filtering out irrelevant stimuli, both external and internal. A study by Clayton, Richards, and Edwards (1999), using the Test of Everyday Attention, reached very similar conclusions. Finally, Okasha et al. (2000) found that patients with OCD were over-attentive to irrelevant stimuli and displayed delayed attention to relevant tasks. They also were deficient in their ability to shift cognitive sets, a finding that has been reported by others (Head, Bolton, & Hymas, 1989; Lucey et al., 1997; Veale, Sahakian, Owen, & Marks, 1996).

Another useful tool for assessing the effects of irrelevant stimuli on subsequent behavior is the latent inhibition (LI) procedure (Lubow, 1989). The LI phenomenon is observed when a previously irrelevant stimulus becomes weakened in its ability to contribute to new learning as compared to a novel stimulus. This robust selective attention effect has been demonstrated with a variety of learning paradigms and across many different species (for reviews, see Lubow, 1989, 2005). The normal LI effect has been interpreted as being the result of a decline of stimulus-specific attention during a preexposure (PE) stage, the consequence of which is that subsequent associations with that stimulus are more difficult to acquire or express as compared to a novel stimulus or a previously attended one. (For alternative explanations of LI based on competition/retrieval concepts, see Bouton, Nelson, & Rosas, 1999; Miller & Escobar, 2002.)

Numerous studies have demonstrated that LI can be used to index dysfunctional attentional processing in pathological groups. When LI is attenuated, as in non-medicated schizophrenic patients with positive symptoms (e.g., Gray, Hemsley, & Gray, 1992; Gray, Pilowsky, Gray, & Kerwin, 1995: but see Swerdlow, Braff, Hartston, Perry, & Geyer, 1996), it is usually attributed to high levels of distraction, such that during the PE stage attention to the preexposed stimulus is maintained rather than reduced. Conversely, when LI is potentiated, this may indicate an inability to shift from a previously learned association to a new one. This condition may have two independent sources. In the PE stage of an LI experiment, the patient learns two associations: an association between an irrelevant stimulus and the absence of a consequence (A-0), and an association between a relevant stimulus and the presence of a consequence (B+). In the test stage, where the relationships are reversed (A+, B-0), potentiated LI may result from a failure to abandon either one or both of the associations that were learned in the PE stage. In either case, there would appear to be something akin to an attentional rigidity, an inability to “switch sets” when the previously irrelevant stimulus becomes the currently relevant target. Such attentional inflexibility also can be described in terms of controlled and automatic attentional processes (Schneider & Shiffrin, 1977), or, relatedly, implicit and explicit processes. By the end of the PE stage, the process underlying the ignoring of the irrelevant stimulus by normal participants has moved from the fully controlled (explicit) mode towards increased automaticity (implicit mode). When a switch is made from the PE-stage to the control-demanding test-stage, test-trials that contain targets that were distractors in the PE phase will be responded to more slowly than those trials that have novel targets (Lubow & Kaplan, 2005). Therefore, groups that are deficient in set switching, such as OCD patients, should exhibit potentiated LI relative to healthy controls.

The evidence related to attention deficits in OCD motivated Swerdlow and his colleagues to examine LI in OCD patients. In the first of two studies, Swerdlow et al. (1996), using an auditory LI task that has been effective in detecting reduced LI in schizophrenic patients (e.g., Baruch, Hemsley, & Gray, 1988), failed to find LI differences between OCD patients and normal controls. The authors reasoned that the absence of enhanced LI in OCD may have been the result of using auditory stimuli and/or a ceiling effect produced by task difficulty. Indeed, with a relatively easy visual task, Swerdlow, Hartston, and Hartman (1999) did obtain potentiated LI in OCD patients as compared to non-anxious controls. The authors interpreted their results as indicating that patients with OCD have difficulty in switching cognitive sets, as indicated by the delay in learning that previously irrelevant stimuli have become relevant. However, they used a new between-subject LI procedure for which there was no comparable data from other pathological groups. In addition, the LI effect
in the control group was small (a difference of one trial between the stimulus preexposed group and the non-preexposed group in the number of trials to reach the learning criterion in the test stage).

In the present study, we attempted to replicate Swerdlow et al.’s findings using a within-subject procedure based on a visual search protocol that has been shown to tap the attentional processes that are operative in standard LI (Lubow & Kaplan, 2005). The visual search LI procedure has proven to be differentially and directionally sensitive to various pathologies, including schizophrenia (e.g., Cohen et al., 2004; Lubow, Kaplan, Abramovich, Rudnick, & Laor, 2000), Parkinson’s disease (Lubow, Dressler, & Kaplan, 1999), and attention deficit disorder (Lubow, Braunstein-Bercovitz, Blumenthal, Kaplan, & Toren, 2005; for a review, see Lubow & Kaplan, 2005).

Specifically, we used a modified version of the Lubow and Kaplan (1997) two-stage visual search LI procedure (e.g., Cohen et al., 2004) to compare OCD participants with a matched healthy control group. Following a PE stage, each participant was tested under two conditions: (1) stimulus preexposure (PE), in which the distractor that was preexposed in stage-1 became the target in stage-2, and the preexposed target became the test distractor; (2) non-preexposure (NPE), in which the test target was novel, and the preexposed target became the test distractor. Based on the findings of Swerdlow et al. (1999), we expected that the OCD group would exhibit a potentiated LI effect as compared to the control group.

Methods

Participants

Eighteen clinically diagnosed OCD patients (15 male and 3 female) and 18 participants with no history of mental disorder (15 male and 3 female) took part in the study. Participants with psychotic symptoms, past or present, were not included. Sixteen of the OCD patients were recruited by their therapists based on their medical history and diagnosis. Two others were recruited by internet advertising (they self-reported the OCD diagnosis and provided the name of the professional who diagnosed them). All patients were diagnosed as OCD on the basis of DSM criteria (American Psychiatric Association, 2000). Of the 18 patients, 16 were on an anti-OCD monotherapeutic regimen (SSRIs), four of whom were also treated with low doses of anti-psychotic drugs. Two patients were drug-free. According to the therapists’ reports, five participants also had symptoms of depression, and five had an additional anxiety disorder (i.e. social phobia, agoraphobia, general anxiety disorder). The age of OCD participants ranged from 21 to 39 years ($M = 29.05; SD = 4.46$), and years of education from 12 to 18 ($M = 13.72; SD = 1.75$). Control group participants were matched on gender, age, and education to OCD patients. Ages ranged from 21 to 39 years ($M = 29.29; SD = 4.28$), and years of education from 12 to 17 ($M = 13.88; SD = 1.68$). All participants volunteered to take part in the study after receiving explanations of the procedure and the length of the experiment.

Apparatus and materials

Questionnaires

Three questionnaires were administered to all participants: (1) the Revised Obsessive–Compulsive Inventory (OCI-R; Foa et al., 2002), an 18-item, six sub-scale (washing, obsessing, hoarding, ordering, checking, and neutralizing), self-report instrument assessing the severity of OCD; (2) the State-Trait Anxiety Inventory (STAI; Spielberger, Gorsuch, & Lushene, 1970; Hebrew version by Teichman & Melnic, 1979), each of the two parts containing 20 self-report statements that are scored on 4-point Likert scales; (3) the Obsessive–Compulsive Personality Scale from the Wisconsin Personality Disorders Inventory (WISPI; Klein et al., 1993; Hebrew version by Dar, 1991), containing 19 self-report items rated on a 1–10 scale of frequency. For half of the participants, the questionnaires were administered before the visual search task, and for half after the task.

Apparatus

Experimental events were presented on a laptop computer. On any given trial (practice, PE stage, and test), the computer screen displayed 20 white figures on a dark gray background. Nineteen of the figures were
identical in shape and size (distractors) and one figure was unique (the target). All figures were constructed from five randomly connected straight-lines generated from a $3 \times 3$ matrix measuring 1.5 $\times$ 1.5 cm.

**Procedure**

**Practice and PE phases**

Participants, run individually, were seated in front of the computer keyboard, at normal viewing distance from the screen. They were informed that they would see a series of displays with 20 figures, one of which was different from all of the others. Participants were told to press the left arrow key if the unique figure appeared to the left of the midline of the screen, and to press the right arrow key if the unique figure was on the right side of the screen. The figures remained on the screen until the participant responded. The interval between the response and the next display was 1.5 s.

On half of the trials the target appeared on the left side of the screen, and on half on the right side. Targets and distractors could appear in any one of 96 positions created by an imaginary $12 \times 8$ matrix. The positions of the 20 figures were randomly determined for each trial, and the target appeared in a different position on each trial.

The experiment began with 12 practice trials that were constructed in a similar manner to the trials in the PE and test stages, but with different figures as target and distractors. The target and distractor figures remained unchanged during the 12 trials. After each trial, participants were told whether their response was correct or incorrect. In the subsequent stages, the participants were not given any feedback for their responses.

The PE stage immediately followed the practice session. Participants were told that they would see a new series of displays, and that their task was the same as in the practice phase. The PE stage consisted of 96 trials, each of which contained the same target figure and the same distractor figures. The position of the target was randomized, but it appeared only once in each of the possible 96 screen positions. Columns, rows, and left–right positions were counterbalanced. On each trial, display presentation was terminated when the participant responded.

**Test phase**

The 96-trial test stage began immediately after the pre-exposure phase. Participants were informed that they would have the same task as before, but now the targets and distractors would vary from trial to trial. The test stage was composed of four different trial-types: (1) the target and distractors were the same as in PE; (2) the target and distractors were novel; (3) the target and distractors were the same as in PE, but with reversed roles: the previous target became distractors, and the previous distractors became the target (PE condition); (4) the test target was novel, and the preexposed target became the distractor (NPE condition). The first trial-type was used in order to provide a retrieval cue for the PE stage and by that to enhance the LI effect (Kaplan & Lubow, 2001). In addition, the first and second trial-types were used to increase task difficulty. Each of the four trial-types appeared 24 times in a random order, with the restriction of no more than two successive identical trial types. Figure shapes were completely counterbalanced across participants and across status as target and distractor.

The dependent variable, in both stages of the experiment, was response time (RT), as measured from the onset of the display to the key press response. Errors were also recorded. For statistical analyses, the median RTs for correct responses for each participant were computed separately for each trial-type.

**Results**

**Psychometric scores**

Table 1 presents the mean questionnaire test scores for the Obsessive–Compulsive Inventory (OCI-R), State Anxiety, Trait Anxiety, and Wisconsin Personality Disorders Inventory (WISPI) for OCD and control Groups. As can be seen, the OCD group had significantly higher scores than the Control group on all of the questionnaires and on all but one of the OCI sub-scales (Table 2).
PE phase

Mean median RT for target detection was not significantly different for OCD patients (2.35 s, SD = 1.00) and control participants (2.00 s, SD = .68), t(34) = 1.22, p > .10. The mean percentage of errors was higher for OCD patients (6.5%, SD = 4.6%) than controls (4.3%, SD = 2.2%), although only marginally significant, t(34) = 1.82, p = .08. Pearson correlations between RTs and errors were calculated separately for OCD patients and controls. For OCD patients, there was a significant positive correlation between RTs and errors (r_p = .63, p = .005). The correlation for control participants was not significant (r_p = 0.20, p > .10).

Test phase

Overall, mean median RT for target detection was significantly longer for OCD (2.68 s, SD = .82) than for control participants (2.16 s, SD = .64), t(34) = 2.11, p < .05. In addition, the mean percentage of errors for OCD (8.4%, SD = 7.1%) was significantly higher than for the control participants (4.4%, SD = 2.6%), t(34) = 2.26, p < .05. Pearson correlations between RTs and errors, calculated separately for OCD and control participants, were not significant.

Latent inhibition

Fig. 1 displays the mean median RTs for the OCD and control participants in the PE and NPE conditions. As can be seen, both groups responded more slowly on PE trials than on NPE trials, thus exhibiting the basic LI effect. Furthermore, the LI effect appears larger for the OCD group than the control group. These observations were confirmed by a 2 x 2 mixed ANOVA that yielded a main effect of LI (PE vs. NPE), F(1,34) = 30.37, p < .001, \eta^2 = .47, and a significant LI X Group interaction, F(1,34) = 4.72, p < .05, \eta^2 = .12. Separate paired-t tests, indicated significant LI effects for the OCD and control groups, t(17) = 4.26, p < .001; t(17) = 3.87, p < .001, respectively. Furthermore, the OCD and control groups differed significantly in the PE
condition, \( t(34) = 2.09, p < .05 \), but not in the NPE condition, \( t(34) = .91, p > .10 \). The Group effect (OCD vs. Control) was not significant, \( p > .10 \).

A number of reports indicate that dopamine antagonists (e.g., haloperidol) administered before the stimulus PE phase enhance LI (e.g., Weiner & Feldon, 1987; Williams et al., 1996). Since four members of the OCD group were on anti-psychotic medication, this may have disproportionately contributed to the potentiated LI in that group. Although the mean LI effect (PE−NPE), indeed, was larger in those four than in the remaining 14 subjects, the mean LI effect for the 14 OCD subjects that were not on anti-psychotic medication was still twice that of the healthy controls (.68 versus .34; for the medicated-4, 1.19). Furthermore, the elevated LI in the four critical participants can be accounted for by the fact that they also had disproportionately severe OCD symptoms (higher mean scores than the remaining 14 OCD participants on 5 of the 6 OCI-R sub-scales).

As an additional check of the effects of the anti-psychotic medication on LI in the OCD group, we examined the mean LI score of the four OCD participants on anti-psychotic medication with that of four OCD participants who were not on anti-psychotic medication, and who were matched to the former group on the basis of OCI scores. The mean LI score for the former group was lower (1.19) than that of the latter group (1.28). In summary, there is no evidence that the significant Group \( × \) LI interaction was affected by the fact that four of the OCD patients were on anti-psychotic medication.

**Discussion**

The present study found that OCD patients displayed significantly more LI than normal participants. These results replicate those of Swerdlow et al. (1999) and extend them in two significant aspects. First, the present study used a within-subject visual LI procedure that has proven to be sensitive to various pathologies, including schizophrenia (e.g., Cohen et al., 2004; Lubow et al., 2000), Parkinson’s disease (Lubow et al., 1999), and attention deficit disorder (Lubow et al., 2005). Second, we used RT rather than the number of trials as the dependent measure. The procedure produced a substantial LI effect in the control group (see Fig. 1), yet left room to detect the enhanced LI in the experimental group. Hence, our results were not compromised by the ceiling effects that frequently plague the search for potentiated LI (Lubow & Kaplan, 1997).

In attempting to explain the potentiated LI in OCD patients, one must first ensure that the effect is not a result of procedural confounds such as the one already described, and dismissed, in regard to the effects of anti-psychotic medication. A second source of concern comes from the fact that the OCD group had significantly higher anxiety scores than the control group. However, a number of studies have shown that LI decreases with an increase in state and trait anxiety levels (for a review, see Braunstein-Bercovitz, Rammsayer, Gibbons, & Lubow, 2002). Therefore, if anything, the higher anxiety in the OCD than in the control group might be masking what would otherwise be an even more elevated LI effect in the OCD group.

In order to understand the elevated LI in the OCD group, it is necessary to account for the standard LI effect in healthy participants and the attenuated LI in non-medicated, acute schizophrenics and in high
schizotypal normals (for review, see Lubow, 2005), particularly in those studies that used the same procedures as the present one (Cohen et al., 2004; Lubow et al., 2000; Lubow, Kaplan, & De la Casa, 2001; for review, see Lubow & Kaplan, 2005). According to Conditioned Attention Theory (CAT; Lubow, 2005; Lubow & Gewirtz, 1995), normal participants in the PE phase initially attend to the distractors as well as targets. However, with repeated trials, attention to these distractors declines, generating a stimulus-specific inattentional response. Thus, in the test phase, when the previous distractor becomes a target, efficient target detection requires overcoming the previously acquired inattentional response to that stimulus. Consequently, detection RTs are slower to a test-phase target that was previously a distractor than to a novel test-phase target. CAT proposes that schizophrenic patients are deficient in the acquisition of the inattentional response to the distractors during the PE phase, a result that depends on a shift from controlled to automatic processing. As might be expected from the many descriptions of high distractibility in schizophrenics (e.g., Anscombe, 1987), they continue to allocate attentional resources to the non-target distractors. As a consequence, in the test phase, when those distractors are now targets, the patients with schizophrenia, unlike their healthy counterparts, do not have to surmount the stimulus-specific inattentional response that normally accrues to irrelevant stimuli, the result of which is that the patients exhibit attenuated LI as compared to the controls.

However, CAT does not provide an explicit prediction regarding LI in OCD patients. As discussed in the Introduction, these patients are often characterized by increased distractibility (Kuelz et al., 2004) and display deficits in selective attention and negative priming (Enright & Beech, 1990, 1993a; Clayton et al., 1999; Okasha et al., 2000). For example, a recent study with the global–local hierarchical-letters paradigm (Yovel, Revelle, & Mineka, 2005) showed that individuals with an obsessive–compulsive cognitive style tended to be distracted by to-be ignored small details when instructed to respond to global information. These findings would lead to the prediction that patients with OCD, like schizophrenics, should display attenuated LI. However, our study and Swerdlow et al.’s (1999) show that OCD patients display the opposite effect, i.e., potentiated LI. Swerdlow et al. (1999) interpreted this finding as reflecting OCD patients’ cognitive rigidity and their tendency to become “stuck in set,” which has been demonstrated using other procedures (e.g., Head et al., 1989; Lucey et al., 1997; Veale et al., 1996).

Alternatively, the inflated LI in OCD may reflect a compensatory process, rather than a cognitive deficit per se. Specifically, patients with OCD may use a strategy-determined attentional process to overcome distractibility and related deficits in executive function. They may compensate for their natural tendency to be distracted by the irrelevant stimulus in the LI paradigm by rigidly focusing on the relevant stimulus in the PE stage. Such a tactic would result in an increased difficulty to switch from that stimulus when it is presented in the test stage with a new relevant stimulus.

In a similar vein, Rauch and Savage (2000) have suggested that patients with OCD are deficient in procedural learning and related forms of implicit information processing. As a result of that limitation, these patients must rely on less efficient and more resource-demanding explicit processing. These compensatory explicit mechanisms are adequate to deal with most cognitive tasks, which is why OCD patients do not show a general cognitive dysfunction. However, if task demands increase, these explicit compensatory mechanisms may no longer be sufficient, and, as a consequence, the deficit in implicit processing would impair performance (Deckersbach et al., 2002; Rauch et al., 1997). This idea is consistent with our finding that OCD patients had longer RTs in test but not in PE compared to the control group, suggesting that they had difficulties in switching from the low load PE task to the high load test task.

The hypothesis that OCD patients employ explicit mechanisms in tasks that are normally handled by implicit processes was recently supported by Joel et al. (2005). The majority of patients in this study failed to acquire a card-betting task in which explicit processing impairs, rather than benefits, task acquisition. This would suggest that patients with OCD may be using explicit, rather than implicit, processes in the relatively low-load PE stage task of the visual search LI procedure. As a consequence of formulating explicit rules regarding the relevant and the irrelevant stimulus in the PE stage, the OCD patients may amplify the difficulty to switch to the new contingencies in the test phase.

The contrast between attenuated LI in schizophrenic patients and elevated LI in OCD patients yields some interesting insights and generalizations. It is suggested that during the PE stage, the schizophrenic group overly maintains attention to the irrelevant stimulus, while the OCD group overly maintains attention to the
relevant stimulus, relative to healthy control groups. In both pathologies, then, controlled attentional processes are prolonged during the PE stages, but to different stimulus sets: for schizophrenic patients, to currently irrelevant stimuli; for OCD patients, to currently relevant stimuli. In the former case, this leads to reduced LI because the subject has more than normal attention allocated to the newly relevant test-stage stimulus that was formerly overly attended when it was irrelevant in the PE stage. In the latter case, this leads to potentiated LI because the subject has less than normal attention allocated to the newly relevant test-stage stimulus as a result of continuing to allocate attention to the previously relevant stimulus.

In summary, the present study replicates and extends previous findings of enhanced LI in OCD, which is consistent with earlier results indicating selective attention deficits in OCD. In addition, these data may be related to those from other paradigms that suggest implicit learning deficits and possible compensatory explicit learning in this disorder. Our results, together with those from Parkinson patients (Lubow et al., 1999) and schizophrenics (Lubow et al., 2000, 2001), suggest that LI effects, and by extension effects from other multiple-stage learning protocols, are a function of a complex interaction between controlled and automatic information processing mechanisms, and where those processes are targeted—on relevant or irrelevant stimuli and events.

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References


