

# Imminent Danger? Probabilistic Classification Learning of Threat-Related Information in Obsessive-Compulsive Disorder

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A tendency to overestimate threat has been shown in individuals with OCD. We tested the hypothesis that this bias in judgment is related to difficulties in learning probabilistic associations between events. Thirty participants with OCD and 30 matched healthy controls completed a learning experiment involving 2 variants of a probabilistic classification learning task. In the neutral weather-prediction task, rainy and sunny weather had to be predicted. In the emotional task danger of an epidemic from virus infection had to be predicted (epidemic-prediction task). Participants with OCD were as able as controls to improve their prediction of neutral events across learning trials but scored significantly below healthy controls on the epidemic-prediction task. Lower performance on the emotional task variant was significantly related to a heightened tendency to overestimate threat. Biased information processing in OCD might thus hamper corrective experiences regarding the probability of threatening events.

*Keywords:* obsessive-compulsive disorder; probabilistic classification learning; overestimation of threat; implicit learning

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A TENDENCY TO OVERESTIMATE THE PROBABILITY and the consequences of negative, threatening events has been proposed to play a role in the etiology and maintenance of obsessive-compulsive disorder (OCD; [Obsessive Compulsive Cognitions Working Group, 2001](#)). Clinical observations suggest that individuals with OCD misjudge the probability by which minor, everyday lapses (e.g., not fully stubbing out your burning cigarette) might cause major catastrophe (e.g., house will be completely destroyed by fire). Previous research could demonstrate several problems in the processing of threatening information in individuals with OCD: First, there is an attention bias towards threatening aspects of the environment ([Cisler & Koster, 2010](#)). Second, individuals with OCD overestimate the probability that negative, obsession-related events will happen to them. Thus, they perceive themselves to be more vulnerable to experience negative events ([Moritz & Jelinek, 2009](#)). Third, higher danger expectancies have been shown to mediate obsessive-compulsive fears and ritualistic behavior. If individuals with washing obsessions endured negative consequences after a contamination, it is more likely they experienced higher anxiety and greater urge for neutralizing rituals and spent more time washing afterwards ([Jones & Menzies, 1997, 1998b](#)). Thus, overestimation of threat is conceptualized by cognitive theories of OCD as a central dysfunctional belief that contributes to the negative appraisal of intrusive thoughts and raises negative emotional states and the urge to neutralize (see, for instance, [Rachman, 1997](#),

1998). Consequently, the normalization of threat appraisal by cognitive restructuring is an important part of cognitive treatment approaches to OCD (see, for example, Wilhelm & Steketee, 2006) and has been shown to be equally effective as standard exposure and response prevention protocols (Rosa-Alcazar, Sanchez-Meca, Gomez-Consena, & Marin-Martinez, 2008).

Although the biases of individuals with OCD in dealing with the probabilities of threat and danger are well established, their causes are unclear. From a neuropsychological point of view one could suspect that patients with OCD have difficulties in learning complex and hidden redundancies. The cognitive ability to associate outcomes that follow cues in a *probabilistic* fashion relies on implicit information processing. The classic experimental paradigm in cognitive psychology used to study the gradual acquisition of probabilistic cue-outcome associations is probabilistic classification learning (PCL). In the prototypic PCL task, subjects learn to predict which of two future events would occur on each trial after presentation of a particular combination of (mostly visual) cues. Each cue combination is probabilistically related to one of the two outcomes and feedback is provided after each decision. Lesion studies and functional imaging studies show that the ability to acquire such complex probabilistic cue-outcome relations depends upon the integrity of frontostriatal structures and circuits (Aron et al., 2004; Ptak, Gutbrod, Perrig, & Schnider, 2001; Sage et al., 2003; Seger & Cincotta, 2005; Witt, Nuhsman, & Deuschl, 2002). Neurobiological models of OCD associate the disorder with dysfunctions in orbitofrontal-striatal circuits (Menziez et al., 2008), although findings show inconsistencies across studies and, due to their correlational nature, do not prove that OCD is actually caused by fronto-striatal dysfunctions.

Some implicit learning tasks that are supposed to test the integrity of frontal-striatal circuits (e.g., serial reaction time learning) have been shown to be affected in OCD (Goldman et al., 2008; Kathmann, Rupertseder, Hauke, & Zaudig, 2005; Marker, Calamari, Woodard, & Riemann, 2006). Thus, clinical, behavioral, and neurobiological data provide reason to suspect that individuals with OCD might have a general difficulty in learning probabilistic cue-outcome associations. Those assumed difficulties in probabilistic learning might even be exacerbated if contents of the task elicit disorder-related attention bias toward threat, which subsequently might lead to increased arousal and worries. While heightened arousal by emotionally relevant stimuli in a learning situation has been consistently shown to facilitate explicit forms of learning (LaBar & Cabeza, 2006),

there is growing evidence that it has an opposite effect on implicit learning, leading to initial acquisition impairment on probabilistic learning tasks (Prince, Thomas, Kragel, & LaBar, 2012; Steidl, Mohi-uddin, & Anderson, 2006; Thomas & LaBar, 2008).

The aim of the present study was to investigate probabilistic learning in OCD using neutral and emotionally relevant stimuli. We expected participants with OCD to show a general deficit in probabilistic learning. We further hypothesized that probabilistic learning would be even more compromised if emotionally significant and important material eliciting disorder-related concerns and fears was used.

## Method

### PARTICIPANTS

#### *Participants With OCD*

The sample comprised 30 outpatients with OCD (see Table 1). Participants were recruited for the study from outpatient clinics ( $n = 3$ ), by advertisements in local newspapers ( $n = 21$ ), and on an OCD web portal ( $n = 6$ ). All participants met criteria for lifetime OCD according to the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-IV; American Psychiatric Association, 1994). The diagnosis was verified by SCID interview (see section on clinical assessment). Twenty-six participants met criteria for current OCD at the time of testing, while 4 participants had done so previously but were in partial remission (still symptomatic but no longer fulfilled the C criterion of significant functional disturbances). As OCD is seen as a mostly chronic condition, we decided to include participants with partial remission in order to represent a wider range of OC symptom severity.<sup>1</sup> Seventeen participants with OCD presented with one to four comorbid current mental disorders (major depressive disorder or dysthymia in 14 participants, anxiety disorders in 12 participants, and eating disorders in 2 participants). Subjects with a history of head injury, neurological diseases, psychoses or substance dependence were excluded. Twelve participants with OCD were on psychotropic medication (selective serotonin reuptake inhibitors or other antidepressant agents).

#### *Healthy Controls*

Participants with OCD were compared with 30 healthy control participants recruited for the study by advertisements in local newspapers and leaflets distributed in town. Healthy control participants were not taking any psychoactive medication and were free of any psychiatric disorder (verified by SCID interview), neurological disorder, and

<sup>1</sup> However, if only those 26 participants who fully met criteria for current OCD were included, all results remained the same.

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