Which is the driver, the obsessions or the compulsions, in OCD?

Claire M. Gillan[123] and Barbara J. Sahakian[34]

Running Title: What drives OCD, obsessions or compulsions?

Affiliations

[1]New York University, Department of Psychology, New York, USA

[2]University of Cambridge, Department of Psychology, Cambridge, UK

[3]MRC/Wellcome Trust Behavioural and Clinical Neuroscience Institute (BCNI), Cambridge, UK

[4]University of Cambridge, Department of Psychiatry, Cambridge, UK

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The conventional view is that obsessive-compulsive disorder (OCD) is driven by irrational beliefs, which are a putative basis of obsessions. Compulsions are considered a coping mechanism, which neutralize anxiety or reduce the likelihood that these fears will be realized. Contrary to this view, recent data suggests that compulsions in OCD are a manifestation of a disruption in the neurobiologically well-defined balance between goal-directed action and automatic habits.

In one study, OCD patients and matched control subjects were trained to make simple instrumental responses to gain valuable outcomes (Gillan et al., 2011). Analogous to the 'outcome devaluation' technique developed to test for habits in rodents (Adams, 1980), these outcomes were then devalued by instructing the participant they were no longer worth points. If behavior is under goal-directed control, subjects should not make responses that yield devalued outcomes. Habits are reciprocally defined as automatic responses to stimuli that continue in spite of devaluation. Using this well-validated procedure, OCD patients demonstrated greater habits compared to healthy controls (Figure 1A). This result was replicated in the aversive domain, where patients were instead required to avoid an unpleasant shock to their wrists (Gillan et al., 2014b). These data suggest that the tendency towards developing compulsive-like habits in OCD is both valence-independent and, as the content of the tasks employed were unrelated to OCD symptomatology, obsession-independent. Together these data suggest that if excessive habit-learning is an adequate model of compulsive behavior, then compulsions are not epiphenomenal, but rather constitute a core component of OCD.

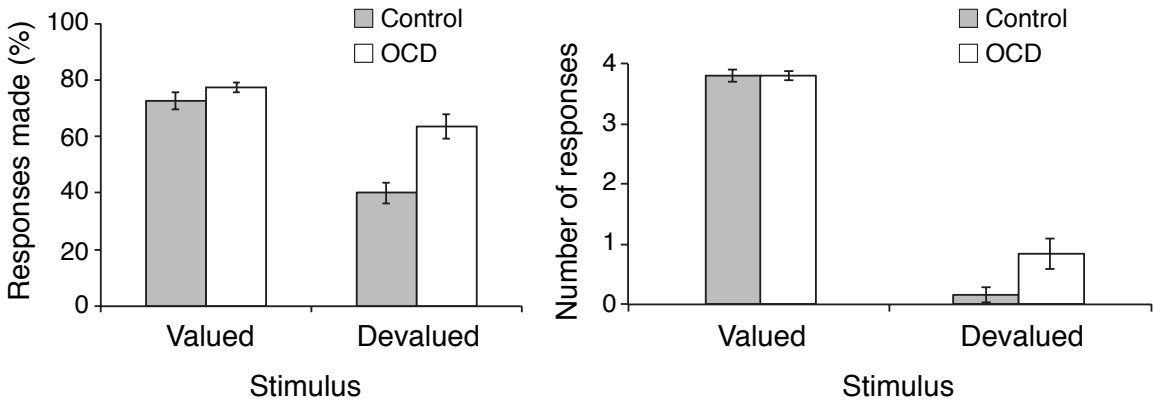

Figure 1. Excessive habit-learning in OCD. Data reprinted with permission from Gillan et al, 2011; Gillan et al, 2014. Error bars denote standard error of the mean SEM)

A. **OCD patients show excessive habit learning index by elevated responses towards devalued outcomes following appetitive instrumental learning. There was no group difference in responding for valuable outcomes (Gillan et al., 2011).**
B. **Over-active habits are also observed following aversive learning in OCD (Gillan et al., 2014b).**

The habit hypothesis of OCD is neurobiologically plausible; goal-directed control (which protects against habits) relies upon the integrity of two key brain regions implicated in the pathophysiology of OCD, the caudate nucleus and medial orbitofrontal cortex (Gillan et al., 2014a) . Neurobiological models of obsessions, on the other hand, are lacking. One promising model implies that obsessions may be a consequence of dysfunction in fear conditioning processes in OCD, whereby patients cannot adequately extinguish fears that accompany normal intrusive thoughts and worries. In support of this, impairments in extinction recall are evident in OCD, and the respective neural correlates also overlap on

regions thought to be involved in the disorder (Milad et al., 2013). However, patients with post-traumatic stress disorder (PTSD), for example, have similar deficits in fear-extinction recall, but do not typically present with obsessions. In this light, fear-conditioning abnormalities in OCD may more parsimoniously reflect concomitant anxiety in OCD, rather than obsessions.

If not a dysfunction in fear extinction, what are obsessions in OCD? One possibility is that they are not an underlying trait in OCD, but instead an agitated mental urgency, or cognitive instantiation of more abstract feelings of anxiety and compulsive urges. A more elaborated view is that obsessions in OCD might arise as a result of compulsive behaviour. When trying to explain their bad habits, in the avoidance habit study described above, some OCD patients fell foul of reverse inference, erroneously deducing that if they felt driven to perform an act of (habitual) avoidance, they must have had something to fear (Gillan et al., 2014b). Studies have shown that with continued avoidance; normal, albeit faulty, beliefs about threat cannot extinguish (Lovibond et al., 2009). It is plausible in this light that we have been thinking about OCD backwards: perhaps compulsions are a core feature of the disorder and obsessions are a troublesome by-product.

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