

# Intrusive Uncertainty in Obsessive Compulsive Disorder

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**Abstract:** In this article we examine obsessive compulsive disorder (OCD). We examine and reject two existing models of this disorder: the Dysfunctional Belief Model and the Inference-Based Approach. Instead, we propose that the main distinctive characteristic of OCD is a hyperactive sub-personal signal of being in error, experienced by the individual as uncertainty about his or her intentional actions (including mental actions). This signalling interacts with the anxiety sensitivities of the individual to trigger conscious checking processes, including speculations about possible harms. We examine the implications of this model for the individual's capacity to control his or her thoughts.

## 1. The Varieties of Thought Control

There are a variety of ways in which the control of thought may be realised. For instance, there's a difference between consciously controlling your thoughts, and thoughts flowing in conformity with your goals without you having to consciously worry about it. There's also a difference between actively deciding how your thoughts will go, and merely intervening if your thoughts are going wrong somehow. Moreover, what counts as going wrong (or right) depends on a variety of norms—some of which may be acquired, and some innate. We may care about such features of thoughts as their coherence, speed, accuracy, originality, moral goodness and so on.

The form, or method of our thought control activities also falls into a few different sub-types: i) we may control the movement from one thought to the next; ii) we may control the extent to which we have thoughts of a certain type (e.g. more creative thoughts); iii) if thoughts are the sorts of things that can change properties while remaining the same thoughts, we may try to change some of those properties (e.g. to make a thought more vivid, or certain); iv) we may finally control which thoughts are consciously attended to, or for how long they occupy our attention.

Overall, it is unlikely that any single mental function corresponds to all of these varieties of thought-control. The move from one thought to the next, for instance, seems to be governed by processes ranging from sheer association, to deductive reasoning, to creative exploration. However, it seems to us that being able to direct our attention at will is at the heart of our feeling of being in control of our thoughts.

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Being able to shift our attention to the matters that concern us—be they aspects of the world, or the thoughts themselves—is the first step in conscious attempts to control the kinds of thoughts we have, or the flow of one thought to the next.

Unfortunately, it is this very capacity to direct one's attention that is disrupted in individuals with Obsessive Compulsive Disorder (OCD). OCD sufferers constantly attend to possible harms that may befall them, or that they might inflict on others, despite their desire not to do so. Our hypothesis is that this is caused by the over-activation of a sub-personal system responsible for signalling when the individual is in error, or about to be in error. This signalling is experienced by the individual as uncertainty about his or her actions (including mental actions). It then interacts with the anxiety sensitivities of the individual to stimulate conscious checking processes, including speculation about possible harms. The upshot of all this is that the individual's attention is constantly pre-occupied, and understandably, they experience considerable distress regarding their inability to control their thoughts.

To fully develop this model of OCD we will examine and reject some alternate models of the disorder. These models highlight various pieces of evidence that we must account for, and offer suggestions upon which our model builds. This will occupy Sections 2–4 of this article. In Sections 5 and 6 we will then outline our own account in detail and how it manages to account for the various pieces of evidence. Finally in Section 7 we will summarise the implications of our model for thought control. In particular, the case of OCD reveals some of the ways in which our attention is driven by sub-personal factors over which we have little conscious control.

## 2. Characterising OCD

Obsessive compulsive disorder is one of the most common mental disorders. It has a lifetime prevalence of approximately 2.3% in the US population (Ruscio *et al.*, 2010) and this frequency seems consistent internationally, though of course estimates depend greatly on the diagnostic criteria employed (Fontenelle *et al.*, 2006). The disorder develops gradually, with an average age of onset of 19.5 years, and is usually chronic if left untreated. Moreover while cognitive behavioural therapy and/or anti-anxiety medication can have a very significant impact on severity, it is rare for treatment to fully eliminate symptoms, and relapse is common (Abramowitz, 2009; O'Connor *et al.*, 2012).

It is noteworthy that while the DSM-IV (1994) classifies OCD as an anxiety disorder, the recent DSM-5 (2013) creates a new chapter for OCD and related disorders such as body-dysmorphic disorder, trichotillomania (hair pulling), excoriation (skin-picking), and hoarding.<sup>1</sup> Strong connections to anxiety disorders are still

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<sup>1</sup> Hoarding was classed as a sub-type of OCD in the DSM-IV, but has been recognized as a distinct OCD-related disorder in the DSM-5. Hoarding seems to be mainly characterised by distress at the thought of parting with an object, or failing to acquire it.

recognized however. The diagnostic criteria for OCD specify that the individual's obsessive thoughts should cause 'marked anxiety or distress' in most cases, and that their compulsions are aimed at 'preventing or reducing anxiety' (DSM-5). Moreover, co-morbidity with an anxiety disorder is the norm rather than the exception, with up to 76% of OCD sufferers also displaying either social anxiety disorder, generalised anxiety disorder, panic disorder, or specific phobias (DSM-5, cf. Diniz *et al.*, 2012: S82-83).<sup>2</sup> Indeed, we will suggest that a background anxiety problem is likely to play an important (though not necessary) role in the development of the disorder.

Making sense of the connection with anxiety is an important desideratum for models of OCD, but differences between OCD and the commonly recognized anxiety disorders mentioned above should be recognized. OCD is defined by the twin components of obsessive thoughts and compulsive behaviours, neither of which need be found in the commonly recognized anxiety disorders. Moreover, where the worries of anxiety sufferers are often of a mundane nature (e.g. fear of social embarrassment), the worries of OCD sufferers may be extreme, characterised by improbable causal attributions (e.g. blasphemous thoughts may make God kill a loved one; the photo of a dog may be infectious), and are often fixated on certain distinctive themes. These themes include 1) worries about harming other people; 2) worries about violating social or religious taboos; 3) worries about the threat of contagious disease and; 4) worries that one has failed to secure against a potential hazard (e.g. whether one has remembered to lock the front door). The compulsions meanwhile may vary greatly and can include both behaviours that are somewhat rational in light of the obsessive theme, such as hand-washing or repeatedly checking that an appliance has been turned off, and behaviours of a more superstitious nature such as placing items in a very specific order or mentally rehearsing lists.

Compulsive behaviours play an important definitional role in the clinical diagnosis of OCD since treatment is often sought when compulsions are taken to such an extreme that normal day-to-day functioning is impaired. However, we should not understand OCD as an impulse disorder along the same lines as Tourette's syndrome. While some compulsive behaviours may, due to habitual repetition, become fairly unconscious or automatic, the OCD sufferer is in many ways the opposite of impulsive. As Kevin Zaragoza (2006) argues, it is not that OCD sufferers possess a weak will that is easily overwhelmed or bypassed. Rather OCD behaviours arise from the exhaustive pressure to relieve constant obsessive worries. It is because of excessive concern regarding harms to oneself or others that the behaviours are, in a sense, well-motivated (for instance, sufferers with harm-to-other obsessive themes never actually harm their loved ones, they take excessive precautions to avoid doing so). Similarly, while superstitious rituals may appear unreasonable, they may be explained as a more or less desperate means to gain a sense of control over the threats haunting

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<sup>2</sup> OCD is also frequently comorbid with depression (41%). Many experimental findings may be confounded by the presence of these comorbid disorders.

the OCD sufferer.<sup>3</sup> Such behaviours satisfy a cognitive demand to do *something* about the worries, and this control-gaining function is likely to be shared with other more 'rational' compulsive behaviours.

Thus compulsive behaviours should in general be understood as driven by the goal to 'neutralise' the obsessive thoughts,<sup>4</sup> and it is for this reason that explanations for the disorder tend to focus on the obsessive aspects of OCD. In particular, a central task for any model of OCD is to make sense of the intrusive nature of obsessive thoughts. OCD sufferers recognize that their obsessive thoughts are their own, (unlike perhaps, schizophrenic patients). Yet they are often aware that the thoughts are irrational, and certainly experience them as unwanted and distressing. Despite their desire to rid themselves of such thoughts however, they feel compelled to actively engage with them by means of introspective or behavioural checking processes.

In this article, we identify three main strategies to account for this phenomenon, all of which make sense of obsession or 'over-thinking' in different ways: The **Dysfunctional Belief Model** regards OCD as an emotional disorder concerning the *evaluation* of thoughts. The individual takes certain thoughts too seriously and this leads to rumination upon them. Meanwhile the **Inference Based Approach** takes OCD to be a cognitive disorder relating to delusional commitments and irrational confirmation processes. This leads the individual to *generate* imaginary narratives that confirm suspected harms. Finally, there are views appealing to a general cognitive problem in the individual's sense of certainty. Exactly how this uncertainty problem is construed varies between researchers, but a distinctive claim is that the individual's uncertainty fails to be dispelled by checking activities. On our model, which we call the **Intrusive Uncertainty Model**, a hyperactive signal of uncertainty intrudes upon the consciousness of the individual. The downstream effects of this dysfunction include the generation of imagined harms (as identified in the inference based approach) and the formation of dysfunctional concerns (as identified in the dysfunctional belief model).

### 3. Dysfunctional Beliefs

The Dysfunctional Belief Model of OCD, derived from Beck's 1976 cognitive model of mental disorder, is currently the dominant theoretical approach in the

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<sup>3</sup> Boyer and Liénard (2006) make the interesting suggestion that perfectionistic ordering may be the product of an evolved precautionary mechanism, since intruders to a very ordered environment can be detected more readily. While this mechanism plausibly explains why ordering, as a general type of behaviour, may be triggered in response to feelings of vulnerability, it could hardly be a rational response to the actual environments confronting OCD sufferers, and again serves mainly as a salve for feelings of anxiety.

<sup>4</sup> Freeston and Ladouceur (1997: 344) define neutralising as 'a voluntary, effortful cognitive or behavioural act that is directed at removing, preventing and attenuating the intrusive thought and the associated discomfort.'

psychological literature. It focuses primarily on the disordered *evaluation* of thoughts, arguing that it is because the OCD patient takes certain thoughts too seriously, or as presenting scenarios that may actually occur, that they then have difficulty dismissing them.

A key claim of this model is that the intrusive thoughts reported by OCD sufferers lie on a continuum with ordinary cognition. It is widely agreed that everyone occasionally experiences thoughts of an intrusive nature (for a review see Berry and Laskey, 2012). We know we have the capacity to harm others or to violate social norms, and so it is understandable that thoughts reflecting this knowledge strike us from time to time. In the same way it is healthy to be vigilant to potential dangers, even to the extent of imagining improbable catastrophes on occasion. Furthermore, when confronted with particularly disturbing mental images (for instance from a news story, or a nightmare) it can often take weeks for rumination on such images to fade away. Yet while in ordinary cases, thoughts of harm or taboo-violation are normally stimulated by environmental cues, it seems that OCD sufferers experience such thoughts at any time, and at a frequency and extremity of content far exceeding the norm (Clark and Purdon 1995; Julien, O'Connor and Aardema, 2007).

The Dysfunctional Belief Model makes sense of this extremity of intrusive thinking by appeal to the possession of dysfunctional beliefs that encourage OCD sufferers to respond in an exaggerated way to ordinary intrusive thoughts. More precisely, these dysfunctional beliefs should be understood as background attitudes or concerns. The claim is that if one has a strong background concern regarding say, the duty to take care of one's children, one will become particularly distressed if a stray thought about actively harming one's children comes to mind. Such an attitude does not seem particularly distinctive however. Thus more recent versions of the dysfunctional belief model appeal to concerns directed at the thoughts themselves- i.e. metacognitive attitudes (Wells 1997; Clark, 2004). OCD sufferers seem to regard the mere occurrence of a thought about harm as meriting anxiety or moral condemnation. It has also been suggested that this metacognitive attitude reflects belief in what is known as 'thought-action fusion' (Rachman 1997); the OCD subject has the irrational belief that thoughts can directly influence events, and/or that they are equivalent to actions.

In general, triggering an emotional reaction requires both a target stimulus and a background concern that the target is recognized as impacting. In this model of OCD, it is neither the target intrusive thoughts nor the responses that are dysfunctional (at least initially), but the concerns that drive those responses. The OCD sufferer has the unrealistic expectation that they should have only good and peaceful thoughts, and this unrealistic expectation leads to suffering and distress when it inevitably fails to be met. As with any other emotional reaction, distress will then tend to arouse attention towards the target (re-activating the intrusive thought) and to motivate preventative behaviours. However, trying to suppress a thought tends not to work. It tends instead to maintain the thought, just as asking someone to

not think of a white bear encourages them to think of a white bear.<sup>5</sup> What healthy individuals might then realise is that such explicit attempts do not work, and allow themselves to be distracted by something else. Yet OCD subjects seem not to learn this lesson (Najmi *et al.*, 2010 even provides some experimental confirmation of this learning difference). Instead, the inability to dispel the thought is believed to create further distress, fuelling a vicious cycle of obsessive attempts at self-control, and ultimately the compulsive behaviour. Similarly, acting to neutralise the obsessive thought by means of outward preventative behaviours reinforces the subject's memory and awareness of the obsessive content, while also strengthening the association between the obsessive thought and its behavioural output.

The treatment currently favoured for OCD also reflects the understanding of OCD as an emotional disorder involving dysfunctional concerns. Exposure Response Prevention therapy works by getting the individual with OCD to think of the matter that distresses them, while encouraging them to resist compulsive behaviours, or attempts at thought suppression (in the case of Wells' (2009) metacognitive variety of this approach to treatment). That is, the OCD obsession is treated somewhat like a phobic reaction towards certain thoughts, on the assumption that like a phobic fear, if the subject gradually habituates him- or herself towards the presence of the thought without engaging in neutralising responses, the aversive emotional responses will be gradually extinguished.

The main evidence in favour of the Dysfunctional Belief Model comes from self-reports of OCD sufferers. Subjects need not be explicitly aware of possessing a dysfunctional belief, but they typically display a pattern of beliefs or attitudes in response to questionnaires that suggest the presence of certain underlying attitudes. In probably the largest study of its kind (Taylor *et al.*, 2010, surveying more than 5000 people) factor analysis of these self-reports has been used to identify 3 core dysfunctional belief domains: 1) Inflated personal responsibility and the overestimation of threat; 2) Perfectionism and the intolerance of uncertainty and; 3) Over importance of thoughts and the need to control these thoughts.<sup>6</sup> It should be noted however that these three factors could only account for 23% of the variance amongst OCD sufferers. Taylor *et al.* also show that the thought-control factor is statistically correlated to some degree with all the other factors identified, supporting the claim that the dysfunctional beliefs are particularly focused on metacognitive attitudes.

Overall, while we agree that dysfunctional beliefs could plausibly account for the obsessive reinforcement of certain intrusive thoughts, we do not believe that this model provides a sufficient characterisation of the disorder. The biggest problem is that not all individuals with OCD report a strong commitment to any dysfunctional beliefs. A significant sub-group of OCD sufferers report that their compulsive

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<sup>5</sup> This well-known phenomenon has received formal treatment in Wenzlaff and Wegner (2000).

<sup>6</sup> Cf. the same finding by the Obsessive Compulsive Cognitions Working Group (2005). Note that this study worked with both OCD sufferers and non-clinical individuals, while the Taylor *et al.* (2010) study worked with obsessive compulsive symptoms in a non-OCD population.

behaviours are driven by feelings that things are 'not just right' somehow, rather than beliefs in say, the likelihood of contamination (e.g. Coles *et al.*, 2005). On the questionnaire methods used by belief theorists to infer the presence of dysfunctional beliefs, this sub-group displays belief scores comparable to healthy subjects (Taylor *et al.*, 2006). One possible response to this evidence is to simply allow for a distinct sub-group of OCD sufferers. However, the similarities in compulsive behaviours across the major obsessive themes (i.e. washing, checking, ordering), as well as a comparable sense of intrusiveness for both the feeling that things are not right and explicit obsessive concerns, suggest that there is a common root to these sub-types that does not rely on underlying dysfunctional beliefs.

We can also question whether the identified dysfunctional beliefs are the cause or the consequence of the specific OCD obsessions (cf. Julien *et al.*, 2007). Plausibly, suffering from obsessive thoughts leads to greater endorsement of the importance of such thoughts or the need to control them. Similarly, if one were unable to rid oneself of thoughts of harming one's loved ones, one may well be prone to overestimate the threat one bears towards others. Given that it is common to infer possibility from conceivability, the greater frequency with which harms are imagined, or the inability to imagine otherwise, is likely to strengthen the subject's beliefs that harms may occur unless preventative measures are taken.

Difficulties concerning what-causes-what are particular acute for models of OCD because it is often recognized to be a disorder characterised by vicious cycles of mutually reinforcing symptoms and evaluative attitudes. As such it will always be difficult to establish a single generating factor that gets the cycle moving. At any rate, the Dysfunctional Belief Model requires some explanation of where the dysfunctional beliefs come from that is more defensible than an account in which obsessive thinking appears prior to dysfunctional beliefs. Since OCD is known to develop gradually, it is possible to appeal to the sheer accumulation of mutually reinforcing beliefs and attitudes. But in order to explain why such large numbers of people suffer from OCD, the development of these beliefs could hardly be a matter of chance, especially given the consideration that everyday experience should repeatedly disconfirm factually improbable sources of harm or magical thought control.

Thus it is usual for dysfunctional belief theorists to appeal to formative life experiences in which danger or misbehaviour are highlighted, encouraging inflated beliefs concerning personal responsibility or vulnerability to develop (e.g. Taylor *et al.*, 2011). In support, it is observed that life circumstances in which responsibilities are increased, such as pregnancy, are risk factors for developing OCD (Abramowitz *et al.*, 2007).

Yet while special life-circumstances may be risk factors for the development of OCD, they seem neither necessary nor sufficient for the development of the disorder. Plenty of people suffer strict upbringings or personal trauma without developing OCD, and plenty of people develop OCD without such background experiences (at least of an unusual kind that would be sufficient to differentiate the OCD population from the non-OCD population; cf. Grisham *et al.*, 2011). Experimental

manipulations of responsibility (e.g. setting a task in which the subject is given increased responsibility for ensuring that a stove is turned off) have also been found to increase checking behaviours more in OCD subjects than controls, with accompanying deteriorations in confidence regarding memories (Boschen and Vuksanovic, 2007, cf. Bouchard, Rhéaume and Ladouceur 1999). While this evidence supports the claim that dysfunctional concerns regarding responsibility may mediate obsessive checking symptoms in some cases, it also suggests that an underlying condition is making OCD sufferers more sensitive to conditions of increased responsibility than healthy individuals.

A further problem with the Dysfunctional Belief Model is that while clusters of beliefs and evaluative attitudes may be robust and mutually reinforcing, we should still predict that cognitive-behavioural therapy could unpick these dysfunctional attitudes with more success than is currently observed. The degree of severity and resistance to treatment displayed in many cases of OCD suggests that a more fundamental affective or cognitive problem is fuelling the development of the disorder.

Overall, it is difficult to rely solely on life-history factors in the development of OCD. While we are happy to allow dysfunctional belief to play an immediate role in the evaluation of intrusive thoughts, at least in some cases, it seems that an additional vulnerability is required to *power* the development and maintenance of the dysfunctional belief, especially in more severe cases of the disorder. It is moreover known that there is a significant genetic factor in the appearance of OCD. The DSM-5 reports that there is a 0.57 concordance rate in monozygotic twins, and that first-degree relatives of individuals with childhood-onset OCD are 10 times more likely to have the disorder. It is advisable then to explore neurobiological factors that mediate the appearance of the disorder. Such factors could conceivably stretch to biases towards magical thinking, but they are more probably associated with basic affective and cognitive processing differences.

#### **4. The Search for Harms**

As an alternative to the Dysfunctional Belief Model, Kieron O'Connor and various collaborators (e.g. O'Connor and Robillard 1995; O'Connor *et al.*, 2005; O'Connor *et al.*, 2012) propose what they call an 'Inference-Based Approach'. A distinctive feature of this model is its denial that the intrusive thoughts of OCD sufferers lie on a smooth continuum with ordinary cognition. If there were such a smooth continuum, they argue, we would expect ordinary intrusive thoughts to reflect basically the same content as OCD thoughts. Yet in a study conducted by Clark and O'Connor (2005), only 11% of the intrusive thoughts reported by non-OCD subjects related to the distinctive themes reported by OCD subjects (though such a study depends a great deal on how broadly one defines the themes).

Instead, O'Connor and colleagues suggest that individuals with OCD have a cognitive disorder that causes distressing thoughts to *appear* more frequently. If this is the case, additional dysfunctional beliefs may not be required to turn intrusive thoughts



into obsessions; the subject's thoughts are already generated in an obsessive manner. In particular, O'Connor and colleagues claim that the OCD sufferer is led to their obsessive thoughts because they are overly invested in imaginary possibilities, which come to dominate their thinking by a process they call 'inverse inference'. The OCD sufferer begins with a doubt—that an imagined harm is available, or that they might be a terrible person. They then hypothesize ways in which this possibility could be realised, which must be pre-emptively avoided or managed. So for example, a person suffering contagion-themed obsessions constantly suspects that there is something infectious in their environment. If they look at the handrail or pole on the bus, they are acutely aware that infected people may have touched it, and consequently assume that it is probably infectious. Such inferences can be even more extreme: The subject has a persistent fear that they could catch rabies. They look at a photo of a dog, and hypothesize that the person who took the picture was infected with rabies by the dog, and that this infection then (somehow) spread to the magazine carrying the picture. In this way the OCD sufferer's judgements about themselves or the environment they inhabit may be reached not on the basis of neutral evaluations of the empirical evidence at hand, but by means of imaginary causal narratives, heavily biased towards confirming the initial doubt.

Since on O'Connor's model the obsession stems from the initial doubt, some account of where these doubts come from is required. Here O'Connor and colleagues appeal to delusional 'core beliefs' that certain harms *are possible*, or that the subject *could* possess a certain undesirable character trait (e.g. 1995: 888; 2005: 3). So it turns out that the initial doubts are not so much doubts as definite commitments to possibilities. In this way the Inference-Based Approach captures quite well the striking way in which OCD sufferers are absorbed with possible harms that others recognize as obviously implausible or imaginary. The presence of delusional beliefs could help to explain the OCD sufferer's resistance to ordinary disconfirmation.

In defending their model, O'Connor and colleagues note their success in treating chronic OCD sufferers that have been particularly resistant to traditional cognitive behavioural therapies (O'Connor and Robillard 1995; O'Connor *et al.*, 2005: 178–198).<sup>7</sup> In accordance with their model, the treatment method employed involves a twin-pronged strategy: First the therapist helps the patient to gain insight into the ways in which they develop imaginary narratives supporting their obsessive theme, noting the ways in which the patient ignores relevant evidence that they rely on in nearly all other circumstances. Second, the patient is encouraged to rehearse alternate imaginary narratives that do not support the obsessive theme.

The problem with this evidence, however, is that the treatment fails to distinctly pick out a delusional commitment as the primary cause of OCD. Rehearsing an alternate narrative may well be useful for starving an obsession of attention, but it

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<sup>7</sup> See also O'Connor *et al.*, 2005: 141–144 which details a study showing improved results using the inference based approach over traditional cognitive behavioural therapy. Note that O'Connor and colleagues do not claim that these treatments provide a complete cure.

reflects nothing about where the obsession comes from. Rather it helps to prevent obsessions that have already taken root from further festering in the mind of the patient. A similar point can be made about the other strand of the therapy. The theory we outline below agrees that the OCD sufferer is engaged in the active elaboration of possible harms. Thus gaining insight into the ways this happens could be beneficial for the patient. However the effectiveness of this treatment may be because irrational thinking *exacerbates* the disorder (as we claim) and not because irrational thinking is its root (as O'Connor and colleagues claim).

In addition to their clinical case studies, O'Connor and colleagues present evidence from questionnaire studies in which OCD sufferers are more likely than controls and anxiety sufferers to display what is called 'inferential confusion'; they affirm statements indicating the enhanced commitment to imaginary scenarios such as 'I am sometimes more convinced by what might be there than by what I actually see' (Aardema *et al.*, 2005). However, affirming statements like these are insufficient to show that the imaginary narratives of OCD sufferers are grounded in the delusional commitments rather than the reverse. Becoming convinced of the presence of the harm could be the ultimate *product* of constant obsession. As mentioned above with regards to the Dysfunctional Belief Model, when one's attention is constantly occupied with thoughts of the harm occurring, one's sense of its likelihood will become exaggerated.

Meanwhile, by appealing to distinctive beliefs, the inference based approach seems vulnerable to the same difficulties that beset the dysfunctional belief model. 1) Factors about background environment or upbringing are insufficiently distinctive to make sense of the development of such core beliefs, and 2) there is a significant population of OCD sufferers who do not express definite beliefs. An additional problem specific to the inverse inference approach is that OCD sufferers often switch the themes of their obsession over the course of their lives (Summerfeldt *et al.*, 2005). An individual obsessed with ordering at one time in life may become obsessed with violating taboos, or with contagion threats at another. Thus again, we should be on the lookout for an underlying factor that is driving the generation of the doubts.

We are left with the key claim that OCD sufferers display a disordered inference or reasoning style; that they are biased towards the confirmation of their imaginary harms. However it is common practice to begin with a hypothesis and then search for ways to confirm or disconfirm that hypothesis (where confirmation bias is common in the general population). Indeed, Dar 2004 presents evidence of no difference in confirmation bias across OCD and control groups. Pélissier and O'Connor (2002) also find no differences in a deductive reasoning task. What both studies instead find is greater *doubt* in OCD sufferers compared to controls when questions are repeated, or when alternative solutions are presented. This evidence is more compatible with the appeal to uncertainty problems that we defend below.

Finally, it does not seem to be the case that OCD sufferers have a distinctive vulnerability to magical thinking. For instance, magical thinking is not required to generate worries about contagious surfaces in public spaces. However, when one is highly disposed to find *some* source of possible harm, relatively implausible

suggestions are likely to become tempting. In this way, magical thinking could certainly aggravate an individual's tendency to develop obsessions, since it massively multiplies the potential availability of harms.

Overall, we do not find evidence that exclusively supports the Inference-based Approach, and there's evidence that OCD subjects have reasoning capacities that are comparable to the general population (though we can allow that some of the most severe or chronic cases could be compounded by reasoning difficulties). Rather the most interesting, and in our opinion, correct aspect of O'Connor's theory is specifically that the OCD sufferer is not merely inflicted by thoughts of a distressing nature, but is in some sense *actively searching* for sources of harm.

O'Connor and colleagues are right to doubt the claim of the dysfunctional belief model that an exaggerated emotional response to ordinary intrusions is sufficient to generate extreme and unusual obsessive concerns. Being highly distressed by a thought seems sufficient to attract one's attention to it, and thereby generate its repetition. But it does not predict the *elaboration* of the thought. Rather, elaborative rumination is an indirect result. The subject may question whether they are in fact a terrible person for thinking the intrusive thought. Or they may worry that they *might* have another terrible thought and generate possible scenarios as a result. That is, elaborative thinking is more directly the consequence of trying to defend one's hypothesis against contradictory considerations, or exploring what ideas may satisfy a general theme or concern.

By active search, we do not mean that the OCD sufferer has reflectively endorsed intentions to think about harm. Rather they display a definite attentional bias. There is a more or less conscious mental search activity in which the subject explores their environment or conceptual network for items that satisfy certain selection criteria. The selection criteria might initially take the general form: 'what is the *worst thing* that could happen to me?' or, 'what is the worst thing I could do?' But if one is searching for harms, one is likely to eventually come across specific sources of harm that are particularly difficult to falsify. Thus it is predictable that the obsessive latches onto certain themes such as the presence of invisible germs, supernatural means of causation, or one's own ability to harm others.<sup>8</sup> These themes act like natural basins of attraction in the active search for harms. And at this point the mental search becomes fixated on how that specific harm may be brought about.

The appeal to active search helps to explain why OCD sufferers are prone to distressing thoughts regardless of the situation they are currently in. It also helps to explain why the intrusive thoughts can acquire such extreme and specific content. But since we have rejected the claim that the OCD subjects are driven by the commitment to any particular belief, we require an alternate driver of the search for

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<sup>8</sup> Consider; how do you know you couldn't harm your child? Do you attempt to do so and then find out you can't go through with it? Wouldn't even that experience fail to disconfirm the possibility that you might overcome that constraint if you *really tried*, or that your self-constraining processes might somehow fail you?

harms. Our partial suggestion is that feelings of anxiety dispose individuals to search for ways to test or confirm their safety. Anxiety sensitivity is neither necessary nor sufficient to generate OCD symptoms, but it takes us some way towards explaining the active search for harms.

Under normal circumstances, we feel anxiety when it seems to us that something bad may happen. One also tends to be uncertain about whether or not the harm will occur (when you are sure that a harm is upcoming, you feel definite fear or panic instead). The typical response pattern of anxiety includes heightened physiological and behavioural preparedness, and most notably for us, cognitive responses of increased vigilance and attempts to resolve uncertainty about possible harms. If one's sense of anxiety is enduring, this cognitive response can include speculations about ways in which a harm may be brought about. For instance, if you're anxious about where your children are, you may begin to speculate more and more about terrible things that might have happened to them.

Thus feelings of anxiety are sufficient to motivate the search for harms. Moreover, anxiety generates an attentional bias towards thoughts that confirm one's sense of vulnerability. De Jong and Vroling (2013) present converging lines of evidence for reasoning biases in the general population that support the confirmation of possible threats, while ignoring or responding slower to disconfirmations of threats (called the 'better safe than sorry' strategy).<sup>9</sup> In particular, de Jong and Vroling show that subjects with anxiety disorders show these same biases towards objects that healthy subjects do not (e.g. phobic threats, signals of social disapproval).

The fact that the OCD obsessions all take the general theme of how things could go catastrophically wrong is already compelling evidence that anxiety is playing a role in the construction of the doubts. Anxiety is pushing the subject towards fixating on one or other source of vulnerability. Given that the most straightforward variety of anxiety concerns one's *personal* vulnerability to harm, the disposition would presumably have to interact with the particular sensitivities of patients towards the attitudes of others, or their responsibilities for others, to make sense of obsessive themes regarding harm to others and taboo-violation. Yet these different sensitivities seem easy enough to accommodate within ordinary personality variations.

A dispositional sensitivity towards anxiety is highly compatible with the observed co-morbidity rates with anxiety disorders that were noted in Section 2. It is also compatible with the display of various concerns highlighted by the dysfunctional belief model. If one is feeling anxious on a day to day basis, one may feel a greater need for certainty or control more generally, and thereby more readily endorse the validity of such concerns (cf. Steketee *et al.*, 2002). It would be particularly noteworthy if the presence of anxiety in children or teenagers prior to the development of OCD could be established.<sup>10</sup>

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<sup>9</sup> See also Yiend (2010), who reviews a large number of experimental confirmations of this attentional bias.

<sup>10</sup> Grisham *et al.* (2011) find 'negative emotionality' to be a predictor of OCD development but controls against anxiety disorders. More generally, it seems that evidence is hard to come by

Yet even if anxiety sensitivity was found in a majority of children who went on to develop OCD, we do not believe that OCD can be reduced to the influence of anxiety alone on the active search for harms. In particular, appealing to anxiety without additional cognitive factors will not allow us to distinguish between OCD and generalised anxiety disorder or social anxiety disorder. Recall that OCD involves elements of compulsive behaviour, and in many cases the endorsement of certain beliefs (such as the need to control thoughts) that we do not find in anxiety disorders. This is the reason why the DSM-5 has distinguished a separate category of OCD spectrum disorders. As such, while we recognize the important role that anxiety is likely to play, we believe there is a distinctive cognitive disorder underlying the development of OCD. This disorder seems to interact with different kinds of anxiety sensitivity in the majority of cases, but in some cases, it can generate OCD symptoms independently of any special sensitivity to anxiety.

## 5. Intrusive Uncertainty

So far we have reason to believe that anxiety can stimulate increased vigilance and mental search activities, and can explain why the individual's obsessions tend towards themes of harm. However, we need an additional cognitive factor to explain why OCD sufferers fail to be convinced by evidence contradicting their worries, or checking procedures that should resolve their doubts. It would also help if this cognitive factor could make sense of what is triggering or sustaining feelings of anxiety.

Our proposal is that individuals with OCD suffer from a general cognitive problem relating to uncertainty. A constant and intrusive sense of uncertainty is plausibly a feature that is consistent across the various sub-types of OCD and checking compulsions. If you are uncertain whether your hands are clean for instance, then it makes sense to check further by washing them again. Similarly, if you are uncertain whether you have unknowingly run someone over with your car (as one OCD sufferer reported in O'Connor and Robillard 1995: 894) you must carefully check if such an incident could have occurred. Again, if you are uncertain about whether or not you're a paedophile, you may need to check whether or not you get aroused by thoughts of paedophilia. Or if you are uncertain about whether or not you're a good Christian, you may check by rehearsing certain religious rituals.

As mentioned in the previous section, uncertainty about harms is sufficient to generate anxiety. Anxiety also motivates the individual to resolve uncertainties. Thus a cognitive problem with uncertainty bears a definite affinity with anxiety, explaining why it should interact most powerfully with this emotion, rather than others. This lends some *prima facie* plausibility to the thesis.

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partly because OCD has commonly been classified as an anxiety disorder, implying that diagnoses of anxiety in childhood may already include cases of OCD.

Meanwhile, empirical support for this hypothesis comes from two sets of evidence. The first and most direct evidence comes from a large number of cognitive tests indicating an increased susceptibility to uncertainty in OCD individuals across a variety of domains. A second source of evidence comes from studies indicating increased neural activity related to the processing of error in OCD individuals. This evidence is less direct, since it relies on an argument that error signalling will be experienced by the individual as feelings of uncertainty. But crucially, in neither case is this evidence specifically related to the anxious concerns that beset OCD sufferers, allowing us to identify an independent cognitive function at work.

A distinctive susceptibility to uncertainty in OCD sufferers was discovered when examining whether individuals with OCD suffer memory impairments. An impaired memory would be a plausible explanation for the checker sub-group of OCD sufferers in particular, given that it should be extremely easy for a person endowed with normal episodic memory to confirm whether or not the oven has been switched off, or the front door locked by simple recall of their recent actions. However, across a large number of studies (reviewed in Muller and Roberts, 2005; Olley *et al.*, 2007; Harkin and Kessler, 2011) it has been found that OCD sufferers display no consistent pattern of memory impairments. What is most robustly confirmed is a definite lack of confidence in memories. Other studies have found that the distrust of OCD sufferers is not confined to episodic memory. It also appears in tests of general knowledge (Dar, 2004), and even ongoing perceptual experience (van den Hout and Kindt, 2003; Hermans *et al.*, 2008).

Since the reliability of OCD sufferers' memories and attention is comparable to controls, some psychologists have suggested that the problem is *metacognitive*; that is, sufferers' awareness of their own thoughts is dysfunctional in some way.<sup>11</sup> This suggestion is comparable to certain versions of the dysfunctional belief model that highlight dysfunctional attitudes about thoughts (e.g. Wells 1997; Clark, 2004). The difference here is that the distrust of thought is not believed to be a consequence of dysfunctional *appraisal* (at least primarily) but rather has something to do with the very mechanism of becoming aware of one's own thoughts. For instance, Hermans *et al.* (2008) suggest that OCD sufferers are more likely to experience metacognitive distrust as the ironic result of checking too frequently. This may be because heightened attention reveals additional details to the experience that need to be verified if one is to be really sure. Alternatively, repeated checking leads to conceptual generalisation about the task, inhibiting the richness of the individual perceptual check (cf. Van den Hout and Kindt 2003; Dar 2004).

However, we do not construe the problem with uncertainty as specifically relating to metacognition. Prior to attaining insight into their condition, and realising that

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<sup>11</sup> Metacognition, defined as broadly as possible by Joëlle Proust (2013: 4), is 'the set of capacities through which an operating cognitive subsystem is evaluated or represented by another subsystem in a context-sensitive way.'

it's the uncertainty itself which is the problem, OCD sufferers are focused precisely on the first order issue of whether or not the door is locked, or they have HIV, or they could harm their children, and so on. Moreover, it seems that at least some groups of OCD sufferers have problems monitoring their actions, rather than their thoughts (e.g. Belayachi and Der Linden 2010).<sup>12</sup> Again, this does not suggest a specifically metacognitive problem.

Our proposal is simply that there is a dedicated cognitive mechanism for signalling uncertainty that is overactive in the OCD sufferer. Because the neural signal of uncertainty is conceived as physically independent of uncertainty regarding a specific task, we hypothesise that the activation of this signal could well be the direct physical realiser of the feeling that things are just not right.<sup>13</sup> However, if there is a particular intentional act that is currently salient for the individual, we think that the sense of uncertainty is likely to be associated with that action by the individual, as a form of post-hoc rationalisation of the uncertainty signal. As a result, the individual can experience uncertainty about their intentional behaviour across a variety of different domains. This includes mental actions such as deliberately recalling a memory, or deliberately paying attention to something. It can also include the compliance with norms (such as being a moral person, or keeping clean), given that the intention to comply with these norms can at certain times be consciously salient for the individual. Thus despite the fact that different cognitive mechanisms are most likely responsible for monitoring all these different sorts of actions, if our intentions to act in such ways can be equally consciously experienced, they can be equally consciously experienced as uncertain.

We believe that this suggestion best captures the cross domain nature of the uncertainty problem observed in OCD sufferers, as well as its potential independence from particular worries in the case of 'not just right' feelings.<sup>14</sup> Attributing the sense of uncertainty to the breakdown of a specific neuro-biological system can plausibly accommodate the role of genetic factors, or disease in the development of

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<sup>12</sup> Lazarov *et al.* (2012) argue that OCD sufferers have a reduced sense of conviction for all internal states—cognitive, affective and bodily. They suggest that this is due to attenuated access to such states. Bédarda *et al.* (2009) observe a compatible pattern of slower motor skills in OCD sufferers. However the evidence of poorer performance on bodily tasks may also be due to over-correction encouraged by general uncertainty.

<sup>13</sup> This notion aligns well with what are described as epistemic or 'noetic' feelings, which include the feeling of knowing something, and the feeling that a fact is on the 'tip of your tongue'. It is claimed that such feelings play an important role in mental actions such as remembering, planning, or deciding, by providing an intuitive, non-conceptual feedback on the current state of one's mental economy (e.g. Proust, 2014). Dokic (2012) in particular emphasizes the highly separable and contingent relationship between the feeling of knowing and the thought contents with which this feeling is associated.

<sup>14</sup> Though note that to generate checking responses, the 'not just right' cases must still link uncertainty to some action that they then check, potentially as a form of testing feelings of uncertainty.

the disorder.<sup>15</sup> It also makes sense of why the disorder is relatively independent of life-history factors, and can be resistant to cognitive behavioural therapies.

More support for the role of an independent uncertainty signal comes from evidence of increased neural activity related to error detection in OCD sufferers. To cite some relevant studies, Riesel *et al.* (2011) found increased error-related negativity signals (ERNs) in OCD sufferers and first-degree relatives where Hanna *et al.* (2012) observe increased ERNs in paediatric OCD. Fitzgerald *et al.* (2005) observes hyper-activation proportional to OCD severity in the anterior cingulate cortex, which has been correlated with error detection and management.<sup>16</sup> Harrison *et al.* (2009) similarly observe hyperactivity in corticostriatal networks incorporating the anterior cingulate cortex, the orbitofrontal striatum and the basal ganglia. Note that increased activity is found both during error-related task activities and when at rest.<sup>17</sup>

Error detection in these studies typically refers to activity observed when the individual makes a mistake like hitting an arrow key that fails to match the direction of an arrow shown on a computer screen. So what has this got to do with the sense of uncertainty? First, we note that processing of both error and uncertainty have been linked with the same areas of the prefrontal cortex (e.g. Rushworth and Behrens, 2008; Yeung and Summerfield, 2012; Asp *et al.*, 2013). Second, it is highly plausible that if one receives a signal of error without an obvious cause, it is like receiving an email from your boss with the subject line: 'Urgent problem with your work!' You will immediately wonder what you could have done wrong, thus manifesting uncertainty (cf. Aouizerate *et al.*, 2004). Third, and most important, there are good theoretical reasons to believe that uncertainty is itself a signal of *potential error*. That is, whereas error involves a definite conflict between one's intention and what has been observed, uncertainty is where the subject's current representational state is *compatible* with two (or more) representations that mutually conflict, thus threatening error. A signal of error or uncertainty can then trigger information gathering or reasoning processes aimed at resolving the conflict by strengthening the preference for one side of the conflict, and inhibiting the other (cf. Rushworth and Behrens, 2008). All this might potentially be achieved without the conscious involvement of the individual. But if the representations under consideration are already close to attention due to their salience to the subject's current situation, the call for further

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<sup>15</sup> The DSM-5 (2013: 240) notes that up to 10% of cases of early onset OCD have been associated with a streptococcal infection (PANDAS) known to cause inflammation in the basal ganglia (cf. Abramowitz, 2009: 493). The basal ganglia are generally correlated with motor control.

<sup>16</sup> Carter and Van Veen (2007) review a number of studies that link activity in the anterior cingulate cortex with the detection of error and representational conflicts. This structure is observed to trigger further activity in the dorsolateral prefrontal cortex, correlated with enhanced cognitive flexibility to changing task demands.

<sup>17</sup> Notably, under-activity in the frontostriatal pathway (including the orbitofrontal cortex and anterior cingulate cortex) is observed in ADHD (Abramovitch *et al.*, 2013), suggesting an opposition in the two disorders related to the avoidance of error.



resources may well cross a threshold in capturing the full attention of the subject. We hope to see more focused neurological and psychological studies that confirm this hypothesis.<sup>18</sup>

Meanwhile, it is important to note that even though signals of uncertainty may be highly persistent in OCD sufferers, it need not compel confirmatory or exploratory checking of every single thought or action that they have. A crucial additional factor concerns the degree to which uncertainties are tolerated, and this tolerance can be domain specific. In domains of particular concern to the OCD sufferer (such as the wellbeing of his or her children) stricter criteria for certainty are likely to be required. This may be understood mechanistically as the narrowing of the tolerance ranges for what counts as a 'right' answer, and withholding assent from representations falling outside of those tolerances. So it is this tolerance, in combination with excessive signals of uncertainty that we suggest is responsible for the different sorts of obsessions that can beset the life of the OCD sufferer.

By appeal to both a basic problem with intrusive uncertainty, and a domain-relative tolerance for this experience, we can explain why OCD sufferers tend to gravitate towards certain distinctive obsessive themes. We suppose that even if one suffers from strong and persistent signals of uncertainty, this need only motivate checking for highly salient concerns, particularly those relating to potential harm (i.e. where one has mild or merited feelings of anxiety). Meanwhile, milder signals of uncertainty may require more definite anxiety sensitivities to compel checking. So in a large proportion of OCD sufferers, the sense of uncertainty may interact with different varieties of anxiety sensitivity, such that one is prone to move from the sense of uncertainty to conscious evaluation only in circumstances that one tends to be anxious about. If you are disposed towards social anxiety for instance, a sense of uncertainty accompanying any thought regarding the attitudes of others towards you will more readily trigger evaluation (ultimately being attracted towards obsessions regarding the violation of social or moral norms). The same goes for anxiety sensitivities towards personal harm (leading to contagion and other harm-to-self obsessions), or one's responsibility for others (leading to harm-to-other obsessions).

Some final clarifications about this model are important. We are not claiming that OCD sufferers are more *intolerant* of uncertainty than individuals with anxiety problems. Intolerance of uncertainty has been linked about equally with OCD and Generalised Anxiety Disorder (see Gentes and Ruscio, 2011 for a meta-analysis). We are also not claiming that OCD sufferers generally feel a higher *intensity* of uncertainty, or that they are less capable of making sound judgements of their level of certainty about some fact, *at least initially*. An experiment by Shachar *et al.* (2013) examining uncertainty judgements indicates that on both of these measures OCD sufferers are comparable to controls. Our claim is rather that OCD sufferers *more frequently*

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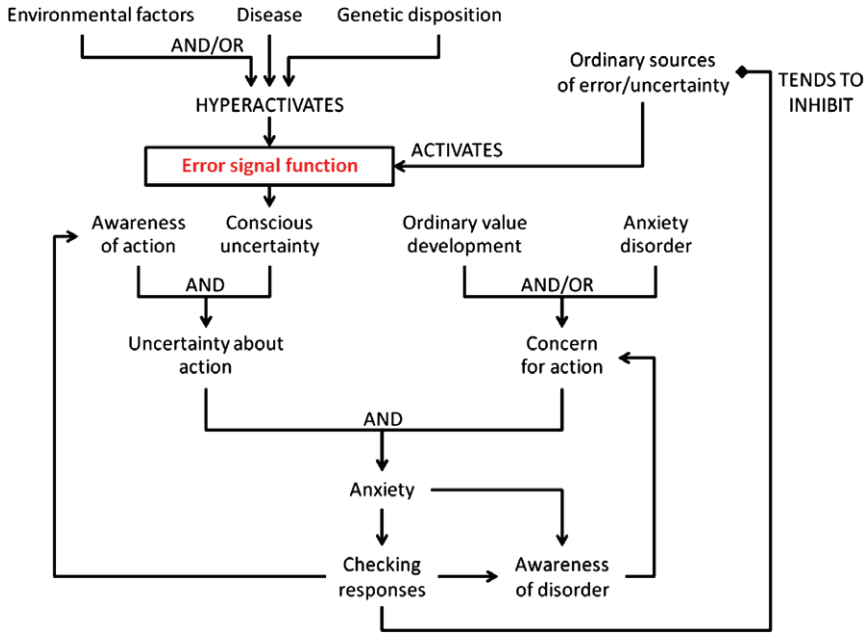
<sup>18</sup> For evidence of distinct conscious and non-conscious responses to conflict signalling see Charles *et al.*, 2013.

experience reports of being uncertain, many of which are false or inappropriate to the situation. So the crucial experimental studies that will allow our hypothesis to be potentially falsified will investigate the relative frequency with which individuals with OCD question (unprompted) their level of certainty for salient matters, relative to controls. Then, having obsessed about a harm over an extended period of time, the individual's sense of the probability of that harm may well become distorted (as we discussed in Section 3). However, it's not the mere fact of adopting a poor checking strategy that makes OCD sufferers more susceptible to doubt (as others have claimed). Our view is that OCD sufferers repeatedly check because they are plagued by persistent, intrusive signals of uncertainty that *demand* further checking.

## **6. Accommodating the Various Observations about OCD**

Considerations about the interaction of uncertainty problems with different anxiety sensitivities allow us to accommodate the patterns of comorbidity with anxiety sensitivity observed in the OCD population. The checking subtype (involving a very strong disposition for uncertainty signals) allows for a pure form of OCD that requires no *special* sensitivity to anxiety (i.e. no anxiety disorder), where other OCD subtypes involve interactions with definite anxiety sensitivities. We are also able to accommodate the phenomenology of intrusiveness more effectively than other models. Our model is comparable to the Inference-Based Approach with respect to the active search for harms. Yet unlike the Inference-Based Approach, we appeal to a neurobiological signal of error/uncertainty that the individual cannot directly control, the function of which is to trigger confirmation processes. When combined with the individual's anxiety sensitivities, it is fair to say that the subject is very strongly pushed, if not compelled to explore possible harms (we will explore the degree of resistance to reasoned control in the following section).

Our model can also account for the presence of the various dysfunctional beliefs in OCD subjects. An intolerance of uncertainty is a predictable consequence of the problem we outline. Although cognitive problems with certainty must be distinguished from emotional distress taken in uncertainty, it is understandable that subjects find the habitual signalling of uncertainty to be distressing when it attaches to personal concerns. Thus they strongly desire to achieve greater certainty about such matters, in the hope that this will remove the feelings of uncertainty. It is similarly predictable that an over-estimation of threat results from being unable to achieve certainty regarding the things that matter to them most, particularly when intensified by anxiety sensitivities that are present in most (though not all) individuals with OCD. Finally, constant intrusions encourage the OCD sufferers to develop metacognitive concerns about their thoughts. Such concerns are particularly pernicious because they motivate the individual to check their thoughts, leading to their repetition and elaboration rather than their dismissal.



**Figure 1** A schema for the Intrusive Uncertainty Model of OCD. This schema outlines a hypothesised set of causal dependencies for OCD. The key problem we identify at the root of the disorder is hyperactivity of the error signal function. This fuels a positive feedback loop between uncertainty, anxiety and checking, depicted in the lower-left quadrant of the diagram. The process relies on the individual associating a feeling of uncertainty with some intentional action. Intentional actions can include compliance with personal and moral norms as well as metacognitive norms regarding thought control. Checking responses can include both bodily and cognitive actions (e.g. the search for harms). In healthy individuals, checking has a tendency to reduce ordinary sources of error or uncertainty and thereby halt the entire loop. Checking may not always succeed however, and may sometimes be counter-productive (e.g. in revealing new things to be uncertain about). Note also that an anxiety disorder will tend to increase concerns (potentially to dysfunctional levels) and thereby encourage uncertainty-based anxiety. However an anxiety disorder is not necessary for OCD to develop. Awareness of the disorder can also encourage dysfunctional levels of concern to develop. Please note that not all features of anxiety disorders are included in this diagram.

Thus the Intrusive Uncertainty Model can account for the formation of beliefs found in the self-report data. Our model however has the advantage that it need not appeal to any unusual emphasis on personal responsibility in the developmental environment to account for the formation and preservation of these attitudes. Yet we can certainly allow that if an individual’s environment heavily emphasises their vulnerability to error, or the negative consequences of error, this could either trigger the disorder or intensify a pre-existing susceptibility to the disorder.

Overall, the Intrusive Uncertainty Model can accommodate the evidence appealed to by other models. Yet it conceives the over-thinking that we observe in obsessive compulsive disorder in a different way to other models. The Intrusive

Uncertainty Model conceives OCD as essentially a response to uncertainty. Like the inference based approach, this is taken to include suppositions regarding possible sources of harm. However, unlike the Inference-Based Approach, generating suppositions is understood as a variety of checking behaviour, rather than a means to confirm a deep seated conviction. Furthermore, the Inference-Based Approach claims that OCD sufferers ignore the evidence provided by the environment, since they are too wrapped up in their imagined narratives. In contrast the Intrusive Uncertainty Model allows for checking behaviours (including compulsive washing) that are straightforwardly aimed at resolving the issue one way or the other, and only fail to deliver certainty (without very deliberate behavioural interventions) due to persistent signals of uncertainty. Endless checking is thus central to the Intrusive Uncertainty Model of OCD in a way that we do not find in other models, and in this way seems truer to the phenomenology of the disorder.

Finally the Intrusive Uncertainty Model accommodates experimental findings that do not sit so well with either the Dysfunctional Belief Model or the Inference-Based Approach. Having delusional commitments or a poor reasoning style should not make one susceptible to uncertainty about one's ability to recall general knowledge facts for instance (Dar, 2004 cited above). And it is hard to see how having dysfunctional concerns about the need to control one's thoughts could achieve this either.

## **7. Implications for Thought Control**

This article has focused on a disorder that is known to undermine the individual's overall thinking efficiency. OCD can cause the individual to become locked in cycles of paralysing doubt, and even make them susceptible to irrational beliefs concerning personal trustworthiness. However our Intrusive Uncertainty Model has nuanced implications for thought control. We have identified several distinct stages in the generation and exacerbation of obsessive worries. Some of these stages are likely to be more resistant to reasoned control than others.

First, we have argued that enduring anxiety (sustained by constant signals of error/uncertainty) disposes the individual to actively search for harms. Although it is part of the function of anxiety to search for harms, this response seems to be strongly motivated rather than absolutely compelled. Normally when undergoing emotions, we are able to inhibit or redirect at least our overt behavioural responses, and this capacity may also be true of certain cognitive responses. For example, CBT techniques often recommend 'acknowledging' intrusive worries without catastrophizing their presence and thereby fastening one's attention upon them (e.g. Bishop *et al.*, 2004; Hoffman *et al.*, 2010). In a similar vein we suggest that the subject can acknowledge the anxious uncertainty they have about some harm, but resist searching for *novel* ways in which harm may be brought about. This should prevent the subject from gravitating towards obsessions that are particularly hard to disconfirm.

Note that the existence of a population of OCD sufferers who experience only 'not just right' feelings indicates that elaborative thinking about harms may be avoided. However, this subgroup may have milder anxiety sensitivities than OCD sufferers who display more elaborate obsessions. Thus future experiments should investigate the extent to which novel imaginings can be resisted on command and the degree to which this is proportional to anxiety levels.

Another key stage proposed by our model is a post-hoc association made between the signal of uncertainty and intentional behaviour that is currently salient for the individual (including mental acts). Note that the normal function of the uncertainty/error signal is to be triggered by represented errors or ambiguities. If the uncertainty signal is triggered independently, the subject will experience an *illusion* of uncertainty attaching to a current concern. This seems analogous to certain emotional illusions where physiological cues of emotion get misattributed to the individual's situation (e.g. Dutton and Aron's (1974) famous shaky bridge experiment). However, it is worth emphasising that the repetitive co-occurrence of the sense of uncertainty with a particular concern should considerably reinforce any associative link.

Given that the individual's salient intentions and the sense of uncertainty are functionally distinct, it seems theoretically possible for the association to be resisted. As in emotional misattribution (e.g. Storbeck and Stefanucci, 2014), reflective awareness of what is happening may make a difference. Most importantly, the individual retains the capacity to reason that such associations are not valid. Thus cognitive behavioural therapy could encourage the individual with OCD to note the signal of uncertainty without regarding it as a reliable. Recall also O'Connor and colleagues therapeutic strategy in which the individual was encouraged to develop positive imaginative narratives in order to replace harm-confirming narratives. In a similar way, it is possible that the individual's feeling of uncertainty be deliberately associated with some emotionally neutral or positive narrative instead.

Finally, and unique to our model, it has been crucial for making sense of the intrusive nature of the OCD sufferer's doubts that the error signalling system functions independently of the individual's conscious control. Of course we can consciously choose to question how certain we are, but much more frequently, we will simply be struck by uncertainty. It is the breakdown of this mechanism that we most readily link with a genetic predisposition,<sup>19</sup> and that we take to be the least susceptible to reasoned control. The sub-personal system calls on our attention. It will most likely succeed in grabbing our attention if the uncertainty is linked with a matter of current concern. Anxiety will be most likely triggered if the uncertainty is linked with a potential harm, and anxiety will reinforce attention towards the representation of harm. Without a general theory of attention we cannot decisively say that the attention will be *compelled*, however these are clearly powerful attractors on attention. In healthy cases, this system plays an important role in helping the individual

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<sup>19</sup> Though disease and environmental factors also remain possible causes.

to appropriately manage his or her concerns. But it seems our capacity to modify its functioning if it ever fails to align with our reflectively endorsed goals is very limited.

Moreover, the incapacity for OCD sufferers to dismiss worries that they know to be highly unlikely or irrational is not due to any distinctive absence of a direct system for withdrawing attention. No direct mechanism for withdrawing attention seems to exist.<sup>20</sup> Rather the normal procedure is to become distracted by something else. In normal cases of uncertainty, distraction may be aided by the weakening of the uncertainty signal, should checking procedures manage to confirm matters one way or the other. Yet checking seems largely ineffective in OCD sufferers. Thus the system will continue to call on their attention, and will only be reinforced by distress and conscious attempts at thought control.

We shall conclude, however, with a novel positive prediction: *if* we are right that intrusive uncertainty is at the root of the disorder, *and* that uncertainty is identifiable with error signalling, then any technique that is effective at reducing error signalling should have a significant beneficial impact on OCD severity. Direct pharmaceutical interventions are the most likely candidate for such effects.<sup>21</sup> However, it is our hope that this model will stimulate novel clinical approaches.

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<sup>20</sup> Wenzlaff and Wegner's (2000) 'white bear' experiment cited earlier indicates that we cannot simply banish an idea on command without it reappearing moments later (cf. Najmi *et al.*, 2010; Magee *et al.*, 2012; Hooper and McHugh, 2013). Wegner (2011) instead proposes various indirect strategies. For instance, actively thinking about the matter as much as possible for a period can ironically aid distraction following this period (cf. Hooper and McHugh, 2013).

<sup>21</sup> Recent pharmaceutical interventions have targeted the glutamate signalling system (reviewed in Wu *et al.*, 2012). This system is active in the areas of the prefrontal cortex we earlier linked with both uncertainty and error related negativity.

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