Understanding repeated actions: Examining factors beyond anxiety in the persistence of compulsions

by

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Author's Declaration

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

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Abstract

Two decades of research on obsessive-compulsive disorder (OCD) has helped us develop a strong understanding of why obsessions are often followed by the performance of a compulsive act. What we have understood less well is why that act is repeated, even though it often results in an increase, rather than decrease, in discomfort. Emergent research on compulsive checking implicates a number of beliefs—including perceived responsibility, perceived harm, need for certainty, and beliefs about one's memory— that may influence behavioural parameters (e.g., check duration) of checking episodes. Furthermore, it has also been suggested that the act of compulsive checking may recur in part because of a self-perpetuating mechanism in which checking has paradoxical effects on these beliefs. Finally, some researchers have proposed that attentional focus (e.g., focus on threat) during checking may be related these paradoxical outcomes. At present, these ideas are mostly speculative, in part because there have been so few detailed studies of the actual phenomenology of compulsive rituals. The purpose of the present research was to gather phenomenological data on compulsions as performed by a clinical sample under ecologically valid conditions.

Study 1 extended emergent research suggesting that compulsions may persist because the act of checking has a number of ironic effects on beliefs. Individuals with a diagnosis of obsessive-compulsive disorder (OCD) and anxious controls (AC) completed a naturalistic stove task in our laboratory kitchen. Participants were fitted with portable eyetracking equipment and left on their own to boil a kettle, turn the stove off, and check to ensure that the stove is safe before leaving the kitchen. Surrounding the stove were household items that are "threatening" (e.g., matches) or "non-threatening" (e.g., mugs). Ratings of mood, responsibility, harm (severity, probability) and memory confidence were taken pre- and post-task and a portable eyetracker was used to monitor attention throughout the stove task. We examined the relations

between behavioural indices (check duration, attentional focus) and pre- and post-task ratings of responsibility, perceived harm, mood, and memory confidence. Although we found that OCD (as compared to AC) participants took significantly longer to leave the kitchen after using the stove, we found no evidence that stronger pre-task ratings of responsibility, perceived harm, or memory confidence were associated with longer check duration. However, we found some evidence of an ironic effect whereby greater check duration was associated with greater perceived harm and decreased certainty about having properly ensured the stove was off. Of note, these ironic effects were not unique to participants with OCD, but were also observed in the AC group. With respect to the eyetracking data, we found minimal evidence linking threat fixations and beliefs in participants with OCD. In contrast, a number of interesting relations emerged in the eyetracking data of our anxious control participants. For AC participants, a greater proportion of time spent looking at the stove was associated with greater post-task sense of responsibility for preventing harm, greater post-task harm estimates, decreased certainty (about having ensured the stove was off), and decreased confidence in memory for the task.

In Study 2, individuals with a diagnosis of OCD completed a structured diary of their compulsions as they occurred naturally over a three-day period. Participants recorded the circumstances leading to each compulsion and reported on the acts involved in the compulsive ritual, the duration and repetitiveness of the ritual, and the criteria used to determine completeness of the ritual. The findings of this study suggest that unsuccessful compulsions (i.e., compulsions in which certainty was not achieved) were associated with a longer duration (trend), more repetitions, a higher standard of evidence, and offered little in the way of distress reduction. These findings are discussed within the theoretical context of cognitive-behavioural model of obsessive-compulsive disorder and clinical implications are offered.

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Introduction

Obsessive- compulsive disorder (OCD) is an anxiety disorder characterized by the recurrence of unwanted thoughts, images, or impulses (obsessions) and the performance of repetitive acts (compulsions). The lifetime prevalence of OCD is estimated to be approximately 2.5% (APA, 2000), meaning that over 800,000 Canadians are likely to be sufferers at some point in their lifetime. Results of the World Health Organization Global Burden of Diseases Study (2000) characterizes OCD as one of the most debilitating mental health disorders and ranks it among the top 20 causes of all illness-related disability for individuals aged 15 to 44 years (Ayuso-Mateos, 2000). Indeed, studies examining quality of life in obsessive-compulsive disorder consistently find that individuals with OCD experience significant social and occupational interference and report substantially lower quality of life as compared to individuals whose symptoms have remitted and individuals without a psychiatric diagnosis (Huppert, Simpson, Nissenson, Liebowitz, & Foa, 2009; Stengler-Wenzke, Kroll, Matschinger, & Angermeyer, 2006). Moreover, a number of studies suggest that the extent of impairment experienced by individuals with OCD is greater than that experienced by patients with a range of medical conditions, including diabetes (e.g., Antony, Roth, Swinson, Huta, & Devins, 1998). OCD generally proceeds according to a chronic course and although symptoms may wax and wane periodically, the condition rarely remits without treatment (APA, 2000).

Over the last three decades, the prognostic picture for OCD has been much improved due in large part to the development of a cognitive behavioural model of OCD and corresponding psychological treatment. First developing from Mowrer's (1960) two-factor theory of fear and the work of other behaviourists (e.g., Meyer, Levy, & Schnurer, 1974), psychological models of OCD came to understand how obsessive and compulsive symptoms developed via behavioural

conditioning (Abramowitz, 2006). According to behavioural models, normal thoughts, images, or impulses become obsessional via classical conditioning (i.e., through association with a high degree of anxiety) and thus become reliably associated with an aversive affective response. Strategies to decrease anxiety (i.e., compulsions and other forms of neutralizing) are said to be learned via operant conditioning and maintained via negative reinforcement by the reduction in distress that they provide. Neutralizing strategies are further maintained because they pre-empt the natural process of habituation to anxiety, thereby preventing the individual from learning that the obsessional fear will diminish even in the absence of ameliorative efforts.

The leading psychological treatment for OCD—exposure and response prevention (ERP)—is predicated on a behavioural model. In ERP, the individual is exposed to the obsessional fear while the compulsion is resisted. Exposure to the obsessional stimulus is gradual and repeated which allows for habituation to the anxiety associated with obsessions, and ultimately extinction of the aversive response associated with the obsessional stimulus. Because the process allows the response to extinguish on its own, the compulsion is rendered obsolete. Early reports on the efficacy of ERP treatment for OCD suggested that this approach brought marked improvement in symptoms for the majority of individuals treated (e.g., Meyer et al., 1974). And indeed, a large body of empirical work continues to support the effectiveness of ERP treatment for OCD (for reviews see Foa, Franklin, & Kozak, 1998; Rowa, Antony, & Swinson, 2007). Treatment outcome studies suggest that among those who complete treatment, approximately 80% respond well and see a significant reduction in symptoms (e.g., Abramowitz, 2006). Unfortunately however, because ERP involves a great deal of experienced anxiety, it can be a difficult treatment for individuals to complete. Research suggests that approximately 20-30% of individuals who begin ERP drop out prematurely (Abramowitz, 2006). Additionally,

ERP might not be relevant for the symptoms experienced by a subset of individuals with OCD, such as cases involving primarily covert compulsions or "mental rituals" (Rachman, 1997; 1998). Finally, among those who remain in treatment, approximately 20% do not show a significant improvement in symptoms (Abramowitz, 2006). Therefore, as many as 50% of individuals with OCD who present for treatment do not experience a significant improvement in symptoms with ERP (Franklin, Abramowitz, Kozak, Levitt, & Foa, 2000; Abramowitz, 2006).

Conditioning models of fear acquisition, such as Mowrer's two-factor theory, have some important limitations as they are applied to OCD. Many individuals with OCD do not have a history of relevant conditioning and the obsessional fear (e.g., of contamination) cannot be traced back to a previous incident (Shafran, 2005; Taylor, Abramowitz, & McKay, 2007). In addition, the fear conditioning model does not readily explain important clinical phenomena seen in OCD such as why anxiety tends to wane and neutralizing behaviour diminish when in the feared situation with another individual present (e.g., Rachman 1976; as cited in Shafran, 2005). Further, conditioning models do not readily explain why prevalence rates of OCD do not increase under conditions well-suited to fear conditioning. For example, why are there not higher OCD prevalence rates in countries engaged in war or among individuals with high-risk occupations? These phenomena are not easily explained from a strict behavioural conditioning perspective.

Research over the last two decades has focused on examining cognitive components in the disorder with the aim of improving treatment outcomes through the development of cognitive techniques. According to cognitive models of OCD, clinical obsessions lie at the extreme end of a continuum with normal, albeit, unwanted intrusive thoughts (Salkovskis, 1985) that are experienced by up to 99% of nonclinical individuals (Freeston, Ladouceur, Thibodeau, &

Gagnon, 1991; Purdon & Clark, 1993; Rachman & de Silva, 1978). Obsessional problems arise when these otherwise normal cognitions are erroneously appraised as having important meaning to the individual, as threatening, or as otherwise unacceptable (Shafran, 2005). More specifically, Salkovskis' model (1985; 1999) posits that clinical obsessions will develop when the thought is appraised as indicating a potential for harm that the individual has responsibility to prevent. Rachman (1997, 1998) implicates interpretations involving morality-related (e.g., aggression, sex, blasphemy) themes as being responsible for the escalation of intrusive thoughts to an obsessional level. In addition, Purdon and Clark (1999) suggest that faulty beliefs about the importance of controlling one's thoughts and negative interpretations of the perceived consequences of failing to control one's thoughts similarly contribute to the escalation process through which normal intrusive thoughts become clinical obsessions. In all, six domains of beliefs have been identified as particularly relevant to the development of OCD; in addition to beliefs about threat, responsibility, and importance of controlling thoughts, overestimation of threat intolerance of uncertainty, overimportance of thoughts, and perfectionism are also key components of the cognitive model of OCD (Purdon, 2007).

Following closely from these theoretical models of obsessional thinking, cognitive interventions aim to challenge the characteristic interpretations and beliefs underlying the obsession (Tolin, 2009). One of the main therapeutic goals of cognitive therapy techniques is to help the client to understand and modify the beliefs, assumptions, and thoughts that are associated with his/her problematic emotional and behavioural response (Purdon, 2007). It has been argued that cognitive techniques might serve to "tenderize" (Abramowitz, 2006, p. 413) or "detoxify" (Purdon, 2009, p. 239) obsessional fears, thus making individuals more able to engage in ERP. Overall, the inclusion of cognitive techniques in OCD treatment approaches

might translate into a more tolerable treatment with downstream effects of greater treatment engagement and improved treatment outcomes for a larger majority of treatment-seeking individuals (Salkovskis, 1985). However, evidence to date is mixed regarding whether treatment incorporating cognitive interventions (as compared to behaviourally based therapy) leads to improved engagement and outcomes for individuals with OCD (Cottraux, Note, Yao, Lafont, Note, Mollard, et al., 2001; van Oppen, de Haan, van Balkom, Spinhoven, Hoogduin & van Dyck, 1995; Whittal, Thordarson, & McLean, 2005; Whittal, Robichaud, Thordarson, & McLean, 2008). Recent dismantling studies suggest that the active ingredients in treatments for anxiety, including OCD, are those that target behavioural change (Tolin, 2009). For example, Vogel, Stiles, and Götestam (2004) found that ERP + Cognitive Therapy (CT) was not more effective than ERP + placebo (relaxation training) in improving OCD symptoms. Moreover, across OCD treatment studies, CT with behavioural experiments consistently results in greater improvement than does CT without behavioural experiments (Abramowitz, Franklin, & Foa, 2002). Taken together, these findings suggest that direct efforts to alter beliefs may not translate into superior treatment outcomes (Tolin, 2009).

As we enter the third decade of research guided by cognitive behavioural models of OCD, the efficacy of current cognitive-behavioural treatments for OCD appears to have reached a plateau (Whittal et al., 2008). Moving forward, a fresh perspective is needed to gain new insights into OCD with the aim of more effectively treating the large minority who are not able to benefit from current treatments. The question is: Where to next?

One of the challenges in developing a comprehensive treatment with improved efficacy for OCD is that OCD presents as a heterogeneous disorder, with a variety of symptoms. Efforts to categorize OCD subtypes have come primarily from an examination of symptom themes, with

patients being categorized according to their major compulsive behaviour (Sookman, Abramowitz, Calamari, Wilhelm, & McKay, 2005). The results of these studies generally suggest at least four replicable subtypes including: i) contamination obsessions and washing/cleaning compulsions, ii) harm obsessions and checking rituals, iii) obsessions without overt compulsions; and iv) hoarding , though symmetry concerns and ordering, repeating, and counting compulsions have also been suggested as a distinct subtype (Mataix-Cols, Rosario-Campos, & Leckman, 2005). It should be noted however that replicating these symptom-based subtypes has sometimes proved difficult and that alternative approaches to subtyping (e.g., based on age of onset or possible latent dimensions) have also been limited in their ability to capture the heterogeneity of OCD in a reliable and valid way (see Leckman, Rauch, & Mataix-Cols, 2007; McKay, Abramowitz, Calamari, Kyrios, Radomsky, Summerfeldt, Richter, Antony, & Swinson, 1999). Certainly, obsessive-compulsive disorder subtypes remains an important area for further research. It is possible that increased knowledge of the cognitions associated with OCD will help to support these research efforts (Radomsky & Taylor, 2005) as might efforts to examine the differential effects of current treatments on different symptom presentations. As Sookman and colleagues (2005) point out, subtypes have received limited consideration in CBT outcome research thus far.

Presumably, research directed toward better understanding the unique phenomenology of the various OCD symptom presentations will translate into improved treatment outcomes. In this vein, increasingly specific models for these OCD 'subtypes' have emerged, and in some cases have led to the development of more tailored treatment protocols. Good examples of such symptom-specific models are Rachman's (2002) cognitive model of compulsive checking and

Radomsky, Shafran, & Rachman's (2010) corresponding CBT protocol for the treatment of compulsive checking

Rachman's (2002) model of compulsive checking incorporates a number of new ideas about how subtype-specific cognitive factors may serve to maintain the OC checking cycle. Importantly, it extends beyond a strict behavioural perspective to implicate cognitive, information processing, and behavioural factors in the development and persistence of repeated checking. Rachman suggests that checking occurs when individuals who believe they have a special, elevated responsibility for preventing harm feel unsure that a perceived threat has been adequately reduced or removed. In an attempt to achieve certainty, they check that all is safe. According to this model, three components are important for the initiation of compulsive checking, namely: i) an inflated sense of responsibility for preventing harm, ii) inflated perceptions of the probability of harm, and iii) inflated estimates of the seriousness of harm. Although each of these components contribute to the need to check, an inflated sense of responsibility for preventing harm might be especially important. Further, Rachman proposes that the act of checking itself ultimately has paradoxical effects which ultimately reinforce the checking behaviour to create a "self-perpetuating mechanism" capable of driving further checking bouts (p.629). The mechanism by which the cycle is perpetuated begins with an unsuccessful search for certainty that harm has not/will not occur. (This search is almost by definition unsuccessful because certainty about future harm—or any future event for that matter—is rarely, if ever, attainable.) Second, the act of checking itself is said to tarnish one's memory of the check, making a feeling of certainty less, not more, likely. Finally, checking is said to reinforce the cognitive biases that led to checking in the first place by paradoxically increasing one's sense of the likelihood of harm and one's sense of responsibility for preventing

it. This self-perpetuating mechanism is essential for understanding how compulsive checking becomes a pernicious experience full of doubt.

Radomsky, Shafran, & Rachman (2010) suggest that efforts aimed at restoring confidence in these cognitive abilities, particularly memory, may lead to improved treatment outcomes in cases of compulsive checking. Interventions targeting the inflated sense of responsibility, perceived likelihood and seriousness of harm might also be incorporated into a more specific and perhaps more effective treatment (Radomsky et al., 2010). More generally, it may also be that arming sufferers with a better understanding of their compulsions (and why they feel it necessary to repeat them) may also help individuals to better resist their compulsions, and thus, better engage with current treatments (e.g., ERP).

Checking initiation: What drives the urge to check?

Research examining the components of Rachman's model includes studies supporting the key role of responsibility appraisals in checking as well as a variety of experimental studies examining the effects of repeated actions on memory confidence. An inflated sense of responsibility figures prominently in cognitive behavioural models of OCD (e.g., Rachman, 1997; Salkovskis, 1999) and is said to play a key role in the initiation of compulsive checking in particular (Rachman, 2002). A number of studies support the key role of responsibility appraisals in driving the urge to check. Lopatka and Rachman (1995) asked 30 individuals with OCD to sign contracts pledging that they would take either full responsibility or no responsibility for the outcome of different situations (e.g., turning the stove off and walking away from it). Results indicated that increased responsibility led to higher levels of subjective discomfort and a greater urge to perform compulsive behaviours (e.g., checking) relative to the low responsibility condition. More recently, Arntz, Voncken, and Goosen (2007) demonstrated that the urge to

check can be elicited by less direct manipulations of responsibility. OCD patients, non-OCD anxious controls, and non-clinical participants were asked to sort pills according to a colour-system the researchers had developed. Individuals in the high responsibility condition were led to believe that their performance on the task had important consequences for the researchers; those in the low responsibility were given so such suggestion. Results indicated that under conditions of high responsibility individuals with OCD reported a greater urge to check and engaged in higher-levels of checking behaviour (e.g., prolonged inspection of pills before sorting, changing pills from one pot to another) relative to the low responsibility condition. The findings of these and other studies (e.g., Cougle, Lee, & Salkovskis, 2007) highlight the role of perceived responsibility in checking initiation.

However, as some (e.g., van den Hout & Kindt, 2003; Hermans, Engelen, Grouwels, Joos, Lemmens, & Guido, 2008) have pointed out, checking is a relatively common experience in that all individuals are driven to check if they feel a personal responsibility for preventing harm. What differs is the repetitive nature of obsessive-compulsive checking and the perpetual doubt that appears to accompany it. These distinguishing features cannot be solely explained by increased responsibility perceptions; additional beliefs and appraisals must be considered in providing a fuller account for the repeated nature of compulsive checking.

Checking persistence: New ideas about what 'fuels the fire'

Confidence in cognitive abilities. A growing number of studies suggest that individuals with OCD and especially those with checking compulsions show biases in judgments about certain cognitive abilities, namely memory, attention, and perception; individuals with OCD report low confidence in these areas, despite no objective impairments in cognitive ability (for a

review see Cuttler & Graf, 2009). Interestingly, a series of experimental studies have demonstrated links between the act of repeated checking and loss in memorial confidence, providing support for Rachman's assertion that the act of checking 'tarnishes' memory. In an early study of this kind, van den Hout and Kindt (2003) monitored memory accuracy and confidence over a series of trials in which participants checked a virtual stove to ensure its safety. Results indicated that whereas actual memory accuracy remained stable with additional rounds of checking, memory confidence declined. This effect has since been replicated in a number of additional studies suggesting that declining memory confidence is observed after repeatedly checking the same object (Radomsky, Gilchrist, and Dussault, 2006), after a relatively limited number of repetitions (i.e., as few as 5 checks; Coles, Radomsky, & Horng, 2006), and may be especially pronounced under conditions of high responsibility (Boschen & Vuksanovic, 2007).

Similar findings pertain to confidence in attention and perception in individuals with OCD. A series of studies report that individuals with OCD experience less confidence in attention and perception as compared to individuals with another psychiatric diagnosis or individuals with no diagnosis (Hermans, Marten, De Cort, Pieters, & Eelen, 2003; Hermans et al., 2008; Nedeljkovic & Kyrios, 2007; Nedeljkovic, Moulding, Kyrios, & Doron 2009; van den Hout, Engelhard, de Boer, du Bois, and Dek, 2008). Beliefs about the untrustworthiness of attention and perception were particularly apparent for individuals with OCD in reference to OCD-relevant actions such as locking a door (Hermans et al., 2008). Confidence in memory, attention, and perception have also demonstrated some ability to predicted greater self-reported checking symptoms over and above other OCD-relevant cognitions such as increased responsibility and confidence in memory (Bucarelli and Purdon, 2009). Indeed, Alcolado and

Radomsky (2010) recently showed that low memory confidence may be considered a risk factor for repeated checking, especially under conditions of uncertainty. Participants without any psychiatric diagnosis were given positive or negative false feedback about their memory abilities. Those who were given false feedback reported stronger urges to check than did those who received the positive feedback, demonstrating in a straightforward way that one's subjective sense of memory may play a role in the initiation of checking (whether it be the first check or the first of many checks).

Evidence is beginning to accrue to suggest that poor confidence in memory, perception and attention may each evoke doubt about whether a check has been completed properly, and ultimately lead to further checks. However, the majority of studies to date have included experimental constraints on the checking task, offering a prescription for how to check the item of interest (e.g., the stove) and providing a pre-determined number of repetitions. While these studies have offered valuable insights, there is still much to be gained from studies adopting a less contrived approach to repeated checking. For example, when Hermans, and colleagues (2008) examined confidence in memory for repeated actions, they found the most pronounced effects when the actions being repeated were ideographically selected compulsive actions as opposed to normatively selected compulsive actions. Certainly, there is a need for research examining these ideas in a more naturalistic way.

Attentional deployment. Differences in information processing might also contribute to the persistence of compulsive checking (e.g., Rachman, 2002; Boyer & Liénard, 2007) and might in fact underlie distrust in memory (Hermans et al., 2003). Indeed, a number of models have been put forth to account for the increasingly common finding of memory distrust in OC checkers; each proposes a mechanism by which the repetitive nature of the checking results in

less vivid and detailed recollections, and subsequent distrust in memory. Van den Hout & Kindt (2004) suggest that degraded memories result from conditions of increased familiarity (such as those created by repeated checking) which promote a shift from perceptual to conceptual processing. The result is a less vivid, less detailed memory that is perceived by the individual as untrustworthy. Rachman (2002) suggests that where inflated perceptions of responsibility, probability of harm and severity of harm are present, individuals will focus attention on salient threat cues and will do poorly at the recording of additional information (e.g., contextual cues) regarding the check. The resultant memory will be less vivid and detailed than it would have been had additional details been encoded. Subsequent difficulties in recalling the check will be interpreted by the individual as reflecting untrustworthy memory, which in turn will drive further checking behaviour. A common implication of these models is that the quality of early encoding of information is important for later recall. These models also imply that individuals who repeatedly check may differ in the type and amount of information they attend to (and therefore encode) while checking. These ideas are broadly consistent with theoretical views of biased information processing in anxiety and mood disorders and suggestions that anxiety disorders are characterized by selective attention to threatening information (e.g., Matthews & MacLeod, 1994; Mathews & MacLeod, 2005).

Few studies to date have examined the role of attention in compulsive checking. Most recently, Harkin, Miellet, and Kessler (2012) used eyetracking technology to examine eye movement patterns in a sample of subclinical checkers. Participants were asked to encode a set of letters displayed to them on a computer screen before being asked to recall the letters' locations. However, on some trials participants were asked for the location of a letter that had not been part of the initial display. Results indicated that under these circumstances, subclinical

checkers spent greater time 'checking' stimulus locations as well as locations that had actually been empty during encoding. The authors concluded that these 'atypical' eye movements reflect a tendency of individuals who check to undertake greater internal checking of their memories.

Following a more ecologically valid paradigm, Ashbaugh & Radomsky (2007) examined whether increasing the amount of contextual detail encoded during repeated checking would ameliorate distrust in memory. Their rationale followed closely from Rachman's (2002) assertion that under perceived conditions of elevated responsibility and harm, individuals selectively attend to threat-relevant stimuli at the expense of encoding contextual information that might aid memory formation. Ashbaugh and Radomsky invited participants to complete a series of stove checks and randomly assigned them to receive instructions to focus on either a) their actions involved in checking the stove (central detail condition) or b) their actions involved in checking the stove + their surroundings (peripheral detail condition). Following 30 trials of checking the stove knobs, participants were asked a series of questions assessing memory accuracy and confidence regarding both central (e.g., *Which knob did you check last? Did any of the burners glow orange?*) and peripheral details (e.g., *How many cups were in the sink? What colour was the tea towel on the stove?*). They found that individuals who were instructed to attend both to context and central action (i.e., those in the peripheral detail condition) evidenced greater memory accuracy for items relating to the stove task itself as well as contextual detail. Despite this, they did not report greater confidence in their memories than did participants who attended to central actions only. That is, whereas attending to peripheral details increased memory accuracy, it had no ameliorative effect on memory distrust.

These findings appear contrary to the notion that declines in memory confidence occur because of decreased encoding of detail (e.g., van den Hout & Kindt, 2004; Rachman, 2002).

However, as Ashbaugh & Radomsky (2007) point out, it could be that attending to peripheral details represents a strategy that is employed by OC checkers. Thus, it might be more helpful to suggest that the individual attend to the context of his/her actions in order to better focus on the act of checking as an integrated whole. In a similar vein, it remains possible that participants would differ in their evaluation of whether objects in the surrounding kitchen (i.e., peripheral details) were relevant to the task. If not, encoding of those additional details might be deemed uninformative to one's sense of confidence regarding memory for the task. Moreover, participants might differ in their evaluation of the valence of the additional details. For example, a tea towel near the stove (peripheral detail) might appear relatively innocuous to some, but might represent a fire hazard for others. Thus, for individuals in the latter group, the presumably neutral peripheral details might actually serve to increase the perception of harm likelihood and thus make confidence regarding memory more elusive. However, these ideas remain speculative at present because studies have yet to examine how attention is deployed during a naturalistic checking task featuring self-guided action and free viewing of various (threatening and non-threatening) stimuli.

Taken together, this recent research on OCD and compulsive checking in particular suggests a cycle comprised of much more than anxiety and anxiolytic behaviours. Emergent research suggests that the initiation of this cycle may involve a complex dance between many psychological, cognitive, and behavioural factors. Anxiety, doubt ("Was the stove *really* off?"), and distrust in memory, attention, and perception ("Do I remember seeing that the burner was off?") might all compel an individual to engage in protective behaviours, such as checking, designed to ensure that harm has been/will be averted.

Ritual termination: Why is it so difficult to stop?

The drive behind compulsive behaviour may not be the only essential piece of obsessive compulsive phenomenology in need of understanding. An early observation of Reed (1977) attests to this notion: "Those who are trapped in a circle of repetitive behaviour do not report that something forces them to *continue* but that they lack something to make them *stop.*" (p. 384). The years following Reed's observation have seen the advancement of several models of OCD implicating disturbances in the processes by which individuals conclude that action can be terminated. For example, Reed (1977, 1983), described the individual with OCD as being prone to cognitive uncertainty regarding categorical limits (e.g., "Is it finished?") and, subsequently, unable to put closure on his/her actions. More recently, Summerfeldt (2004) proposed that a sense of incompleteness—"the troubling and irremediable sense that one's actions or experiences are not 'just right'," —is at the core of many of the symptoms of OCD (p. 1155). Szechtman and Woody (2004) developed a model featuring a particular type of feeling of knowing proposed to be deficient in OCD. Termed *yedasentience*, it is a feeling of knowing that serves as a termination or satiety signal for actions motivated specifically by a security-motivation system—a system concerned with protecting the organism (human or otherwise) from potential threat (p. 116). Yedasentience is essential to this system because it provides closure for situations in which there are no objectively verifiable termination cues. (Recall that the system is concerned with *potential* threat and there is no reliable cue, environmental or otherwise, to signal the absence of a potential.) For individuals with OCD, ritualized behaviour represents an attempt to create a clearly defined, closed-ended task with which one might manage the uncertainty of the potential threat and thereby create an alternative satiety signal. Viewing compulsive checking as the attempt to shut down the security-motivation system, they argue, provides an account of the

specificity of symptoms in OCD because it is commensurate with the observation that the content of most obsessional concerns involves issues of safety and security, either of oneself or others (e.g., Salkovskis, 1985). Moreover, because the security-motivation system is evolutionarily based, it is associated with a number of pre-programmed behaviours designed to assess and reduce the perceived threat (and promote survival). Thus, it provides an account of the relatively ritualized behaviours that comprise compulsions such as checking and washing. Boyer & Liénard (2006) similarly proposed that OCD symptoms are related to failures in systems designed to trigger a feedback process for satiety feelings in response to inferred threats. In OCD, this "evolutionary precaution system" goes awry so that in the face of a perceived threat the individual experiences doubts about the potential for harm and his/her precautionary efforts.

Notwithstanding their differences, these models share the notion that a key problem in OCD, and compulsive behaviour more specifically, is one of stopping; that is, it is a problem stemming from a "relative failure of the systems that normally terminate thoughts, ideas, or actions," (Szechtman & Woody, 2004, p.112). In a recent experimental study, Wahl, Salkovskis, and Cotter (2008) investigated termination criteria in a sample of compulsive hand washers. Broadly consistent with models implicating a "feeling of knowing," they found that the more important the decision to stop the compulsion becomes, and the more likely it is that the individual will rely on subjective criteria (e.g., a feeling) to terminate the compulsion. In a more recent study, Hinds, Woody, Van Ameringen, Schmidt, and Szechtman (2012) examined responses to contamination threat in individuals with OCD as compared to clinical controls. Participants were randomly assigned to "contaminate" their hands with styrofoam beads (lowest threat), dry clean diapers, or wetted diapers (highest threat). After touching the "contaminant", they were invited to complete a fixed hand wash (of 30 seconds at a preset water temperature),

and then a free hand wash (the duration of which was determined by the participant). Biological (respiratory sinus arrhythmia (RSA)), behavioural (wash duration), and subjective (self-reported level of feeling "clean") were evaluated immediately following exposure to contamination cues, following the fixed wash, and following the free wash. Results of the study indicated that although the measured biological markers decreased after the free wash (signalling an end to potential threat), OCD washers continued to report that their hands did not feel "clean". This mismatch between objective measure and subjective sense fits with the notion that individuals with OCD may not "feel right" even after an objectively adequate compulsion has been completed. Furthermore, it is consistent with security motivation system theory (Szechtman & Woody, 2004) in that the security motivated behaviour (washing) failed to terminate thoughts associated with the threat (i.e., of being "contaminated"). The lingering feelings might beckon to the individual to engage in further neutralizing efforts in an attempt to achieve a subjective sense of safety, thus prolonging the ritual.

These new insights regarding the motivational systems and reasoning processes associated with the termination of compulsive rituals can be combined with the growing body of new insights regarding the initiation of compulsions to provide a fresh new perspective on the persistence of OCD, and compulsive checking in particular. Far beyond negative reinforcement, these new ideas suggest an insidious cycle involving low confidence in one's cognitive abilities (i.e., memory, attention, and perception), information processing biases, and counterproductive termination criteria, all of which have the potential to erode certainty and compel the individual to repeat the ritual.

Summary: The pernicious cycle of compulsive checking

The emergent ideas reviewed here might be integrated into the framework provided by Rachman's (2002) theory of compulsive checking to provide an enhanced understanding of the persistence of compulsive checking. As a starting point, we revisit Rachman's model (as stated in his words):

> It is proposed that compulsive checking occurs when individuals who believe that they have a special, elevated responsibility for preventing harm, mainly to others, are unsure that the perceived threat has been reduced or removed. The intensity and duration of this checking is determined by three 'multipliers': increased responsibility, probability of harm and anticipated seriousness of harm. The recurrency of the checking is promoted by a self-perpetuating mechanism, comprising four elements: paradoxical increases in responsibility and in perceived probability of harm, reduced confidence in memory and the absence of a certain end to the threat. (p. 625).

Building on this foundation, we propose the following conceptualization of the obsessive compulsive checking cycle:

> Compulsive checking may be initiated by beliefs related about harm and one's responsibility to prevent it as well as distrust in memory. It may be driven not only by uncertainty regarding whether the harm has been prevented or removed (e.g., *Was the check adequate?*), but also by distrust of one's ability to properly evaluate its effectiveness in the first place (e.g., *Do I have a clear memory of the check? Did I really attend to the important details?*). Furthermore, the intensity and duration of the checking may be determined by perceived responsibility for preventing harm, anticipated seriousness of harm, and estimates of the probability of harm (Rachman, 2002) in

addition to beliefs about one's memorial, attentional, and perceptual capabilities. However, ritual duration may also be influenced by the need for certainty, the desire to attain certain termination criteria, and/or the drive to experience a certain "feeling of knowing," (e.g., Szechtman & Woody, 2004; Wahl et al., 2008).

Compulsive checking may recur in part because of a self-perpetuating mechanism in which the act of checking itself leads to paradoxical increases in responsibility, perceived probability of harm, and reduced confidence in memory (Rachman, 2002). The processes by which the individual arrives at each of these paradoxical outcomes might involve basic information processing factors, such as attentional focus on threat-related aspects (Rachman, 2002; Ashbaugh & Radomsky, 2007).

At present, these ideas are mostly speculative, in part because there have been so few detailed studies of the actual phenomenology of compulsive rituals. To date, research examining the role of cognitive confidence in OCD has been based primarily on studies using retrospective self-report or observations within a contrived paradigm, mostly by participants without OCD. As previously noted, these studies often specify the type, number, and order of actions to be involved in the check, whereas clinical evidence suggests that checking behaviour is likely more variable. Moreover, checking behaviour may vary not only between individuals but also across checks carried out by the same individual. Thus, the question remains: How do the maintenance factors implicated above relate to compulsive behaviour as it occurs naturally? Similarly, research to date has examined the role of information processing, including attentional allocation and its downstream effects using indirect methods. As such, there remain more informative conclusions to be drawn regarding the role of attention in compulsive rituals. A host of questions also remain regarding the termination of compulsive rituals. In many experimental investigations

to date, the instructions given by the experimenter provide guidelines for judging "completeness" of the check and also suggest a termination point for the individual (e.g., when 20 left burner + 10 right burner checks are complete). Outside of the laboratory, these elements are rarely clear for individuals who compulsively check; indeed uncertainty is a key factor in compulsive checking (e.g., Rachman, 2002). We know very little about what evidence individuals will use to assess whether an act has been conducted properly in the absence of such direction. To what extent is feeling-based information desired versus external criteria? According to a number of recent theories of compulsive checking, the number of evidence requirements should increase with each repetition, and the "stop" rules change. Does the information sought change at all across repetitions?

More general phenomenological data is also lacking as there have been very few systematic observations of compulsive behaviour. How long do rituals last? How many repetitions of the act typically occur within one compulsive episode?

Overview of the present research

The purpose of the present dissertation was to gather phenomenological data on compulsions as performed by a clinical sample under ecologically valid conditions. To this end, we undertook a set of two studies in which the cognitive, behavioural, and emotional parameters of compulsions were examined. Both studies utilized samples of community members who have received clinical diagnoses of OCD (in the OCD group) or other anxiety disorders (in the Anxious Control group). Furthermore, the studies incorporated various sources of information, including self-report questionnaire, video observation, eye-tracking technology, and diary entries, thereby providing a rich view of compulsive rituals.

Study One: Examining beliefs, checking behaviour, and attention using a naturalistic stove-checking task

One aim of this work was to examine how confidence in cognitive abilities relates to checking behaviour occurring in 'real time' in a naturalistic setting. A stove checking task was thus designed to be completed by participants in our laboratory kitchen. As the kitchen was intended specifically for studies of this type, it was designed to look and function very much as would a typical home kitchen.

The experimental task involved using a stove to boil a kettle of water. In contrast to previous studies, participants were given little direction on how to check the stove—for example, they were free to look at and/or touch whatever they liked as often as they liked and in any order they liked. They were simply asked to ensure that the stove was 'off' and 'safe' before leaving the kitchen (see Appendix A for script of instructions given to participants). Participants were therefore unconstrained with respect to the number and type of actions they used before leaving the kitchen. Moreover, participants were unconstrained with respect to how long they chose to remain in the kitchen following the task. This design therefore allowed a key behavioural parameter. 'Check Duration'[1] to be evaluated as a dependent variable. Self-report measures administered at baseline, pre-task, and post-task were analyzed with respect to check duration to examine the following research questions:

1. Do individuals with OCD report higher estimates of responsibility for preventing harm, harm severity, and harm likelihood than anxious controls?

[1] Regarding the stove task, participants are instructed to turn off the burner being used to boil the kettle of water once they hear the whistle of the kettle (signifying that the water is boiling). "Check Duration" is calculated as the time between the point at which the participant turns off the burner being used to boil the kettle and the time at which the participant walks out the kitchen door.

2. Will individuals with OCD spend longer checking the stove than will the anxious controls?
3. Do trait factors, such as memory confidence and attentional control affect check duration? If so, do they affect these factors to a different extent in OCD vs. Anxious Control (AC) groups?
4. Are state factors such as estimates of harm and responsibility associated with how long individuals with OCD vs. anxious controls spend checking?
5. Does check duration have an ironic effect on post-check harm, responsibility and certainty that the check was completed properly? Is this more pronounced in individuals with OCD?

It is expected that stronger beliefs about obsessions (e.g., responsibility for preventing harm) and poorer confidence in memory will be associated with longer check duration. It is expected that these relations will be more pronounced in participants with OCD.

This study used portable eyetracking technology to gather some of the first data on what individuals attend to while checking. Importantly, the portable nature of the eyetracker allows it to be used in a variety of settings and the data it gathers speaks to how individuals attend to *tangible, real-world* stimuli, as opposed to the computer-presented stimuli used in research employing fixed eyetrackers. Furthermore, this study was the first to measure idiosyncratic evaluations of threat. A subset of the stimuli surrounding the stove were rated by participants on a 10-point scale from *not at all* to *very* threatening, thereby taking into account individual differences in a way that has not been considered previously. We used this information to examine the following research question:

6. Do individuals with OCD, as compared to controls, show greater proportion of eye fixations on threat-relevant stimuli?

It is expected that participants with OCD, as compared to control participants, will spend a greater proportion of time attending to threat cues. It is hypothesized that this time will be spent attending to both common threat cues (e.g., stove burners, knobs) and idiosyncratic threat cues (e.g., paper towel).

Just as we examined the impact of check duration on later reports of harm, responsibility, certainty and memory for the check, we were interested in how attentional deployment was associated with post-check appraisals, and whether this was more pronounced in the OCD group. We thus asked the following question:

7. Does attentional deployment have an ironic effect on post-check harm, responsibility and certainty that the check was completed properly? Is this more pronounced in individuals with OCD?

Finally, participants also provided information on the criteria they used in deciding they could leave the kitchen, thereby allowing us to categorize checks as 'successful' or 'unsuccessful' and to examine the differences between these. More specifically, we considered the following question:

8. Do successful and unsuccessful and unsuccessful compulsions differ in terms of their behavioural parameters and impact on beliefs?

In summary, the purpose of the first study is threefold:

a. To examine to what extent obsessive compulsive beliefs and cognitive confidence are associated with checking behaviour;

b. to examine if the act of checking has an ironic effect whereby it increases perceptions of responsibility, estimates of harm severity and probability, and worsens undermines certainty; and
c. to investigate the allocation of attention towards threat- versus non-threat stimuli in real time while checking.

Study Two: A diary study of compulsions

In the second study, a diary method was used to gather phenomenological data on compulsions as they occurred naturally in the individual's home over a three day period. Based on the diary developed by Purdon, Rowa and Antony (2005) to assess the suppression of obsessions, the diary required participants to report on one episode of compulsive acts each morning, afternoon and evening for three days, as soon as possible after completion of the episode. The diary asked about both psychological and behavioural aspects of the compulsion. Psychological aspects included the obsession triggering the compulsion, how discomforting it was, the perceived consequences of not completing the compulsion properly, the level of certainty needed to decide that it had been done correctly and the criteria used to determine completeness of the compulsion. Behavioural aspects included a description of the acts involved in the compulsive episode, duration of the episode, and number of repetitions within the episode. The diary also included questions regarding how psychological and behavioural aspects of the compulsion changed over repetitions; how the individual's confidence in memory, perception, and attention changed over repetitions and how the criteria used to decide completeness of the act changed over repetitions.

The objectives of the second study were:

a. To document basic phenomenological data regarding the length and repetitiveness of rituals;
b. to examine how mood and psychological factors vary with greater iterations of a compulsive ritual; and
c. to investigate the criteria involved in ritual termination.

Three research questions follow from these objectives:

1. What is the self-reported frequency and duration of compulsive rituals?

This is an exploratory question. However, diagnostic guidelines (APA, 2000) suggest that a combined daily duration of 60 minutes or more might be expected in a clinical sample.

2. How do psychological factors associated with successful versus unsuccessful compulsions differ?

It is expected that unsuccessful compulsions will be associated with decreased confidence in memory, attention, and perception. It is also expected that unsuccessful compulsions will be associated with less certainty about the adequacy of the compulsion and will be less successful in reducing distress.

3. To what extent are different types of criteria involved in ritual termination?

It is expected that a greater need for certainty will be associated with a greater reliance on subjective, feeling based criteria in deciding when to terminate a ritual.

Study 1 Method

Participants

Participants were 60 individuals (47 females, 13 males) with a mean age of 31 years (SD = 12.9 years). The mean age of female participants was 30.5 years (SD=12.1 years) and the mean age of male participants was 36.5 years (SD = 15.2 years). All participants were recruited through the Anxiety Studies Division (ASD) of the University of Waterloo Centre for Mental Health Research. All participants in the OCD group (*n* = 36, 26 females, 10 males) received a principal diagnosis of OCD using the MINI International Neuropsychiatric Interview for DSM-IVTR administered by interviewers from the ASD, senior graduate students in the UW PhD program in Clinical Psychology. Participants comprising the Anxious Control Group (*n* = 24, 21 females, 3 males) received a principal diagnosis of another anxiety disorder but no co-morbid OCD. Exclusion criteria for both groups were: current diagnosis of substance dependence or psychotic disorder, bipolar disorder, or any changes in psychoactive medication within the 6 weeks prior to the study.

Assessments and Measures

Attention Control Scale. (ACS; Derryberry & Reed, 2002). Attentional control refers to one's general capacity to control attention in relation to positive as well as negative reactions. The scale is comprised of twenty items, rated on a 4-point scale (1= almost never; 4= always). Items load onto a single factor reflecting general capacity to control attention. The ACS is internally consistent and has demonstrated good construct validity using measures of positive and negative emotionality (Derryberry & Reed, 2002).

Memory and Cognitive Confidence Scale. (MACCS; Nedeljkovic & Kyrios, 2007). This measure is designed to capture a range of beliefs about memory and related processes, such

as confidence in decision-making abilities, concentration and attention. Participants provide responses based on a 7-point Likert scale, ranging from 1 (strongly disagree) to 7 (agree very much). The MACCS has demonstrated good internal consistency and adequate validity in initial investigations (Nedeljkovic & Kyrios, 2007).

Obsessive Belief Questionnaire. (OBQ-44; Obsessive-compulsive cognitions working group (OCCWG, 2005)). This is a 44-item self-report scale that measures belief domains linked to OCD. Participants are asked to indicate how much each statement reflects the way they typically look at things, using a 7-point scale, from 1 (disagree very much) to 7 (agree very much). Factor analysis has suggested a three-factor structure of this measure: 1) Responsibility/ Overestimation of Threat, 2) Tolerance for Uncertainty/Perfectionism, and 3) Importance of Thoughts/ Control of Thoughts. Each of the three factors has been found to have good internal consistency (e.g., Tolin, Worhunsky, & Maltby, 2006) and the overall scale has shown good criterion- related validity in non-clinical and clinical samples (OCCWG, 2005).

Positive and Negative Affect Schedule. (PANAS; Watson, Clark, & Tellegen, 1988). This is a measure of current affect. Participants rate 20 adjectives using a five point scale (1 = very slightly or not at all; 5 = extremely) based on how they are feeling in the moment. The PANAS consists of two 10- item scales. Positive affect (PA) reflects the extent to which a person experiences high energy, concentration, and pleasurable engagement. Low PA reflects sadness and lethargy. Negative affect (NA) reflects general distress and un-pleasurable engagement. A variety of negative mood states are associated with high NA, including anger, disgust, fear, and nervousness. Watson et al. (1988) report strong psychometric properties, including strong internal consistency and good construct validity.

Vancouver Obsessional Compulsive Inventory. (VOCI; Thordarson, Radomsky, Rachman, Shafran, Sawchuk, & Hakistan, 2004). This 55-item self- report measure is designed to provide an assessment of a range of obsessions, compulsions, avoidance behaviour, and personality characteristics in obsessive-compulsive disorder (OCD). The scale is comprised of six subscales, each measuring a different symptom type: contamination, checking, obsessions, hoarding, just right, indecisiveness. Participants use a 5- point Likert scale to indicate the extent to which each of the 55 statements is true of them. The VOCI has exhibited good internal consistency, adequate test-retest reliability, as well as acceptable convergent and divergent validity in a student sample (see Thordarson et al., 2004).

Visual Analog Scales- Responsibility and Harm Estimates. Participants provided ratings of perceived responsibility, guilt, probability of harm, and severity of harm both before and after completing the stove-checking task. In addition, after the stove task participants also provided ratings of how certain they were regarding the adequacy of the check as well as how certain they were regarding their memory of the check. A series of 100mm visual analog scales, with anchors *not at all* on the left and *extremely* on the right were used for this purpose (see Appendices B and C).

Apparatus

iViewX™ HED Portable eye-tracker.[2] The eye tracker used in this study was a video-based portable, head-mounted eye-tracking system from SensoMotoric Instruments (SMI) that captures the coordinates of the participant's point-of-gaze and displays that information as a cursor or crosshair superimposed over a video image of the scene. The system consists of a

[2] Originally we had at our disposal a Mobileye Technologies portable eyetracker. However, calibration was very difficult to establish and maintain and we thus acquired this new equipment part way through the study. It was not feasible to merge the data from the old eyetracker (n = 14 participants with OCD, n= 1 AC). Only data collected with the new eye tracker are examined in the study.

lightweight headset incorporating eye-and scene-camera assemblies, a portable control unit, and a notebook computer to record and process the data.

The iViewX™ HED is a dark pupil eye tracking system that uses infrared (IR) illumination. In dark pupil systems, the eye is illuminated by (IR) light at an angle from an IR sensitive camera. The eye and face reflects most of this illumination, but the pupil absorbs IR light and appears as a high contrast area. Image analysis software is able to use this contrast area to locate the center of the pupil and map it to gaze position via an eye-tracking algorithm. Calibrating this system involves instructing the participant to look at a series of known points while the system observes the pupil position at each point. Once a calibration is performed, the pupil location is translated into gaze location data. The present study used a manual, 5-point calibration procedure. A calibration plane with five distinct targets was placed in front of the participant on a flat panel (a sheet of 8 ½"×11" white paper) attached to the range hood above the stove. The five targets were laid out as specified in the SMI Manual. The distance between the participant and the calibration plane was approximately the same distance as that between participants and objects (e.g., stove knobs, objects around the stove) during the experiment. During the calibration process, the experimenter examined the participant's eye image and confirmed the fixation of each calibration point by pressing a keyboard button. Once successful calibration was achieved, the experimenter initiated the live video recording with gaze cursor overlay.

SMI BeGaze Version 2.5 Eye Tracking Analysis Software. This software was utilized to extract data on the number of fixations and fixation durations for each participant. Consistent with guidelines provided by SMI, fixations ≥ 80 msec in duration were retained as data points. Once fixations ≥ 80 msec were retained, the experimenter used the *BeGaze* program to manually

code the location of the registered fixations. Because *BeGaze* software is fully integrated with the *iViewX HED system,* the experimenter was able to determine the location of each fixation by viewing the position of the gaze cursor overlay on the participant's scene video. Thus, the experimenter examined each registered fixation and coded the location of the gaze cursor. This process resulted in output that included the location of fixations (in sequence), along with the corresponding fixation duration for each fixation point. Fixations on identical locations were then summed by the experimenter in order to provide the total number of fixations on a particular item. Similarly, fixation durations were summed for identical items, thus allowing the experimenter to derive a measure of the total fixation duration for any given item/location in the kitchen.

Video recording equipment. Participants' actions were recorded using a pinhole camera mounted in the range hood above the stove. A wide-angle lens was used in order to provide a view of the stove and the surrounding area, including the counters to each side and the area behind the participant. High resolution video was transmitted in real time to a computer in the lab room adjacent to the kitchen where it was recorded directly to the hard disk using Dazzle DVD Recorder from Pinnacle Technologies.

Kitchen. The Purdon laboratory includes a realistic kitchenette equipped with a double sink, small fridge, cupboards, bistro table and chairs, and an electric four-burner stove with a range hood. It is decorated to look and feel like a typical family kitchen.

Procedure

Participants were seated in a room two doors down from the lab kitchen and were informed that they would be asked to complete questionnaires at different time-points and to

conduct a task involving a working stove. Participants reviewed a copy of the Information Consent Letter for the study and were given the opportunity to ask any questions they had regarding the study. Participants then provided written consent both to participation in the study and to the videotaping aspect of the study in particular, in accordance with the requirements set out by the University of Waterloo Office of Research Ethics. They were then administered the PANAS followed by the following measures (in randomised order): ACS, MACCS, OBQ-44, and VOCI.

Upon completion of the questionnaire package, participants were taken into the kitchen and given a brief overview of the stove-checking task (see Appendix A). The task required participants to wait until a kettle containing a pre-measured amount of water came to a boil, (indicated by its whistle), at which time they were to remove the kettle, place it on a trivet beside the stove, turn off the stove, place a pot of dry rice on the burner used to boil the water, remove the eye tracker and leave the kitchen (closing the door behind them), to join the researcher waiting behind a closed door two doors down. The instructions were intended to orient the participant to the fact that the stove is a real working stove with all the associated potential for harm, and that the researcher would not be present to monitor or intervene.

Participants then completed the PANAS (pre-task mood) and provided pre- task VAS ratings for responsibility, guilt, harm likelihood, and harm severity resulting from failing to ensure the stove was turned off at the end (see VAS T1 scales in Appendix B). The participant was then fitted with the portable eye tracker and the eye tracker was calibrated by having the participant hold their gaze on each point of a five- point calibration plane (as described above). Once the eye-tracker was fitted and calibrated, the experimenter demonstrated the use of stove, reviewed the instructions for the task and left the kitchen to allow the participant to begin the

task. It should be noted that prior to the beginning of the task, the kettle was filled by the experimenter with the same amount of water for each participant and that all participants were instructed to use the same burner (right rear burner) to boil the kettle.

As per instructions, upon finishing the stove task participants removed the portable eye tracker, left the kitchen (closing the door behind them) and joined the researcher back in the original interview room two doors down from the kitchen. They were then re-administered the PANAS and provided post- task VAS ratings for responsibility, guilt, harm likelihood, and harm severity (see T2 VAS scales in Appendix B). Additional VAS ratings for overall certainty of the adequacy of the check, as well as certainty about memory, attention, and perception were also provided at this time point (see Appendix B). Finally, participants were shown photos of the items surrounding the stove (e.g., paper towel, wooden spoons, metal canister), and provided ratings of the level of threat they felt was associated with having the item near the stove. These ratings formed the basis of analyses examining attention to idiosyncratic threat objects, as described below.

Results

Data Preparation

Data for each specific variable of interest were cleaned and examined for extreme values. Potential outliers were identified through a screening of residuals (i.e., *z* scores) for each variable of interest. A case was considered extreme if the *z* score was ≥ 3 and if the value was discontinuous with the distribution. Variables identified as meeting these two criteria were adjusted to the next highest or lowest value, depending on whether the original response was identified as an extreme high or an extreme low response.

Preliminary Analyses

Participant Characteristics. The sample was comprised of individuals recruited from the community with a principal or secondary diagnosis of OCD (OCD group) or a diagnosis of an anxiety disorder other than OCD with no comorbid OCD (AC group). Table 1 presents a summary of the diagnostic characteristics of the OCD and AC groups.

Selection of OCD checkers and AC non-checkers. Many of the ideas reviewed in the present study pertain to OCD in general, but are perhaps especially relevant for compulsive checking. However, five (14%) participants in the OCD sample did not report clinically significant checking and six (25%) participants in the AC sample did report clinically significant checking. We decided that including such participants would make it difficult to apply our findings to understanding perseverative checking behaviour in OCD. As such, we restricted our analyses to the subset of those individuals in the OCD sample who had clinically significant scores on the checking subscale of the VOCI and those in the AC group who did not have clinically significant scores, based on established clinical norms reported for the VOCI (see Thordarson et al., 2004). Participants whose VOCI scores fell above 0.5 standard deviations of the clinical mean were included in the OCD sample (n = 31) and those below were excluded (n = 5), with the reverse being the case for the AC sample (n = 18 and 6, respectively).

Descriptive Statistics. The means and standard deviations for the self-report measures across groups are presented in Table 2. Using independent sample t tests, found significant differences between the OCD and AC groups in terms of checking symptoms and overall OCD symptom severity (as measured by the VOCI Total Score). In addition, there were significant differences between groups in general level of obsessional beliefs (as measured by the OBQ-44)

and obsessive-compulsive symptoms more generally (as measured by the VOCI). There were no significant between- group differences in confidence in general memory or attention (as measured by the MACCS and ACS).

Research Question 1: Do individuals with OCD report higher harm and responsibility estimates?

Responsibility and Harm Estimates. The first research question was whether individuals with OCD would report greater estimates of responsibility for harm, harm severity, and harm likelihood, and greater, than anxious controls. Furthermore, we were interested in whether these estimates resolved following the checking task to the same extent in both groups. We thus examined within-participant changes in responsibility across two time points of interest: T1 (pre-task) and T2 (post-task). First, examining changes in responsibility, a MANOVA with Group as the independent factor was conducted on T1 and T2 Responsibility Composite Scores[3]. There was a main effect of time whereby responsibility estimates decreased significantly from pre- to post-task, F (1, 45) = 21.11, $p < .001$. However, there was no main effect of Group, nor was there a significant Time × Group interaction, suggesting that the groups did not differ in the extent to which their estimates of responsibility changed across the study, F (1, 45) = 2.03, $p > .100$. We were similarly interested in examining changes in harm estimates across the two time points of interest: T1 (pre-task) and T2 (post-task). A separate MANOVA with Group as the independent factor was conducted on T1 and T2 Harm Composite Scores[4]. There was a main effect of time F (1, 44) = 52.85, $p < .001$, suggesting that estimates of harm decreased from pre- to post-task. There was no main effect of Group, nor was there a Time × Group interaction,

[3] Responsibility Composite Scores were computed as the sum of VAS Responsibility and VAS Guilt Ratings.
[4] Harm Composite Scores were computed as the sum of VAS Harm Severity and VAS Harm Likelihood Ratings.

suggesting that the two groups did not differ in the degree of change in harm estimates experienced across the study F (1, 44) = 1.40, $p > .20$.

Research Question 2: Do individuals with OCD check longer?

Check Duration. *Check duration* was defined as the time between the moment when the participant turned off the burner used to boil the kettle and the moment the participant exited the kitchen. An independent-samples *t*-test of check duration was conducted, revealing a significant difference such that OCD participants checked longer (M = 218.6 s, SD = 204.5 s) than did the AC participants (M = 104.2 s, SD = 73.3 s), t (1, 45) = 2.74, $p = .009$.

Research Question 3: Are trait factors of memory confidence and attention control associated with check duration?

We hypothesized that confidence in memory and attention would predict check duration, and that this association would be greater in the OCD group. To test this hypothesis, a hierarchical regression analysis was conducted on check duration with Group (Step 1), MACCS-General Memory subscale and ACS (Step 2), and the interaction terms for Group with MACCS-General Memory subscale and Group with ACS (Step 3). Results are summarized in Table 4. Consistent with our analyses showing that there were differences in check duration between the OCD and AC groups, entry of Group on the first step resulted in a significant R^2_{change} of .11, F (1, 44) = 5.48, $p = .024$. Entry of MACCS-General Memory and ACS on the second step yielded an R^2_{change} of .011, which was not significant, F (1, 42) = .266, $p = .768$. The third step, in which the interactions of Group × MACCS- General Memory and Group × ACS were entered, did not yield a significant change in the amount of explained variance in Check Duration: R^2_{change}= .002 F (1, 40) = .039, $p = .962$.

Research Question 4: Are estimates of harm and responsibility associated with check duration?

To address this question, we examined the extent to which responsibility and harm estimates were associated with check duration in the OCD and AC groups. We hypothesized that check duration would be predicted by pre-task ratings of responsibility to prevent harm as well as one's estimates of harm (likelihood, severity) and that this relation would be stronger in the OCD group. To test this hypothesis, a hierarchical regression analysis was conducted on Check Duration, with Group (Step 1), VAS T1 Responsibility Composite and VAS T1 Harm Composite (Step 2), and the interaction terms for Group with VAS T1 Responsibility and Group with VAS T1 Harm (Step 3). Results are summarized in Table 5. Entry of Group on the first step resulted in a significant R^2_{change} of .11, F (1, 44) = 5.51, p = .023, indicating that individuals with OCD spent longer checking as compared to the AC participants. Entry of T1 Responsibility and T1 Harm Composite Scores on the second step yielded an R^2_{change} of .020, which was not significant, F (1, 42) = .490, p = .616. The third step, in which the interactions of Group × T1 Responsibility and Group × T1 Harm were added, did not yield a significant change in the amount of explained variance in Check Duration: R^2_{change}= .004 F (1, 40) = .088, p = .916.

Research Question 5: Does check duration have an ironic effect on post-check responsibility, harm estimates, and certainty that the check was completed properly? Is this more pronounced in individuals with OCD?

To address this question we conducted a series of hierarchical regression analyses on post- T2 (post- task) Responsibility estimates, T2 (post- task) Harm estimates, and T2 (post-task) Certainty.

Responsibility. To examine whether check duration predicted subsequent (post-task) ratings of responsibility across groups, we conducted a hierarchical regression analysis on T2 Responsibility, with Group and T1 Responsibility (Step 1), check duration (Step 2), and the interaction term for Group with check duration (Step 3). Results are summarized in Table 6. Entry of group and T1 Responsibility on the first step resulted in a significant R^2_{change} of .277, F (2, 43) = 8.24, p = .001. Examining the partial correlations for the variables entered on the first step revealed that higher T1 Responsibility estimates were associated with higher T2 Responsibility estimates, b = .483, p = .001. There was no significant main effect of Group, b = -.154, p = .252

Entry of check duration on the second step yielded an R^2_{change} of .019, which was not significant, F (1, 42) = 1.13, p = .293. The third step, in which the interaction of Group × Check Duration was entered, did not yield a significant change in the amount of explained variance in T2 Responsibility ratings: R^2_{change}= .031, F (1, 41) = .031, p = .180. These results would suggest that the length of time spent checking did not have a significant impact on subsequent (i.e., post-task) ratings of responsibility for preventing harm.

Harm Estimates. In order to examine the effect of Check Duration on subsequent (post-task) estimates of harm, we conducted a hierarchical regression analysis on T2 Harm, with Group and T1 Harm (Step 1), Check Duration (Step 2), and the interaction term for Group with Check Duration (Step 3). Results are summarized in Table 7. Entry of Group and T1 Harm on the first step resulted in a significant R^2_{change} of .183, F (2, 42) = 4.71, p = .014. Examining the partial correlations for the variables entered on the first step revealed that higher T1 Harm estimates were associated with higher T2 Harm estimates, b = .435, p = .005. There was no main effect of Group, b = .023, p = .875. Entry of Check Duration on the second step yielded an

R^2_{change} of .083, which was significant, F (1, 41)= 4.66, p = .037, indicating that longer check duration was associated with greater post-task estimates of harm, controlling for pre-task estimates of harm. The third step, adding in the interaction of Group × Check Duration, did not yield a significant change in the amount of explained variance in T2 Harm estimates: R^2_{change}= .017, F (1, 40) = .933, p = .340.

Certainty. We regressed Check Duration on T2 Certainty ratings, with Group (Step 1), Check Time (Step 2), and the Group × Check Duration interaction term (Step 3). Results are summarized in Table 8. Group accounted for a change in R^2 of .004, which was not significant, F (1, 43) = .170, p = .682. The entry of Check Duration on the second step yielded a significant change in R^2= .165, F (1, 42) = 8.35 , p = .006, such that greater time spent checking was associated with less post-check certainty about having had completed the check properly. The Group × Check Duration interaction term was not significant, R^2_{change}= .000, F (1, 41) = .000, p = .996.

Memory. We examined the relation between check duration and post-task ratings of memory confidence (i.e., T2 Memory VAS ratings) using hierarchical regression. This analysis did not yield any significant effects (see Table 9).

Research Question 6: Do individuals with OCD show greater proportion of eye fixations on threat-relevant stimuli as compared to AC participants?

To examine this question, the eyetracking data were processed to create the following composite dependent variables: *Stove Fixations* = fixations on burners, fixations on knobs, and fixations on stove indicator lights; *Threat Fixations* = fixations on matches, fixations on

coupons, fixations on wooden spoons, and fixations on paper towel; and *Idiosyncratic High Threat Fixations* = fixations on items rated by participants as 7 or higher on a 10- point scale. The items comprising the *Idiosyncratic High Threat Fixations* composite scores differed with each individual (hence the idiosyncratic distinction). In order to account for the fact that participants varied in the number of overall fixations they made, the aforementioned variables were calculated as proportions, using total number of fixations or total fixation duration as the denominator.

In the present study fixations could also be categorized according to the period of time during which they occurred. More specifically, in analyses examining fixations across time, we made use of the following two time periods: *Pre-Check* = the period of time when the kettle was boiling, and *Check* = the period of time after the kettle had boiled up until the participant removed the eye tracker (just before leaving the kitchen).

As mentioned previously, eyetracking data were only available for a subset of the total sample of participants who completed the study. Of those who completed the stove task with the new eye tracker, five in the OCD group and two in the AC group still produced data that was unusable due to calibration failure during the task itself, most commonly because they bumped the eyetracking apparatus, throwing off the calibration. The final sample of participants with viable eye tracking data consisted of n=17 individuals with OCD and n = 14 individuals in the AC group. Please see Table 3 for a summary of the final sample contributing to our eyetracking analyses.

First, we were interested in whether attentional deployment during the pre-check phase was different than during the check phase. To this end, we conducted a 2 (Group: OCD vs AC)

×2 (Time: Pre-check vs. Check) Mixed ANOVA on *Stove Fixations*. There was a main effect of time, F (1, 28) = 14.49, p = .001, such that there was an overall increase in the proportion of time spent looking at the stove from *Pre-Check* (M =.145, SD = .062) to *Check* (M = .304, SD = .217). The main effect of Group and the Group × Time interaction were not significant. Second, we examined fixations on individual threat items surrounding the stove, namely *Threat Fixations,* as defined above. We therefore conducted a 2 (Group) ×2 (Time) Mixed ANOVA on *Threat Fixations*. There was a main effect of Time F (1, 28) = 9.30, p =.005, such that there was an overall decrease in the proportion of time spent looking at the threat items from *Pre-Check* (M = .130, SD = .126) to *Check* (M = .046, SD = .080). There was also a main effect of Group, F (1, 28) = 5.22, p = .03, such that individuals in the AC group spent a greater proportion of their time looking at threat items than did the OCD group, both during the *Pre-Check* (M = .150, SD = .147 for AC versus M = .115, SD = .109 for OCD) and during the *Check* (M = .095, SD = .103 for AC versus M = .009, SD = .013 for OCD). The Group × Time interaction was not significant. Finally, we examined *Idiosyncratic High Threat* fixations, using a 2 (Group) ×2 (Time) Mixed ANOVA. Results indicated a trend towards a main effect of Time F (1, 30) = 2.89, p = .099, such that there was trend towards an overall decrease in the amount of time spent looking at the idiosyncratic threat items from *Pre-Check* (M = .026, SD = .047) to *Check* (M = .012, SD = .025). The effect of Group and the Group × Time interaction were not significant.

Research Question 7: Does attentional deployment have an effect on post-check harm, responsibility, memory, and certainty that the check was completed properly? Is this more pronounced in individuals with OCD?

The same approach used to address research question 5, which examined the impact of check duration on post-check appraisal, was used to address this question. A series of

hierarchical regression analyses predicting T2 Responsibility estimates, T2 Harm estimates, T2 Memory ratings and T2 Certainty from attentional focus were conducted. The results of these analyses are presented in the sections that follow.

Responsibility Estimates.

Stove Fixations. We conducted a hierarchical regression on T2 Responsibility, with Group and T1 Responsibility (Step 1), duration of *Stove Fixations* during the *Pre-Check* (Step 2), and the interaction term for Group with duration of *Pre-Check Stove Fixations* (Step 3). Results are summarized in Table 10. Entry of Group and T1 Responsibility on the first step resulted in a significant R^2_{change}=.256, F (1, 28) = 4.81, p = .016. Examining the partial correlations for the variables entered on the first step revealed that higher T1 Responsibility estimates were associated with higher T2 Responsibility estimates, b = .504, p = .005. There was no effect of Group, b = .013, p = 939. Neither the main effect of *Pre-check Stove Fixations*, nor the Group × *Pre-check Stove Fixations* were significant.

Regarding predicting T2 Responsibility from *Stove Fixations* during the *Check* phase, we conducted a hierarchical regression, with variables entered as above, except with *Check Stove Fixations*. Results are summarized in Table 11. There was a significant main effect of Group, R^2_{change}=.297, F (1, 26) = 5.49, p = .010, and a significant Group × *Check Stove Fixations* interaction, R^2_{change}=.118, F (1, 24) = 5.14, p = .033. The interaction is depicted in Figure A. Whereas post-check responsibility did not vary according to the proportion of stove fixations for the OCD group (b = -.096, p < .678), a greater proportion of stove fixations was associated with higher responsibility for harm in the AC group (b=.540, p < .05). In summary, greater time spent fixating on the stove after the kettle had finished boiling was ironically associated with greater

post-check responsibility; however, this relation was only seen in the Anxious Control/ Low Checker group of participants.

Threat Fixations. We examined the relation between *Threat Fixations* and post-task ratings of responsibility using two separate hierarchical regression analyses. The first, examining T2 Responsibility and *Threat Fixations* during the *Pre-Check* phase, did not yield any significant effects (see Table 12). Similarly, examining T2 Responsibility and *High Threat Fixations* during the *Check* phase did not yield any significant effects (see Table 13).

Idiosyncratic High Threat Fixations. Finally, we examined the relation between attention to idiosyncratic high threat items (*Idiosyncratic High Threat Fixations*) and post-task ratings of responsibility using two separate hierarchical regression analyses. The first, examining T2 Responsibility and *Idiosyncratic High Threat Fixations* during the *Pre-Check* phase, did not yield any significant effects (see Table 14). Similarly, examining T2 Responsibility and *Idiosyncratic High Threat Fixations* during the *Check* phase did not yield any significant effects (see Table 15).

Harm Estimates.

Stove Fixations. We conducted a hierarchical regression on T2 Harm composite scores, with Group and T1 Harm (Step 1), duration of *Stove Fixations* during the *Pre-Check* (Step 2), and the interaction term for Group with duration of *Pre-Check Stove Fixations* (Step 3). This analysis did not yield any significant effects (see Table 16).

We conducted a hierarchical regression on T2 Harm composite scores, with Group and T1 Harm (Step 1), duration of *Stove Fixations* during the *Check* (Step 2), and the interaction term for Group with duration of *Check Stove Fixations* (Step 3). Results are summarized in Table 17.

Neither the main effect of Group nor the main effect of *Check Stove Fixations* was significant, R^2_{change}=.178, *F* (2,25)= 2.70, *p*=.087; R^2_{change}=.068, *F* (1,24)= 2.17, *p*=.153, respectively. However, the Group × *Check Stove Fixations* interaction was significant, R^2_{change}=.171, *F* (1,23)= 6.74, *p*=.016. The interaction is depicted in Figure B. To examine the nature of the interaction, separate regression analyses were conducted on each group. Results indicated that for individuals in the OCD high checking group, post-check harm estimates remained relatively constant, regardless of whether stove fixations were high (1SD above mean level of *Check Stove Fixations*) or low (1 SD below the mean level of *Check Stove Fixations*), *b*=.011, *p*=.967. In contrast, individuals in the AC low checking group reported a greater sense of post-check harm when *Check Stove Fixations* were high versus low (i.e., when they spent a good portion of the pre-check phase looking at the stove), *b*=.666, *p*<.05. These results suggest that greater time spent fixating on the stove after the kettle had finished boiling was associated with greater post-check harm estimates; however, this relation was only seen in the Anxious Control/ Low Checker group of participants.

Threat Fixations. We examined the relation between *Threat Fixations* and post-task ratings of harm using two separate hierarchical regression analyses. The first, examining T2 Harm estimates and *Threat Fixations* during the *Pre-Check* phase, did not yield any significant effects (see Table 18). Similarly, examining T2 Harm estimates and *Threat Fixations* during the *Check* phase did not yield any significant effects (see Table 19).

Idiosyncratic High Threat Fixations. We examined the relation between attention to idiosyncratic high threat items (*Idiosyncratic High Threat Fixations*) and post-task ratings of T2 Harm using two separate hierarchical regression analyses. The analysis of the *Pre-Check* phase did not yield any significant effects (see Table 20). Similarly, the second regression analysis,

examining *Idiosyncratic High Threat Fixations* during the *Check*, did not yield any significant effects (see Table 21).

Memory.

Stove Fixations. We conducted a hierarchical regression on T2 Memory ratings, with Group (Step 1), duration of *Stove Fixations* during the *Pre-check* (Step 2), and the interaction term for Group with duration of *Pre-Check Stove Fixations* (Step 3). Results are summarized in Table 22. There was a trend towards a significant main effect of *Pre-check Stove Fixations*, R^2_{change}=.124, *F* (1,27)= 3.88, *p*=.059, suggesting that a greater proportion of fixations on the stove (during the period of time when the kettle was boiling) was associated with less confidence in memory following the stove task, *b*=-.303, *p*=.196. Neither the main effect of Group, nor the Group × *Pre-check Stove Fixations* interaction were significant, R^2_{change}=.011, *F*(1,28)= .300, *p*=.589; R^2_{change}=.124, *F* (1,26)= .162, *p*=.691, respectively.

We then predicted T2 Memory from *Stove Fixations* during the *Check* phase using a hierarchical regression, with variables entered as above, except with *Check Stove Fixations* in place of *Pre-Check Stove Fixations*. Results are summarized in Table 23. The main effect of Group was not significant, *F* (1,27)= .193, *p*=.664, nor was the main effect of *Check Stove Fixations, F* (1,26)= 1.32, *p*=.261. However, there was a significant Group × *Check Stove Fixations* interaction, R^2_{change}=.258, *F* (1,25)= 9.41, *p*=.005. The interaction is depicted in Figure C. To examine the nature of the interaction, separate regression analyses were conducted on each group. Results indicated that for individuals in the OCD high checking group, post-check memory remained relatively constant, regardless of whether stove fixations were high (1SD above mean level of *Check Stove Fixations*) or low (1 SD below the mean level of *Check Stove*

Fixations), b=.199, p=.461. In contrast, individuals in the AC low checking group reported less confidence in their memory when *Check Stove Fixations* were high versus low (i.e., when they spent a good portion of the check phase looking at the stove), b=-.652, p<.05. In summary, greater time spent fixating on the stove after the kettle had finished boiling was ironically associated with less post-check confidence in memory; however, this relation was only seen in the Anxious Control/ Low Checker group of participants.

Threat Fixations. We examined the relation between *Threat Fixations* and post-task ratings of memory confidence (i.e., T2 Memory) using two separate hierarchical regression analyses. The first, examining *Threat Fixations* during the *Pre-Check* phase, did not yield any significant effects (see Table 24). Similarly, examining *Threat Fixations* during the *Check* phase did not yield any significant effects (see Table 25).

Idiosyncratic High Threat Fixations. We examined the relation between *Idiosyncratic High Threat Fixations* and post-task ratings of memory confidence using two separate hierarchical regression analyses. The first, examining *Idiosyncratic High Threat Fixations* during the *Pre-Check* phase, did not yield any significant effects (see Table 26). Similarly, examining *Idiosyncratic High Threat Fixations* during the *Check* phase did not yield any significant effects (see Table 27).

Certainty.

Stove Fixations. We conducted a hierarchical regression on T2 VAS Certainty Composite ratings, with Group (Step 1), duration of *Stove Fixations* during the *Pre-check* (Step 2), and the interaction term for Group with duration of *Pre-Check Stove Fixations* (Step 3). Results are summarized in Table 28. Entry of Group on the first step resulted in an R^2_{change} of

.053, which was not significant F (1,28) = 1.56, p = .222. Entering *Pre-check Stove Fixations* on the second step yielded an R^2_{change} of .111, which was marginally significant, F (1,27) = 3.58, p= .069. The third step, accounting for the interaction of Group × *Pre-check Stove Fixations* yielded a significant change in the amount of explained variance in post-task Certainty estimates: R^2_{change}= .189, F (1,26) = 7.61, p = .010. This interaction is depicted in Figure D. For individuals in the OCD high checking group, post-check certainty remained relatively constant, regardless of whether stove fixations were high (1SD above mean level of *Pre-Check Stove Fixations*) or low (1 SD below the mean level of *Pre-Check Stove Fixations*), b = -.021, p = .937. In contrast, individuals in the AC low checking group experienced less post-check certainty when *Pre-Check Stove Fixations* were high versus low (i.e., when they spent a good portion of the pre-check phase looking at the stove), b = -.676, p<.05. In summary, greater time spent fixating on the stove while the kettle was boiling was ironically associated with less post-check certainty about having completed the check properly/ having averted harm; however, this relation was only seen in the Anxious Control/ Low Checker group of participants.

We proceeded to conduct the same analyses for the *Check* period of time. We began with a hierarchical regression on T2 VAS Certainty Composite ratings, with Group (Step 1), duration of *Stove Fixations* during the *Check* (Step 2), and the interaction term for Group with duration of *Check Stove Fixations* (Step 3). Results are summarized in Table 29. Entry of Group on the first step resulted in an R^2_{change} of .067, which was not significant F (1,27)= 1.93, p=.176. Entering *Check Stove Fixations* on the second step yielded an R^2_{change} of .117, which was marginally significant, F (1,26)= 3.74, p=.064. The third step, accounting for the interaction of Group × *Check Stove Fixations* yielded a significant change in the amount of explained variance in post-task Certainty estimates: R^2_{change}= .309, F(1,25)= 15.26, p=.001. A graphical depiction of this

interaction is presented in Figure E. For individuals in the OCD high checking group, post-check certainty remained relatively constant, regardless of whether they stove fixations were high (1SD above mean level of *Check Stove Fixations*) or low (1 SD below the mean level of *Check Stove Fixations*), b=-.01, p=.970. In contrast, individuals in the AC low checking group experienced less post-check certainty when *Check Stove Fixations* were high versus low (i.e., when they spent a good portion of the check phase looking at the stove), b=-.816, p=.001. In summary, greater time spent fixating on the stove after the kettle had boiled was ironically associated with less post-check certainty about having completed the check properly/ having averted harm; however, this relation was again only seen in the Anxious Control/ Low Checker group of participants.

Threat Fixations. We examined the effect of attention to threat during the *Pre-Check* period of time on later certainty using a hierarchical regression on T2 Certainty Composite ratings, with Group (Step 1), duration of *Threat Fixations* during the *Pre-check* (Step 2), and the interaction term for Group with duration of *Threat Fixations* (Step 3). Results are summarized in Table 30. Entry of Group on the first step resulted in an R^2_{change} of .053, which was not significant F (1,26)= 1.46, p=.237. Entering *Pre-check Threat Fixations* on the second step yielded an R^2_{change} of .039, which was not significant, F (1,25) = 1.07, p =.310. The third step, accounting for the interaction of Group × *Pre-check Threat Fixations* did not yield a significant change in the amount of explained variance in post-task Certainty estimates: R^2_{change}= .006, F (1,24) = .173, p =.682.

Lastly, we examined the effect of attention to *Threat* items during the *Check* on later ratings of certainty, using a hierarchical regression on T2 Certainty Composite ratings, with Group (Step 1), duration of *Threat Fixations* during the *Check* (Step 2), and the interaction term

for Group with duration of *Check Threat Fixations* (Step 3). Results are summarized in Table 31. Entry of Group on the first step resulted in an R^2_{change} of .067, which was not significant F (1,27)= 1.93, p=.176. Entering *Check Threat Fixations* on the second step yielded an R^2_{change} of .038, which was not significant, F (1,26)= 1.11, p=.301. The third step, accounting for the interaction of Group × *Check Threat Fixations* did not yield a significant change in the amount of explained variance in post-task Certainty estimates: R^2_{change}= .055, F (1,25)= 1.63, p=.213.

Idiosyncratic High Threat Fixations. We examined the relation between *Idiosyncratic High Threat Fixations* and post-task ratings of certainty using two separate hierarchical regression analyses. The first, examining *Idiosyncratic High Threat Fixations* during the *Pre-Check* phase, did not yield any significant effects (see Table 32). Similarly, examining *Idiosyncratic High Threat Fixations* during the *Check* phase did not yield any significant effects (see Table 33).

Research Question 8: Do successful and unsuccessful and unsuccessful compulsions differ in terms of their behavioural parameters and impact on beliefs?

We were interested in examining the proportion of participants who were able to achieve a sense of certainty while checking the stove after it had been used. Participants who were categorized as having achieved certainty were those who ranked one of the following three options as the main reason they stopped: *Felt completely certain it was okay to stop; Felt certain enough that it was okay to stop*, or *Knew in my head that it was okay to stop (even if I didn't feel it).* Participants were considered having terminated the check without certainty if they ranked any other reason as the primary reason for having ended the task. To examine whether there were differences between groups in the proportion of participants who were able to achieve a sense of

certainty before leaving the kitchen, we computed the mean number of "successful" compulsions for the OCD and AC groups and performed an independent samples *t* test on the results. Results revealed no significant differences between groups, t (1,27)=-1.86, p=.08), with roughly eighty percent of the participants in the OCD group and all of the participants in the AC group achieving certainty (81.25% and 100% respectively). There were also no significant differences in the number of termination criteria used between the two groups t (1,25)=1.29, p=.208), with an average of 4.5 criteria cited by the OCD group (SD=2.23) and 3.3 criteria cited by the AC group (SD= 2.21).

Because there were a small number of "unsuccessful" compulsions, we were not able to conduct analyses pertaining to our final research question concerning whether successful and unsuccessful compulsions differ in terms of their behavioural parameters and impact on beliefs. However, this question is addressed in the second study through an analysis of participants' diary records.

Study 1 Discussion

In the first study, we examined how beliefs about responsibility, harm estimates, and confidence in cognitive abilities (especially memory) were related to behavioural parameters of checking using a naturalistic laboratory task. One of the main areas considered in the first study was to what extent the cognitive biases implicated in cognitive models of OCD related to behavioural parameters of checking, namely check duration and attentional deployment during the check.

Responsibility estimates are said to be key to both the initiation of the checking cycle and to its persistence (Rachman, 2002). Within the present study, we found no evidence that there were significant differences in the amount of responsibility reported by OCD versus anxious control individuals. Indeed, it seemed that under the conditions created in the laboratory setting, participants generally considered themselves to be in a position of responsibility for the outcome of the task at hand, with mean pre-check ratings of responsibility being near ceiling on the composite Responsibility VAS scale (M= 180.96, SD= 20.03). Although responsibility ratings decreased across time (i.e., from pre- to post-task), they did so equally across groups. This is broadly consistent with the idea that most everyone perceives responsibility to be high in certain situations.

Similarly, there were no group differences in the severity or likelihood of harm participants associated with the task included in the present study, and although there was a general decrease in harm estimates across the study (i.e., from pre- to post-task), there were no differences in the degree to which OCD versus AC control participants' ratings changed. Thus, in consideration of Research Question 1— Do individuals with OCD report greater harm and responsibility estimates?—the answer seems to be no, at least with respect to the current paradigm.

We did however find a difference in the behavioural response of OCD versus AC participants as they completed the stove task. Specifically, we found significant differences in the length of time it took OCD versus AC participants to leave the kitchen after having used the stove. Recall that the task involved boiling a kettle of water before turning off the burner and leaving the kitchen (when one decides to do so). Recall also that the amount of water in the kettle was pre-set by the experimenter and was thus equal across groups of participants; the amount of time it took to boil the kettle was then also equal across the groups. Despite this, individuals with OCD took significantly longer to leave the kitchen after they had finished boiling the kettle and had turned off the stove. This difference is consistent with our understanding of checking behaviour associated with OCD as being time consuming and interfering (APA, 2000).

The crux of this study lay in its examination of the links between various OCD relevant beliefs and behavioural indices (namely check duration and attentional deployment). We began this line of inquiry by examining the relation between trait level factors and checking behaviour. Following emergent literature, we considered whether cognitive distrust (i.e., distrust in memory and attention) related to checking behaviour. More specifically, examining the question of whether trait factors of memory confidence and attention control are associated with check duration, we found no evidence of this being the case with respect to our study.

We also examined our data for links between an inflated sense of responsibility for preventing harm and the behavioural index of check duration. Contrary to our hypothesis, we found no evidence that higher estimates of responsibility led to longer checks. Nor did we find evidence that a longer time spent checking in the kitchen had an impact on ratings of responsibility following the task. However, our analysis of harm estimates with respect to check duration revealed an interesting pattern. Much like the case for responsibility, we did not find

evidence that higher estimates of harm led to a longer time spent in the kitchen, but there was a relation between check duration and post-task estimates of harm. In line with our hypotheses, individuals who spent longer in the kitchen after the kettle had boiled also perceived that a higher likelihood and degree of potential harm remained after they had left the kitchen. This was true of all participants, as there were no group differences in how the length of time spent checking impacted post-task harm estimates. Furthermore, the relation between the amount of time spent in the kitchen and later estimates of harm remained significant after taking into account (i.e., controlling for) T1 (pre-task) estimates of harm. Also in line with our hypotheses about the ironic effects of checking on subsequent beliefs, our data suggested that individuals who spent longer in the kitchen tended to report less post-task certainty about having completed the check properly/ having ensured that the stove was off.

In summary, when we examined the link between beliefs and the behavioural index of check duration, we did not find evidence that stronger beliefs necessarily preceded longer checks. However, we did find some instances where the length of the check had an ironic effect on subsequent beliefs, namely perceived harm and a general sense of certainty about having completed the check properly. This is broadly consistent with Rachman's (2002) model, which implicates beliefs about harm in the initiation and persistence of checking behaviour. In contrast, we did not find evidence of ironic effects on responsibility or memory, even though these are also essential elements of Rachman's model. Why might this have been the case? Of the four belief domains assessed (responsibility, harm, memory confidence, certainty), it is possible to imagine responsibility and memory confidence being conceptualized as more "trait like" constructs in that they have links to a broader set of experiences and situations beyond that facing participants in the experimental session. Thus, participants' ratings of responsibility and

memory may not have been uniquely related to the task at hand. In contrast, estimates of harm and certainty may have been more easily attached to the task at hand and participants' ratings of these constructs may have been less impacted by participants' general beliefs.

It should also be noted that it is difficult to ensure that participants fully adopt a sense of responsibility while in a laboratory setting. Although the experimenter made efforts to highlight each participant's responsibility to ensure the safety of the stove (primarily through the instructions provided and through the experimenter not being physically present during the stove task), there were undoubtedly a number of contextual factors that participants could have used to ameliorate their sense of responsibility while in the lab. As participants generally completed the study on weekdays, within general business hours, they may have seen and/or heard individuals who were working within the psychology department and could thus sense that although they were to be alone in the kitchen, other people around would likely notice and respond if there did happen to be a fire or some other negative outcome. In other words, participants may have experienced a shared sense of responsibility by virtue of seeing and hearing that others were nearby. Indeed, clinically, it is often the case that individuals who compulsively check refrain from doing so if they are able to shift responsibility to someone else (e.g., by strategically leaving the house first, so that the responsibility for ensuring the house is safe for the day naturally falls to someone else). Although the experimenter asked participants about their perceived level of responsibility as a form of manipulation check at the end of the study session, it remains possible that the degree of responsibility experienced by participants pales in comparison to that experienced in real life situations.

A unique feature of the present study was its use of portable eyetracking technology to establish an index of each participant's gaze location for the duration of the stove task. We were

thus able to derive a second behavioural index, fixation duration, which could be examined with respect to the aforementioned OCD relevant beliefs. More specifically, to examine the relation of attention to threat and OCD relevant beliefs we used three eye-fixation indices: *Stove Fixations, General Threat Fixations,* and *Idiosyncratic High Threat Fixations.* These indices reflect different levels of specificity with respect to categorizing threat: stove fixations represent attention to normative threat in the situation at hand; *General Threat Fixations* capture attention to various items that most would agree represent a threat in the stove task; and *Idiosyncratic Threat Fixations* which reflects the most individualized level of threat, as it includes attention to only those items the individual deems threatening. We also considered there to be two phases during which participants could vary in what they were attending to. The first phase, the *Pre-Check,* included fixations made from the time the experimenter left the room (at the beginning of the stove task) to the time when the kettle had boiled. Although the duration of this period of time was the same for everyone (and thus was not considered in analyses examining check duration), we recognized that there were no constraints on what participants could look at during this time; thus, there were individual differences that could be examined by looking at fixations during this phase of the task. The second phase, the *Check* included the time between the moment when the participant turned off the burner used to boil the kettle and the moment the participant took off the eyetracker.

Looking across the results of our eyetracking data, we broadly found that a) *Stove Fixations* were most strongly associated with beliefs, and b) fixations made during the *Check* phase of the task seemed to have the most impact on beliefs. Additionally, similar to the pattern of results discussed previously with respect to check duration, we did not find evidence that stronger beliefs preceded certain fixation patterns (i.e., greater fixations on threat). However, we

did find a number of instances where attentional deployment during the stove task had an ironic effect on post-task beliefs. These findings are reviewed below.

Our first research question concerning eyetracking data aimed to establish whether there was a basic difference in the proportion of eye fixations on threat made by individuals with OCD versus AC participants (Research Question 6: Do individuals with OCD show greater proportion of eye-fixations on threat-relevant stimuli as compared to AC participants?). We did find a significant group difference in the amount of time spent attending to threat. Contrary to our hypothesis, however, it was individuals in the AC sample who showed greater attention to threat-relevant stimuli over the course of the stove task. How could this be the case? One possible explanation emerges if we consider how individuals responded to the presence of the threatening items in the kitchen and around the stove. Through the process of reviewing the video recordings it became apparent to the experimenter that a subset of participants managed the threatening items by moving them to an entirely new location within the kitchen—for some that location was at the far edge of the counter beside the stove, for others it was on the counter behind them, and for others still, the new location for the threat items was in the cupboard(s) beside the stove. Moving items in this way may be viewed as a form of neutralizing in that it effectively removed the threat from the equation. When we examined the proportion of participants in each group who neutralized in this way, we found that whereas only one of the fifteen AC participants (6.67%) neutralized in this way, 17.7% (or three of the seventeen OCD participants) moved threat items early on in the task. Therefore, it is possible that the OCD participants did not show a greater proportion of eye fixations on threat because for some of them, the sources of threat had been removed.

Following our basic analysis of group differences in threat fixations, we examined whether attentional deployment had effects on post-task estimates of responsibility, harm, memory, and certainty. We also considered whether these relations, if any, would be more pronounced in individuals with OCD. Our findings were by and large contrary to what we expected. In short, we found minimal evidence linking beliefs and threat fixations in participants with OCD. There was a significant relation whereby attention to the stove during the *Pre-Check* phase of the task was associated with lower post-task ratings of memory confidence. However, this relation was not unique to individuals with OCD, but was shared with our sample of AC participants. Indeed, in our analyses examining threat fixations and beliefs, we did not find a single predictor of attention to threat that was unique to OCD, nor did we find a single effect of attention to threat on subsequent (post-task) beliefs that was unique to OCD.

In contrast, a number of interesting relations emerged in the eyetracking data of our AC group. Specifically, we found that a greater proportion of time spent looking at the stove during the *Pre-Check* phase was associated with decreased certainty about having completed the check properly. Stove fixations during the *Check* phase had the same ironic effect, suggesting that the more AC individuals looked at the stove during the task, the less certain they reported feeling about having ensured that the stove was off. Furthermore, stove fixations during the *Check* phase of the study had a number of additional ironic effects on post-task beliefs in our AC sample. To summarize these effects, for AC individuals, a greater proportion of time spent looking at the stove was associated with: an increased sense of responsibility for preventing harm, increased estimates of the likelihood and severity of harm, decreased certainty (as noted above), and decreased confidence in memory of the task. These effects correspond to those implicated by Rachman's (2002) model of compulsive checking. The question then becomes, why did we see

evidence of these effects in our group of low checkers, but not in our OCD sample, comprised of individuals who compulsively check?

To address this question, we can begin by looking at previous studies examining the impact of checking behaviour on beliefs. The majority of these studies have examined the impact of repeated checking on memory confidence in particular and have utilized unselected student samples (e.g., van den Hout & Kindt, 2004) or student samples reporting low levels of checking symptoms (e.g., Alcolado & Radomsky, 2011). In this respect our study is consistent with previous research, as we have also found ironic effects in individuals with significant anxiety, though not compulsive checking symptoms specifically. The majority of previous studies have tended to use repetition as their independent/ predictor variable. Unlike these previous studies, the present investigation utilized a single 'checking episode' in the sense that participants boiled the kettle once and did not return to the kitchen to complete the task again (and again). The main predictor in the present study was therefore not repetition, but instead, other indices of duration and attentional deployment during the check. It remains possible that attentional deployment and check duration would emerge as meaningful predictors of post-check beliefs in both groups if the task was repeated more than once. Indeed, when Tolin and colleagues (2001) examined memory confidence differences in OCD versus AC groups similar to ours, they found differences begin to emerge only after the second trial. Thus, a natural extension of the present line of research would be to conduct a study where participants complete our stove paradigm several times consecutively, while providing ratings of beliefs (e.g., responsibility, harm estimates, memory confidence, and certainty) after each repetition.

It is also possible that individuals in our OCD and AC group responded differently to the laboratory task simply because of their prior experience (or lack thereof) with checking.

Consider that there were of course significant differences in checking symptoms across our two groups (AC=low previous checking; OCD= high previous checking). It remains possible that the experimental task may have been perceived as straightforward (or even benign) by our OCD checkers who are undoubtedly regularly engaged in much more demanding and anxiety provoking situations. Perhaps the 'strength' of our current paradigm was sufficient to elicit components of the checking cycle in our anxious controls, but was less effective amongst those who may be accustomed to more evocative situations.

Finally, another possible explanation for the lack of findings in the OCD sample has to do with how many of the OCD participants chose to neutralize the threat that was present in the kitchen. We anticipated that checking the stove to neutralize threat would be the primary way in which participants coped with the threat at hand. However, as previously mentioned a number of the participants in the OCD group instead chose to move items around the kitchen, presumably in an attempt to neutralize. Because of this, they were likely to look less at the aspects of the kitchen we were interested in and therefore made fewer fixations on threat in general, which ultimately had an impact on our ability to detect these participants' patterns of attentional deployment during the stove task. Had we restricted participants in their ability to move the items within the kitchen, we may have observed a different pattern of results than that presented here.

It should be noted again that to the best of our knowledge, there have been no previous studies examining the effects of checking behaviour on subsequent beliefs about responsibility and harm. The hypothesized relations offered in the present study followed closely from Rachman's (2002) theoretical predictions, but had little to draw on in the way of previous research in this area. Further research examining post-task beliefs about responsibility and harm

will undoubtedly help to validate the findings of the present study. Certainly even replicating the general effect found in the present study is an important first step in this regard. Research studies examining these constructs over a time course of repeated tasks would be particularly helpful, as there is some evidence that repetition of actions may have a progressive effect (e.g., on memory; Tolin et al., 2001).

Study 1 Limitations

One limitation of the present study has to do with our ability to detect more nuanced individual differences in fixations. Certainly, we maintain that it is important to move beyond examinations of normative threat in order to consider patterns of attention to idiosyncratic items because what may be deemed as threatening by one or even by some may not be seen as threatening by all. In the present study, however, our ability to detect significant relations generally decreased as we moved from the broadest definition of threat (i.e., stove fixations) to the most specific level of threat (i.e., the idiosyncratic threat items). Indeed, the vast majority of our significant findings involved stove fixations. To remedy this limitation, future studies would do well to adopt relatively comprehensive calibration procedures (in order to maximize the specificity of the point of gaze tracking, allowing it to better register fixations on comparatively small or less prominent objects/ areas). Although the recommended 5-point calibration process was adopted in the present study, the specificity of the eyetracker could nonetheless be improved. In addition, and as previously mentioned, our yield of threat fixation data may have been improved had we restricted participants in their ability to move items in the kitchen. The reasoning behind this is straightforward: if the threat item is removed or otherwise neutralized, participants are no longer able to view it. Although instructing to participants to leave items as they are (or physically fixing the items in their positions) would ultimately impact ecological

validity, eyetracking data on threat fixations would likely become more plentiful, which would in turn allow us to better examine attentional deployment to threat in the way we intended in the present study.

A number of steps were taken in the present study in order to maximize ecological validity while remaining within a laboratory setting. Indeed, the paradigm used in the present study represents a progression from a majority of previous paradigms using contrived tasks and virtual stimuli, for example. However, there are a number of ways in which the present study may have been limited in its ability to inspire the same feelings and experiences that individuals have while checking at home. This was likely particularly true for participants in our OCD group, as they have likely faced much stronger urges to check in settings with higher perceived stakes on a routine basis (perhaps daily even when leaving the home, for example). This is likely a common limitation of laboratory studies examining compulsive behaviour; however, it should be noted here as it may have had impact on the present findings (particularly in the ways noted in the sections above).

Study 2 Method

Participants

Participants were 23 individuals (14 females, 9 males) ranging in age from 18 to 65, with a mean age of 33 years (*SD* = 13.8). All participants were recruited through the Anxiety Studies Division (ASD) of the University of Waterloo Centre for Mental Health Research. All participants received a principal diagnosis of OCD using the MINI International Neuropsychiatric Interview administered by interviewers from the ASD, senior graduate students in the UW PhD program in Clinical Psychology. The participants who completed the diary study also completed the in lab study (Study 1) of the current program of research.

Of the 23 participants, one had a co-principal diagnosis of Social Phobia, Generalized, and one had a co-principal diagnosis of Major Depressive Disorder. A further 18 participants had one or more comorbid anxiety disorders, and one had an additional diagnosis of another type.

OCD severity was assessed by the self-report VOCI. The mean overall VOCI score for the present sample was 103.2 (*SD*= 39.0), indicating that the level of OCD symptoms within the present sample is about 0.5 standard deviations above the mean level of symptoms reported by the clinical sample on which the measure was originally validated (M in original sample= 86.26, *SD*=37.47; see Thordarson et al., 2004). Inclusion criteria for this study were a diagnosis of OCD and exclusion criteria were: current diagnosis of substance dependence or psychotic disorder, bipolar disorder, or any changes in psychoactive medication within the 6 weeks prior to the study.

Measures

Repeated Actions Diary. The Repeated Actions Diary (RAD) was designed for use in the current study. Based on the diary developed by Purdon, Rowa and Antony (2005) to assess

the suppression of obsessions, the diary requires participants to report on one episode of compulsive acts each morning, afternoon and evening for three days, as soon as possible after completion of the episode.

Diary items for the RAD were developed based on a review of Purdon and colleagues' (2005) diary evaluating the suppression of obsessions and a review of the current literature on compulsive checking. Following this review process, a number of cognitive, behavioural, and emotional domains of interest were identified. Direct consultation with one of the authors (C. Purdon) of the suppression diary facilitated translation of these areas of interest into diary items.

The RAD asks about both psychological and behavioural aspects of the compulsion. Psychological aspects include the obsession triggering the compulsion, how discomforting it was, the perceived consequences of not completing the compulsion properly, the level of certainty needed to decide that it had been done correctly and the criteria used to determine completeness of the compulsion. Behavioural aspects include a description of the acts involved in the compulsive episode, duration of the episode, and number of repetitions within the episode. The diary also includes assesses how psychological and behavioural aspects of the compulsion changed over time; how the individual's confidence in memory, perception, and attention changed over time and how the criteria used to decide completeness of the act. The diary also asks individuals to report on how much relief the compulsive episode gave them. Please see Appendix D for the Repeated Actions Diary, showing questions for entries made on Day One Morning, Day One Afternoon, and Day One Evening. (Questions for entries made on Day Two and Day Three are identical to those shown in Appendix D).

Procedure

Participants completed the RAD over three consecutive days with three entries per day– one each morning, afternoon, and evening. Thus, a total maximum of nine diary entries per participant were possible.

Results

A total of 30 participants were invited to complete the Repeated Actions Diary. Of those, 29 agreed to complete the diary. Of the 29 participants who agreed to complete the diary, five participants (17%) did not return the completed diary, leaving a total of 24 participants with completed and returned diaries. The diary of one participant was excluded from analyses after a review of the diary's content suggested that the diary entries were based on typical daily events rather than compulsive episodes. Thus, the sample analysed consisted of 23 individuals.

The majority of participants who returned the diary (n=23) completed eight or more diary entries, or 80% of the diary entries they had been asked to complete (n=19 completed 9 entries, n=1 completed 8 entries). Three participants (1 male, 2 females) completed six or fewer diaries. There were no differences between those who completed 80% of the diaries and those who did not in terms of age, t (1,21) = 0.94, p =.36, VOCI total score, t (1, 19) = 1.64, p = .12, or gender distribution, χ^2 = 3.5, p = .47, thus all participants were retained in the following analyses

Participants recorded the time a compulsive episode occurred and the time they completed the diary entry corresponding to that particular episode. There was substantial variation in the latency between these two times, both within and between participants, ranging from an average of 18 minutes to 10 hours after the compulsive episode reportedly took place. The average latencies for each participant were calculated and the mean latency was determined

to be 128 minutes (2 hours 8 minutes; *SD* = 132 minutes). High and low latency groups were created based on a median split of the mean latency (median = 95 minutes). The high and low groups did not differ on OCD severity, t (1,16) = -.236, p = .82. Nor did the high and low groups differ on average duration of compulsive episodes (t (1,17) = -1.14, p = .27), or proportion of successful compulsions (t (1,17) = .996, p = .91.

Approach to Data Analysis. Data for each variable of interest were cleaned and examined for extreme values. Potential outliers were identified through a screening of residuals (i.e., z scores) for each variable of interest. A case was considered extreme if the z score for the particular variable of interest was ≥ 3and if the value was discontinuous with the distribution. Variables identified as meeting these two criteria were adjusted to the next highest or lowest value, depending on whether the original response was identified as an extreme high or an extreme low response.

Data for each variable of interest were summed across entries and average scores were calculated for each participant by dividing the summed total by the number of entries completed by the participant. Thus, the calculated overall scores controlled for the number of diary entries completed. Two variables of interest were examined using aggregate scores which summed across diary items that asked about conceptually similar constructs. The variable *Sensory/ Cognitive Doubt* (see Table 37) was computed as the mean response to diary items 12b.i., 12b.ii, and 12b.iii for each entry. Similarly, the variable *Elevated Evidence* (see Table 37) was computed as the mean response to diary items 12b.vi and 12b.vii.

For a subset of analyses, we were interested in comparing compulsive episodes in which individuals achieved a sense of certainty to compulsive episodes in which certainty was not

achieved by the termination of the episode—that is, compulsions which were terminated because internal criteria were met versus compulsions that were terminated in response to external factors. For these analyses, specific variables of interest were summed across those episodes in which certainty was achieved and divided by the number of entries in which certainty was indicated. For example, for a particular participant, the episodes in which certainty was achieved were identified by examining the question *How did you decide to stop* [the compulsion]? Episodes were considered having terminated with certainty if the participant ranked one of the following three options as the primary reason they stopped: *Felt completely certain it was okay to stop; Felt certain enough that it was okay to stop; Knew in my head that it was okay to stop (even if I didn't feel it).* Episodes were considered having terminated without certainty if the participant ranked any other reason as the primary reason for having ended the episode. For the purposes of the remaining discussion, episodes in which certainty was achieved will be referred to as "successful" episodes and those episodes which terminated without certainty referred to as "unsuccessful" episodes. Each participant's entries were examined in this way and categorized as either successful or unsuccessful.

Duration and Repetition of Compulsive Episodes. There were eight extreme entries on compulsion repetition and six extreme entries on the item asking about compulsive episode duration. Note however that these fourteen extreme entries were contributed by eight participants, as some participants contributed more than one extreme entry (five participants had one extreme entry, one participant had two extreme entries one participant had three extreme entries, and one participant had four extreme entries). In each of these cases, the data extreme entries were adjusted so as to bring the value to the next highest or next lowest value, while

maintaining participants' rank order at each end of the distribution. All adjustments were made prior to completing any of the analyses using these variables.

Data on the duration and number of repetitions of compulsions reported by participants are presented in Table 34. Duration of compulsive episodes varied across days, ranging from an average of 28.2 minutes on Day 3 to 40.7 minutes on Day 2. There was variation in the number of repetitions enacted during a compulsive episode, ranging from 1 to 20. The median number of repetitions was 4.2, 5.2, and 5.0 for days 1, 2, and 3, respectively. In order to determine whether duration and repetitions changed across the three days, separate three-way repeated measures analyses of variance were conducted on these variables. These analyses provided information on whether there was an natural "intensification" (i.e., increase in repetition or duration) of compulsions across a specified time period, thereby allowing us to consider whether completing the diary influenced participants' reports across days. A repeated measures ANOVA with the Greenhouse-Geisser correction revealed no significant differences in reported duration across the three days, $F(1.34, 20.16)=.728$, $p=.443$. Similarly, a repeated measures ANOVA examining repetition revealed no significant differences across the three day time period $F(2, 34)=.017$, $p=.983$. Thus, the task of completing the diary had no systematic effect on participants' reporting of their compulsions.

Characteristics of Successful and Unsuccessful Compulsions. We examined the factors associated with successful compulsions—i.e., those in which individuals were able to achieve a sense of certainty— and those factors associated with unsuccessful compulsions, which were terminated without an internal sense of certainty. Zero-order correlations of self-reported OCD symptoms (VOCI, OBQ-44) and confidence in cognitive abilities (MACCS) with proportion of successful compulsions were examined and are presented in Table 35. The results

indicated that obsessive-compulsive symptom severity, beliefs about obsessions (particularly beliefs about responsibility and threat estimation) are meaningfully associated with the outcome of compulsive episodes. Specifically, higher levels of previous checking behaviour (as measured by the VOCI checking subscale) and stronger obsessional beliefs about one's responsibility to prevent harm (as measured by the OBQ-44 Responsibility/ Threat subscale) were associated with a lower proportion of successful compulsions.

It was also of interest to examine more closely the differences between successful and unsuccessful episodes, both in terms of episode parameters (duration, repetition) as well as factors preceding the compulsion (e.g., obsessional beliefs, distress resulting from the obsession) and those following the compulsion.

Episode duration and number of repetitions were examined separately for episodes in which certainty was achieved and episodes in which certainty was not achieved (i.e., successful versus unsuccessful episodes). These data are presented in Table 36. Overall, the number of successful episodes reported by participants ranged from 0 to 9 with an average of 5.6 (SD= 2.6) or 63.5% of episodes being reported as "successful" according to the above criteria. Unsuccessful episodes also ranged from 0 to 9, with an average of 3.0 (SD=2.3) or 36.5% of episodes. There was wide variation reported in the sample: 4 participants endorsed a 33% success rate; 4 participants endorsed a 56% success rate; and 4 participants endorsed 100% of their compulsions as being completed successfully. Differences between successful and unsuccessful episodes are explored below.

In order to determine whether there was a difference in the duration and number of repetitions in successful versus unsuccessful compulsions, paired-samples *t* tests were conducted.

Comparing the overall mean duration of successful episodes with the overall mean duration of unsuccessful episodes in this way revealed a trend towards significant differences in reported duration between successful and unsuccessful compulsive episodes, $t(1,17)= 1.93$, $p=.070$, such that unsuccessful compulsive episodes tended to take longer than successful ones. In addition, there was a significant difference in reported repetition between successful and unsuccessful compulsions, with participants reporting more repetition during unsuccessful episodes ($M=6.9$ $SD=4.5$) as compared to successful episodes ($M=3.9$, $SD=2.4$), $t(1,16)= 2.58$, $p=.020$.

A series of paired-sample *t* tests were conducted to examine whether factors preceding and following the compulsion varied between successful and unsuccessful episodes. A summary of the results of these analyses is offered in Table 37. Results of these analyses showed no significant differences in the amount of obsessional distress associated with the onset of successful versus unsuccessful compulsions. Similarly, there were no significant differences between successful and unsuccessful compulsions when considering the strength of participants' desire for certainty. However, the results shown in Table 37 support the idea that successful compulsions require significantly fewer evidence requirements, and result in greater general relief, greater relief of responsibility, and greater reported reduction in distress as compared to unsuccessful compulsions.

Taken together, these results provide evidence to suggest that the successful compulsions are shorter with fewer repetitions and require a lower standard of evidence in determining when to terminate the compulsion.

Study 2 Discussion

A common limitation of studies examining compulsive behaviour is the somewhat contrived paradigms from which findings are derived. In Study 1, we aimed to increase the ecological validity of the task we were using by allowing it to be relatively open ended. At the same time however, laboratory studies, including ours, will always be somewhat limited in their ability to capture OCD symptomatology as it truly occurs for the individual. Hence, one of the main reasons we undertook the second study in the present program was to gain a more full understanding of the basic phenomenology of compulsions as they occur naturally at home.

The broadest goal of the second study in the present program was to gather the type of basic phenomenological data on compulsions that is lacking in current literature. To this end, we had a group of community members with a principal diagnosis of OCD completed diary entries three times per day over a three day period. Importantly, the diary entries reflected what individuals thought, how they felt, and what they did as they carried out their own compulsions at home.

A number of the basic parameters reported by our sample are in line with current diagnostic criteria for OCD. In line with current diagnostic guidelines, we found that the amount of time devoted to compulsive episodes was greater than one hour per day. Consider also that our diary data only took into account three compulsive episodes within a given day; therefore, to the extent that additional, unreported compulsive episodes took place, any aggregate duration estimates (e.g., total duration within one day) derived from our data are likely to be conservative approximations of the actual amount of time consumed by obsessive- compulsive symptoms. In fact, the duration of compulsive episodes recorded by individuals in our study ranged, on average, between 28.2 and 40.7 minutes each. Multiplied across the span of a day, this amounts

to a significant amount of time being devoted to compulsive rituals. We also found evidence suggesting that repetition of actions figured prominently in participants' compulsions: on average, participants reported between 4.2 and 5.2 repetitions per recorded episode.

One of the most interesting set of findings in our diary study strongly corroborated the notion that despite the time and effort invested in compulsive rituals, they are not always successful! In our sample, there wide variability in the number of successful compulsive episodes, with two of the modes being right around 50% success rate or under (modes were 56% and 33% respectively). Further consider that only a small subset of participants (17%) reported a 100% success rate at neutralizing their distress with compulsive rituals. This is a dismally low success rate from the perspective of the individual doing the compulsion, especially when one considers how high they perceive the stakes to be. Indeed, from a clinical perspective, it is important to keep in mind that attempts to neutralize are the individual's way of protecting against very upsetting possibilities and/or managing their discomfort and so devoting time and effort to rituals may seem like a worthwhile investment. The occasions when the compulsion successfully reduces distress only reinforce this perspective. And therein lies the difficulty for clinicians: although the success rate may seem low to clients, from the clinician's perspective, compulsions have a surprisingly high rate of success. Certainly if one takes into account what is known about the effects of intermittent reinforcement on the persistence of a behavior, it becomes clearer to see why compulsions can be so difficult for clients to give up while in the process of undergoing treatment or otherwise.

The present study also found that unsuccessful compulsions were generally associated with a longer duration (trend), more repetitions, a higher standard of evidence, and offered little in the way of distress reduction! Although these results are correlational and cannot address the

issue of causality, one interpretation of the findings is that individuals were unfortunately expending more effort for less relief— counterintuitive for those seeking to alleviate their distress, but very much in line with the literature suggesting that compulsions have paradoxical effects.

We also examined in some detail the extent to which various psychological factors were associated with successful versus unsuccessful compulsions. If we begin with factors occurring prior to the compulsion, we found that the distress participants recall being associated with the obsession did not differ between successful and unsuccessful compulsions. The need for certainty participants recalled feeling at the outset of the compulsion similarly had little effect on the outcome of the compulsive episode in terms of whether it was successful or unsuccessful. In contrast, if we consider those factors which came into play during the compulsion, we see evidence that they have greater implications for whether the compulsion was ultimately successful or unsuccessful. In short, our data suggest that what happens during the compulsion may be more critical to its outcome than what precedes the compulsion. These findings may run contrary to clients' intuitions about their own obsessive-compulsive behavior, suggesting for example that higher distress is not necessarily associated with a poorer outcome (i.e., an unsuccessful compulsion) and that a greater need for certainty will not necessarily translate into a more effective (i.e., successful) compulsion. However, our findings—namely the idea that what happens during the compulsion is important—are highly consistent with existing literature emphasizing the internal state as playing an important role in compulsion termination (e.g., Wahl et al., 2008; Szechtman & Woody, 2004). Indeed, considering Wahl and colleagues' (2008) examination of the termination criteria of compulsive washing, their findings are broadly similar to our own: although there was some indication that *pre-determined* rules and memory based

cues played a role in the termination of a compulsive wash, these criteria were observed less often than internal feelings (which were presumably experienced *during* the wash). It is worth noting that Salkovskis and colleagues were strictly examining termination and did not appear to consider whether the compulsion was deemed successful (or unsuccessful) on termination. Thus, the results of Salkovskis and colleagues' study are not directly translatable to the present study. However, the results of these studies together nonetheless support the notion that factors arising *during* a compulsion are important determinants of its stopping point and— in the case of the present study—perhaps even its outcome.

Following naturally from these insights is the recommendation that obsessional beliefs (e.g., need for certainty) and distress not only be examined with respect to their role in the onset of a compulsive ritual, but that they also be explored with respect to their role in the persistence of a compulsive episode, and perhaps even the persistence of compulsions across time. That is, clients should understand that although compulsions may begin as a targeted attempt to reduce obsessional distress, the degree of distress may not necessarily be predictive of whether it will be successfully alleviated by the compulsion, and that once the compulsion is underway it may involve a number of additional factors (e.g., standards of evidence, sense of responsibility) which ultimately have their own impact on whether or not distress is alleviated. Furthermore, it may be advisable to discuss with clients the amount of importance they place on achieving certainty via their compulsions and to challenge them to tolerate uncertainty while still terminating the compulsion. In practice, it may therefore be helpful to challenge clients to conduct their compulsion but to stop before they get the right feeling, before they feel perfect certainty, or even feel certain enough. The idea that individuals with OCD have difficulty tolerating uncertainty is not a new one (e.g., Steketee, Frost, & Cohen, 1998; Tolin, Abramowitz, Brigidi,

& Foa, 2003; Sarawgi, Oglesby, & Cougle, 2013). However, the present study offers additional insight as to why it may be important to promote tolerance of uncertainty. Especially if we consider that individuals are likely making trade-offs in the hunt for the elusive sense of certainty (e.g., spending longer in their ritual, being late for appointments, spending less time with loved ones), we can see that it is important to help individuals understand that what they are seeking may not necessarily come from greater effort or more time spent. Instead, we can help them to consider that what they are seeking seems to come from a subjective sense or feeling that is not reliably linked to objective criteria, and may not be easily predicted or achieved.

Of course, we are limited in our ability to suggest that these are causal links between the extent to which obsessional beliefs predict the outcome of a compulsion (successful vs. unsuccessful) as these factors were rated by participants at the same time point (i.e., when they were completing the diary entry following the compulsive episode). Similarly, we cannot suggest from the present data that there are causal relations between what happens during a compulsive episode and its eventual outcome.

However, were able to examine whether trait factors are associated with the overall proportion of successful compulsions reported by participants over the three day period. While participants were in the lab completing the first study (described in earlier sections of this document), they also completed a number of self-report measures assessing OCD symptoms, obsessional beliefs, and general cognitive confidence. Examining participants' results on these measures in relation to their diary data allowed us to examine more longstanding, trait-like predictors of the outcomes of compulsions participants reported on in the diary. In short we found that higher OCD symptomatology, specifically greater checking symptoms and greater obsessional symptoms (trend) predicted fewer successful compulsions over the three day period

measured. Similarly, we found that higher estimates of responsibility and threat were associated with fewer successful compulsions and there was a trend towards a relation between higher perfectionism and fewer successful episodes. It is possible that with a larger sample size, this relation would be more apparent and would thus fall in line with our other analyses suggesting that there is a difference between the standard of evidence desired across successful versus unsuccessful compulsions.

Study 2 Limitations

There were no restrictions placed on the type(s) of compulsions (e.g., checking, washing) participants could report on in the diary. Participants were instead encouraged to focus on the types of compulsion that they predominantly engage in when choosing a compulsions to report on for each given time period. As a result, there is heterogeneity in terms of the types of compulsions included in the present results. One strength of this approach is that it offers a set of results that are broadly generalizable to compulsions in general as it reflects the heterogeneity that is typical of OCD. It would be interesting however to have future diary studies in which the compulsions were restricted to one 'type' (e.g., checking, washing) so as to examine whether there are differences in the overall adequacy/ success of particular types of compulsions. Based on our theoretical understanding of OCD and the results of this study, one might argue that such efforts would be unlikely to find variable success rates across compulsions, as the mechanisms contributing to compulsions' ineffectiveness likely involve common or underlying factors. However, it remains important to consider whether the findings of the present study generalize across different OCD presentations and future research would do well to focus on this area.

General Discussion

The two studies presented here offer novel insights into the psychological and behavioural components of compulsions. Together these studies may help us better understand the factors at play in the persistence of compulsions and more generally, the obsessive-compulsive cycle. More specifically, the pair of studies discussed here offer insights into the inner workings of compulsions, exploring the cognitive and behavioural factors at play during compulsions and pointing to their various impacts on the outcome of compulsions. These data may be integrated with the body of existing work on cognitive-behavioural models of OCD to provide a more nuanced understanding of compulsions. However, they may also serve as the starting point for a number of clinical considerations and possible interventions, as discussed below.

Clinicians who understand the client's perspective and are armed with compelling data on the persistence of compulsions will be best equipped to support the client in resisting their compulsions and engaging in treatment, especially ERP. Moreover, with access to these data clients will be better equipped with the information they need to challenge themselves to change. Regardless of whether a client's commitment to change manifests as increased curiosity about the success rate of their own compulsions or a willingness to engage fully in difficult ERP experiences, it should have a positive influence on any treatment relying on client effort and active collaboration between client and therapist. In this sense, the phenomenological data and findings of the present study may eventually serve as useful psychoeducational tools aimed at helping individuals through treatment.

One particularly good and highly relevant example of how new data about compulsions might be integrated into clinical treatment is offered by Radomsky and colleagues' (2010) cognitive behavior therapy for compulsive checking. This treatment framework is a refined version of CBT for OCD which acknowledges the self-perpetuating cycle that maintains compulsive checking and aims specifically to "weaken" the cycle by addressing the relevant sustaining factors. Although the list of sustaining factors offered by Radomsky and colleagues does not map directly onto the findings of the present study, the general idea is nonetheless the same: work to better understand compulsions and how their components are maintaining the OCD cycle; work systematically to challenge these sustaining factors; and help the client to understand how their own cycle of obsessive-compulsive symptoms are maintained by various factors beyond distress. This may mean providing psychoeducation regarding the impact of compulsions on certainty and post-task beliefs or collaborating on behavioural experiments designed to test the psychological and/or behavioural effects of repeated actions (e.g., How is memory impacted? Do compulsions grow longer over repetitions? Does it become more or less difficult to generate a sense of certainty?) as they pertain to each client's presentation. Regardless of the particular technique, the idea is that this information is valuable because it can help tailor treatment to the individual client.

Further to the discussion of treatment tailoring, the diary developed in this study may also become a valuable clinical tool. Certainly, the concept of self-monitoring is not new to cognitive behavioural therapies and can offer clients a wealth of information about their baseline experience, habitual responses, and treatment progress, among other things. Monitoring exercises can also help the client and therapist discuss the client's experience outside of their therapeutic sessions and can give a fuller sense of the client's experienced symptoms than can be reported by

the client's retrospective review (of the week, or of the time since the onset of symptoms) alone. The diary constructed for this study (or likely some variation of it) could undoubtedly be used for this purpose. Additionally, the diary supports a quantitative analysis of a client's progress. Especially if given over a longer period of time or intermittently over the course of therapy, the results of the diary can help clients to examine their use of compulsions over time (less frequent? shorter? only in response to a higher degree of distress than before?) and to monitor a fair amount of detail that could be used to formulate a treatment plan for ERP.

Indeed, there are many possibilities to translate the basic elements and objectives of the diary for use in a therapeutic context. One of the best things we can do in the name of translating research into practice is to have information and tools at our disposal which will help us (and the client themselves) explain the client's experience and design interventions. Sometimes basic information is the most powerful and useful in this regard. We need to look no further than Rachman and Hodgson's (1980) seminal investigations of the obsessive-compulsive cycle to see the truth in this notion. The present studies cannot rival the elegant simplicity of this and other iconic works, it is our hope that they will nonetheless offer information that is of clinical importance and will help in the treatment of OCD.

Conclusion

The present studies contribute to our understanding of the basic phenomenology of compulsions, and compulsive checking in particular. Importantly, the first study in the present research examined links between cognitive and behavioural parameters of checking behavior. It extended the previously noted research by using a clinical sample of individuals with OCD and an Anxious Control group. The first study in the present study also employed a naturalistic

laboratory task and utilized portable eyetracking technology to gather some of the first data on what individuals attend to while they are checking. Results of this study provided some support for the notion that attention during a check can reinforce subsequent beliefs about responsibility for preventing harm and estimates of the likelihood of harm occurring. Interestingly, we also found some preliminary evidence to suggest that focusing attention on threat (in this case the stove) during a checking episode can undermine one's sense of confidence in memory and certainty about having completed the check properly/ having prevented harm. Although these findings were limited to our anxious control sample, they are nonetheless consistent with previous literature documenting the deleterious effects of checking on individuals with anxiety. Further examinations of these relations in individuals with OCD, and individuals with significant compulsive checking symptoms in particular, remains an important area for future research. It might be particularly important for these studies to examine the effects of checking across multiple repetitions of the same task, rather than following a single performance of the task, as was the case in the present study. We also gained a number of insights into the basic phenomenology of compulsions through the data collected in our second study. Indeed, the diary method we used allowed us to confirm that compulsive rituals are time consuming and marked by a good deal of repetition. It also became clear that compulsions are not always effective in alleviating anxiety, nor do they leave the individual with a sense of certainty that the compulsion has been successful in averting harm/ the feared outcome which the compulsion is intended to prevent. This is invaluable information for clinicians, as it may help individuals with OCD to better understand their compulsions and to better engage in treatment targeting the obsessive-compulsive cycle.

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Appendix A: Stove Task Instructions

Overview of the Task

The participant enters the kitchen and is seated at a small table. The stove is in view.

Experimenter (E): In today's session you will be using an electric stove no different from the type people typically use in their homes. [Gesture towards stove] It has four working burners on the stovetop and a working oven below. Each burner is controlled by a knob on the back panel of the stove. I will give you a demonstration of the stove in a moment. But right now, I want to give you some more details about the study procedure. In today's study, you will be using the stove to boil a kettle of water. The kettle will whistle when the water is boiling. Once you hear the whistle of the kettle, please take the kettle off of the burner and turn off the stove. You can place the kettle on this pad [point to heat pad beside stove]. In order for the stove to be safe, it must be turned off properly, so it is very important that you are sure the stove is absolutely off. Once you are sure the stove is off, please place this pot of dry rice on the burner you used to boil the water. If the pot of rice is placed on a burner that has not been turned off properly, the dry rice could smoke or burn. It is okay however to put the pot on a burner that is off, but still cooling down.

I will not be in the kitchen while you are doing this task. Also, once you complete the task and inform me that you are finished, I will not be re-entering the kitchen to make sure the stove is off. So, please consider it entirely your responsibility to ensure that the stove is safe. Be careful because the stove and the kettle will be hot!

While you are doing this task, you will be wearing portable eye tracking equipment. I will help get you set up with the eye tracking equipment in a minute. But first, I would like you to fill out these short questionnaires. [Experimenter gestures to have participant completed Pre-task PANAS and VAS ratings, which are on table in front of participant].

[Once the participant has completed the Pre-task PANAS and VAS scales, the participant stands in front of the stove and is fitted with the eyetracker. The eyetracker is calibrated by the experimenter according to the protocol specified in the Method section.]

Review of Instructions

E: [Upon completion of the calibration process]. Now that you have the eye tracking equipment on and it has been calibrated, I would like to remind you of your task. You will be using this stove to boil a kettle of water. Please use this burner to boil the kettle. [Experimenter puts kettle on right rear burner with spout positioned at 9 o'clock on the burner]. I have already put some water in the kettle, so you don't need to worry about doing that. When the water starts boiling and the kettle whistles, I would like you to remove the kettle and turn off the stove. Again, please make sure the stove is definitely off because I will not be watching to make sure it is off or coming back in to check. Once you are sure the stove is off, please place the pot of dry rice on the burner you just finished using and come to get me. I will be in the room next door.

E: [Experimenter turns on all burners of the stove to high.] As you can see, the stove gets very hot, so please take care not to burn yourself or anything else in the kitchen. I do have a number of first aid options available should you need them. If at any point you need help, simply open the kitchen door and call "help" or "burn" or "fire" and I will be here immediately. I'm going to leave you now to start the task. Remember, you will be using

this burner to boil the kettle [experimenter points to rear right burner]. Please turn the others off before you start.

[Experimenter leaves kitchen and goes two doors down where she remains until the participant exits the kitchen and comes to join her.]

Appendix B: Pre-Task (T1) VAS Scales

Imagine what could happen if the stove was left on...

How much harm could occur?

no harm ——————————————————————— extreme harm at all

How responsible would you feel if harm occurred?

not at all ——————————————————————— extremely

How guilty would you feel if harm occurred?

not at all ——————————————————————— extremely

How likely is it that harm will occur?

not at all ——————————————————————— extremely

Appendix C: Post-Task (T2) VAS Scales

Imagine the status of the stove right now...

How much harm could occur?

no harm ——————————————————— extreme harm
at all

How responsible would you feel if harm occurred?

not at all ——————————————————— extremely

How guilty would you feel if harm occurred?

not at all ——————————————————— extremely

How likely is it that harm will occur?

not at all ——————————————————— extremely

How certain are you that the check has been done properly?

not at all certain ——————————————————— 100% certain

How certain are you that harm has been prevented?

not at all certain ——————————————————— 100% certain

How certain are you of your memory for the status of the stove?

not at all certain ——————————————————— 100% certain

How vivid is your memory for the status of the stove?

not at all vivid ——————————————————— extremely vivid

How detailed is your memory of the status of the stove?

not at all detailed ——————————————————— extremely detailed

Appendix D: Repeated Actions Diary

Repeated Actions Diary Study (RAD)

Preface

We all repeat certain kinds of actions more often than we may know we really need to, such as checking that a door is locked or that a stove is off, washing our hands a few times when once would probably do, or repeating a word or phrase several times to make ourselves feel better about something. We are interested in learning more about why we repeat actions in this manner.

In some individuals, repeated actions take a substantial part of the day and/or they cause a lot of distress. For example, individuals with OCD may spend a significant portion of their time doing certain things over and over again even though they try to resist doing them. In the context of OCD, these actions are referred to as **compulsions.**

What is the relation between the repeated actions we all do and compulsions seen in OCD?

Research suggests that the repeated actions we all do lie on a continuum with compulsions in OCD. This means that they *differ mainly in how often they are done, how long they take, and how much they interfere with one's life*. The actions themselves generally do not differ.

If I repeat actions (e.g., checking, washing, counting), does that mean I have OCD?

Research has shown that we all repeat certain actions (e.g., Muris et al., 1997). That means that people with and without OCD may do things like checking, counting, and washing more often than we know we really need to. Again, the difference lies in whether the repeated actions interfere with your life or how distressing they are.

If you find that you are spending a significant amount of time repeating certain actions or if you feel greatly distressed by having to complete the actions, or by the thoughts, images, or impulses that precede them, resources are available (please see list on last page of diary).

Guidelines for completing this diary

Please complete this diary over a three day period. Please make each entry at the first available opportunity following a compulsive episode. Do your best to answer all questions to the best of your ability. There are no right or wrong answers.

Please have the following definitions in mind while completing the diary:

Compulsions are behaviours or acts that you feel driven to perform although you may recognize them as senseless or excessive. At times, you may try to resist doing them but this may prove difficult. You may experience discomfort that does not diminish until the behaviour is completed. You may also find that the discomfort you feel does not diminish when the behaviour is completed.

Common examples of compulsions are:

- washing your hands excessively or in a ritualized way
- washing other items (e.g., countertops, doorknobs) excessively or in a ritualized way
- checking for contaminants. For example checking the environment for used band aids, needles, bodily fluids, checking yourself for cuts, checking to see if others have symptoms of illness, etc.
- checking whether or not an object or situation is safe. For example, checking that the stove is off, that the doors are locked, that harmful substances are out of reach, etc.
- mental compulsions—rituals that are completed entirely in one's mind, without any observable behaviour. For example, needing to "think the right thought" in order to prevent harm from coming to a loved one.

Some of the compulsions that you have identified as relevant to you are:

1. _____

2. _____

*A **compulsive episode*** may consist of one or more repetitions of a given compulsion. For the purposes of this diary, a compulsive episode begins with the first action involved in the compulsion and ends when you leave the item or situation involved in the compulsion. That is, it involves a change in location. For example, an episode of repeated checking may end when you leave the house. Likewise, an episode of washing may end when you leave the washroom or kitchen.

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ANXIETY STUDIES

If you have any questions or concerns regarding the diary as you are completing it at home, please feel free to call or email the researcher, Bianca Bucarelli.

Researcher phone:

Researcher email:

DAY ONE- MORNING Date: _____

Time of diary completion:_____

Time of episode: _____

Please complete at the first available opportunity following a compulsive episode.

1. What was the obsessional thought, image or fear preceding the compulsive episode?

_____
_____

2. What was the compulsive act?

_____
_____

3. How discomforting was this obsessional thought, image or fear? (circle the number that best applies)

1	2	3	4	5	6	7
not at all discomforting						very discomforting

4. How awful would the consequences of not performing the compulsion have been?

1	2	3	4	5	6	7
not at all awful						extremely awful

5. How certain did you need to be that the compulsion had been done properly?

1	2	3	4	5	6	7
didn't need to be certain at all						needed to be 100% certain

6. How long did the episode last? ___ hours ___ minutes

7. How many times did you repeat the compulsion within this episode? ____

8. How much general relief did you feel upon completion of this compulsive episode?

1	2	3	4	5	6	7
no relief at all						total and complete relief

9. To what extent did you feel a relief of guilt upon completion of this compulsive episode?

1	2	3	4	5	6	7
no relief at all						total and complete relief

10. To what extent did you feel a relief of responsibility upon completion of this compulsive episode?

1	2	3	4	5	6	7
no relief at all						total and complete relief

11. To what extent did you feel a reduction in distress upon completion of this compulsive episode?

1	2	3	4	5	6	7
no reduction at all						complete reduction

If the compulsion was only done once during this episode, skip to question 13.

12. If you did the compulsion more than once, please answer the following questions:

a) What made you do the compulsion the second time? (please use your own words)

_____
_____
_____
_____

b) Please answer each of the following using the scale where
1= Strongly Disagree, 7 = Strongly Agree

The more I repeated the compulsion, the:

i)	More I found myself doubting my senses (e.g., sight, hearing, smell, touch, and/or taste)	1	2	3	4	5	6	7
ii)	More I found myself doubting my memory	1	2	3	4	5	6	7
iii)	More I found myself doubting whether I had been paying proper attention	1	2	3	4	5	6	7
iv)	More I found myself feeling confident that it had been conducted properly	1	2	3	4	5	6	7
v)	More I found myself feeling uncertain that it had been conducted properly	1	2	3	4	5	6	7
vi)	More details of the action I needed to attend to	1	2	3	4	5	6	7
vii)	More evidence I needed to confirm that it had been done properly	1	2	3	4	5	6	7
viii)	Longer it took	1	2	3	4	5	6	7
ix)	More certain I was of my memory	1	2	3	4	5	6	7
x)	More certain I was that I had been paying proper attention	1	2	3	4	5	6	7
xi)	More certain I was that it had been conducted properly	1	2	3	4	5	6	7

13. How did you decide when to stop? (read all and then rank order all that apply)

1. Felt *completely certain* it was okay to stop___
2. Felt *certain enough* that it was okay to stop___
3. Got the right feeling ___
4. Had to stop because there was something else I had to do instead___
5. Was too tired to continue___
6. Was interrupted by something or someone___
7. Knew in my head that it was okay to stop (even if I didn't feel it)___
8. Someone else reassured me it was okay to stop___
9. Other (please specify) _____

DAY ONE- AFTERNOON Date: _____

Time of diary completion:_____

Time of episode: _____

Please complete at the first available opportunity following a compulsive episode.

1. What was the obsessional thought, image or fear preceding the compulsive episode?

_____

_____

2. What was the compulsive act?

_____

_____

3. How discomforting was this obsessional thought, image or fear? (circle the number that best applies)

1	2	3	4	5	6	7
not at all discomforting						very discomforting

4. How awful would the consequences of not performing the compulsion have been?

1	2	3	4	5	6	7
not at all awful						extremely awful

5. How certain did you need to be that the compulsion had been done properly?

1	2	3	4	5	6	7
didn't need to be certain at all						needed to be 100% certain

6. How long did the episode last? ___ hours ___ minutes

7. How many times did you repeat the compulsion within this episode? ____

8. How much general relief did you feel upon completion of this compulsive episode?

1	2	3	4	5	6	7
no relief at all						total and complete relief

9. To what extent did you feel a relief of guilt upon completion of this compulsive episode?

1	2	3	4	5	6	7
no relief at all						total and complete relief

10. To what extent did you feel a relief of responsibility upon completion of this compulsive episode?

1	2	3	4	5	6	7
no relief at all						total and complete relief

11. To what extent did you feel a reduction in distress upon completion of this compulsive episode?

1	2	3	4	5	6	7
no reduction at all						complete reduction

If the compulsion was only done once during this episode, skip to question 13.

12. If you did the compulsion more than once, please answer the following questions:

a) What made you do the compulsion the second time? (please use your own words)

_____
_____
_____
_____

b) Please answer each of the following using the scale where
1= Strongly Disagree, 7 = Strongly Agree

The more I repeated the compulsion, the:

i) More I found myself doubting my senses (e.g., sight, hearing, smell, touch, and/or taste)	1	2	3	4	5	6	7
ii) More I found myself doubting my memory	1	2	3	4	5	6	7
iii) More I found myself doubting whether I had been paying proper attention	1	2	3	4	5	6	7
iv) More I found myself feeling confident that it had been conducted properly	1	2	3	4	5	6	7
v) More I found myself feeling uncertain that it had been conducted properly	1	2	3	4	5	6	7
vi) More details of the action I needed to attend to	1	2	3	4	5	6	7
vii) More evidence I needed to confirm that it had been done properly	1	2	3	4	5	6	7
viii) Longer it took	1	2	3	4	5	6	7
ix) More certain I was of my memory	1	2	3	4	5	6	7
x) More certain I was that I had been paying proper attention	1	2	3	4	5	6	7
xi) More certain I was that it had been conducted properly	1	2	3	4	5	6	7

13. How did you decide when to stop? (read all and then rank order all that apply)

1. Felt *completely certain* it was okay to stop___
2. Felt *certain enough* that it was okay to stop___
3. Got the right feeling ___
4. Had to stop because there was something else I had to do instead___
5. Was too tired to continue___
6. Was interrupted by something or someone___
7. Knew in my head that it was okay to stop (even if I didn't feel it)___
8. Someone else reassured me it was okay to stop___
9. Other (please specify) _____

DAY ONE- EVENING Date: _____

Time of diary completion:_____

Time of episode: _____

Please complete at the first available opportunity following a compulsive episode.

1. What was the obsessional thought, image or fear preceding the compulsive episode?

_____

_____

2. What was the compulsive act?

_____

_____

3. How discomforting was this obsessional thought, image or fear? (circle the number that best applies)

1	2	3	4	5	6	7
not at all discomforting						very discomforting

4. How awful would the consequences of not performing the compulsion have been?

1	2	3	4	5	6	7
not at all awful						extremely awful

5. How certain did you need to be that the compulsion had been done properly?

1	2	3	4	5	6	7
didn't need to be certain at all						needed to be 100% certain

6. How long did the episode last? ___ hours ___ minutes

7. How many times did you repeat the compulsion within this episode? ____

8. How much <u>general relief</u> did you feel upon completion of this compulsive episode?

1	2	3	4	5	6	7
no relief at all						total and complete relief

9. To what extent did you feel a <u>relief of guilt</u> upon completion of this compulsive episode?

1	2	3	4	5	6	7
no relief at all						total and complete relief

10. To what extent did you feel a <u>relief of responsibility</u> upon completion of this compulsive episode?

1	2	3	4	5	6	7
no relief at all						total and complete relief

11. To what extent did you feel a <u>reduction in distress</u> upon completion of this compulsive episode?

1	2	3	4	5	6	7
no reduction at all						complete reduction

If the compulsion was only <u>done once during this episode, skip to question 13</u>.

12. If you did the compulsion more than once, please answer the following questions:

a) What made you do the compulsion the second time? (please use your own words)

_____
_____
_____
_____

b) Please answer each of the following using the scale where
1= Strongly Disagree, 7 = Strongly Agree

The more I repeated the compulsion, the:

i)	More I found myself doubting my senses (e.g., sight, hearing, smell, touch, and/or taste)	1	2	3	4	5	6	7
ii)	More I found myself doubting my memory	1	2	3	4	5	6	7
iii)	More I found myself doubting whether I had been paying proper attention	1	2	3	4	5	6	7
iv)	More I found myself feeling confident that it had been conducted properly	1	2	3	4	5	6	7
v)	More I found myself feeling uncertain that it had been conducted properly	1	2	3	4	5	6	7
vi)	More details of the action I needed to attend to	1	2	3	4	5	6	7
vii)	More evidence I needed to confirm that it had been done properly	1	2	3	4	5	6	7
viii)	Longer it took	1	2	3	4	5	6	7
ix)	More certain I was of my memory	1	2	3	4	5	6	7
x)	More certain I was that I had been paying proper attention	1	2	3	4	5	6	7
xi)	More certain I was that it had been conducted properly	1	2	3	4	5	6	7

13. How did you decide when to stop? (read all and then rank order all that apply)

1. Felt *completely certain* it was okay to stop___
2. Felt *certain enough* that it was okay to stop___
3. Got the right feeling ___
4. Had to stop because there was something else I had to do instead___
5. Was too tired to continue___
6. Was interrupted by something or someone___
7. Knew in my head that it was okay to stop (even if I didn't feel it)___
8. Someone else reassured me it was okay to stop___
9. Other (please specify) _____

Figures

Figure A: *Post-task responsibility ratings as a function of stove fixations during the check phase*

Figure B: *Post-task harm estimates as a function of stove fixations during the check phase*

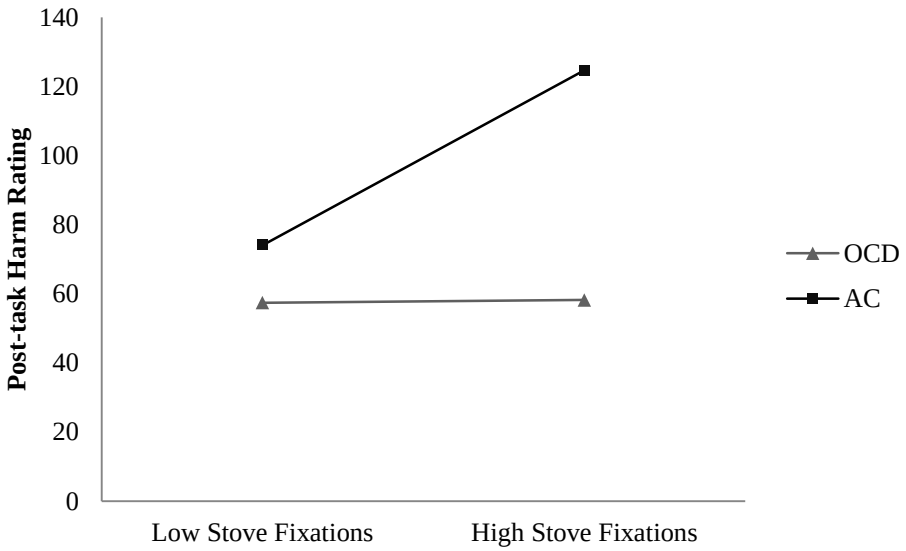


Figure C: *Post-task memory ratings as a function of stove fixations during the check phase*

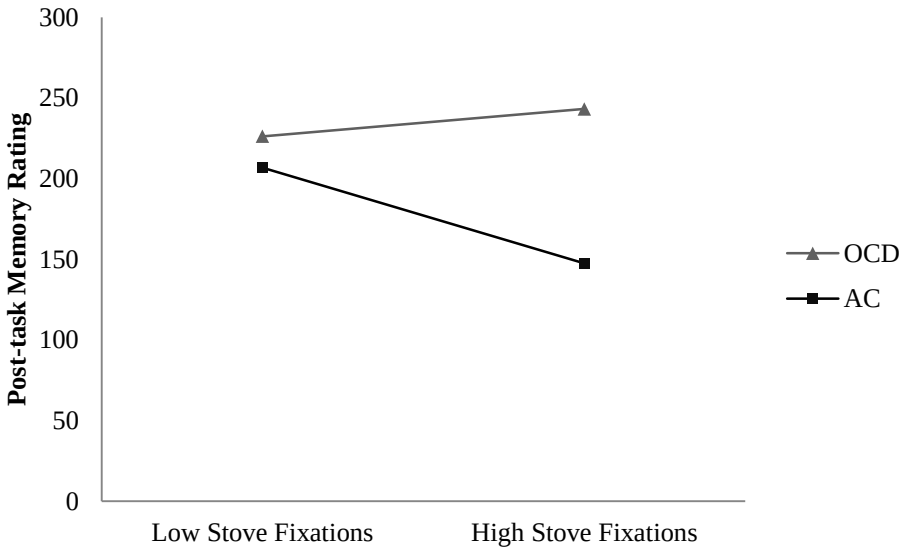


Figure D: *Post-task certainty ratings as a function of stove fixations during the pre-check phase*

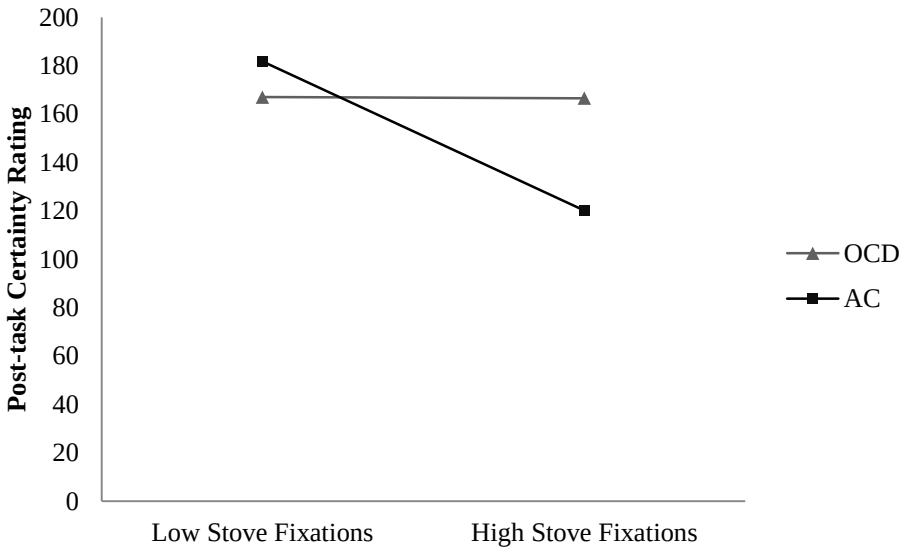
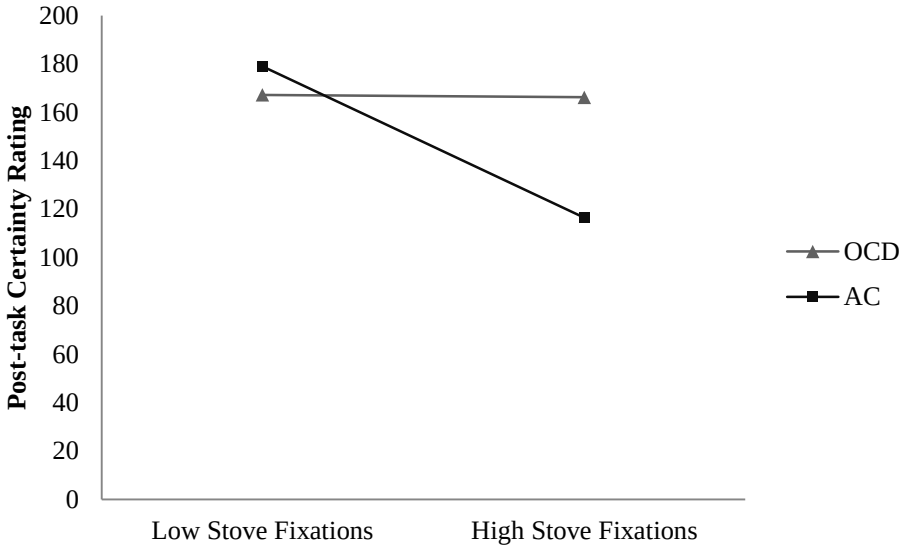


Figure E: *Post-check certainty ratings for low stove fixations and high stove fixations during the check phase*



Tables

Table 1

Diagnostic characteristics

	Diagnosis	Number (Percent) of Participants	
		OCD (*n*=36)	Anxious Control (*n*=24)
Principal Diagnosis	Obsessive-Compulsive Disorder	32 (88.9)	0
	Other Anxiety Disorder	4 (11.1)	21 (87.5)
	Mood Disorder	0	2 (8.3)
	Substance Abuse	0	1 (4.8)
Co-Principal Diagnosis	Obsessive-Compulsive Disorder	0	0
	Other Anxiety Disorder	3 (8.3)	3 (8.3)
	Mood Disorder	1 (2.8)	1 (4.2)
Additional Diagnosis	Obsessive-Compulsive Disorder	4 (11.1)	0
	Other Anxiety Disorder	30 (83.3)	18 (75.0)
	Mood Disorder	6 (16.7)	5 (20.8)
	Post-Traumatic Stress Disorder	0	1 (4.2)
	Substance Abuse	0	1 (4.2)
	Eating Disorder- NOS	1 (2.8)	0

Note. Some participants received more than one additional diagnosis, whereas others did not have any additional diagnoses.

Table 2

Means, standard deviations and t statistics for self-report measures across groups

		OCD (n=17)		Anxious Control (n=15)		Group Difference
VOCI	Total Score	99.9	(33.3)	44.4	(17.3)	6.0**
	Checking	16.1	(5.2)	2.5	(2.0)	10.0**
OBQ-44	Responsibility/ Threat Estimation	76.8	(19.8)	60.3	(14.7)	2.6*
	Perfectionism/ Need for Certainty	80.3	(18.6)	69.1	(17.0)	.46†
MACCS	General Memory Confidence	48.3	(13.0)	44.8	(13.5)	1.7†
	Attention/ Concentration	14.6	(3.8)	14.9	(3.7)	-.23
ACS	Total Score	50.5	(13.1)	42.9	(10.0)	1.8†

**p<.001, *p<.05, $^{\dagger}p$<.09

Note. Higher MACCS subscale scores indicate greater distrust

Table 3

Summary of sample contributing to eyetracking analyses

	OCD	Anxious Control
Total number of participants completed stove task	36	24
Completed with old eyetracker	14	1
New Eyetracker		
Lost to technical difficulties (e.g., poor calibration, equipment failed)	5	2
Did not rate any items as high threat[a]	8	8

[a]*Note*. Although these individuals were not included in analyses involving attention to idiosyncratic threat, they were included in analyses involving general fixations.

Table 4

Hierarchical regression analysis predicting check duration from memory and attention distrust

Step	Predictors	R^2	R^2_{change}	F_{change}
Dependent Variable: Check Duration				
1	Group	.111	.111	5.482
2	Group, MACCS-GM, ACS	.122	.011	.266
3	Group, MACCS-GM, ACS, Group × MACCS-GM, Group × ACS	.124	.002	.039

Coefficients	sr^2	β	t
Step 1			
Group	.111	-.333	-2.341
Step 2			
Group	.100	-.324	-2.183*
MACCS-GM	.007	-.095	-.587
ACS	.009	.105	.642
Step 3			
Group	.000	-.067	-.044
MACCS-GM	.007	-.121	-.577
ACS	.009	.126	.634
Group × MACCS-GM	.001	.163	.251
Group × ACS	.001	-.411	-.235

** Result significant at 0.01 level (2-tailed)

* Result significant at 0.05 level (2-tailed)

MACCS-GM= Memory and Cognitive Confidence Scale: General Memory; ACS= Attention Control Scale

. *Note.* Higher MACCS subscale scores indicate greater distrust

Table 5

Hierarchical regression analysis predicting check duration from responsibility and harm estimates

Step	Predictors	R^2	R^2_{change}	F_{change}
Dependent Variable: Check Duration				
1	Group	.111	.111	5.514
2	Group, T1 Responsibility, T1 Harm	.132	.020	.490
3	Group, T1 Responsibility, T1 Harm, Group × T1 Responsibility, Group × T1 Harm	.135	.004	.088

Coefficients	sr^2	β	t
Step 1			
Group	.111	- .334	- 2.348*
Step 2			
Group	.100	- .306	- 2.007*
T1 Responsibility	.007	- .141	- .809
T1 Harm	.009	.167	.919
Step 3			
Group	.000	- .617	- .413
T1 Responsibility	.007	- .148	- .681
T1 Harm	.009	.132	.592
Group × T1 Responsibility	.001	.147	.088
Group × T1 Harm	.001	.164	.314

** Result significant at 0.01 level (2-tailed)

* Result significant at 0.05 level (2-tailed)

Table 6

Hierarchical regression analysis predicting post-task responsibility from check duration

Step	Predictors	R^2	R^2_{change}	F_{change}
Dependent Variable: T2 Responsibility				
1	Group, T1 Responsibility	.277	.277	8.242**
2	Group, T1 Responsibility, Check Duration	.296	.019	1.134
3	Group, T1 Responsibility, Check Duration, Group × Check Duration	.327	.031	1.859

Coefficients	sr^2	β	t
Step 1			
Group	.023	- .154	- 1.160
T1 Responsibility	.214	.473	3.574**
Step 2			
Group	.009	- .105	- .752
T1 Responsibility	.223	.483	3.646**
Check Duration	.019	.146	1.065
Step 3			
Group	.038	- .329	- 1.532
T1 Responsibility	.221	.481	3.664**
Check Duration	.007	.094	.669
Group × Check Duration	.031	.275	1.363

** Result significant at 0.01 level (2-tailed)

* Result significant at 0.05 level (2-tailed)

T1 Responsibility= pre-task responsibility estimate; Check duration= time from target knob off to leaving kitchen

Table 7

Hierarchical regression analysis predicting post-task harm estimates from check duration

Step	Predictors	R^2	R^2_{change}	F_{change}
Dependent Variable: T2 Harm				
1	Group, T1 Harm	.183	.183	4.710*
2	Group, T1 Harm, Check Duration	.267	.083	4.659*
3	Group, T1Harm, Check Duration, Group × Check Duration	.283	.017	.933
Coefficients		*sr²*	*β*	*t*
Step 1				
	Group	.000	.023	.158
	T1 Harm	.017	.435	2.957*
Step 2				
	Group	.011	.116	.789
	T1 Harm	.148	.407	2.876
	Check Duration	.084	.307	2.159*
Step 3				
	Group	.028	.292	1.247
	T1 Harm	.162	.434	3.006*
	Check Duration	.097	.344	2.333
	Group × Check Duration	.017	- .207	- .966

** Result significant at 0.01 level (2-tailed)

* Result significant at 0.05 level (2-tailed)

T1 Harm= pre-task harm estimates; Check duration= time from target knob off to leaving kitchen

Table 8

Hierarchical regression analysis predicting post-task certainty from check duration

Step	Predictors	R^2	R^2_{change}	F_{change}
Dependent Variable: T2 Certainty				
1	Group	.004	.004	.170
2	Group, Check Duration	.169	.165	8.348
3	Group, Check Duration, Group × Check Duration	.169	.000	.000
Coefficients		sr^2	β	t
Step 1				
Group		.004	- .063	- .413
Step 2				
Group		.035	- .198	- 1.335
Check Duration		.165	- .428	- 2.889
Step 3				
Group		.015	- .199	- .853
Check Duration		.154	- .428	- 2.751
Group × Check Duration		.000	.001	.005

** Result significant at 0.01 level (2-tailed)

* Result significant at 0.05 level (2-tailed)

Check duration= time from target knob off to leaving kitchen

Table 9

Hierarchical regression analysis predicting post-task memory from check duration

Step	Predictors	R^2	R^2_{change}	F_{change}
Dependent Variable: T2 Memory				
1	Group,	.026	.026	1.156
2	Group, Check Duration	.058	.032	1.421
3	Group, Check Duration, Group × Check Duration	.072	.014	.623
Coefficients		*sr²*	*β*	*t*
Step 1				
Group		.026	.162	1.075
Step 2				
Group		.009	.102	.649
Check Duration		.003	- .188	- 1.192
Step 3				
Group		.001	- .046	-.187
Check Duration		.042	- .223	- 1.355
Group × Check Duration		.014	.185	.789

** Result significant at 0.01 level (2-tailed)

* Result significant at 0.05 level (2-tailed)

Check duration= time from target knob off to leaving kitchen

Table 10

Hierarchical regression analysis predicting post-task responsibility from stove fixations during the pre-check phase

Step	Predictors	R^2	R^2_{change}	F_{change}
Dependent Variable: T2 Responsibility				
1	Group, T1 Responsibility	.256	.256	4.814*
2	Group, T1 Responsibility, Pre-Check Stove Fixations	.261	.005	.183
3	Group, T1 Responsibility, Pre-Check Stove Fixations, Group × Pre-Check Stove Fixations	.270	.009	.326

Coefficients	sr^2	β	t
Step 1			
Group	.000	.013	.078
T1 Responsibility	.239	.509	2.999
Step 2			
Group	.000	- .005	- .026
T1 Responsibility	.232	.504	2.912
Pre-Check Stove Fixations	.005	.073	.427
Step 3			
Group	.007	.210	.504
T1 Responsibility	.233	.505	2.882
Pre-Check Stove Fixations	.014	.165	.699
Group × Pre-Check Stove Fixations	.009	- .270	- .571

** Result significant at 0.01 level (2-tailed)

* Result significant at 0.05 level (2-tailed)

T1 Responsibility= pre-task responsibility estimate

Table 11

Hierarchical regression analysis predicting post-task responsibility from stove fixations during the check phase

Step	Predictors	R^2	R^2_{change}	F_{change}
Dependent Variable: T2 Responsibility				
1	Group, T1 Responsibility	.297	.297	5.493**
2	Group, T1 Responsibility, Check Stove Fixations	.329	.032	1.194
3	Group, T1 Responsibility, Check Stove Fixations, Group × Check Stove Fixations	.447	.118	5.137*

Coefficients	sr^2	β	t
Step 1			
Group	.003	.055	.324
T1 Responsibility	.291	.556	3.276**
Step 2			
Group	.002	.046	.274
T1 Responsibility	.220	.503	2.863**
Check Stove Fixations	.032	.186	1.093
Step 3			
Group	.066	- .460	- 1.685
T1 Responsibility	.291	.539	3.293**
Check Stove Fixations	.004	- .062	- .323
Group × Check Stove Fixations	.436	.660	2.267*

** Result significant at 0.01 level (2-tailed)

* Result significant at 0.05 level (2-tailed)

T1 Responsibility= pre-task responsibility estimate

Table 12

Hierarchical regression analysis predicting post-task responsibility from threat fixations during the pre-check phase

Step	Predictors	R^2	R^2_{change}	F_{change}
Dependent Variable: T2 Responsibility				
1	Group, T1 Responsibility	.256	.256	4.814*
2	Group, T1 Responsibility, Pre-Check Threat Fixations	.303	.047	1.839
3	Group, T1 Responsibility, Pre-Check Threat Fixations, Group × Pre-Check Threat Fixations	.304	.000	.013

Coefficients	sr^2	β	t
Step 1			
Group	.000	.013	.078
T1 Responsibility	.239	.509	2.999**
Step 2			
Group	.000	- .009	- .052
T1 Responsibility	.259	.534	3.172**
Pre-Check Threat Fixations	.048	.221	1.356
Step 3			
Group	.000	.009	0.390
T1 Responsibility	.259	.537	3.094**
Pre-Check Threat Fixations	.036	.234	1.153
Group × Pre-Check Threat Fixations	.000	- .029	- .113

** Result significant at 0.01 level (2-tailed)

* Result significant at 0.05 level (2-tailed)

T1 Responsibility= pre-task responsibility estimate

Table 13

Hierarchical regression analysis predicting post-task responsibility from threat fixations during the check phase

Step	Predictors	R^2	R^2_{change}	F_{change}
Dependent Variable: T2 Responsibility				
1	Group, T1 Responsibility	.297	.297	5.493**
2	Group, T1 Responsibility, Check Threat Fixations	.298	.001	.043
3	Group, T1 Responsibility, Check Threat Fixations, Group × Check Threat Fixations	.298	.000	.001

Coefficients	sr^2	β	t
Step 1			
Group	.003	.055	.324
T1 Responsibility	.291	.556	3.276**
Step 2			
Group	.004	.076	.378
T1 Responsibility	.286	.554	3.195**
Check Threat Fixations	.001	-.041	- .206
Step 3			
Group	.003	.074	.324
T1 Responsibility	.282	.554	3.104**
Check Threat Fixations	.000	-.082	- .057
Group × Check Threat Fixations	.000	.043	.029

** Result significant at 0.01 level (2-tailed)

* Result significant at 0.05 level (2-tailed)

T1 Responsibility= pre-task responsibility estimate

Table 14

Hierarchical regression analysis predicting post-task responsibility from idiosyncratic high threat fixations during the pre-check phase

Step	Predictors	R^2	R^2_{change}	F_{change}
Dependent Variable: T2 Responsibility				
1	Group, T1 Responsibility	.256	.256	4.814**
2	Group, T1 Responsibility, Pre-check Idiosyncratic High Threat Fixations	.256	.000	.013
3	Group, T1 Responsibility, Pre-check Idiosyncratic High Threat Fixations, Group × Pre-Check Idiosyncratic High Threat Fixations	.268	.012	.416

Coefficients	sr^2	β	t
Step 1			
Group	.000	.013	.078
T1 Responsibility	.239	.509	2.999**
Step 2			
Group	.000	.006	.032
T1 Responsibility	.231	.506	2.895**
Pre-Check Idiosyncratic High Threat Fixations	.000	.020	.115
Step 3			
Group	.002	.047	.237
T1 Responsibility	.210	.488	2.727*
Pre-Check Idiosyncratic High Threat Fixations	.012	.430	.651
Group × Pre-Check Idiosyncratic High Threat Fixations	.012	-.438	- .645

** Result significant at 0.01 level (2-tailed)

* Result significant at 0.05 level (2-tailed)

T1 Responsibility= pre-task responsibility estimate

Table 15

Hierarchical regression analysis predicting post-task responsibility from idiosyncratic high threat fixations during the check phase

Step	Predictors	R^2	R^2_{change}	F_{change}
Dependent Variable: T2 Responsibility				
1	Group, T1 Responsibility	.256	.256	4.814**
2	Group, T1 Responsibility, Check Idiosyncratic High Threat Fixations	.299	.043	1.644
3	Group, T1 Responsibility, Check Idiosyncratic High Threat Fixations, Group × Check Idiosyncratic High Threat Fixations	.299	.001	.033

Coefficients	sr^2	β	t
Step 1			
Group	.000	.013	.006
T1 Responsibility	.239	.509	8.992**
Step 2			
Group	.000	-.020	.014
T1 Responsibility	.195	.469	7.518**
Check Idiosyncratic High Threat Fixations	.043	.212	1.644
Step 3			
Group	.000	-.005	.001
T1 Responsibility	.188	.464	6.975**
Check Idiosyncratic High Threat Fixations	.018	.261	.677
Group × Check Idiosyncratic High Threat Fixations	.001	-.061	.033

** Result significant at 0.01 level (2-tailed)

* Result significant at 0.05 level (2-tailed)

T1 Responsibility= pre-task responsibility estimate

Table 16

Hierarchical regression analysis predicting post-task harm from stove fixations during the pre-check phase

Step	Predictors	R^2	R^2_{change}	F_{change}
Dependent Variable: T2 Harm				
1	Group, T1 Harm	.142	.142	2.230
2	Group, T1 Harm, Pre-Check Stove Fixations	.144	.002	.072
3	Group, T1 Harm, Pre-Check Stove Fixations, Group × Pre-Check Stove Fixations	.144	.001	.002

Coefficients	sr^2	β	t
Step 1			
Group	.005	.071	.381
T1 Harm	.141	.390	2.101*
Step 2			
Group	.003	.060	.313
T1 Harm	.138	.388	2.051*
Pre-Check Stove Fixations	.002	.050	.268
Step 3			
Group	.000	.043	.092
T1 Harm	.136	.387	1.993
Pre-Check Stove Fixations	.001	.042	.161
Group × Pre-Check Stove Fixations	.000	.021	.040

** Result significant at 0.01 level (2-tailed)

* Result significant at 0.05 level (2-tailed)

T1Harm= pre-task harm estimate

Table 17

Hierarchical regression analysis predicting post-task harm from stove fixations during the check phase

Step	Predictors	R^2	R^2_{change}	F_{change}
Dependent Variable: T2 Harm				
1	Group, T1 Harm	.178	.178	2.699
2	Group, T1 Harm, Check Stove Fixations	.246	.068	2.173
3	Group, T1 Harm, Check Stove Fixations, Group × Check Stove Fixations	.315	.171	6.736**

Coefficients	sr^2	β	t
Step 1			
Group	.004	.067	.361
T1 Harm	.176	.432	2.315*
Step 2			
Group	.005	.072	.396
T1 Harm	.154	.406	2.213*
Check Stove Fixations	.068	.263	1.474
Step 3			
Group	.093	-.565	- 1.912
T1 Harm	.105	.340	2.036
Check Stove Fixations	.000	-.023	- .116
Group × Check Stove Fixations	.171	.794	2.595*

** Result significant at 0.01 level (2-tailed)

* Result significant at 0.05 level (2-tailed)

T1Harm= pre-task harm estimate

Table 18

Hierarchical regression analysis predicting post-task harm from threat fixations during the pre-check phase

Step	Predictors	R^2	R^2_{change}	F_{change}
Dependent Variable: T2 Harm				
1	Group, T1 Harm,	.142	.142	2.230
2	Group, T1 Harm, Pre-Check Threat Fixations	.176	.034	1.066
3	Group, T1 Harm, Pre-check Threat Fixations, Group × Pre-Check Threat Fixations	.183	.007	.228

Coefficients	sr^2	β	t
Step 1			
Group	.005	.071	.381
T1 Harm	.141	.390	2.101*
Step 2			
Group	.002	.047	.250
T1 Harm	.132	.380	2.044
Pre-Check Threat Fixations	.034	.185	1.032
Step 3			
Group	.008	.124	.497
T1 Harm	.131	.377	2.001
Pre-Check Threat Fixations	.040	.245	1.109
Group × Pre-Check Threat Fixations	.009	-.135	- .478

** Result significant at 0.01 level (2-tailed)

* Result significant at 0.05 level (2-tailed)

T1Harm= pre-task harm estimate

Table 19

Hierarchical regression analysis predicting post-task harm from threat fixations during the check phase

Step	Predictors	R^2	R^2_{change}	F_{change}
Dependent Variable: T2 Harm				
1	Group, T1 Harm,	.178	.178	2.699
2	Group, T1 Harm, Check Threat Fixations	.267	.089	2.930
3	Group, T1 Harm, Check Threat Fixations, Group × Check Threat Fixations	.347	.080	2.810

Coefficients	sr^2	β	t
Step 1			
Group	.004	.067	.361
T1 Harm	.176	.432	2.315*
Step 2			
Group	.046	.262	1.232
T1 Harm	.192	.452	2.508*
Check Threat Fixations	.089	-.355	- 1.712
Step 3			
Group	.094	.402	1.814
T1 Harm	.130	.382	2.134*
Check Threat Fixations	.058	2.107	1.421
Group × Check Threat Fixations	.109	-2.563	- 1.676

** Result significant at 0.01 level (2-tailed)

* Result significant at 0.05 level (2-tailed)

T1Harm= pre-task harm estimate

Table 20

Hierarchical regression analysis predicting post-task harm from idiosyncratic high threat fixations during the pre-check phase

Step	Predictors	R^2	R^2_{change}	F_{change}
Dependent Variable: T2 Harm				
1	Group, T1 Harm,	.142	.142	2.230
2	Group, T1 Harm, Pre-check Idiosyncratic High Threat Fixations	.206	.064	2.111
3	Group, T1 Harm, Pre-check Idiosyncratic High Threat Fixations, Group × Pre-Check Idiosyncratic High Threat Fixations	.226	.019	.627

Coefficients	sr^2	β	t
Step 1			
Group	.005	.071	.381
T1 Harm	.141	.390	2.101*
Step 2			
Group	.001	.031	.166
T1 Harm	.095	.330	1.767
Pre-Check Idiosyncratic High Threat Fixations	.065	.261	1.453
Step 3			
Group	.002	-.048	- .230
T1 Harm	.099	.336	1.784
Pre-Check Idiosyncratic High Threat Fixations	.000	.036	.105
Group × Pre-Check Idiosyncratic High Threat Fixations	.024	.282	.792

** Result significant at 0.01 level (2-tailed)

* Result significant at 0.05 level (2-tailed)

T1 Harm= pre-task harm estimate

Table 21

Hierarchical regression analysis predicting post-task harm from idiosyncratic high threat fixations during the check phase

Step	Predictors	R^2	R^2_{change}	F_{change}
Dependent Variable: T2 Harm				
1	Group, T1 Harm,	.142	.142	2.230
2	Group, T1 Harm, Check Idiosyncratic High Threat Fixations	.206	.064	2.111
3	Group, T1 Harm, Check Idiosyncratic High Threat Fixations, Group × Check Idiosyncratic High Threat Fixations	.226	.019	.627

Coefficients	sr^2	β	t
Step 1			
Group	.005	.071	.381
T1 Harm	.141	.390	2.101*
Step 2			
Group	.001	.031	.166
T1 Harm	.095	.330	1.767
Check Idiosyncratic High Threat Fixations	.065	.261	1.453
Step 3			
Group	.002	-.048	- .230
T1 Harm	.099	.336	1.784
Check Idiosyncratic High Threat Fixations	.000	.036	.105
Group × Check Idiosyncratic High Threat Fixations	.024	.282	.792

** Result significant at 0.01 level (2-tailed)

* Result significant at 0.05 level (2-tailed)

T1Harm= pre-task harm estimate

Table 22

Hierarchical regression analysis predicting post-task memory confidence from stove fixations during the pre-check phase

Step	Predictors	R^2	R^2_{change}	F_{change}
Dependent Variable: T2 Memory				
1	Group,	.011	.011	.300
2	Group, Pre-Check Stove Fixations	.135	.124	3.875
3	Group, Pre-Check Stove Fixations, Group × Pre-Check Stove Fixations	.140	.005	.162

Coefficients	sr^2	β	t
Step 1			
Group	.011	.103	.547
Step 2			
Group	.025	.159	.875
Pre-Check Stove Fixations	.124	-.357	-1.969
Step 3			
Group	.016	.341	.696
Pre-Check Stove Fixations	.058	-.303	-1.326
Group × Pre-Check Stove Fixations	.005	-.212	-.402

** Result significant at 0.01 level (2-tailed)

* Result significant at 0.05 level (2-tailed)

Table 23

Hierarchical regression analysis predicting post-task memory confidence from stove fixations during the check phase

Step	Predictors	R^2	R^2_{change}	F_{change}
Dependent Variable: T2 Memory				
1	Group,	.007	.007	.193
2	Group, Check Stove Fixations	.055	.048	1.320
3	Group, Check Stove Fixations, Group × Check Stove Fixations	.314	.258	9.413*
Coefficients		sr^2	β	t
Step 1				
Group		.007	.084	.440
Step 2				
Group		.006	.079	.414
Check Stove Fixations		.048	-.219	- 1.149
Step 3				
Group		.699	.836	2.813
Check Stove Fixations		.017	.132	.656
Group × Check Stove Fixations		.943	-.971	-3.068*

** Result significant at 0.01 level (2-tailed)

* Result significant at 0.05 level (2-tailed)

Table 24

Hierarchical regression analysis predicting post-task memory confidence from threat fixations during the pre-check phase

Step	Predictors	R^2	R^2_{change}	F_{change}
Dependent Variable: T2 Memory				
1	Group,	.011	.011	.300
2	Group, Pre-Check Threat Fixations	.016	.005	.150
3	Group, Pre-Check Threat Fixations, Group × Pre-Check Threat Fixations	.110	.094	2.738

Coefficients	sr^2	β	t
Step 1			
Group	.011	.103	.547
Step 2			
Group	.008	.092	.480
Pre-Check Threat Fixations	.005	.075	.387
Step 3			
Group	.021	-.201	-.780
Pre-Check Threat Fixations	.013	-.138	-.607
Group × Pre-Check Threat Fixations	.095	.492	1.655

** Result significant at 0.01 level (2-tailed)

* Result significant at 0.05 level (2-tailed)

Table 25

Hierarchical regression analysis predicting post-task memory confidence from threat fixations during the check phase

Step	Predictors	R^2	R^2_{change}	F_{change}
Dependent Variable: T2 Memory				
1	Group,	.007	.007	.193
2	Group, Check Threat Fixations	.034	.027	.723
3	Group, Check Threat Fixations, Group × Check Threat Fixations	.034	.000	.004

Coefficients	sr^2	β	t
Step 1			
Group	.007	.084	.440
Step 2			
Group	.000	-.020	-.089
Check Threat Fixations	.027	.194	.850
Step 3			
Group	.000	-.028	-.106
Check Threat Fixations	.000	.091	.056
Group × Check Threat Fixations	.000	.108	.063

** Result significant at 0.01 level (2-tailed)

* Result significant at 0.05 level (2-tailed)

Table 26

Hierarchical regression analysis predicting post-task memory confidence from idiosyncratic high threat fixations during the pre-check phase

Step	Predictors	R^2	R^2_{change}	F_{change}
Dependent Variable: T2 Memory				
1	Group,	.011	.011	.300
2	Group, Pre-Check Idiosyncratic High Threat Fixations	.014	.003	.087
3	Group, Pre-Check Idiosyncratic High Threat Fixations, Group × Pre-Check Idiosyncratic High Threat Fixations	.038	.024	.655

Coefficients	sr^2	β	t
Step 1			
Group	.011	.103	.547
Step 2			
Group	.009	.096	.497
Pre-Check Idiosyncratic High Threat Fixations	.003	.057	.295
Step 3			
Group	.000	.007	.032
Pre-Check Idiosyncratic High Threat Fixations	.010	-.189	-.524
Group × Pre-Check Idiosyncratic High Threat Fixations	.024	.313	.809

** Result significant at 0.01 level (2-tailed)

* Result significant at 0.05 level (2-tailed)

Table 27

Hierarchical regression analysis predicting post-task memory confidence from idiosyncratic high threat fixations during the check phase

Step	Predictors	R^2	R^2_{change}	F_{change}
Dependent Variable: T2 Memory				
1	Group,	.011	.011	.300
2	Group, Check Idiosyncratic High Threat Fixations	.062	.051	1.462
3	Group, Check Idiosyncratic High Threat Fixations, Group × Check Idiosyncratic High Threat Fixations	.062	.000	.000

Coefficients	sr^2	β	t
Step 1			
Group	.011	.103	.547
Step 2			
Group	.000	.021	.105
Check Idiosyncratic High Threat Fixations	.051	.240	1.211
Step 3			
Group	.000	.022	.102
Check Idiosyncratic High Threat Fixations	.004	.252	.344
Group × Check Idiosyncratic High Threat Fixations	.000	-.012	-.016

** Result significant at 0.01 level (2-tailed)

* Result significant at 0.05 level (2-tailed)

Table 28

Hierarchical regression analysis predicting post-task certainty from stove fixations during the pre-check phase

Step	Predictors	R^2	R^2_{change}	F_{change}
Dependent Variable: T2 Certainty				
1	Group,	.053	.053	1.563
2	Group, Pre-Check Stove Fixations	.164	.111	3.578
3	Group, Pre-Check Stove Fixations, Group × Pre-Check Stove Fixations	.353	.189	7.614**
Coefficients		sr^2	β	t
Step 1				
	Group	.053	-.230	- 1.250
Step 2				
	Group	.031	-.177	- .995
	Pre-Check Stove Fixations	.111	-.337	- 1.892
Step 3				
	Group	.114	.911	2.141*
	Pre-Check Stove Fixations	.000	-.015	- .073
	Group × Pre-Check Stove Fixations	.189	-1.260	-2.759**

** Result significant at 0.01 level (2-tailed)

* Result significant at 0.05 level (2-tailed)

Table 29

Hierarchical regression analysis predicting post-task certainty from stove fixations during the check phase

Step	Predictors	R^2	R^2_{change}	F_{change}
Dependent Variable: T2 Certainty				
1	Group,	.067	.067	1.930
2	Group, Check Stove Fixations	.208	.141	4.624*
3	Group, Check Stove Fixations, Group × Check Stove Fixations	.492	.285	14.032**

Coefficients	sr^2	β	t
Step 1			
Group	.067	-.258	- 1.389
Step 2			
Group	.071	-.267	- 1.532
Check Stove Fixations	.141	-.376	- 2.150*
Step 3			
Group	.086	.528	2.064*
Check Stove Fixations	.000	-.007	- .039
Group × Check Stove Fixations	.285	-1.019	-3.746**

** Result significant at 0.01 level (2-tailed)

* Result significant at 0.05 level (2-tailed)

Table 30

Hierarchical regression analysis predicting post-task certainty from threat fixations during the pre-check phase

Step	Predictors	R^2	R^2_{change}	F_{change}
Dependent Variable: T2 Certainty				
1	Group,	.053	.053	1.563
2	Group, Pre-Check Threat Fixations	.105	.052	1.569
3	Group, Pre-Check Threat Fixations, Group × Pre-Check Threat Fixations	.114	.009	.274

Coefficients	sr^2	β	t
Step 1			
Group	.053	-.230	-1.250
Step 2			
Group	.038	-.198	-1.076
Pre-Check Threat Fixations	.052	-.230	-1.252
Step 3			
Group	.044	-.291	-1.131
Pre-Check Threat Fixations	.059	-.297	-1.315
Group × Pre-Check Threat Fixations	.009	.155	.524

** Result significant at 0.01 level (2-tailed)

* Result significant at 0.05 level (2-tailed)

Table 31

Hierarchical regression analysis predicting post-task certainty from threat fixations during the check phase

Step	Predictors	R^2	R^2_{change}	F_{change}
Dependent Variable: T2 Certainty				
1	Group,	.067	.067	1.930
2	Group, Check Threat Fixations	.105	.038	1.114
3	Group, Check Threat Fixations, Group × Check Threat Fixations	.160	.055	1.630
Coefficients		sr^2	β	t
Step 1				
	Group	.067	-.258	-1.389
Step 2				
	Group	.104	-.383	-1.741
	Check Threat Fixations	.038	.232	1.056
Step 3				
	Group	.154	-.520	-2.145
	Check Threat Fixations	.042	-1.700	-1.112
	Group × Check Threat Fixations	.055	2.023	1.277

** Result significant at 0.01 level (2-tailed)

* Result significant at 0.05 level (2-tailed)

Table 32

Hierarchical regression analysis predicting post-task certainty from idiosyncratic high threat fixations during the pre-check phase

Step	Predictors	R^2	R^2_{change}	F_{change}
Dependent Variable: T2 Certainty				
1	Group,	.053	.053	1.563
2	Group, Pre-Check Idiosyncratic High Threat Fixations	.108	.055	1.669
3	Group, Pre-Check Idiosyncratic High Threat Fixations, Group × Pre-Check Idiosyncratic High Threat Fixations	.108	.000	.003

Coefficients	sr^2	β	t
Step 1			
Group	.053	-.230	-1.250
Step 2			
Group	.039	-.200	-1.091
Pre-Check Idiosyncratic High Threat Fixations	.055	-.237	-1.292
Step 3			
Group	.028	-.194	-.905
Pre-Check Idiosyncratic High Threat Fixations	.014	-.220	-.633
Group × Pre-Check Idiosyncratic High Threat Fixations	.000	-.021	-.057

** Result significant at 0.01 level (2-tailed)

* Result significant at 0.05 level (2-tailed)

Table 33

Hierarchical regression analysis predicting post-task certainty from idiosyncratic high threat fixations during the check phase

Step	Predictors	R^2	R^2_{change}	F_{change}
Dependent Variable: T2 Memory				
1	Group,	.053	.053	1.563
2	Group, Check Idiosyncratic High Threat Fixations	.069	.016	.466
3	Group, Check Idiosyncratic High Threat Fixations, Group × Check Idiosyncratic High Threat Fixations	.111	.042	1.241

Coefficients	sr^2	β	t
Step 1			
Group	.053	-.230	-1.250
Step 2			
Group	.067	-.276	-1.397
Check Idiosyncratic High Threat Fixations	.016	.135	.682
Step 3			
Group	.101	-.365	-1.718
Check Idiosyncratic High Threat Fixations	.027	-.627	-.881
Group × Check Idiosyncratic High Threat Fixations	.042	.823	1.114

** Result significant at 0.01 level (2-tailed)

* Result significant at 0.05 level (2-tailed)

Table 34

Mean compulsive episode duration (in minutes) and repetition with standard deviations in parentheses

Episode		Duration (minutes)	Repetition (number)
Day One	Morning	21.6 (33.0)	4.8 (4.5)
	Afternoon	46.0 (63.2)	3.6 (1.6)
	Evening	32.5 (33.9)	5.8 (6.4)
	Average	31.8 (35.3)	5.1 (3.2)
Day Two	Morning	39.3 (46.4)	5.3 (4.1)
	Afternoon	47.5 (70.3)	6.1 (7.2)
	Evening	37.0 (51.0)	3.4 (3.0)
	Average	40.7 (43.7)	5.2 (3.4)
Day Three	Morning	30.5 (31.7)	3.6 (4.0)
	Afternoon	24.7 (38.0)	5.9 (6.3)
	Evening	38.4 (58.0)	5.5 (5.6)
	Average	28.2 (32.4)	5.0 (3.4)

Table 35

Zero-order correlations of VOCI, OBQ-44, and cognitive confidence measures with proportion of successful compulsions

Measure		Proportion of Successful Episodes
VOCI	Total	-.342
	Checking	-.464*
	Contamination	.247
	Obsessions	-.394†
OBQ-44	Responsibility/Threat	-.480*
	Perfectionism/Certainty	-.306
	Importance/ Control of Thoughts	-.156
MACCS	General Memory Distrust	-.070
	Difficulties with Decision Making	-.143
	Attention/ Concentration	-.306
	High Standards	-.169

Note. Higher MACCS subscale scores indicate greater distrust (in General Memory, in Attention/Concentration). *$p<.05$, †$p<.08$

Table 36

Average episode duration and repetition for successful and unsuccessful compulsions

	Successful	Unsuccessful
Duration	30.5 (31.7)	51.0 (49.4)
Number of Repetitions	4.1 (2.5)	6.8 (4.4)
Number of Episodes	5.6 (2.6)	3.0 (2.3)

Table 37

Means, standard deviations and t statistics showing differences between successful and unsuccessful compulsions

	Successful M(SD)	Unsuccessful M(SD)	*t statistic*
Events prior to the compulsion			
Distress from Obsession	5.27 (1.05)	5.35 (1.03)	-.376
Need for Certainty	5.71 (.948)	5.58 (1.18)	.540
Events During the Compulsion			
Sensory/ Cognitive Doubt	4.02 (1.04)	4.66 (1.31)	-1.53
Elevated Evidence	4.17 (.780)	5.18 (1.02)	-5.15**
Relief of Responsibility	5.19 (1.27)	4.36 (1.39	2.39*
General Relief	5.49 (.923)	4.18 (1.19)	5.03**
Reduction in Distress	5.28 (1.08)	4.16 (1.25)	4.58**

**p<.001, *p<.05