What Predicts Safety Behaviour?
Examining the Phenomenology of Compulsive Washing

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

Leading models for understanding repetitive behaviour assert that concerns about the safety or well-being of oneself or others, combined with an overvalued sense of responsibility to protect oneself and others from harm, evoke anxiety (Rachman, 2002). This anxiety is not resolved until the person is able to feel certain that potential danger has been neutralized via some kind of action (Salkovskis, 1985; Rachman, 2002). We do not, however, have a good understanding of why that sense of certainty can be so elusive, at times leading to excessive repetitions of an action which are conducted at the expense of other tasks. Prominent explanations for this phenomenon suggest that beliefs such as distrust of memory, attention, or perception may influence parameters of safety behaviours (such as their duration) and that behaviour repetition can actually have a paradoxical effect on these beliefs, contributing to a self-perpetuating cycle. The purpose of the present study was to examine such factors as they relate to fears of contamination and repetitive or prolonged washing behaviours.

In the current study we examined the basic phenomenology of prolonged hand-washing, as well as cognitive factors that might contribute to the development and persistence of repetitive or prolonged washing behaviours. Through the use of a naturalistic paradigm, we examined the nature of washing behaviours and beliefs of those who were low versus high in fears of contamination. Findings provide data on the basic phenomenology of washing behaviours following contact with a potential contaminant and indicate that those who are high in fears of contamination might hold dysfunctional beliefs, such as inflated estimates of harm, that contribute to prolonged washing behaviour. Furthermore, the findings of the present study suggest that washing behaviours themselves can contribute to increases in dysfunctional beliefs that might serve to perpetuate washing behaviours, such as a lack of confidence in sensory

perception. These findings are considered within the theoretical context of cognitive-behavioural models of obsessive-compulsive disorder and clinical implications are discussed.

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Introduction

Obsessive-Compulsive Disorder (OCD) is a severe and persistent mental health problem estimated to be one of the top 20 causes of illness-related disability for individuals aged 15 to 44 years old (World Health Organization (WHO), 2001). Found to significantly impair quality of life in several domains, including the ability to work, perform household duties, maintain social relationships, and take pleasure in leisure activities (Eisen et al., 2006; Norberg, Calamari, Cohen, & Riemann, 2008), research suggests that OCD afflicts 2.3% of the population at some point in their lifetime (Chiu, Kessler, Ruscio, & Stein, 2010). As defined in the 5th edition of the Diagnostic and Statistical Manual of Mental Disorders (American Psychiatric Association, 2013), OCD is characterized by the presence of obsessions, defined as unwanted and recurrent, intrusive ideas, images, or impulses and compulsions, defined as repetitive behaviors or mental acts that are intended to reduce the anxiety evoked by obsessions. Common obsessions include persistent thoughts of germs or contamination, fears of accidentally harming another individual (e.g., hitting a pedestrian while driving), or doubting whether one has completed an action such as locking a door or turning off the stove (Clark & Purdon, 1993). Typical compulsions include excessive washing and cleaning, repeated checking (e.g., checking doors and appliances), counting, or arranging and rearranging items. The most common compulsions are washing and checking compulsions (Rachman, 2002).

In understanding OCD, it is important to recognize that the majority of healthy individuals report experiencing fairly frequent unwanted and unpleasant thoughts (Clark, 1992; Rachman & de Silva, 1978; Purdon & Clark, 1993). Similarly, Muris, Merckelbach and Clavan (1997) found that that 54% of the healthy adults they surveyed reported engaging in repetitive behaviours such as checking, washing, and superstitious acts, even though they recognized them

as unnecessary and/or excessive. Therefore, it is not simply the experience of intrusive thoughts or repetitive behaviours that separates those with OCD from the majority of the adult population. What, then, accounts for the fact that obsessional thoughts are common but clinically severe OCD is rare?

Leading models of OCD assert that a critical determining factor is the way in which intrusive thoughts are interpreted (Salkovskis, 1989). Salkovskis (1989) proposed that when an intrusion occurs its implications and the necessity of further action will be evaluated. If the intrusion is appraised as having few or no implications, as is the case for most individuals, then further processing of the intrusion is unlikely. However, in those vulnerable to developing OCD, intrusive thoughts activate concerns about the safety or well-being of oneself or loved ones combined with an overvalued sense of responsibility to protect oneself and others from harm, and thus evoke anxiety (Rachman, 2002; Salkovskis, 1989). There is now a large body of research that supports the idea that those with OCD report significantly higher levels of personal responsibility for harm than both anxious and non-anxious controls (e.g., Cougle, Lee, & Salkovskis, 2007; Foa, Sacks, Tolin, Prezworski, & Amir, 2002; Freeston, Ladouceur, Gagnon, & Thibodeau, 1992; Salkovskis et al., 2000).

In addition to experiencing distress due to a heightened sense of responsibility for harm, individuals with OCD often interpret obsessive thoughts as potentially revealing of negative aspects of the self (e.g., "These thoughts mean that I am damaged, wicked, likely to harm others"; Rachman, 1993; Salkovskis, 1985; 1999). A study by Ferrier & Brewin (2005) found that in comparison to anxious and non-anxious controls, those with OCD drew a significantly greater number of negative inferences about themselves based on their intrusive thoughts. Clark and Purdon (1993) argued that individuals vulnerable to developing OCD might also interpret

their inability to control their intrusive thoughts as evidence of the feared negative personal qualities. Additional beliefs and negative appraisals that might contribute to distress resulting from obsessions include inflated estimates of the probability and severity of harm, perfectionism and intolerance of uncertainty, and overestimation of the importance of thoughts (Obsessive Compulsive Cognitions Working Group, 2005).

Such beliefs and negative appraisals of intrusive thoughts evoke significant distress and anxiety and indicate to the individual that there is a need for action, both to reduce distress and to mitigate any perceived danger to the self or others (Salkovskis, 1989). As such, the individual engages in a compulsive behaviour. For example, an individual who has intrusive thoughts of contaminating others might wash their hands to prevent the spread of contamination and vindicate themselves of any responsibility for harm resulting from contamination. Within this context, the reasoning behind compulsive behaviours is easily comprehended.

However, for more than two decades, much of the research conducted on OCD has examined the content and beliefs involved in obsessions and intrusive thoughts while there has been relatively little work done to examine compulsions. One reason for this lacuna in the research is that obsessions may have been regarded as a more important component in the OCD model. If we view distress and fear resulting from the obsessions as the driving force of compulsions, then it makes sense to focus on obsessions: if one can eliminate the distress over the obsessions then this renders the compulsions irrelevant. Indeed, the frontline treatment for OCD, exposure and response prevention (ERP), is based on the principle that if individuals are exposed to their obsessions repeatedly, without being allowed to engage in compulsive behaviours, they will habituate to the obsessions and will no longer experience distress or anxiety in response to the obsessions, thus also eliminating the need to engage in compulsions

(Rowa, Antony, & Swinson, 2007). However, although this treatment is the most effective treatment to date for OCD, when the treatment refusal and drop-out rates are taken into account, this treatment is unsuccessful for 40 to 50% of patients (Abramowitz, 2006; Fisher & Wells, 2005). Therefore, there is still considerable opportunity for improvement in treatment efficacy, and this is likely to be accomplished through expanding our understanding of OCD. Current models of this disorder may be overlooking relevant factors that contribute to the persistence of OCD and hinder the effectiveness of current treatments.

What do we know about compulsions? Although it seems logical that distress and anxiety evoked by obsessions results in compulsive or neutralizing behaviours enacted to prevent harm, it is not clearly understood why individuals with OCD continue to engage in perseverative or prolonged neutralizing behaviours, repeating safety behaviours well beyond what would be considered effective by most. For example, individuals with OCD may check to make sure a task has been done correctly as many as 150 times consecutively or take a three-hour shower each morning (MacDonald & Davey, 2005; Rapoport, 1991). There may be aspects of the mental and physical actions involved in conducting the compulsions that perpetuate prolonged or repetitive behaviour.

For example, as previously stated, research has demonstrated that those with OCD report an inflated sense of responsibility for harm associated with potential negative consequences of their obsessions (Foa et al., 2002). This fear of being held responsible for harm is thought to yield compulsive behaviours (Salkovskis, 1989; Rachman, 2002; 2004). However, it has also been suggested that engaging in compulsive behaviour might serve to further increase estimates of personal responsibility (Rachman, 2002). Research has shown some preliminary evidence for this: after engaging in a check for safety, participants diagnosed with OCD reported an increase

in perceived personal responsibility (Rachman, 2002). Additionally, Bucarelli (2014) found that increased attention to threat during checking behaviours was associated with increased estimates of responsibility following the check. Therefore, an inflated sense of responsibility may not only contribute to the onset of compulsive behaviours, but might also be maintained or heightened through these behaviours.

There is also a large body of work examining whether compulsions persist because people with OCD have impairments in memory. The findings from this work have been very mixed (e.g. Harkin & Kessler, 2011; Hermans et al., 2008). When OCD relevant stimuli are actually used to test memory, several studies have found no differences between those with OCD and controls (e.g., Ceschi et al., 2003; Tolin et al., 2001; Karadag, Oguzhanoglu, Ozdel, Atesci, & Amuk, 2005). Some studies have also found that those with OCD show a memory bias towards threat related stimuli (e.g., which objects were contaminated, how many times they touched the stove), such that they showed significantly *more accurate* recall for these stimuli than neutral stimuli (Ceschi, Van der Linden, Dunker, Perroud, & Brédart, 2003; Radomsky, Rachman, & Hammond, 2001). Therefore, current support for the theory that those with OCD are simply forgetting previously enacted safety behaviours is weak. It is now generally accepted that the problem in OCD is not actual memory impairment but rather strong memory distrust and poor confidence in memory for objects, words and sentences, and actions (Karadag, 2005; Macdonald, Antony, Macleod, & Richter, 1997; McNally & Kohlbeck, 1993; Tolin et al., 2001). This lack of confidence would quite logically contribute to the desire to repeat actions (Abramowitz et al., 2014).

One possible explanation for memory distrust may be that the quality of the memory for having completed an action "properly" degrades across repetitions, as does confidence that the

action has been completed as desired. There is a growing body of research that has consistently found that repeating an action actually compromises rather than enhances memory. When people repeat an action (for example checking to see whether the burners on a stove are turned off) they report reduced vividness and detail of their memory for the action (Boschen & Vuksanovic, 2007; Coles, Radomsky, & Horng, 2006; Cougle, Salkovskis, & Wahl, 2007; Hermans et al., 2008; Van den Hout & Kindt, 2003). It has been suggested that as the number of repetitions increases, aspects of the action start to become processed automatically rather than deliberately and thus fewer cognitive resources are devoted to encoding specific details of the action, resulting in decreased vividness and clarity of memories (Van den Hout & Kindt, 2003). This erosion of memory clarity may in turn lead to distrust of the memories, which would lead to repeated behaviour. Furthermore, confidence in memory also appears to be susceptible to contextual factors such as the degree of personal responsibility for preventing harm. For example, the greater the feeling of personal responsibility for completing a checking task "properly", the lower the confidence in memory reported (Moritz et al., 2007; Radomsky et al., 2001).

Another factor that may be contributing to this reduced confidence in memory is the parsing of compulsive behaviours into many individual units (Boyer & Lienard, 2006). Individuals can describe behaviours at different levels of specificity. For example, one could reduce getting dressed into putting on pants, putting on a shirt, and then putting on socks and shoes; that is, three actions. Or this unit of behaviours could be described at a much more specific level, involving a higher level of detail: picking up our shoe, inserting our foot into the shoe, tying the laces, etc.; multiple actions. When describing behaviour, most individuals would describe the behaviour in terms of larger units of behaviour rather than including specific details

(Boyer & Lienard, 2006). However, research suggests that those with OCD split compulsive behaviour at a lower level (Boyer & Lienard, 2006). Rather than just "washing my hands", the behaviour becomes reduced into many steps such as "placing my hand on the tap, turning on the tap, ensuring that the water is a specific temperature, placing my hand in the water, further adjusting the temperature, squeezing soap onto my hand, etc." Additionally, research has shown that those with OCD include many non-functional or unnecessary actions in the completion of tasks such as washing one's hands or checking that a door is locked (e.g., Eilam, Zor, Fineberg, & Hermesh, 2012; Zor, Hermesh, Szechtman, & Eilam, 2009; Zor et al., 2009). Thus when completing a compulsive ritual there are many more steps to which to attend, each of which must be executed properly and remembered, which heavily taxes working memory. As the individual may have difficulty holding all steps in memory, this could contribute to doubting whether the compulsive behaviour has been executed correctly, ultimately leading the individual to repeat the behaviour in an attempt to gain confirmation (Boyer & Lienard, 2006).

Behavioural parsing is not the only factor that may increase working memory load for those with OCD. The style of decision-making used by those with OCD might also contribute. When we make decisions for which personal importance is low, then our decision-making is quite automatic (e.g., choosing which pair of black socks to wear). However, when we make a decision that has high personal importance (e.g., buying a house), the decision-making processes becomes much more deliberate and conscious. This level of processing requires many more cognitive resources. As those with OCD are more likely to report an increased sense of personal responsibility for preventing harm and are likely to have higher estimates of the severity and probability of harm, it follows that determining when to stop a behaviour enacted to ensure safety will be of higher significance to those with OCD. In support of this, research has shown

that when deciding whether to terminate a safety behaviour, people with OCD exhibit a more deliberate and conscious reasoning style, whereas for those without OCD the decision to stop a behaviour such as hand-washing is much more automatic (Wahl, Salkovskis, & Cotter, 2008).

When the personal importance of a decision is perceived as high a decision is made more purposefully and consciously and we also generally take into account more information before coming to a decision. Therefore, if individuals with OCD are treating the decision to terminate a behaviour as deliberate and conscious, they may take into consideration more information when determining when to stop that behaviour. Consistent with this, individuals with OCD require more evidence that a behaviour has been completed "properly" than do those without OCD (Wahl et al., 2008). Thus, they bring a greater number of criteria (e.g., auditory, tactile, visual, cognitive) to bear on the decision to stop a behaviour than do healthy controls. Therefore, individuals with OCD have a greater number of factors that must be maintained in working memory, further increasing cognitive load, and potentially contributing to lower confidence in memories.

Similar findings have also been reported in terms of confidence in attention and perception. Those with OCD have been found to report lower levels of confidence in their attention, or, their ability to maintain focus during a task (Hermans, Martens, De Cort, Pieters, & Eelen, 2003; Hermans et al., 2008). As well, confidence in attention has also been found to decrease with repeated behaviour (Hermans et al., 2003; 2008). Those with OCD also demonstrate distrust in their senses, questioning, for example, if they can trust what they have seen or what they have felt (Hermans et al., 2008). This doubt in attention and perception may further increase individuals' doubt towards whether compulsions have been completed

adequately, leading them to prolong or repeat a compulsive behaviour in order to gain confirmation.

This lack of trust in perception, memory, and attention, may also contribute to why those with OCD tend to rely on subjective criteria to determine when to stop a behaviour.
The cognitive behavioural model of OCD suggests that in response to the fear of being held responsible for harm, individuals use counter productive stopping criteria where they seek to achieve a particular subjective state in order to determine that they have correctly completed a behaviour (Salkovskis, 1999). It has been suggested that this subjective state is a feeling of completeness and of feeling "just right" (Salkovskis, 1999; Wahl et al., 2008). However it is much harder for an individual to evaluate these subjective states in comparison to relying on objective sensory input, and therefore it takes longer to determine when to terminate a behaviour (Salkovskis, 1999; Wahl et al., 2008). Research supports this, and has found that those who engage in compulsive behaviour rely on internal, subjective criterion such as a general sense of feeling clean, as opposed to objective, external criterion such as one's hands looking clean and not being sticky any more (Whal et al., 2008).

Related to the use of subjective criteria is Szechtman and Woody's (2004) concept of the "feeling of knowing". Their theory of repetitive behaviours in OCD emphasized that the fears present in OCD are focused on potential rather than imminent threat (for example, that someone will contract a disease because you did not wash your hands). However, it is difficult to determine when a potential danger has passed, as it is not tied to any real stimulus in the environment. Therefore, it is difficult or impossible to obtain external confirmation that there is no potential danger. Szechtman and Woody (2004) proposed that, in the absence of objective and explicit information we terminate our response to potential threats through an internal, implicitly

generated feeling of knowing. This feeling of knowing allows us to terminate thoughts, ideas, or actions that are motivated by concerns of potential harm to the self or others.

Szechtman and Woody proposed that those with OCD may not experience this feeling of knowing. Although they may know intellectually that there probably is no threat the knowledge may not be accompanied by a subjective feeling of knowing that the threat has passed or is negligible. As such, Szechtman and Woody suggested that those with OCD are haunted by a subjective feeling that something is wrong. Research conducted by Woody and colleagues (2005) supported this hypothesis. They hypnotized participants and told half that they would experience the regular feeling of satisfaction after washing their hands and half that when they washed they would feel little or no sense of satisfaction. It was found that those high in hypnotizability who were told that they would feel little or no satisfaction washed the longest, indicating that this sense of satisfaction is important to the termination of safety behaviours. This is also consistent with previously cited research by Wahl and colleagues (2008), which found that people who engaged in repetitive washing tended to rely on internal, subjective criteria (e.g., I feel clean, I have done it 10 times) as opposed to external, objective criteria (e.g., my hands look clean and no longer feel sticky; I have washed according to public health guidelines) to determine when to stop. In addition, this theory is consistent with the idea that safety behaviours are repeated when the person's sense of responsibility for preventing harm is excessively high, which changes the goal of very simple tasks, such as washing one's hands, from being rather minor (e.g., get rid of the dirt) to very major (e.g., prevent my family from getting a serious disease). When the stakes are high, we require a high degree of certainty that the behaviour has, indeed, averted harm before the behaviour can be stopped. Therefore, those with OCD may

strive to achieve an even greater internal feeling of certainty than the average person in order to terminate safety behaviours.

In summary, an inflated sense of responsibility for preventing harm, exaggerated estimates of the probability and severity of harm, and negative interpretations of intrusive thoughts may lead those with OCD to feel the need to engage in safety behaviours in response to obsessions. When these individuals engage in such behaviours they are likely to parse the behaviour into many individual steps, use a decision-making style that is suited to making decisions of high personal importance, attempt to satisfy many criteria to determine that the behaviour has been performed correctly and effectively, and rely on subjective evidence to determine if these criteria have been satisfied. Due to the load this places on working memory, they may doubt their memory of having completed the behaviour properly. They may also doubt their ability to maintain focus during the behaviour and might also question their perception and sensory input. As such, the behaviour is likely to be repeated as the individual attempts to gain certainty that it has been completed well enough to prevent harm. However, paradoxically, once the behaviour is repeated, the individual is likely to perceive an increased level of personal responsibility for preventing harm, increase their estimates of the probability and severity of potential harm, experience decreased confidence in their memory, attention, and perception, and further tax their working memory. Thus leading to additional repetition of the behaviour, perpetuating an insidious cycle.

However, although research has provided support for these relationships, research on repetitive actions has focused almost exclusively on repeated checking. Findings from the research on repetitive checking may not generalize completely to repetitive washing (Jones & Menzies, 1997; Lopatka & Rachman, 1995; Rachman, 1993). Whereas we know that people who

check repeatedly rely on their memory for the check to determine whether or not it was done correctly, we do not know if people who engage in repeated washing do the same. There is surprisingly little research on the phenomenology of repetitive acts, particularly washing behaviours. Thus it is difficult to either apply theories of checking to repetitive washing, nor to advance independent theories of repetitive washing. It is possible that memory confidence is less important to repeated washing than confidence in one's senses ("I don't see any dirt but can I trust my eyes?" or, "my hands feel really raw, so maybe I washed enough but what if my skin is overly sensitive?"). Furthermore, research does indicate that people who engage in repetitive washing, but not repetitive checking, exhibit a memory bias for sources of contamination (Ceschi et al., 2003; Radomsky & Rachman, 1999). Therefore, it may be the case that whereas people who engage in repetitive checking rely on their memory for contextual *safety* cues (e.g., the burner light being off), repetitive washers may rely on their memory for the *sources of contamination* (e.g., "I touched that dirty plate and that soiled cloth; have I washed enough to rid myself of the germs they would possess? Am I sure those are the only 'dirty' items I touched?"). Additionally, Lopatka and Rachman (1995) suggested that in comparison to compulsive checking, "distortions of responsibility play a lesser role in compulsive cleaning" (p. 673).

As well, much of the research that has been done on checking behaviours has involved lab studies that may lack ecological validity. For example, many studies have used a computerized stove to complete a checking task (e.g., Boschen & Vuksanovic, 2007; Van den Hout & Kindt, 2003). Additionally research on cognitive factors related to washing behaviours has relied heavily on questionnaires rather than behavioural measures (e.g., Taylor, Abramowitz, & McKay, 2005; Tolin, Brady, & Hannan, 2008; Wheaton, Abramowitz, Berman, Riemann, & Hale, 2010). To address such gaps in the literature, it is important to study compulsive

behaviours within a naturalistic environment and to not only consider the phenomenology of repetitive checking behaviours but also that of repetitive or prolonged washing behaviours.

Therefore, the current study used an ecologically valid paradigm to examine the phenomenology of repetitive washing behaviour and associated cognitive factors. A sample of individuals who were low and high in fears of contamination engaged in a contamination and washing task in our laboratory kitchen. The potential contaminant was designed to mimic the nature of contamination widely encountered in everyday life. Participants touched a damp sponge that they were informed *may* have come into contact with *trace* amounts of dirt, chemicals, or bacteria. Rachman (2004) highlighted that one salient property of contamination is that even a small amount of contamination "goes a long way" (p. 1230). As well, when contaminants are encountered in daily activities, there is often no obvious indicator that alerts us that the object harbouring these contaminants is most certainly contaminated. For example, when individuals touch a doorknob or an elevator button there is often no obvious visual, tactile, or olfactory indicator of contamination. However, there is a chance that some amount of dirt, bacteria, or chemicals (such as cleaning products) is present on these surfaces. Rachman (2004) noted that the triggers of fear of being contaminated are usually invisible and therefore difficult to identify or remove with certainty. We attempted to replicate such a trigger within the laboratory setting. A damp sponge (such as one that might be used to clean dishes) is a common household object that might be found in a kitchen and it is plausible that a sponge may be contaminated with dirt, bacteria, or chemicals. Aside from being dampened with tap water to provide a tactile indicator that the sponge had come into contact with *something*, the sponge used in our study had no obvious indicators of contamination: it was new and brightly coloured, bearing no indicators of being old or soiled, and was free from any unpleasant smells. Wiping

with the sponge left no tactile indicators of contamination such as stickiness or burning sensations. As well, the kitchen used was designed specifically for this type of study and was designed to look and function as a typical home kitchen. Individuals were left alone to wash their hands for as long as they desired following touching the potential contaminant to allow of unconstrained measurement of washing behaviour.

Finally, we also attempted to manipulate feelings of responsibility for preventing harm through the inclusion of a post-wash task about which participants were informed of prior to contaminating their hands. Following contaminating and washing their hands, half of the sample handled items that they were informed would be given to a vulnerable population, young children, and the other half handled papers that would later be discarded.

This design allowed us to measure the phenomenology of washing behaviours such as wash duration and actions involved in washing and to examine differences in these factors between those who were low and high in fears of contamination under low and high consequence conditions. As well, self-report measures administered at pre-contamination, post-contamination, and post –washing allowed us to examine the following research questions:

1. How do predictions of the probability and severity of harm differ between those who are low versus high in fears of contamination? Are these subjective experiences influenced by manipulating feelings of responsibility? If so, do the effects of the manipulation vary based on contamination fears?

2. Do estimates of harm and responsibility influence washing behaviour? Does the influence of these beliefs differ across those who are low versus high in fears of contamination?

3. Does wash duration have a paradoxical effect on post-wash estimates of responsibility or harm, feelings of contamination, confidence in memory of washing, quality of

memory, confidence in sensory perception, confidence in attention, or certainty that the wash was completed adequately? Is this more pronounced in individuals who are high in fears of contamination?

Participants were also asked to speak their thoughts aloud while washing their hands in order to gather information in real time about the cognitions involved in washing behaviour. We were specifically interested in thoughts that might indicate the criteria used to terminate washing behaviours.

Based on the previously reviewed literature, it was hypothesized that:

1. higher fears of contamination and a greater sense of responsibility would be associated with greater wash duration and increased repetitions of the behaviours involved in washing, as well as increased estimates of harm and lower confidence in memory, perception, and attention.

2. pre-wash beliefs regarding the likelihood and potential severity of harm as well as perceived responsibility would predict aspects of the wash such as the duration and frequency of washing and that this relationship would be stronger for those high in fears of contamination.

3. greater wash duration and frequency would predict paradoxical increases in post-wash feelings of responsibility, likelihood of harm, and severity of harm. Additionally, we predicted that longer wash duration and frequency would be associated with decreased confidence in memory, attention, and/or perception. Although, we suggested that confidence in sensory perception might be more related to prolonged washing than confidence in memory and attention.

4. the decision to stop washing would be based on cues relevant to subjective feelings of contamination rather than to safety, especially for those who were high in fears of contamination.

Method

Participants

A total of 80 participants (27% male) were recruited from a pool of undergraduate university students at the University of Waterloo. Participants ranged in age from 17 to 47 (M = 20.29, SD = 3.59). Eligibility for participation in the current study was based on earlier responses on the Concerns about Germs and Contamination subscale of the Dimensional Obsessive Compulsive Scale (described in the Measures section; Abramowitz et al., 2010). Individuals who scored within the established low or high ranges were eligible to complete this study. Those participants who scored more than 0.5 standard deviations below the reported non-clinical (student sample) mean (Abramowitz, 2010) composed the Low Contamination Fears group (LCF; n = 43; $M_{\text{DOCS Contamination Score}}$ = 0.21, SD = 0.41). Participants who scored greater than 0.5 standard deviations above the reported mean for those diagnosed with OCD (Abramowitz, 2010) were identified as the High Contamination Fears group (HCF; n = 37; $M_{\text{DOCS Contamination Score}}$ = 10.97, SD = 1.18). Participants were informed that the study could take up to an hour to complete and received one research participation credit for their psychology courses in appreciation of their time.

Of those in the LCF group, 23 were randomly assigned to the low responsibility level (LRL) condition and 20 were assigned to the high responsibility level (HRL) condition. Similarly, in the HCF group, 18 were randomly assigned to the LRL condition and 19 were assigned to the HRL condition.

Measures

Dimensional Obsessive Compulsive Scale (DOCS; Abramowitz et al., 2010). The DOCS is a 20- item measure designed to assess OCD symptom severity, including assessment of

obsessions, compulsions, and avoidance behaviour. Scores on this measure can be used to calculate a total score and four subscale scores. For the current study, the Concerns about Germs and Contamination subscale score was used to pre-select participants who were either low or high in fears of contamination. The Concerns about Germs and Contamination subscale has shown good internal consistency and convergent and divergent validity in both clinical and non-clinical samples (Abramowitz et al., 2010).

Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988). The PANAS is a 20-item questionnaire designed to measure positive and negative state affect. Participants are asked to use a 5-point Likert scale (*1 = very slightly or not at all – 5 = extremely*) to rate the extent to which they are currently experiencing ten positively valenced emotions and ten negatively valenced emotions. Each set of ten items is totaled to produce a positive affect scale rating and a negative affect scale rating. The PANAS has been widely used and has consistently demonstrated excellent psychometric properties (Crawford & Henry, 2010; Watson, Clark, & Tellegen, 1988).

Obsessive Beliefs Questionnaire (OBQ-44; OCCWG, 2005). The OBQ-44 was designed to measure beliefs considered important to the development and maintenance of OCD. Participants are asked to indicate the extent to which different statements are descriptive of their typical attitudes and beliefs. The ratings are totaled to calculate three subscale scores: Responsibility/Threat Estimation (e.g., "If I don't act when I foresee danger, then I am to blame for any consequences"), Perfectionism/Certainty (e.g., "I must be certain of my decisions), and Importance/Control of Thoughts (e.g., "For me, having bad urges is as bad as carrying them out). Each of these subscales has been found to have good internal consistency (OCCWG, 2005;

Tolin, Worhunsky, & Maltby, 2006) and the scale has shown good criterion-related and convergent validity in clinical and non-clinical samples (OCCWG, 2005).

Fear of Guilt Scale (FOGS; Chiang, 2013). The FOGS was developed to measure individuals' fear of being regarded as guilty or experiencing feelings of guilt and their engagement in behaviours to minimize, prevent, or atone for guilt. Agreement with items is rated on a 7-point Likert scale. The 49 items can be summed to derive a total score and two subscale scores: Reactive Response and Proactive Response to the feared feeling of guilt. The scale has shown excellent internal reliability and good validity in an undergraduate sample (Chiang, 2013).

Visual Analogue Scales (VAS). Ten centimeter visual analogue scales were used to collect ratings of perceived hand contamination, disgust, the likelihood of harm, the predicted severity of any potential harm, how responsible and guilty the participant would feel if any harm were to occur, the participant's certainty in his or her memory of washing, the level of detail in the participant's memory of washing, the vividness of the participant's memory of washing, the amount of attention allocated to washing, the participant's certainty that his or her attention was allocated to washing, the reliability of the participant's sight, the participant's tactile reliability, and the participant's general sensory reliability. Scores were based on the measured distance, in centimeters, between the far left edge of the line and the participant's vertical mark on the line.

Washing Variables. All videos were reviewed and coded for temporal and spatial aspects of hand-washing. *Wash Duration* was defined as the time between the moment an individual began the first action in their wash (e.g. turning on the tap, pressing on the soap pump) and the moment they completed the last action in their wash (e.g. throwing out the last paper towel). Additionally, in order to measure repetitions of washing behaviours we recorded the number of visits to the various objects and locations involved in hand-washing. The spatial coding scheme

was based on the work of Eilam and colleagues (2012), who suggested that the completion of rituals or tasks can be described in terms of the number of visits to and actions at the locations and objects involved in the ritual (e.g., the soap, taps, and towel involved in washing one's hands). In the present study, visits were defined as movement to and interaction with an object or location defined as part of the wash. Six objects and locations were defined as part of the washing rituals: the taps of the sink, the soap dispenser, the stream of water from the tap, the air in front of the participant (i.e. the space in front of the participant where participants held their hands while scrubbing or drying them), the paper towel dispenser, and the garbage. The variable *Total Visits* was calculated by summing the number of visits to each of these six objects and locations across the duration of the washing ritual.

Coding of Thoughts. Participants were asked to speak all of their thoughts aloud while washing their hands. These thoughts were transcribed and examined in order to gather information regarding the criteria individuals used to determine when to terminate washing behaviour. However, very few participants discussed what criteria they were using to determine when to stop washing (e.g. feelings of certainty that their hands were washed properly, changes in feelings of cleanliness, reference to public health guidelines or other standards regarding the recommended duration of hand-washing). As such, we were unable to code the thoughts for termination criteria or use the thoughts to compare termination criteria across groups. Therefore, the coded thoughts will not be discussed in the results section of this thesis.

Apparatus

Video and Audio Recording Equipment. Participant actions were recorded using a pinhole camera mounted through the bottom of the cupboards above the sink. This camera provided a wide-angle aerial view of the sink, the counter on either side of the sink, and the area in front of

the sink. High-resolution video was transmitted in real time to a computer in the lab room adjacent to the kitchen and was recorded directly to the hard drive using Dazzle DVD Recorder from Pinnacle Technologies. Pilot testing revealed that the microphone connected to the camera system was not sensitive enough to clearly record participants' voices in addition to the sound of the running water. As such, a Sony digital voice recorder placed on a ledge near the sink was used to record audio while the participants were washing.

Kitchen. The Purdon lab kitchen is a fully functional kitchen that is decorated to look and feel like a typical residential kitchen. It features a double sink, cupboards, small fridge, bistro-style table and chairs, and an electric four-burner stove.

Procedure

Participants first provided informed consent for participation and audio and video recording and completed a set of baseline measures: the PANAS (Baseline PANAS), OBQ-44, and FOGS. Upon completion of these questionnaires, participants were given instructions regarding the hand-washing task. Participants were informed that they would be asked to copy the experimenter's movements and rub their hands with a damp sponge that "may have come in contact with trace amounts of dirt, chemicals, or bacteria", after which they would be allowed to wash their hands for as long as they would like. Those in the HR condition were informed that following washing their hands, they would be given a variety of items and asked to make a gift bag that would be given to the young children in the onsite preschool. Participants in the LR condition were told that after they washed their hands, they would be asked to sort papers for recycling and shredding.

Participants then completed the Pre-Contamination questionnaire package containing a second PANAS (Pre-Contamination PANAS), and six 10 cm visual analogue scales (Pre-

Contamination VAS, included in Appendix A) that asked participants to rate how contaminated their hands were currently, how likely harm was to occur, the severity of the potential harm, how responsible and how guilty they would feel if harm were to occur, and how disgusted they currently felt.

It was then explained that while the participants were washing their hands, they would be asked to speak their thoughts aloud. In order to establish familiarity with voicing aloud their stream of consciousness, participants were asked to look at a picture for two minutes and voice their thoughts aloud (*cf.* Clark, Ball, & Pope, 1991). They were told that it was important that they say *all* of their thoughts aloud, even those that seemed insignificant or were not related to the picture.

After two minutes, the participants were asked to complete the hand-washing task in the Purdon lab kitchen, which features a fully functional double sink. First the participants were asked to copy the experimenter and rub the back and palm of each hand with a damp sponge and were reminded that their sponge may have come into contact with trace amounts of dirt, chemicals, or bacteria. They were then told that they would be allowed to wash their hands in a moment, but were asked to first complete the same six 10 cm visual analogue scales previously administered (Post-Contamination VAS, included in Appendix B). The experimenter did not handle the completed questionnaire and accompanying pen in the presence of the participants in order to maintain the plausibility of potential participant hand contamination. The participants were then told that the experimenter would leave the room and they could wash their hands for as long as they desired before coming to get the experimenter in the next room. They were also reminded of the task they would complete following the hand wash (i.e. creating a gift bag for young children or sorting papers for disposal). Finally, participants were asked to speak all of

their thoughts aloud while washing, no matter how insignificant or unrelated the thoughts seemed. Participants were then left alone in the kitchen to wash their hands. The hand-washing task was audio and video recorded.

Once participants indicated to the experimenter that they had finished washing their hands to their satisfaction they were given items to create a gift bag (containing crayons, pencils, stickers, note pads, and noise makers) or various boxes, advertisements, and printer papers to sort for recycling and shredding. When they had completed the post-washing task, they were given the Post-Wash questionnaire package containing the PANAS (Post-Wash PANAS) and 16 visual analogue scales (Post-Wash VAS, see Appendix C) measuring: how contaminated their hands were currently, how likely harm was to occur, the severity of the potential harm, how responsible and how guilty they would feel if harm were to occur, how certain they were that they had washed their hands properly, how certain they were that harm had been prevented, how disgusted they currently felt, how certain they were of their memory of washing, how vivid their memory of washing was, how detailed their memory of washing was, how much attention was allocated to washing, how certain they were that their attention had been allocated to washing, how reliable they felt their vision was during washing, how reliable their tactile sense was when washing, and how reliable their senses were generally. Participants were then debriefed and thanked for their time.

Data Analyses

Data for each variable of interest were cleaned and examined for extreme values. Potential univeriate 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 greater than or equal to 3 and if the value was discontinuous with the distribution. No univeriate outliers were

identified. Multivariate outliers were identified through comparing Mahalanobis distances to the appropriate Chi-square value at the significance level of $p < .001$. No multivariate outliers were identified. Levene's test was used to examine the assumption of equality of variance. Additionally, prior to running regression analyses, the assumptions of normality and homoscedasticity were tested graphically through plotting standardized residuals against standardized predicted values. Any violations were corrected through applying an appropriate transformation to the data.

Baseline differences in demographics and OCD-related beliefs were compared using Chi-square tests and factorial analysis of variance. In order to determine whether the responsibility and contamination manipulations were successful, two mixed ANOVAs were conducted to examine the effects of contamination fears, responsibility level, and time on ratings of responsibility and contamination. Factorial ANOVAs were used to examine between-group differences in wash duration and the number of visits to the sites involved in washing. A series of hierarchical regressions was then used to examine whether post-contamination beliefs (such as estimates of responsibility) would predict washing behaviours and whether washing behaviours would predict post-wash beliefs (e.g., confidence in sensory perception).

Results

Demographics

A 2 (Contamination Fears group; CF; Low vs. High) x 2 (Responsibility Level; RL; Low vs. High) ANOVA was conducted on age, revealing no significant differences between CF groups, $F(1, 76) = 0.64$, $p = .43$, or RL groups, $F(1, 76) = 1.27$, $p = .26$ and no interaction, $F(1,76) = 1.27$, $p = .26$. Chi-square tests also indicated that there was not a significant difference in gender across the CF or RL groups (see Table 1 for descriptive statistics).

Baseline Differences

A series of 2 (CF group) x 2 (RL group) ANOVAs was conducted on baseline affect, fear of guilt, and OCD related beliefs (see Table 1 for descriptive statistics). A reciprocal transformation was applied to Pre-Contamination PANAS Negative Affect scores to correct for inequality of variance. It was found that there was not a significant difference between CF or RL groups with regard to Positive Affect as measured by the Pre-Contamination PANAS, $F(1, 76) = 2.72$, $p = .10$, and $F(1, 76) = 0.16$, $p = .69$, respectively. There was no interaction between CF and RL, $F(1, 76) = 0.86$, $p = .36$. There was also no difference between the High and Low RL groups on Negative Affect as measured by the Pre-Contamination PANAS $F(1, 76) = 1.81$, $p = .18$ and no difference in Pre-Contamination Negative Affect between the High and Low CF groups, $F(1, 76) = .975$, $p = .33$. There was no interaction between CF and RL, $F(1, 76) = 2.01$, $p = .16$.

In contrast, there was a significant difference in Total Fear of Guilt between the High and Low CF groups, $F(1, 76) = 18.73$, $p < .001$, $\eta_p^2 = .20$, such that the HCF group had higher scores on the FOGS. However, there was no significant difference between the RL conditions, $F(1, 76) = 0.14$, $p = .71$, and no significant interaction between RL and CF, $F(1, 76) = 0.04$, $p = .84$. Additionally, there was a significant difference between CF groups on all three OBQ-44 subscales: Responsibility/ Threat Estimation, $F(1, 76) = 25.81$, $p < .001$, $\eta_p^2 = .25$, Perfectionism/Certainty, $F(1, 76) = 19.30$, $p < .001$, $\eta_p^2 = .20$, and Importance/Control of Thoughts, $F(1, 76) = 15.32$, $p < .001$, $\eta_p^2 = 17$, such that those in the HCF group scored significantly higher on these subscales. There was not a significant difference between RL groups on the OBQ-44 subscales and no significant interaction between CF and RL.

Manipulation Check

Manipulation One: Responsibility Manipulation

Responsibility and guilt VAS ratings at Post-Contamination ($r(78) = .81$, $p < .001$) and Post-Washing ($r(78) = .89$, $p < .001$) were combined to form the Post-Contamination and Post-Washing Responsibility Composite Scores respectively. If the responsibility manipulation was successful we would expect a main effect of group such that the HR group had higher scores than the LR group. Although a main effect of CF group was also expected, we did not expect an interaction between the CF and RL groups.

A 2x2x2 mixed ANOVA comparing Responsibility Composite scores between the LRL and HRL groups (between-subjects factor) and between the LCF and HCF groups (between-subjects factor) at Post-Contamination and Post-Wash (Time; within-subjects factor) was conducted. It was found that there was a significant main effect of RL group, $F(1, 76) = 5.10$, $p = .03$, $\eta_p^2 = .06$, such that participants in the HRL group rated their responsibility as significantly greater than those in the LRL group both at Post-Contamination ($M = 8.03$, $SD = 6.49$ for HRL versus $M = 5.49$, $SD = 4.84$ for LRL) and Post-Wash ($M = 5.86$, $SD = 5.60$ for HRL versus $M = 3.35$, $SD = 4.59$ for LRL) . There was also a main effect of Time, $F(1, 76) = 37.78$, $p < .001$, $\eta_p^2 = .33$, such that Responsibility Composite scores decreased significantly from Post-Contamination ($M = 6.73$, $SD = 5.81$) to Post-Wash ($M = 4.57$, $SD = 5.23$). Additionally, there was a significant main effect of CF group, $F(1, 76) = 17.02$, $p < .001$, $\eta_p^2 = .18$, such that those in the HCF group rated their responsibility as significantly greater than those in the LCF group both at Post-Contamination ($M = 9.46$, $SD = 5.77$ for HCF versus $M = 4.38$, $SD = 4.77$ for LCF) and Post-Wash ($M = 6.65$, $SD = 5.74$ for HRL versus $M = 2.79$, $SD = 4.02$). There were no significant two-way or three-way interactions between Time, RL, and CF.

Manipulation Two: Contamination Beliefs

A 2x2x3 mixed ANOVA was used to examine the effects of CF (LCF vs. HCF groups; between-subjects factor) and RL (LRL vs. HRL; between-subjects factor) on participants' VAS ratings of contamination (Contamination) at Pre-Contamination, Post-Contamination, and Post-Wash (Time; within-subjects factor). See Figure 1 for a graphical depiction of these ratings. As the assumption of sphericity was violated, the Greenhouse-Geisser correction was used. It was found that there was a main effect of Time, $F(1.72, 131.18) = 93.75$, $p < .001$, $\eta_p^2 = .55$, and a main effect of CF, $F(1, 76) = 15.95$, $p < .001$, $\eta_p^2 = .17$. These effects were further qualified by a significant interaction between Time and CF, $F(1.72, 131.18) = 4.94$, $p = .01$. See Figure 1 for a depiction of this interaction. There was no main effect of RL, $F(1, 76) = 15.95$, $p = .79$, no significant interaction between CF and RL, $F(1, 76) = 0.21$, $p = .65$, and no significant three-way interaction between CF, RL, and Time, $F(1.72, 131.18) = .09$, $p = .89$.

To further examine the interaction between CF and Time, the effect of Time on Contamination was examined separately for each level of CF. It was found that there was a main effect of Time on Contamination for both the HCF group, $F(1.63, 58.98) = 49.23$, $p < .001$, $\eta_p^2 = .58$, (the Greenhouse-Geisser correction was used due to lack of sphericity), and the LCF group, $F(2, 84) = 44.41$, $p < .001$, $\eta_p^2 = .51$. Within each CF group, a series of paired *t*-tests was then used to examine the change in Contamination across time. It was found that for the HCF group, there was a significant increase in perceived contamination from Pre-Contamination ($M = 3.55$, $SD = 2.33$) to Post-Contamination ($M = 7.20$, $SD = 2.50$), $t(36) = -6.23$, $p < .001$. There was then a significant decline in contamination ratings from Post-Contamination to Post-Washing ($M = 2.63$, $SD = 2.27$), $t(36) = 11.70$, $p < .001$. There was not a significant difference in contamination ratings when comparing Pre-Contamination to Post-Wash ratings, $t(36) = -1.98$, $p = .06$.

Similarly, those in the LCF group showed a significant increase in Contamination from Pre-Contamination (M = 3.00, SD = 1.71) to Post-Contamination (M =4.79, SD = 2.41), $t(42) = -4.45$, $p < .001$. There was then a significant decline in Contamination from Post-Contamination to Post-Washing (M = 1.43, SD = 1.70), $t(42) = 9.14$, $p < .001$. However, in contrast to those in the HCF group, those in the LCF group showed a significant difference between Pre-Contamination and Post-Wash ratings, such that after washing their hands they reported that their hands were significantly less contaminated than at the beginning of the study prior to contaminating their hands, $t(42) = -5.38$, $p < .001$.

Further analyses also revealed that prior to contaminating their hands, the LCF and HCF groups did not significantly differ on Contamination, $t(78) = 1.21$, $p = .09$. However, there was a significant difference in contamination ratings between CF groups at Post-Contamination, $t(78) = 4.39$, $p < .001$, and Post-Wash, $t(78) = 2.70$, $p = .01$, such that those in the HCF group rated their hands as being significantly more contaminated at these two time points.

Phenomenology of Washing Behaviour

Wash Duration: How long do individuals who are high versus low in contamination fears typically wash their hands for? Does manipulating feelings of responsibility influence the duration of hand-washing behaviours? If so, do the effects of this manipulation vary based on level of Contamination Fears?

We hypothesized that higher fears of contamination and a greater sense of responsibility would be associated with greater wash duration. To test this hypothesis, a 2 x 2 ANOVA was used to examine the relationship between CF, RL, and how long participants washed their hands for (Wash Duration). It was found that there was a significant difference in Wash Duration between individuals in the LCF and HCF groups, $F(1, 76) = 14.08$, $p < .001$, $\eta_p^2 = .16$. On

average, those who were high in fears of contamination washed for 116.02 seconds (*SD* = 68.98), while those who were low in fears of contamination washed for 70.42 seconds (*SD* = 36.21). There was not a main effect of RL on Wash Duration, $F(1, 76) = 3.26$, $p = .08$. However, the results were in the expected direction, such that those in the LR condition washed for an average of 80.34 seconds (*SD* = 43.39), while those in the HR condition washed for an average of 103.33 seconds (*SD* = 69.21). There was not a significant interaction between Contamination Fears and Responsibility Level, $F(1, 76) = 0.76$, $p = .39$.

Actions Involved in Washing: What is the typical number of visits involved in washing behaviour for individuals high and low in fears of contamination? Does manipulating feelings of responsibility have an effect on the number of visits involved in a wash?

We also predicted that higher fears of contamination and a greater sense of responsibility would be associated with increased repetitions of the behaviours involved in washing. A 2x2 ANOVA was conducted to examine the relationship between CF, RL, and the total number of visits to the sites and objects identified as part of the wash (Total Visits). It was found that there was a main effect of CF on Total Visits, $F(1, 76) = 12.69$, $p = .001$, $\eta_p^2 = .14$. Those in the HCF group (*M* = 18.35, *SD* = 8.75) visited the sites involved in the wash a significantly greater number of times than those in the LCF group (*M* = 13.00, *SD* = 3.80). There was no main effect of RL, $F(1, 76) = 0.59$, $p = .45$, and no interaction between RL and CF, $F(1, 76) = 0.04$, $p = .84$.

Subjective Beliefs and Washing Behaviour

Pre-Wash Beliefs: How do predictions of the probability and severity of harm differ between those who are low and high in fears of contamination? Are these subjective experiences influenced by manipulating feelings of responsibility? If so, do the effects of the manipulation vary based on contamination fears?

Prior to washing their hands, participants were asked to use a VAS to rate the probability of harm occurring (Likelihood of Harm) if their hands were contaminated by the sponge. They also rated the severity of the potential harm (Severity of Harm). Three 2 x 2 ANOVAs were used to examine the effect of RL and CF on these ratings. We expected that higher fears of contamination and a greater sense of responsibility would be associated with greater estimates of harm.

It was found that there was a significant effect of CF on Likelihood of Harm, $F(1, 76) = 13.43$, $p < .001$, $\eta_p^2 = .15$, such that those in the HCF group rated the probability of harm as significantly higher ($M = 3.38$, $SD = 2.97$) than those in the LCF group ($M = 1.47$, $SD = 1.62$). There was not a significant effect of RL on Likelihood of Harm, $F(1, 76) = 0.06$, $p = .80$, or a significant interaction between RL and CF, $F(1, 76) = 2.16$, $p = .15$.

Similarly, when examining ratings of Severity of Harm, there was a significant main effect of CF, $F(1, 76) = 20.67$, $p < .001$, $\eta_p^2 = .21$. Those in the HCF group reported that if harm were to occur, it would be significantly more severe ($M = 5.06$, $SD = 3.16$) than those in the LCF group predicted ($M = 2.24$, $SD = 2.31$). There was no effect of RL, $F(1,76) = 0.76$, $p = .39$, and no interaction between CF and RL, $F(1, 76) = 0.83$, $p = .37$.

Pre-Wash Beliefs: Do estimates of harm and responsibility influence washing behaviour?

To address this question, we examined the extent to which estimates of harm and responsibility predicted washing duration and washing actions for those high and low in contamination fears. We predicted that these estimates would predict the duration of the wash and the number of visits involved in washing for both groups, but that the relationship would be stronger for those high in fears of contamination. To test this hypothesis, two hierarchical regressions were conducted with Wash Duration and Total Visits regressed on CF (Step 1), Post-

Contamination Responsibility Composite and Post-Contamination Harm Composite (Step 2), and the Post-Contamination Responsibility Composite x CF and Post-Contamination Harm Composite x CF interaction terms (Step 3). For the purpose of these analyses, Post-Contamination estimates of the severity and likelihood of harm ($r(78) = .74$, $p < .001$) were combined to form the Post-Contamination Harm Estimate Composite Score. CF was dummy coded with HCF as the reference group and both Post-Contamination Responsibility Composite and Post-Contamination Harm Composite were mean-centred prior to this analysis. Results are summarized in Table 2.

When Wash Duration was the dependent variable, entry of CF in the first step yielded a significant percentage of variance explained (16%). Likewise, entering Post-Contamination Responsibility Composite and Post-Contamination Harm Composite scores in step two significantly increased the percentage of variance explained as demonstrated by the significant change in R^2. However, only CF and Post-Contamination Harm Composite were found to be significant predictors of Wash Duration, while Post-Contamination Responsibility Composite was not. Entering the Post-Contamination Responsibility Composite x CF and Post-Contamination Harm Composite x CF interaction terms in step three did not yield a significant change in R^2.

A second hierarchical regression was used to examine the relationship between the same variables and Total Visits (results are summarized in Table 3). Entry of CF in the first step again yielded a significant percentage of variance explained (15%). Likewise, entering Post-Contamination Responsibility Composite and Post-Contamination Harm Composite scores in step two significantly increased the percentage of variance explained. In this step, only Post-Contamination Harm Composite was found to be significant predictors of Total Visits. Entering

the Post-Contamination Responsibility Composite x CF and Post-Contamination Harm Composite x CF interaction terms in step three did not yield a significant change in R^2.

Post-Wash Beliefs: Does wash duration have a paradoxical effect on post-wash estimates of responsibility or harm, feelings of contamination, confidence in memory of washing, quality of memory, confidence in sensory perception, confidence in attention, or certainty that the wash was completed adequately? Is this more pronounced in individuals who are high in fears of contamination?

It was hypothesized that greater wash duration and frequency would predict paradoxical increases in post-wash feelings of responsibility and estimates of harm. Additionally, we predicted that longer wash duration and frequency would be associated with decreased confidence in memory, attention, and/or perception. To test these hypotheses we conducted a series of regression analyses.

1. Effects of Wash Duration on Responsibility Estimation

To examine whether the duration of washing predicted post-wash estimates of responsibility for harm, a hierarchical regression was conducted with the Post-Wash Responsibility Composite Score regressed on CF and Post-Contamination Responsibility Composite (step one), Wash Duration (step two), and the two-way interaction between CF and Wash Duration (step three). A square root transformation was applied to Post-Wash Responsibility Composite Score to correct for the violations of the assumptions of normality and homoscedasticity of the residuals. CF was dummy coded with HCF as the reference group. Post-Contamination Responsibility Composite and Wash Duration were mean-centred prior to this analysis. Results are summarized in Table 4.

Entering CF and Post-Contamination Responsibility Composite Score in step one explained a significant proportion of variance (73%). Post-Contamination Responsibility Composite Score was found to be a significant predictor of post-wash estimates of responsibility, while CF group was not. Entering Wash Duration in step two did not result in a significant change in R^2. Similarly, entering in the interaction term for CF group and Wash Duration did not result in a significant increase in the amount of variance explained.

2. *Effects of Wash Duration on Harm Estimation*

To examine whether the duration of washing predicted post-wash estimates of harm, a hierarchical regression was conducted with the Post-Wash Harm Composite Score (calculated by combining Post-Wash estimates of the severity and likelihood of harm, $r(78) = .83$, $p < .001$) regressed on CF and Post-Contamination Harm Composite Score (step one), Wash Duration (step two), and the two-way interaction between CF and Wash Duration (step three). A square root transformation was applied to Post-wash Harm Composite Score to correct for the violations of the assumptions of normality and homoscedasticity of the residuals. CF was dummy coded with HCF as the reference group. Post-Contamination Harm Composite and Wash Duration were mean-centred prior to this analysis. Results are summarized in Table 5.

Entering CF and Post-Contamination Harm Composite Score in step one resulted in a significant proportion of variance explained (52%). Post-Contamination Harm Composite Score was found to be a significant predictor of post-wash estimates of harm while CF group was not. Entering Wash Duration in step two did not result in a significant change in R^2. Similarly, entering in the interaction term for CF group and Wash Duration did not result in a significant increase in the amount of variance explained.

3. *Effects of Wash Duration on Feelings of Contamination*

Similar results were found when examining whether duration of washing predicted post-wash feelings of contamination (Post Wash Contamination Rating). A hierarchical regression was conducted with Post-Wash Contamination Rating regressed on CF and Post-Contamination Contamination Rating (step one), Wash Duration (step two), and the two-way interaction between CF and Wash Duration (step three). A reciprocal transformation was applied to Post-Wash Contamination Rating to correct for the violations of the assumptions of normality and homoscedasticity of the residuals. CF was dummy coded with HCF as the reference group. Post-Contamination Harm Composite and Wash Duration were mean-centred prior to this analysis. Results are summarized in Table 6.

Entering CF and Post-Contamination Contamination Rating in step one resulted in a significant percentage of variance explained (56%). Post-Contamination Contamination Rating was found to be a significant predictor of Post-Wash Contamination Rating while CF group was not. Entering Wash Duration in step two did not result in a significant change in R^2. Similarly, entering in the interaction term for CF and Wash Duration did not result in a significant increase in the amount of variance explained.

4. *Effects of Wash Duration on Confidence in Memory*

The relationship between Wash Duration and confidence in memory, as rated on a 10 cm VAS after washing, was examined using a hierarchical regression with confidence in memory regressed on CF (step one), Wash Duration (step two), and the interaction between CF and Wash Duration (step three). This analysis did not yield any significant results (see Table 7).

5. ***Effects of Wash Duration on Ratings of Quality of Memory***

Similarly, we examined the relationship between wash duration and participant ratings of the quality of their memory of washing (Quality of Memory: calculated by summing the ratings of detail and vividness of memory as rated on 10 cm visual analogue scales) using a hierarchical regression with Quality of Memory regressed on CF (step one), Wash Duration (step two), and the interaction between CF and Wash Duration (step three). This analysis did not yield any significant results (see Table 8).

6. ***Effects of Wash Duration on Confidence in Sensory Perception***

The relationship between wash duration and confidence in sensory perception while washing rated on a 10 cm VAS after washing was also examined. A hierarchical regression was conducted with confidence in sensory perception regressed on CF (step one), Wash Duration (step two), and the interaction between CF and Wash Duration (step three). The results of this analysis are presented in Table 9. Entering CF in step one resulted in a non-significant model. However, entering Wash Duration in step two resulted in a significant change in R^2. Entering the interaction term for CF and Wash Duration did not result in a significant increase in the amount of variance explained.

In step two, it was found that CF group was not a significant predictor of confidence in sensory perception; however, Wash Duration was a significant predictor of retrospective confidence in sensory reliability, such that as Wash Duration increased, ratings of how much individuals trusted what their senses had indicated during the wash decreased.

7. ***Effects of Wash Duration on Confidence in Attention***

After washing, participants were asked to rate how certain they were that their attention had been focused on washing. The relationship between this confidence in attention rating and

Wash Duration was examined using the same hierarchical regression procedure used previously (see Table 10). The step one model with CF group as a single predictor explained a significant percentage of the variance in confidence in attention. Entering Wash Duration and the interaction term for CF x Wash Duration did not increase the proportion of variance explained.

8. ***Effects of Wash Duration on Certainty of Proper Completion***

The relationship between Wash Duration and participants' ratings of how certain they were that their hands had been washed properly was analyzed using the same hierarchical regression approach. The results of this analysis are summarized in Table 11. This analysis did not yield any significant effects.

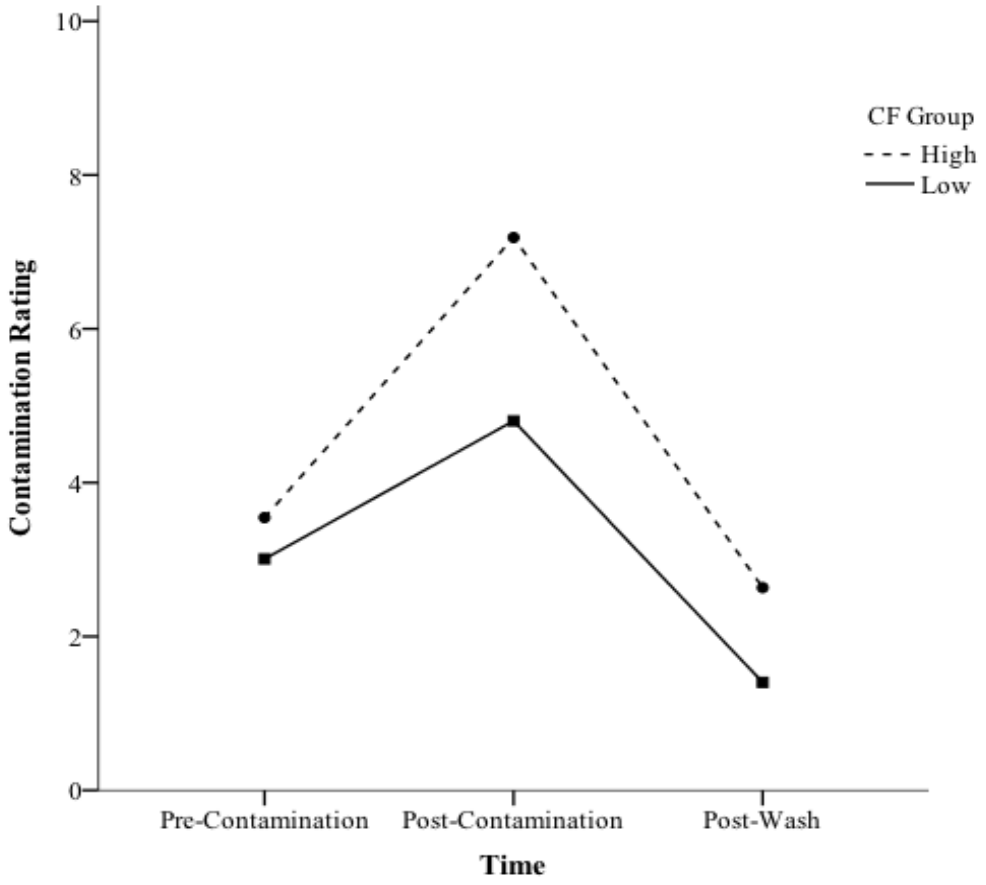

Figure 1. Differences between High and Low Contamination Fears groups in contamination ratings across time

Table 1

Differences Between Those Low and High in Contamination Fears and Responsibility Level on Demographic Variables and Baseline Measures

	Low CF Group		High CF Group	
	Low RL	High RL	Low RL	High RL
Measure	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Gender	43.5% male	30.0% male	33.3% male	26.3% male
Age	20.00 (1.68)	20.00 (2.05)	21.56 (6.68)	19.74 (2.08)
DOCS				
Contamination Score	0.17 (0.29)	0.25 (0.44)	10.89 (1.28)	11.05 (0.97)
Pre-Contamination PANAS				
Positive Affect	23.35 (7.50)	24.25 (7.54)	27.72 (7.36)	25.47 (7.82)
Negative Affect	12.52 (2.57)	12.45 (3.00)	15.06 (4.43)	15.00 (4.98)
OBQ-44				
Responsibility/Threat	46.83 (13.71)	50.25 (15.65)	66.39 (14.86)	65.79 (17.40)
Perfectionism/Certainty	53.52 (19.25)	52.35 (14.12)	71.89 (20.66)	71.00 (20.49)
Importance/Control of Thoughts	26.74 (11.55)	25.00 (7.01)	37.56 (14.13)	35.79 (15.32)
FOG				
Total Score	144.30 (48.55)	151.10 (45.95)	197.44 (60.70)	199.53 (54.27)

Table 2

Hierarchical Multiple Regression Analysis Examining Contamination Fears and Post-Contamination Harm and Responsibility Estimates as Predictors of Wash Duration

	Wash Duration					
	Step 1		Step 2		Step 3	
Predictor Variables	*B*	*SE*	*B*	*SE*	*B*	*SE*
Constant	70.419***	8.215	78.821***	8.256	79.626***	0.26
CF	45.690***	12.080	27.522*	12.990	-0.12	0.07
T2 Harm Composite			4.889**	1.568	3.194*	3.066
T2 Responsibility Composite			-0.976	1.393	0.948	2.400
CF x T2 Responsibility Composite					-2.998	2.986
CF x T2 Harm Composite					2.271	3.576
R^2	.155		.272		.282	
F	14.305***		9.470***		5.810***	
ΔR^2	.155		.117		.010	
ΔF	14.305***		6.114**		0.506	

Note. *$p < .05$. **$p < .01$.***$p < .001$. T2 Composites = Post-Contamination Composites.

Table 3

Hierarchical Multiple Regression Analysis Examining Contamination Fears and Post-Contamination Harm and Responsibility Estimates as Predictors of Total Visits

	Total Visits					
	Step 1		Step 2		Step 3	
Predictor Variables	*B*	*SE*	*B*	*SE*	*B*	*SE*
Constant	13.000***	1.002	14.133***	0.982	13.556***	1.073
CF	5.251	1.473	2.902	1.545	3.046	1.554
T2 Harm Composite			0.696***	0.186	0.428	0.364
T2 Responsibility Composite			-0.166	0.166	-0.162	0.284
CF x T2 Responsibility Composite					0.060	0.353
CF x T2 Harm Composite					0.370	0.423
R^2	.145		.299		.316	
F	13.196**		10.823***		6.840***	
ΔR^2	.145		.155		.017	
ΔF	13.196**		8.387**		0.905	

Note. *$p < .05$. **$p < .01$.***$p < .001$. T2 Composites = Post-Contamination Composites.

Table 4

Hierarchical Multiple Regression Analysis Examining Wash Duration as a Predictor of Post-Wash Responsibility Estimates

	Post-Wash Responsibility Composite					
	Step 1		Step 2		Step 3	
Predictor Variables	*B*	*SE*	*B*	*SE*	*B*	*SE*
Constant	2.115***	0.088	2.136***	0.091	2.115***	0.099
CF	0.022	0.137	-0.023	0.144	-0.013	0.145
T2 Responsibility Composite	0.151***	0.012	0.149***	0.012	0.150***	0.012
Wash Duration			0.001	0.001	0.000	0.002
CF x Wash Duration					0.001	0.003
R^2	.725		.729		.730	
F	101.429***		68.041***		50.617***	
ΔR^2	.725		.004		.001	
ΔF	101.429***		1.073		0.280	

Note. *$p < .05$. **$p < .01$.***$p < .001$. T2 Composite = Post-Contamination Composite.

Table 5

Hierarchical Multiple Regression Analysis Examining Wash Duration as a Predictor of Post-Wash Harm Estimates

	Post-Wash Harm Composite					
	Step 1		Step 2		Step 3	
Predictor Variables	*B*	*SE*	*B*	*SE*	*B*	*SE*
Constant	1.717***	0.088	1.723***	0.090	1.665***	0.099
CF	-0.017	.138	-0.029	0.142	0.003	0.143
T2 Harm Composite	0.109***	0.013	0.107***	0.014	.109***	.014
Wash Duration			0.000	0.001	-0.002	0.002
CF x Wash Duration					0.004	0.003
R^2	.522		.523		.535	
F	42.018***		27.745***		21.571***	
ΔR^2	.5252		.001		.012	
ΔF	42.018***		0.139		1.977	

Note. $*p < .05$. $**p < .01$.$***p < .001$. T2 Composite = Post-Contamination Composite.

Table 6

Hierarchical Multiple Regression Analysis Examining Wash Duration as a Predictor of Post-Wash Contamination Ratings

	Post-Wash Contamination Rating					
	Step 1		Step 2		Step 3	
Predictor Variables	*B*	*SE*	*B*	*SE*	*B*	*SE*
Constant	0.531***	0.039	0.535***	0.040	0.533***	0.044
CF	-0.069	0.061	-0.078	0.063	-0.077	0.064
T2 Contamination Rating	-0.052***	0.011	-0.055***	0.012	-0.055***	0.012
Wash Duration			0.000	0.001	0.000	0.001
CF x Wash Duration					0.000	0.001
R^2	.311		.314		.314	
F	17.367***		11.601***		8.591***	
ΔR^2	.311		.003		.000	
ΔF	17.367***		0.359		0.013	

Note. *$p < .05$. **$p < .01$.***$p < .001$. T2 Rating = Post-Contamination Rating.

Table 7

Hierarchical Multiple Regression Analysis Examining Wash Duration as a Predictor of Memory Certainty

	Memory Certainty					
	Step 1		Step 2		Step 3	
Predictor Variables	*B*	*SE*	*B*	*SE*	*B*	*SE*
Constant	0.297***	0.039	0.289***	0.041	0.275***	0.045
CF	-0.052	0.057	-0.035	0.062	-0.026	0.268
Wash Duration			0.000	.001	-0.001	0.001
CF x Wash Duration					0.001	.001
R^2	.011		.017		.023	
F	0.834		0.664		0.601	
ΔR^2	.011		.006		.006	
ΔF	0.834		0.498		0.484	

Note. *$p < .05$. **$p < .01$.***$p < .001$. CF has been dummy coded with HCF as the reference group. Wash Duration has been mean-centred. A reverse scored Log10 transformation was applied to memory confidence to correct for severe negative skew and heteroscedasticity.

Table 8

Hierarchical Multiple Regression Analysis Examining Wash Duration as a Predictor of Memory Quality

	Memory Quality					
	Step 1		Step 2		Step 3	
Predictor Variables	*B*	*SE*	*B*	*SE*	*B*	*SE*
Constant	2.256***	0.163	2.228***	0.171	2.150***	0.191
CF	-0.452	0.240	-0.290	0.262	-0.341	0.268
Wash Duration			0.001	.002	-0.005	0.005
CF x Wash Duration					0.005	.005
R^2	.043		.048		.059	
F	3.547		1.939		1.576	
ΔR^2	.043		.004		.011	
ΔF	3.547		0.360		0.858	

Note. *$p < .05$. **$p < .01$.***$p < .001$. CF has been dummy coded with HCF as the reference group. Wash Duration has been mean-centred. A reverse scored square root transformation was applied to Memory Quality to correct for severe negative skew and heteroscedasticity.

Table 9

Hierarchical Multiple Regression Analysis Examining Wash Duration as a Predictor of Confidence in Sensory Perception

	Confidence in Sensory Perception					
	Step 1		Step 2		Step 3	
Predictor Variables	*B*	*SE*	*B*	*SE*	*B*	*SE*
Constant	7.686***	0.303	7.468***	0.304	7.375***	0.341
CF	-0.039	0.445	0.432	0.468	0.490	0.479
Wash Duration			-0.010*	0.004	-0.015	.008
CF x Wash Duration					0.006	0.009
R^2	.000		.078		.083	
F	0.008		3.269*		2.289	
ΔR^2	.000		.078		.005	
ΔF	0.008		6.529*		0.382	

Note. *$p < .05$. **$p < .01$.***$p < .001$. CF has been dummy coded with HCF as the reference group. Wash Duration has been mean-centred.

Table 10

Hierarchical Multiple Regression Analysis Examining Wash Duration as a Predictor of Confidence in Attention

	Confidence in Attention					
	Step 1		Step 2		Step 3	
Predictor Variables	*B*	*SE*	*B*	*SE*	*B*	*SE*
Constant	6.026***	0.359	6.065***	0.376	6.053***	0.422
CF	1.591**	0.528	1.507*	0.577	1.515*	0.593
Wash Duration			0.002	0.005	0.001	0.010
CF x Wash Duration					0.001	0.012
R^2	.104		.106		.106	
F	9.091**		4.564*		3.005*	
ΔR^2	.104		.002		.000	
ΔF	9.091**		0.137		0.004	

Note. *$p < .05$. **$p < .01$.***$p < .001$. CF has been dummy coded with HCF as the reference group. Wash Duration has been mean-centred.

Table 11

Hierarchical Multiple Regression Analysis Examining Wash Duration as a Predictor of Confidence in Proper Completion

	Confidence in Proper Completion of Washing					
	Step 1		Step 2		Step 3	
Predictor Variables	*B*	*SE*	*B*	*SE*	*B*	*SE*
Constant	7.776***	0.323	7.723***	0.338	7.742***	0.379
CF	0.332	0.475	0.448	0.519	0.436	0.533
Wash Duration			-0.003	0.004	-0.002	.009
CF x Wash Duration					-0.001	0.010
R^2	.006		.010		.010	
F	0.489		0.402		0.269	
ΔR^2	.006		.004		.000	
ΔF	0.489		0.319		0.013	

Note. *$p < .05$. **$p < .01$.***$p < .001$. CF has been dummy coded with HCF as the reference group. Wash Duration has been mean-centred.

Discussion

The purpose of the present study was to examine repetitive or prolonged washing behaviour using an ecologically valid paradigm. In doing so, we aimed to improve our understanding of the phenomenology of such behaviours and answer questions such as: For how long do individuals who are high in fears of contamination typically wash their hands after being exposed to potential contaminants? What is the typical number and range of actions involved in hand-washing behaviour? Furthermore, in this naturalistic environment, we examined how perceived responsibility, estimates of harm, and confidence in cognitive and sensory abilities were related to washing behaviours.

In order to explore these questions, undergraduate students who reported high and low levels of concerns about germs and contamination were pre-selected using the DOCS. Analyses of baseline differences demonstrated that in comparison with those who reported low levels of fears of contamination, participants who scored high in fears of contamination also scored significantly higher on measures of psychological processes and mechanisms hypothesized to be important to the development and maintenance of OCD. Specifically, those who were high in fears of contamination also reported significantly greater fear of being regarded as guilty or experiencing feelings of guilt and engagement in behaviours to minimize, prevent, or atone for guilt. These individuals also endorsed significantly stronger dysfunctional beliefs, such as overestimates of threat and responsibility, greater importance of and need to control thoughts, and higher levels of perfectionism and need for certainty. This finding is consistent with those of other studies, which have demonstrated that OCD-related beliefs are present and associated with symptom severity not only in clinical samples, but also in analogue or student samples (Abramowitz et al., 2014).

Those who were high and low in fears of contamination did not significantly differ in their baseline ratings of how contaminated their hands were. In order to induce feelings of contamination, participants were asked to rub their hands with a damp sponge that may have come into contact with trace amounts of dirt, chemicals, or bacteria. This manipulation was successful in inducing feelings of contamination and participants in all conditions reported a significant increase in perceived hand contamination after touching the sponge. However, despite touching the same sponge, those who were high in fears of contamination reported a significantly greater increase in feelings of contamination after touching the sponge and reported experiencing a significantly greater sense of contamination than those who were low in fears of contamination. The success of this manipulation highlights the fact that, as stated by Rachman (2004), two notable properties of contamination are how easily the sense of contamination is transferred from an object to a person and the substantial effects of even a small amount of contamination. Despite the fact that there existed only the *possibility* that the sponge had come into contact with *trace* amounts of a contaminant, participants reported significant increases in feelings of contamination after touching the sponge.

We also attempted to manipulate predicted responsibility for future harm through informing half of the participants that they would be preparing a gift bag for young children following contaminating and washing their hands, and telling the other half that they would be sorting papers for disposal after contaminating and then washing their hands. It was found that this manipulation was successful in inducing feelings of responsibility. Those participants who created a gift bag reported significantly greater estimates of their responsibility for any future harm in comparison with those who sorted papers for disposal, both after contaminating their hands and after washing their hands. Additionally, even though those high in fears of

contamination rated their responsibility as higher overall in comparison to those who were low in fears of contamination, the effects of the responsibility manipulation did not differ across those low and high in contamination fears. However, in comparison to the variance in responsibility ratings accounted for by differences in fears of contamination, there was a much lesser effect of the responsibility manipulation on ratings of responsibility. Therefore, when examining the influence of increased estimates of responsibility on factors such as wash duration, the difference associated with contamination fears may account for the majority of these effects, while the difference due to the responsibility manipulation may have been negligible. Consistent with this explanation, there was not a significant difference between those in the low and high responsibility induction groups with regards to washing phenomenology such as duration and total number of visits, or pre-wash beliefs such as estimates of the likelihood and severity of harm. In contrast, there was a significant difference between those who were low and high in fears of contamination in all aspects of washing phenomenology and pre-wash beliefs.

Phenomenology of Washing Behaviour

There has been little research to date on the phenomenology of repetitive acts, particularly washing behaviours. While a large body of research has examined the typical themes, content, and forms of obsessions, the cognitive biases hypothesized to contribute to the link between obsessions and compulsive behaviours, and general categories of compulsive behaviours, few researchers have examined the phenomenology of compulsions themselves. For example, how long does a typical compulsive ritual last? How many times is a compulsive behaviour typically repeated? One goal of the present study was to provide data on the differences in washing behaviour between those low versus high in fears of contamination following contact with a potential contaminant in a naturalistic setting.

As expected, it was found that those who were high in fears of contamination washed for significantly longer than those who were low in fears of contamination after being exposed to the same potential contaminant. Those who were high in fears of contamination washed for an average of 46 seconds (65%) longer than those who were low in fears of contamination after touching the same damp sponge. This is consistent with the current understanding that compulsions associated with OCD are time-consuming and interfering (APA, 2013).

As described by Eilam and colleagues (2012), compulsive rituals such as hand-washing can also be described spatially, through examining visits to the set of sites or objects at which the ritual is performed. Similar to the findings of Eilam and colleagues (Eilam, Zor, Szechtman, & Hermesh, 2006; Eilam et al., 2012), the completion of hand-washing behaviours by those who were high in fears of contamination involved repetitious visits to the same set of locations and objects. As predicted, in contrast to those who were low in fears of contamination, the hand-washing rituals of those who were high in fears of contamination involved an average of six more visits to the locations and items involved in the ritual. This suggests that the hand-washing rituals of those who were high in fears of contamination involved additional unnecessary visits to the sites involved in washing, as those who were low in contamination fears were able to perform the same task with an average of six fewer visits to these sites.

Factors That Contribute to Repetitive or Prolonged Washing Behaviours

1. Pre-Wash Estimates of Responsibility and Harm

In addition to examining the temporal and spatial aspects of behaviours involved in hand-washing, the present study also aimed to contribute to the understanding of how beliefs, such as estimates of responsibility and harm, are associated with washing behaviour in those who are low versus high in fears of contamination.

Numerous studies of those with OCD, as well as healthy controls, have found that inflated feelings of responsibility and overestimates of threat predict increased contamination fear and washing behaviour (Abramowitz et al., 2014). Likewise, in the present study it was found that after contaminating their hands, those who were high in fears of contamination reported significantly heightened estimates of responsibility and the probability and potential severity of harm in comparison to those who were low in fears of contamination. As well, for both groups, estimates of harm were a significant predictor of the duration of hand-washing behaviour and the number of sites visited during washing. In contrast, estimates of responsibility were not found to be a significant predictor of wash duration or the number of sites visited.

This finding is consistent with the findings of Jones and Menzies (1997), who reported that in a sample of individuals with OCD with washing concerns, estimates of harm predicted wash duration after in-lab contact with contaminated items, while perceived responsibility did not. Additionally, Thorpe, Barnett, Friend, and Nottingham (2011) used a similar methodology with a sample of undergraduate students and also found that estimates of harm severity were the best predictor of wash duration. Other studies which have reported that both responsibility and harm estimates predict contamination concerns and related compulsions have failed to differentiate responsibility estimates from harm estimates, looking at the predictive power of subscales that combine responsibility and harm estimates, rather than measuring each individually (Taylor et al., 2005; Tolin et al., 2008; Wheaton et al., 2010). Therefore, the results of the present study support the hypothesis that inflated estimates of responsibility are less important to compulsive washing (Lopatka & Rachman, 1995) and are inconsistent with theories that emphasize inflated estimates of personal responsibility as central to both obsessions and compulsions in general (Salkovskis, 1985; 1989). The findings of the present study suggest that

while those who fear contamination and engage in repetitive or prolonged washing experience a greater sense of responsibility than those low in fears of contamination, inflated estimates of danger and harm might be the more salient motivator of compulsive washing behaviours.

2. The Ironic Effect of Prolonged Washing on Post-Wash Beliefs

While it is plausible that beliefs held prior to washing one's hands, such as the probability and potential severity of harm, contribute to the desire to prolong washing behaviours, it has also been suggested that aspects of the mental or physical components of washing might further perpetuate or prolong washing behaviours (e.g., Rachman, 2002). In the current study we examined whether prolonged washing behaviour predicted increased estimates of harm and responsibility. We expected that greater wash duration and frequency would predict paradoxical increases in post-wash feelings of responsibility and estimates of harm. The results of this study did not support this hypothesis. It was found that the duration of washing behaviours did not predict feelings of responsibility as rated following the wash. Similarly, the duration of washing behaviours did not predict estimates of harm following the wash. This is inconsistent with the findings of a similar study of checking behaviours (Bucarelli, 2014), which found that repetition of checking behaviours led to increased estimates of harm following checking in both anxious controls and those with OCD. This finding supports the hypothesis that the factors involved in the perpetuation of compulsive behaviours might differ across OCD symptom subtypes (e.g., checking versus washing).

It has also been found that those with OCD exhibit significant distrust in their memory (Tolin et al., 2001; Karadag, 2005; Macdonald et al., 1997; McNally & Kohlbeck, 1993) and that repetition of actions (e.g., checking to see whether a stove has been turned off) compromises rather than enhances memory (for example, through decreasing the vividness and detail of

memories, as found by Boschen & Vuksanovic, 2007). The current study failed to replicate these findings when examining washing behaviour and did not find that there was a difference between those low in high in fears of contamination with regards to confidence in memory. We also found that the duration of washing behaviours did not have a paradoxical relationship with memory confidence or quality. As research on memory confidence and quality has focused almost exclusively on checking behaviours, this again provides support for the hypothesis that difference cognitive factors are of importance to washing behaviours. However, it is noteworthy that increased wash times also did not predict an enhancement in memory. As such, if individuals are striving to increase confidence in their memory of washing, or improve the vividness or level of detail in their memory of washing, simply prolonging or repeating washing behaviours does not appear to further these goals.

Those with OCD have also been found to report lower levels of confidence in their ability to maintain focus during a task. As well, confidence in attention has been found to decrease with repeated checking behaviour (Hermans et al., 2003; 2008). In contrast, the current study did not find that there was a difference in attentional confidence between those who were low and high in fears of contamination. Increased wash duration was also not found to predict decreased (or increased) confidence in attention.

In addition to examining confidence in memory and attention, we hypothesized that confidence in one's senses might be more important to washing behaviours than confidence in memory or attention (e.g. "I don't see dirt, but can I trust what I see? My hands don't feel sticky, but can I trust what I feel?"). Studies of those with OCD who primarily engaged in checking behaviours have found that these participants demonstrated significant distrust in their senses (Hermans et al., 2008). However, in a sample of those with OCD who engaged in extensive

checking compulsions, confidence in sensory perception was not found to degrade with repetition of compulsive behaviours (Hermans et al., 2008). The current study did not find a difference in sensory confidence between those who were low in high in fears of contamination. However, we did find support for the hypothesis that wash duration might have a greater influence on sensory confidence than memory or attention confidence. We found that there was a significant paradoxical relationship between duration of washing and confidence in sensory perception, such that increased wash duration predicted a *decrease* in confidence in sensory perception. This was true for both those who were low and high in fears of contamination.

Therefore, in contrast to findings regarding those who engage in compulsive checking, we did not find that confidence in memory, attention, or perception differed across those who were low versus high in fears of contamination. We also did not find evidence that wash duration had a paradoxical relationship with estimates of harm and responsibility or confidence in memory or attention. However, as predicted, we found that wash duration did have a paradoxical relationship with confidence in sensory perception, such that the longer individuals washed, the less they trusted their senses.

Additionally, we examined whether increases in wash duration predicted increases in certainty that one's hands had been washed properly or that harm had been prevented. It was found that the duration of washing behaviours did not predict how certain participants were that their hands were washed properly. This is in contrast to the findings of a recent study examining checking behaviours, which found that increased checking was associated with paradoxical decreases in certainty that the check had been completed properly (Bucarelli, 2014).

In the current study we also examined whether a longer wash duration predicted increased feelings of cleanliness (i.e. decreased feelings of contamination). The findings of our

study suggested that it does not. Wash duration did not predict ratings of contamination after washing for those who were low or high in fears of contamination. Therefore, continuing to wash for longer periods of time may not be beneficial in trying to achieve feelings of cleanliness after contact with a potential contaminant.

Limitations and Future Directions

The present study aimed to maximize the ecological validity of the contamination and washing task. However, it is possible that the laboratory setting influenced the participants' cognitive and behavioural response to contact with the potential contaminant and subsequent washing behaviours. The research setting may have influenced predictions of the severity and probability of harm, as many of the participants were undergraduate students in a psychology program and may have considered that it would be unethical for researchers to place them at risk of suffering extreme harm. Indeed, despite having relatively high ratings of contamination following touching the sponge, even those who were high in fears of contamination rated the likelihood of harm as relatively low (an average of 4 out of 10). However, despite the fact that the task took place in a research context, touching the potentially contaminated sponge was successful in inducing a significant increase in feelings of contamination, even in those who were low in fears of contamination. Additionally, 90% of the participants (72 of 80) reported that they perceived some risk of harm following contaminating their hands. Furthermore, the majority of individuals who were high in contamination fears predicted that if harm were to occur, it would be more than moderately severe (greater than 5.5 out of 10). Therefore, despite the inherent limitation of conducting research in a laboratory context, as few studies have examined washing behaviours, the steps taken to maximize ecological validity in the present study are an

improvement on contrived laboratory tasks and represent a significant progression in research on washing behaviours.

It is unfortunate that preliminary analyses of the data gathered through the use of a thinking aloud paradigm did not provide information on the criteria used to determine when to terminate washing behaviours. However, more in-depth analyses are on-going and might reveal additional insights. We plan to examine the thoughts stated by participants for other features, such as indicators of what participants focused their attention on during the wash (e.g., were those high in fears of contamination more focused on bodily sensations or feelings of contamination than those low in fears of contamination?). Future studies may also consider recording oral responses to specific questions posed while participants are washing to gather more detailed information regarding ongoing cognitive processing during washing behaviours. As well, future studies may focus more specifically on factors hypothesized to be related to the termination of compulsive behaviours, such as the desire to achieve specific of feelings of completeness or levels of certainty.

Conclusion

In summary, through the use of a naturalistic paradigm, we found that those who were high in fears of contamination felt that their hands were significantly more contaminated than those who were low in fears of contamination after coming into contact with the same potential contaminant. Those who were high in fears of contamination also washed for significantly longer than those who were low in fears of contamination and engaged in unnecessary, repetitive visits to the same objects and locations during the wash.

Additionally, those who were high in fears of contamination also reported a greater perceived sense of responsibility and significantly higher estimates of harm. However,

consistent with previous research, only harm estimates predicted subsequent wash duration. Furthermore, wash duration did not predict participants' post-wash sense of responsibility or estimates of harm. It also did not detract from or enhance confidence in memory, quality of memory, confidence in attention, certainty that harm had been prevented, or post-wash feelings of contamination. However, wash duration was found to have a paradoxical relationship with sensory confidence, such that increased wash duration was found to predict decreased sensory confidence.

The findings of this study provide information on the general phenomenology of washing behaviours, as well as specific cognitive factors that might contribute to the development and persistence of compulsive behaviours. They also support the necessity of tailoring cognitive models of OCD to specific symptom subtypes.

As well, these findings may prove useful in the treatment of OCD. Clinicians who take these factors into consideration when developing a case formulation and planning interventions might be better able to tailor treatment to the individual client. For example, providing psychoeducation regarding the relationship between beliefs and compulsive behaviours might improve client insight into their own symptoms and better equip them to resist compulsive behaviours and engage in treatments such as ERP. As well, these beliefs could be directly examined in therapy in order to improve the effectiveness of treatment (e.g., through directly testing the belief that "if I wash longer, I will feel more certain that my hands have been cleaned properly").

As such, we hope that the findings of the current study will allow for greater understanding of the factors that influence repetitive or prolonged washing, and, in turn, the general and common problem of finding it difficult to discontinue a behaviour in spite of

potential detriment to oneself and others. Understanding such factors could assist us in developing strategies for helping people discontinue repetitive actions; for example, clinicians who work with individuals whose repetitious behaviour is distressing and impairing, and more broadly, individuals such as athletes, whose superstitious rituals may interfere with performance, or parents of children whose repetitious behaviours interfere with school and bedtime.

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Appendix A: Pre-Contamination (T1) VAS

Imagine what could happen if your hands were contaminated by the sponge...

How much harm could occur?

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

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 disgusted do you feel?

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

Consider the cleanliness of your hands right now...

How clean are your hands right now?

Not at all contaminated ——————————————— extremely contaminated

Appendix B: Post-Contamination (T2) VAS

Consider the cleanliness of your hands right now...

How clean are your hands right now?

Not at all contaminated _____ extremely contaminated

How much harm could occur?

no harm at all _____ extreme harm

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 disgusted do you feel?

not at all disgusted _____ extremely disgusted

Appendix C: Post-Wash (T3) VAS

Consider the cleanliness of your hands right now...

How clean are your hands right now?

Not at all contaminated _____ extremely contaminated

How much harm could occur?

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

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 your hands have been washed properly?

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

How certain are you that harm has been prevented?

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

How disgusted do you feel?

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

Think back to when you were washing your hands…

How certain are you of your memory of washing?

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

How vivid is your memory of washing?

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

How detailed is your memory of washing?

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

How much attention did you allocate to washing?

no attention ——————————————— all of my attention

How certain are you that your attention was focused on washing?

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

Is what you have seen reliable?

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

Is the impression you got when you touched something reliable?

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

Are your senses reliable?

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