

An experimental approach to understanding beliefs about losing control
in obsessive-compulsive disorder

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ABSTRACT

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Cognitive theories of obsessive-compulsive disorder (OCD) posit that maladaptive beliefs lead to the development and maintenance of symptoms. However, currently identified beliefs (about responsibility and threat overestimation, perfectionism and intolerance for uncertainty, and about the importance of and control over thoughts) do not sufficiently explain OCD symptomatology. Anecdotal and other reports have documented concerns among those diagnosed with OCD regarding a potential loss of control over their thoughts and behaviour, indicating that negative beliefs about losing control may be an important cognitive domain involved in the aetiology of OCD. In this study, 133 undergraduate participants received (positive or negative) false feedback about their capacity to stay in control during a bogus EEG session, and completed a computer task asking them to control the pace of a series of pictures. As hypothesized, participants provided with negative feedback about their capacity to stay in control (i.e., high negative beliefs about losing control) checked significantly more often which keys they should use to control the pictures, $t(106.95) = 2.28, p = .02, d = .44$, as compared to participants provided with positive feedback (i.e., low negative beliefs about losing control), demonstrating that manipulating beliefs about losing control can impact checking behaviour. Also, checking behaviour predicted a lower desire for control over the computer task's pictures, $r(131) = -.30, p < .001$, such that compulsions may be seen as opportunities to re-establish disrupted perceptions of control. Results support the inclusion of beliefs about losing control in cognitive models of OCD.

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An Experimental Approach to Understanding Beliefs About Losing Control in Obsessive-Compulsive Disorder

Obsessive-compulsive disorder (OCD) is characterized by intrusive thoughts, images, or impulses (i.e., obsessions) and repetitive behaviour, mental acts, or rituals (i.e., compulsions) such as repeated washing and checking (American Psychiatric Association, 2013). OCD affects approximately 2.5% of the population (Angst, 1994; Karno, Golding, Sorenson, & Burnam, 1988) and has been listed as one of the top ten causes of disability worldwide (World Health Organization, 1999). Because changes in beliefs during cognitive-behaviour therapy (CBT) for OCD have been shown to be responsible for symptom reduction (e.g., Adams, Riemann, Wetterneck, & Cisler, 2012; Alcolado & Radomsky, 2016; O'Connor et al., 2005; Solem, Håland, Vogel, Hansen, & Wells, 2009; Wilhelm, Berman, Keshaviah, Schwartz, & Steketee, 2015; Woody, Whittal, & McLean, 2011), investigating novel belief domains underlying the aetiology and maintenance of obsessions and compulsions has become increasingly important (e.g., Alcolado & Radomsky, 2011, 2016). The aim of the current experiment was to examine the effect of a manipulation of negative beliefs about losing control on checking behaviour, as a way to further understand the role of dysfunctional beliefs in OCD symptomatology and, accordingly, to improve the efficacy of existing evidence-based psychological treatments.

Current cognitive theories of OCD (e.g., Rachman, 1997, 1998, 2002; Salkovskis, 1985, 1999) posit that misinterpreting intrusive thoughts as overly significant leads individuals to engage in compulsive behaviour to prevent negative outcomes. Critically, specific maladaptive beliefs are thought to be responsible for these misappraisals of normal intrusive thoughts (Clark et al., 2014; Moulding et al., 2014; Radomsky et al., 2014). Early evidence for these theories comes from experiments with manipulations of beliefs about responsibility, showing that higher

perceived responsibility causes increased discomfort, urges to check, and actual checking behaviour (e.g., Arntz, Voncken, & Goosen, 2007; Ladouceur, Rhéaume, & Aublet, 1997; Lopatka & Rachman, 1995; Shafran, 1997). Since then, several belief domains have been identified that play a role in the development and maintenance of OCD. In 2005, the Obsessive Compulsive Cognitions Working Group (OCCWG) identified three empirically-derived groups of beliefs related to OCD and developed a consolidated measure to assess them. However, these beliefs (about responsibility and threat overestimation, perfectionism and intolerance for uncertainty, and about the importance of and control over thoughts) do not sufficiently explain OCD symptomatology. Indeed, not all individuals with OCD endorse such beliefs, and other cognitive domains are necessarily involved (Taylor et al., 2006). Later, Alcolado and Radomsky (2011) provided support for the integration of negative beliefs about memory in cognitive models of OCD. Using a laboratory-based experimental paradigm, they demonstrated that poorer (*versus* better) memory confidence leads to increased urges to check.

OCD has also been theoretically conceptualized through notions of control (e.g., Carr, 1974; McFall & Wollersheim, 1979; Reuven-Magril, Dar, & Liberman, 2008), and several authors have suggested that control cognitions are critical in OCD, but largely understudied (e.g., Moulding & Kyrios, 2006; Moulding, Kyrios, Doron, & Nedeljkovic, 2009). In fact, empirical investigations have usually been limited to the control of thoughts (OCCWG, 2005; Purdon & Clark, 2002; Tolin, Woods, & Abramowitz, 2003), and have left out a number of other control-related beliefs that could well be maintaining factors of OCD (Moulding, Doron, Kyrios, & Nedeljkovic, 2008; Moulding & Kyrios, 2007; Moulding et al., 2009). For instance, Moulding and Kyrios (2007) have shown that one's *desire for control* (i.e., motivation to control a given outcome or situation; Burger & Cooper, 1979; Deci & Ryan, 2000; Harter, 1978; Skinner, 1995;

White, 1959) and one's *sense of control* (i.e., perceived level of control over a given outcome or situation; Skinner, 1996) were tightly linked with obsessive-compulsive symptoms. With a community sample, they found that tendencies toward a higher desire for control and a lower sense of control were associated with greater obsessive-compulsive symptoms. Such results were then replicated with a clinical sample of individuals diagnosed with OCD (Moulding et al., 2008). Similarly, Gelfand and Radomsky (2013) demonstrated that one's desire for control and sense of control over germs explained unique variance in time spent cleaning. As a result, it has been posited that a "control mismatch"—when one's perceived level of control does not match the desired level of control—could be partly responsible for OCD symptoms (Gelfand & Radomsky, 2013; Moulding et al., 2008; Moulding & Kyrios, 2007), such that a desire to re-establish one's sense of control over anxiety-provoking events could motivate compulsions (Radomsky & Rachman, 2004; Reuven-Magril et al., 2008). Experiencing a control mismatch can have a negative impact on one's psychological well-being in many ways. For example, people with tendencies toward such a mismatch are more likely to suffer from symptoms of depression and anxiety (Braith, McCullough, & Bush, 1988; Burger, 1984, 1991, 1992; Conway, Vickers, & French, 1992; Evans, Shapiro, & Lewis, 1993; Garant & Alain, 1995).

Given the influence of control cognitions in OCD, targeting novel control-related beliefs appears particularly relevant to foster a better understanding of the disorder and improve the efficacy of CBT. Anecdotal and clinical reports have documented concerns among those diagnosed with OCD regarding a potential loss of control over their thoughts, behaviour, emotions, and bodily functions (e.g., Carr, 1974; McFall & Wollersheim, 1979; Reuven-Magril et al., 2008). In the same vein, individuals with OCD often fear they will act on unwanted impulses, such as harming someone (Rachman & Hodgson, 1980; Summerfeldt, Richter,

Antony, & Swinson, 1999), and tend to avoid sharp objects such as knives and scissors (e.g., Thyer, 1985). In 1988, Sanavio developed the Padua Inventory to assess OCD symptom severity, and identified “urges and worries of losing control over motor behaviors” as one of the four emerging factors, supporting again the significance of concerns about ‘losing control’ in OCD. Recently, with a sample of non-clinical participants, Froreich, Vartanian, Grisham, and Touyz (2016) reported a positive association between the fear of losing control and OCD symptoms. It is therefore suggested that individuals with OCD likely hold maladaptive beliefs about losing control, which may contribute to the development and maintenance of symptoms.

The goal of the current study was to directly examine the proposition that negative beliefs about losing control play an important role in OCD symptomatology, by shedding light on the causal mechanism between such beliefs and checking behaviour. Along with repeated washing, checking is the most commonly reported compulsion in OCD (Ball et al., 1996; Rachman & Hodgson, 1980), and was posited to reduce the anxiety individuals holding negative beliefs about losing control experience by temporarily increasing their perceptions of control over their environment. For example, if one believes they can lose control of their behaviour, an intrusive thought about pushing a friend out of a window may be particularly disturbing. As a result, repeatedly checking that windows are locked may increase one’s sense of control (and decrease one’s desire for control) over their behaviour and environment. In this experiment, beliefs about losing control were manipulated—by giving positive or negative feedback following a bogus electroencephalography (EEG) session described as ‘recording’ participants’ capacity to stay in control—in a sample of undergraduate students to see if such beliefs would influence checking behaviour during a subsequent laboratory-based computer task asking participants to control the pace of pictures (adapted from Reuven-Magril et al., 2008). It was hypothesized that participants

provided with negative feedback about their performance during the EEG session (i.e., greater negative beliefs about losing control) would check more often which keys they should be using to control the pace of the pictures during the computer task, as compared to participants provided with positive feedback (i.e., lower negative beliefs about losing control). Empirical and experimental support for this mechanism of action would help to justify the inclusion of beliefs about losing control in cognitive models of OCD, and would suggest novel treatment targets to improve the efficacy of CBT. It was further hypothesized that participants provided with negative feedback (i.e., greater negative beliefs about losing control) would report a lower sense of control and a higher desire for control over the computer task's pictures (i.e., a more pronounced and maladaptive control mismatch toward the pictures), as compared to participants provided with positive feedback (i.e., lower negative beliefs about losing control).

Method

Participants

Participants were 136 undergraduate students recruited from Concordia University. They all received course credit for participating. The only inclusion criteria were the ability to understand, read, and communicate in English. Three participants' data were omitted: one did not finish the protocol, one did not understand the instructions during the EEG session, and one did not understand the instructions of the computer task. The final sample consisted of 133 undergraduate student participants, with 67 in the high beliefs about losing control (HLC) condition and 66 in the low beliefs about losing control (LLC) condition. Participants' mean age was 23.26 ($SD = 5.23$; range = 18-45) years, and 91.7% of the sample was female. There were no significant differences between the two conditions with regard to age, $t(131) = -.02, p = .98$, sex,

$\chi^2(1) = .84, p = .36$, ethnicity, $\chi^2(5) = 8.27, p = .14$, or educational attainment, $\chi^2(7) = 6.35, p = .50$.

To ensure the sample was non-clinical in nature, the Vancouver Obsessional Compulsive Inventory (VOCI; Thordarson et al., 2004), Obsessive Beliefs Questionnaire (OBQ-44; OCCWG, 2005), Depression Anxiety Stress Scales (DASS-21; Lovibond & Lovibond, 1995), and an adapted version of Reid and Ware's (1974) Internal-External Questionnaire—Self-Control Subscale (IEQ-SC; Tiggemann & Raven, 1998) were administered (see Measures below and Table 1 for means and standard deviations). There were no significant differences between the two conditions with regard to relevant psychopathology symptoms and aspects of losing control, as evidenced by VOCI scores, $t(131) = -.72, p = .47$, the checking subscale of the VOCI, $t(131) = .10, p = .92$, OBQ-44 scores, $t(131) = -1.23, p = .22$, DASS-21 scores, $t(131) = -.67, p = .51$, and IEQ-SC scores, $t(131) = -1.61, p = .11$.

Measures

Demographic Questionnaire. Participants were asked to report demographic information, such as sex, age, ethnicity, and educational attainment.

Vancouver Obsessional Compulsive Inventory (VOCI; Thordarson et al., 2004). The VOCI is a 55-item measure of a broad range of symptoms related to OCD comprised of six subscales (i.e., contamination, checking, obsessions, hoarding, indecisiveness, and “just right” experiences). Items are rated on a five-point scale ranging from 0 (“Not at all”) to 4 (“Very much”). The VOCI's total scale and subscales have good-to-excellent internal consistency in OCD, clinical control, and student populations (α 's = .79-.98; Radomsky et al., 2006; Thordarson et al., 2004). The inventory also has excellent retest reliability ($r = .91$; Radomsky et al., 2006), as well as convergent and divergent validity (Radomsky et al., 2006; Thordarson et al., 2004). In

the current study, the VOCI exhibited excellent internal consistency ($\alpha = .96$), and was administered to examine condition differences on reported OCD and checking symptomatology. Please see Appendix A for the full questionnaire.

Obsessive Beliefs Questionnaire (OBQ-44; OCCWG, 2005). The OBQ-44 is a 44-item measure assessing the extent to which one holds maladaptive beliefs considered relevant to the development and maintenance of OCD, comprised of three subscales: responsibility and threat overestimation, perfectionism and intolerance for uncertainty, and importance of and control over thoughts. Items are rated on a seven-point scale ranging from 1 (“Disagree very much”) to 7 (“Agree very much”). The OBQ-44 has been shown to have good-to-excellent internal consistency across the three subscales (α 's = .89-.93; OCCWG, 2005). Criterion, convergent, and divergent validity have also been shown to be good (OCCWG, 2005). In the current study, the OBQ-44 exhibited excellent internal consistency ($\alpha = .96$), and was administered to examine condition differences on reported obsessive beliefs. Please see Appendix A for the full questionnaire.

Depression Anxiety Stress Scales (DASS-21; Lovibond & Lovibond, 1995). The DASS-21 is a 21-item measure assessing the severity of possible symptoms of depression, anxiety, and stress (three subscales). Items are rated on a four-point scale ranging from 0 (“Did not apply to me at all”) to 3 (“Applied to me very much or most of the time”). The DASS-21 has been shown to have good-to-excellent internal consistency in both clinical and community samples (α 's = .87-.94; Antony, Bieling, Cox, Enns, & Swinson, 1998; Henry & Crawford, 2005), as well as good convergent and divergent validity (Crawford & Henry, 2003; Henry & Crawford, 2005; Lovibond & Lovibond, 1995). In the current study, the DASS-21 exhibited excellent internal consistency ($\alpha = .96$), and was administered to examine condition differences

on reported symptoms of depression, anxiety, and stress. Please see Appendix A for the full questionnaire.

Internal-External Questionnaire, Adapted Self-Control Subscale (IEQ-SC; Reid & Ware, 1974; Tiggemann & Raven, 1998). The IEQ-SC is an 8-item measure that assesses fears of losing control (e.g., doubts about being able to control one's impulses, desires, and emotional behaviour). Items are rated on a seven-point scale ranging from 1 ("Doesn't apply to me at all) to 7 ("Always applies to me"). The IEQ-SC has been shown to have excellent internal consistency (α 's = .94-.95; Froreich et al., 2016; Tiggemann & Raven, 1998) and convergent validity (Tiggemann & Raven, 1998). In this study, it exhibited excellent internal consistency ($\alpha = .90$), and was administered to examine condition differences on reported levels of fear of losing control. Please see Appendix A for the full questionnaire.

Feedback questionnaire. Participants completed a manipulation check questionnaire following the bogus EEG session under the guise of providing the laboratory with feedback about the EEG device (see Appendix A). It was necessary to assess the efficacy of the experimental manipulation in this way to minimize suspicions about the purpose of the study. Among several buffer items, participants were asked the following question: "On a scale from 0 to 100, do you believe it is possible for you to lose control of your thoughts and behaviour?" This item was used to assess the degree to which participants believed the false feedback about their capacity at staying in control of their thoughts and behaviour provided following the EEG session (i.e., participants in the HLC condition should believe they are more likely to lose control of their thoughts and behaviour compared to participants in the LLC condition).

Checking behaviour. Participants completed a computerized task asking them to control the pace of pictures appearing by trying different combinations of eight specific keys (adapted

from Reuven-Magril et al., 2008; see Procedure for details). Specifically, participants were asked to try to make the pictures disappear as fast as they could. In reality, they were presented with a pre-programmed series of pictures that elicited various degrees of control. Participants were told they could press the space bar at any time during the task to check again which eight keys they should be using to control the pace of the pictures. The number of space bar presses was used as an index of checking behaviour.

Computer task ratings. Following the computer task, participants were asked to rate their desire for control over the pictures of the task: “On a scale from 0 to 100, how motivated were you to control the pictures?” They were also asked to rate their sense of control over the pictures of the task: “On a scale from 0 to 100, did it feel like you were the one controlling the pictures in general?” These questions were asked to assess participants’ perceived and desired level of control over the computer task’s pictures (as well as compute control mismatch scores) and to better understand the motivation behind checking behaviour during the computer task.

Credibility ratings. At the end of the protocol, participants were asked to rate the credibility of the experimental manipulation by answering two questions: “On a scale from 0 to 100, did you believe your brain waves were monitored during the EEG session?” and “On a scale from 0 to 100, did you believe the feedback provided following the EEG session regarding your capacity at being in control?” These questions were asked to ensure the experimental manipulation worked properly and was credible, and verify whether there were significant differences between the two conditions with regard to the believability of the false feedback.

Materials

NeuroSky® Mindwave™ Mobile EEG headset. To manipulate beliefs about losing control, participants wore a black NeuroSky® Mindwave™ Mobile EEG headset, a wireless

device that detects brain waves and that is usually utilized for entertainment purposes. The program accompanying the device was used to pretend the headset needed to be calibrated.

Laminated brochure. To ensure the manipulation was believable, participants were asked to read a laminated brochure (see Appendix B) with realistic yet partially false information about the NeuroSky[®] Mindwave[™] Mobile EEG headset and how it records inhibitory capacities.

Procedure

Participants were told they were participating in a study examining the associations between normal intrusive thoughts and the capacity to stay in control of one's thoughts as assessed by a brain activity device that captures frontal lobe brain waves (see Appendix C for the script). Following the informed consent process (see Appendix D for the initial consent form), participants were asked to report demographic information such as age, sex, ethnicity, and educational attainment (see Appendix A).

Then, participants were told that they would undergo an EEG recording session focusing on frontal lobe activation and that a device would monitor their ability to inhibit their thoughts. They were also told that the results would predict the extent to which they can stay in control of their thoughts and behaviour. The EEG session was actually bogus and used to experimentally manipulate negative beliefs about losing control. In the current study, participants wore a NeuroSky[®] Mindwave[™] Mobile EEG headset. To ensure the manipulation was believable, participants were asked to read a laminated brochure with realistic yet partially false information about the EEG device and how it records inhibitory capacities (see Appendix B). Moreover, participants were asked to follow specific instructions to 'calibrate' the device to, once again, increase the believability. Specifically, they were asked to blink their eyes at specific moments (and they would see the NeuroSky[®] program detect their eye blinks) and to focus their attention

on a specific stimulus (and they would see their attention level increasing on the screen).

Afterwards, participants were instructed to inhibit any visual intrusive thoughts they would have for the next ten minutes, and to only allow themselves to have verbal intrusive thoughts (adapted from Rassin, Merckelbach, Muris, & Span, 1999). The experimenter pretended to activate the EEG software and, toward the end of the EEG session, randomly assigned participants to one of the two conditions (see Appendix C for the script).

Participants in the HLC condition were told the following: “Based on the EEG software, it appears that you were not very good at inhibiting your intrusive thoughts compared to a normative sample. People with results like yours are at a greater risk of losing control of their thoughts and behaviour in a variety of contexts, such as anxiety-provoking situations. You may have noticed yourself that when you are nervous, like during an exam, your mind starts wandering or you start having racing thoughts if you feel you cannot find the answer to a question right away. Again, it appears that you are more likely than others to lose control of your thoughts and behaviour.” Then, the experimenter showed participants in the HLC condition a bogus graph of ‘their’ below-average performance.

Participants in the LLC condition were told the following: “Based on the EEG software, it appears that you were very good at inhibiting your intrusive thoughts compared to a normative sample. People with results like yours are usually very good at staying in control of their thoughts and behaviour in a variety of contexts, and even in anxiety-provoking situations. You may have noticed yourself that even when you are nervous, like during an exam, you usually find the answer to a question right away and your mind stays on task while you answer. Again, it appears that you are less likely than others to lose control of your thoughts and behaviour.” Then, the experimenter showed participants in the LLC condition a bogus graph of ‘their’ above-

average performance. All participants completed a bogus feedback questionnaire—which included a manipulation check question—under the guise of providing comments about the new EEG device (see Appendix A).

Afterwards, participants were told they would complete a computer task (adapted from Reuven-Magril et al., 2008) that assesses a number of cognitive skills (see Appendix C for the script). They were presented with a series of pictures and were instructed to try to control their pace (i.e., shorten the presentation time of each picture) by finding the right combinations of eight specific keys: “m”, “v”, “y”, “d”, “p”, “r”, “t”, “q”. They were told that combinations should contain three to eight letters. In reality, the presentation time of each picture was pre-programmed to elicit various degrees of control. Forty neutral pictures (e.g., furniture, clothing) were presented. Each picture was presented for 2 to 5 seconds, followed by a white screen with a blue plus (+) sign. Each trial lasted 6 seconds, meaning that the white screen with the blue plus (+) sign could be presented for a duration of 1 to 4 seconds. For the first 20 pictures, the presentation time of each picture increased from 2 to 5 seconds; for the last 20 pictures, the presentation time decreased from 5 to 2 seconds. The experimenter reminded participants they could press the space bar at any time during the task to check which keys they should use to control the pictures (i.e., checking behaviour). Following the task, all participants completed ratings of their desire for control and sense of control over the task’s pictures (see Measures).

At the end of the protocol, participants were asked to complete a series of well validated and frequently used questionnaires, which included two credibility ratings (see Appendix A and Measures). Finally, participants were fully debriefed (see Appendices C and D for the debriefing script and the debriefing form, respectively) and a post-debriefing consent form was given so they could consent to the use of their data after hearing about the deception (see Appendix D).

Results

Data Screening

There were two univariate outliers on the main dependent variable (i.e., checking behaviour). Based on Tabachnick and Fidell's (2007) guidelines, each outlying score was replaced with the next highest score within 3.29 *SD* of the mean for this variable. The data were assessed for normality, and were found to have acceptable skewness and kurtosis on most variables (Kline, 2009), except for age, which was positively skewed (2.59, *SE* = .21) and leptokurtic (7.00, *SE* = .42), and for checking behaviour, which was positively skewed (2.04, *SE* = .21) and leptokurtic (3.78, *SE* = .42). Such findings were expected given the nature of the sample and the computer task's instructions (i.e., checking which keys should be used to control the pace of the pictures was not mandatory but only proposed in the instructions).

Manipulation Check

To ensure the experimental manipulation was effective in producing different degrees of negative beliefs about losing control between the two conditions, an independent samples *t*-test was conducted using the manipulation check rating as the dependent variable (see Figure 1). As expected, there was a significant difference between the two conditions, $t(131) = 3.11, p < .001, d = .54$, such that participants in the HLC condition believed to a greater extent that losing control of their own thoughts and behaviour was possible, as compared to participants in the LLC condition (see Table 2 for means and standard deviations).

Checking Behaviour

An independent samples *t*-test was conducted to assess group differences on the main dependent variable (see Figure 2). As hypothesized, there was a significant difference between the two conditions, $t(106.95) = 2.28, p = .02, d = .44$, such that participants in the HLC condition

checked significantly more often which keys they should be using to control the pace of the pictures during the computer task (i.e., greater number of space bar presses), as compared to participants in the LLC condition (see Table 2 for means and standard deviations).

Computer Task Ratings

Independent samples *t*-tests were conducted to examine condition differences on reported desire for control (see Figure 3) and sense of control (see Figure 4) over the computer task's pictures. There was a significant difference between the two conditions on desire for control, $t(121.42) = -2.39, p = .02, d = .43$; surprisingly, following the computer task, participants in the HLC condition reported a lower desire for control over the task's pictures, as compared to participants in the LLC condition. However, there were no significant differences between the two conditions on reported sense of control over the pictures, $t(131) = .13, p = .90, d = .02$. By subtracting reported desire for control scores from reported sense of control scores, control mismatch scores were computed (with more negative discrepancies indicating a more pronounced control mismatch). An independent samples *t*-test was conducted to assess condition differences on this computed variable (see Figure 5). There was a significant difference between the two conditions, $t(131) = 2.06, p = .04, d = .36$. Following the computer task, participants in the HLC condition were reportedly experiencing a more adaptive (i.e., less pronounced) control mismatch toward the pictures, as compared to participants in the LLC condition (see Table 2 for means and standard deviations of desire for control, sense of control, and control mismatch scores).

Checking Behaviour and Desire for Control

Because desire for control scores (reported following the computer task) were in the unexpected direction (see Computer Task Ratings), a zero-order Pearson's correlation was

conducted to assess whether checking behaviour during the computer task predicted desire for control scores reported following the task. A significant moderate negative correlation between checking behaviour and desire for control was found, $r(131) = -.30, p < .001$, such that the more participants checked during the computer task, the lower their desire for control over the pictures was following the task.

Credibility Ratings

Independent samples *t*-tests were conducted to examine potential condition differences on both credibility ratings of the manipulation (see Figures 6 and 7). As expected, there were no significant differences between the two conditions on the first, $t(131) = .78, p = .44, d = .14$, or second, $t(127.46) = -1.44, p = .15, d = .26$, credibility checks, such that participants in both conditions believed that their brain waves were monitored during the bogus EEG session, and believed the false feedback provided following the EEG session (see Table 2 for means and standards deviations).

Discussion

This experiment examined the causal mechanism between negative beliefs about losing control and checking behaviour. It also aimed to foster a better understanding of the motivation behind checking behaviour by assessing desire for control and sense of control over neutral visual stimuli during a computer task (following the experimental manipulation). As expected, it was found that participants provided with negative feedback about their capacity to stay in control of their thoughts and behaviour (i.e., high negative beliefs about losing control) checked significantly more often which keys they should be using to control the pace of the pictures during the subsequent computer task, as compared to participants provided with positive feedback (i.e., low negative beliefs about losing control). Surprisingly, following the task,

participants in the HLC condition reported a significantly lower desire to control the pace of the pictures, as opposed to participants in the LLC condition. Furthermore, reported levels of perceived control over the pace of the pictures did not significantly differ between the two conditions. It was also found that participants in the HLC condition experienced a significantly more adaptive (i.e., less pronounced) control mismatch toward the computer task's pictures, as compared to participants in the LLC condition. However, as described below, participants were asked to report their desire for control over the pictures after engaging in checking behaviour, which may have influenced ratings. For example, a significant negative correlation was found between checking behaviour (during the computer task) and desire for control over the pictures (reported following the computer task), which may indicate that compulsions are seen as opportunities to re-adjust a potential control mismatch. Still, reported sense of control over the pictures failed to produce condition differences, which was most likely an artifact of the computer task. Having eight keys to choose from to control the pictures decreased the probability of producing combinations that could consistently match the pre-programmed pattern of pictures.

Overall, these findings support the hypothesis that negative beliefs about losing control can indeed lead individuals to engage in compulsive behaviour, such as repeated checking. In other words, it appears that beliefs about losing control may well contribute to the aetiology and maintenance of a number of OCD symptoms. For instance, based on cognitive theories of OCD (e.g., Rachman, 1997, 1998, 2002; Salkovskis, 1985, 1999), dysfunctional beliefs about losing control may be responsible for misinterpreting unwanted intrusive thoughts related to urges, impulses, or a general loss of control as overly significant, which could lead to anxiety and neutralizing behaviour. This could also explain why concerns about a potential loss of control are

commonly reported by those diagnosed with OCD (e.g., Carr, 1974; McFall & Wollersheim, 1979; Reuven-Magril et al., 2008).

Interestingly, it seems that asking participants to report their desire for control over the pictures *following* the computer task may have influenced scores in the unexpected direction. Indeed, participants in the HLC (*versus* LLC) condition engaged in significantly more checking during the computer task *and* reported a significantly lower desire for control over the pictures (and a significantly more adaptive control mismatch) once the task was over. Results also showed that greater checking behaviour during the task predicted a lower desire for control over the pictures following the task. Previous work by Braith and colleagues (1988) has shown that a fear of losing control (during a relaxation session) was associated with a greater desire for control following the relaxation session. Perhaps permitting participants to engage in checking behaviour in the current study allowed them to re-establish their perceptions of control and, accordingly, alleviate their desire for control. This hypothesis is in line with theories proposing that individuals with OCD see uncontrollable life events as unbearable and threatening (e.g., McLaren & Crowe, 2003), and compensate by redirecting their control attempts toward repetitive actions and thoughts (i.e., controlling by proxy; Radomsky & Rachman, 2004; Reuven-Magril et al., 2008). Based on the findings, such control attempts (e.g., repetitive checking) may potentially lessen one's desire for control, and appease discrepancies between perceived and desired levels of control (i.e., control mismatch). The fact that participants were motivated to try to control the pace of neutral and non-threatening pictures further supports the suggestion that control attempts may foster repeated everyday actions like hand washing (Reuven-Magril et al., 2008), arranging, and ordering (Radomsky & Rachman, 2004). This is in line with previous research showing that individuals with OCD report greater perceived

responsibility for harm even in *low-risk* situations, as compared to control participants (Foa, Amir, Bogert, Molnar, & Przeworski, 2001; Lopatka & Rachman, 1995).

Despite limitations, this study employed an original laboratory-based methodology to experimentally manipulate negative beliefs about losing control effectively. EEGs and other related techniques such as brain imaging devices have been utilized in past psychology research as tools for experimental manipulations, and have been quite effective (e.g., Olson, Landry, Appourchaux, & Raz, 2016; Rassin et al., 1999). There is nonetheless a possibility that the manipulation activated other related belief domains (e.g., importance of and control over thoughts) and that the negative feedback impacted other psychological constructs (e.g., self-esteem and ego threats), which may have influenced checking behaviour. Still, the design of this study allowed the demonstration of a direct causal association between a novel belief domain and checking behaviour, in a sample of non-clinical participants. Previous correlational studies (e.g., Moulding & Kyrios, 2007) had suggested that control cognitions were not related to checking compulsions, as opposed to contamination symptoms, which shows again an advantage of experimental designs. Critically, the manipulation in the present experiment was found to influence checking *behaviour*, as opposed to urges to check. Behavioural responses are much harder to observe in experiments and laboratory settings; therefore, a majority of studies have focused on urges instead (e.g., Alcolado & Radomsky, 2011; Cuttler, Sirois-Delisle, Alcolado, Radomsky, & Taylor, 2013; Lopatka & Rachman, 1995). Findings also indicate that beliefs about losing control are sufficient to cause repetitive checking in a non-clinical sample, but not *necessary*, as other cognitive domains and aetiologies are clearly involved (e.g., Alcolado & Radomsky, 2011; Arntz, Voncken, & Goosen, 2007; Chiang, Purdon, & Radomsky, 2016;

Cougle, Salkovskis, & Wahl, 2007; Cuttler et al., 2013; Lopatka & Rachman, 1995; OCCWG, 1997, 2001, 2003, 2005; Rachman, 1993, 1997, 1998; Taylor et al., 2006).

Future research should examine the role of beliefs about losing control in OCD and related problems by employing more ecologically valid manipulations and methods. Because contamination symptoms and control cognitions have been shown to be tightly associated (Gelfand & Radomsky, 2013; Moulding & Kyrios, 2007), washing and cleaning tasks could be utilized to examine one's perceptions of control over germs following a manipulation of beliefs about losing control. Moreover, relationships between this novel belief domain and control over thoughts—an important aspect of OCD (OCCWG, 2005; Purdon & Clark, 2002; Tolin et al., 2003)—should be explored, as beliefs about losing control may be motivating urges to neutralize and control thoughts. To address another limitation of the current study and to foster a better understanding of the causal relationship between control cognitions and checking behaviour, future work should compare how perceived and desired levels of control vary depending on whether participants are allowed (*versus* not allowed) to engage in neutralizing behaviour during a specific task. In addition, psychometric analyses will be extremely important to understand basic associations between novel cognitive domains—such as beliefs about losing control—and other variables (e.g., OCD symptoms, anxious symptoms, other types of control cognitions). A measure assessing the severity of beliefs about losing control would not only add to the OCD literature, but could also be used in research and clinical settings to monitor decreases in dysfunctional beliefs during trials and psychotherapy.

Researchers have previously identified relevant maladaptive obsessive beliefs maintaining symptoms (e.g., Alcolado & Radomsky, 2011; Carr, 1974; Chiang et al., 2016; McFall & Wollersheim, 1979; OCCWG, 1997, 2001, 2003, 2005; Rachman, 1993, 1997;

Salkovskis, 1985), and results of the present study support the inclusion of a novel belief domain (i.e., beliefs about losing control) in current cognitive models of OCD (e.g., Rachman, 1997, 1998, 2002; Salkovskis, 1985, 1999). This would allow for a more comprehensive understanding of the disorder, improved case conceptualizations of patients and, ideally, better treatment outcomes. This study demonstrated a novel mechanism of action leading to the development of OCD symptoms, and because changes in beliefs have been shown to cause reduction in symptoms (e.g., Adams et al., 2012; Alcolado & Radomsky, 2016; O'Connor et al., 2005; Solem et al., 2009; Wilhelm et al., 2015; Woody et al., 2011), negative beliefs about losing control should potentially be targeted in CBT. Although effective psychological and pharmacological treatments already exist for OCD (Abramowitz, 2006; National Institute for Health and Clinical Excellence, 2005), improvements are essential given the high number of individuals left unwell post-treatment (e.g., Foa et al., 2005; van Oppen, van Balkom, de Haan, & van Dyck, 2005)—perhaps because other cognitive domains should be addressed in therapy. At this early stage, both research with ecologically valid methods and intervention studies are warranted before proposing concrete treatment strategies. Still, behavioural experiments challenging negative beliefs about losing control over one's thoughts, behaviour, emotions, and/or bodily functions could be implemented, and their efficacy could be empirically tested in future research.

Clinically-oriented research could have implications for other anxiety-related problems and mental disorders that are also marked by beliefs about and fears of losing control, like panic disorder (American Psychiatric Association, 2013; Clark, 1986; Clark et al., 1997), social anxiety disorder (Mattick & Clarke, 1998; Turner, Beidel, Dancu, & Keys, 1986), anorexia nervosa (Pyle, Neuman, Halvorson, & Mitchell, 1991), bulimia nervosa (Fairburn & Garner,

1986; Tiggemann & Raven, 1998), and binge eating disorder (Bennett & Dodge, 2007; Colles, Dixon, & O'Brien; 2008).

Summary

The current research provided evidence for a novel belief domain contributing to the development and maintenance of OCD symptoms. Specifically, with an undergraduate student sample, it was shown that holding negative beliefs about losing control over one's thoughts and behaviour caused repeated checking, a common compulsive behaviour in OCD (Ball et al., 1996; Rachman & Hodgson, 1980). It was also found that greater checking behaviour predicted a lower desire for control, such that individuals with OCD may perceive compulsions as opportunities to temporarily re-balance disrupted control cognitions (Radomsky & Rachman, 2004; Reuven-Magril et al., 2008). Results supported the inclusion of a novel belief domain (i.e., beliefs about losing control) into current cognitive models of OCD (e.g., Rachman, 1997, 1998, 2002; Salkovskis, 1985, 1999).

Table 1

Mean scores and standard deviations by condition (and total) on measures assessing relevant psychopathology symptoms and aspects of losing control.

Questionnaire	LLC ^a		HLC ^b		Total ^c	
	Mean	SD	Mean	SD	Mean	SD
VOCI	33.48	29.76	29.92	26.28	31.68	27.99
VOCI-C	3.00	4.69	3.09	5.22	3.05	4.94
OBQ-44	135.25	45.15	125.67	43.45	130.38	44.39
DASS-21	12.69	10.82	11.52	9.13	12.09	9.98
EIQ-SC	24.45	10.82	21.58	9.57	22.99	10.27

Note. VOCI = Vancouver Obsessional Compulsive Inventory (Thordarson et al., 2004). VOCI-C = Vancouver Obsessional Compulsive Inventory—Checking Subscale (Thordarson et al., 2004). OBQ-44 = Obsessive Beliefs Questionnaire (OCCWG, 2005). DASS-21 = Depression Anxiety Stress Scales (Lovibond & Lovibond, 1995). EIQ-SC = adapted version of Reid and Ware’s (1974) Internal-External Questionnaire—Self-Control Subscale (Tiggemann & Raven, 1998). LLC = low beliefs about losing control condition. HLC = high beliefs about losing control condition.

^a*n* = 66. ^b*n* = 67. ^c*N* = 133.

Table 2

Mean scores and standard deviations by condition on experimental variables.

Variable	LLC ^a		HLC ^b		<i>p</i>
	Mean	SD	Mean	SD	
Manipulation check	53.83	25.76	67.42	24.63	<.001
Checking behaviour	5.33	7.64	9.55	13.02	.02
Desire for control	74.15	21.92	63.33	29.72	.02
Sense of control	30.89	25.42	31.46	25.69	.90
Control mismatch	-43.26	31.59	-32.54	28.46	.04
Task credibility	79.73	25.00	82.90	21.59	.14
Feedback credibility	75.52	26.18	68.28	31.46	.26

Note. Control mismatch scores (i.e., discrepancy between one's sense of control and desire for control) were computed by subtracting reported desire for control scores from reported sense of control scores (with more negative discrepancies indicating a more pronounced control mismatch). LLC = low beliefs about losing control condition. HLC = high beliefs about losing control condition.

^a*n* = 66. ^b*n* = 67.

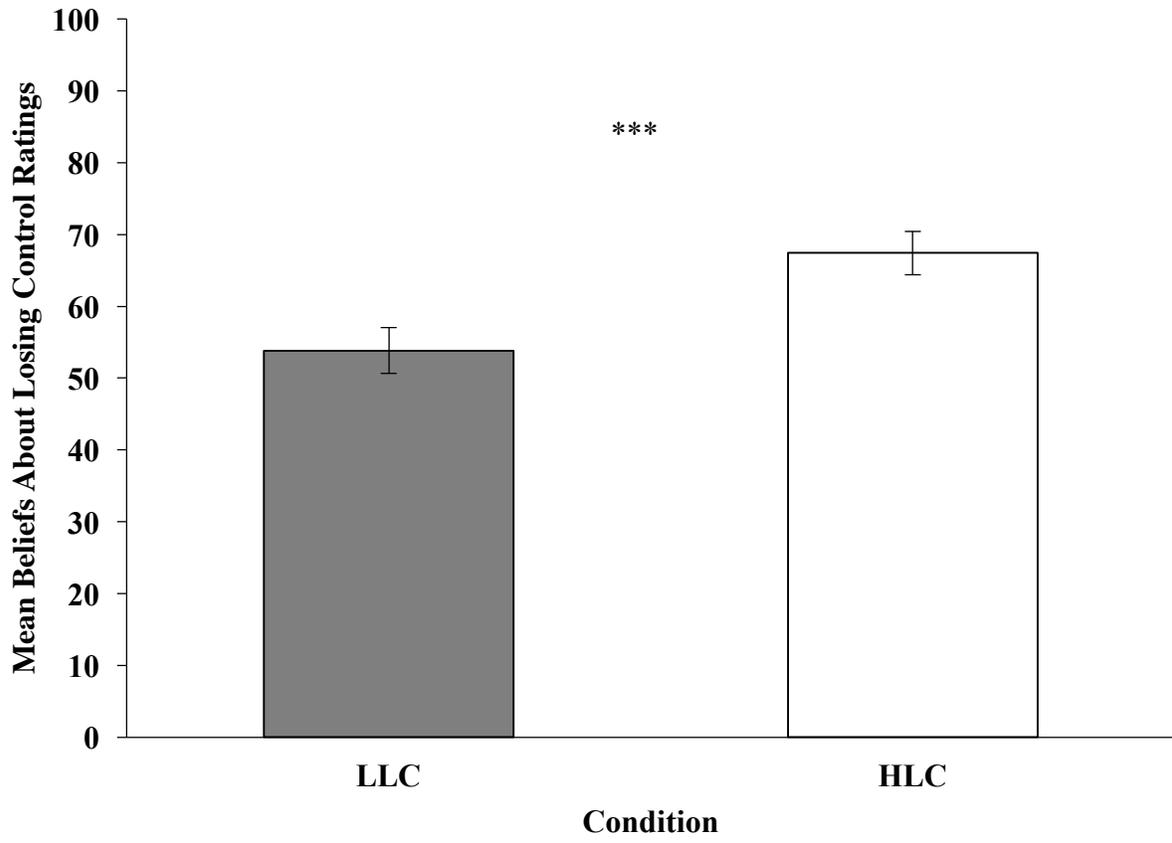


Figure 1. Mean ratings of beliefs about losing control (i.e., manipulation check) by condition. LLC = low beliefs about losing control condition. HLC = high beliefs about losing control condition.

*** $p < .001$.

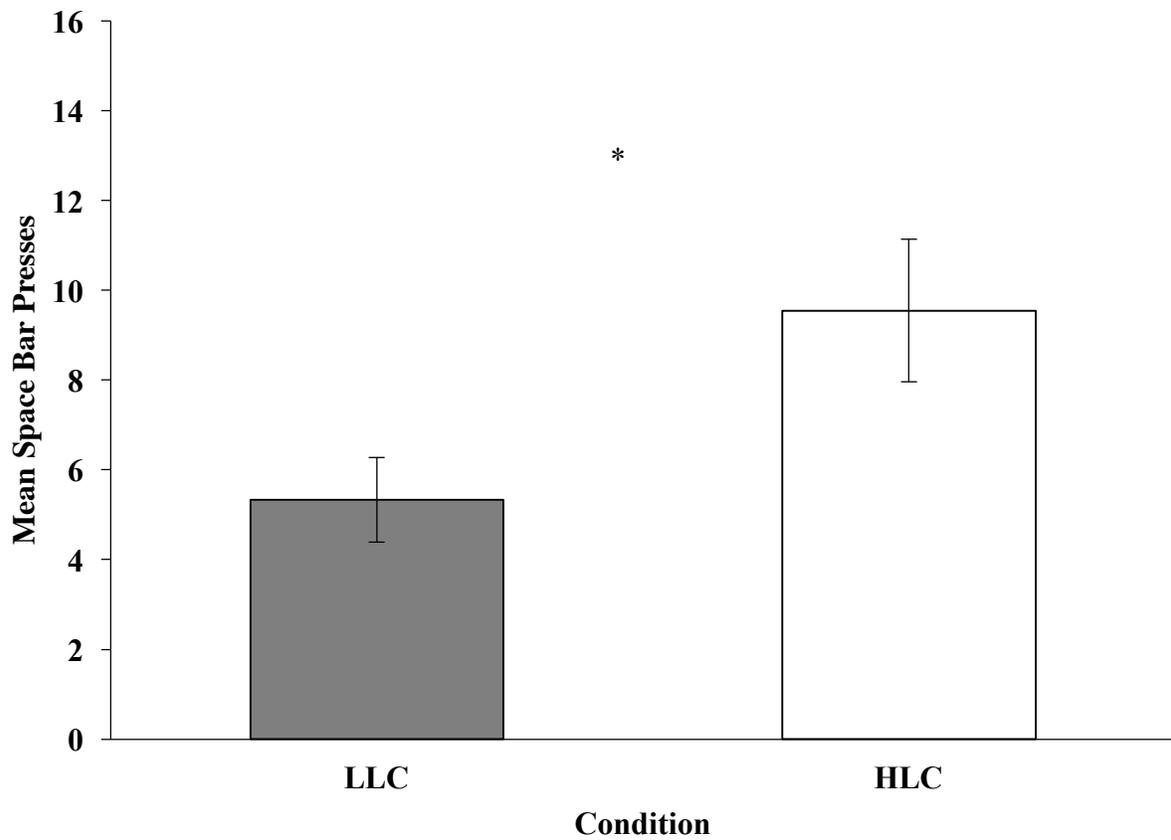


Figure 2. Mean number of space bar presses (i.e., checking behaviour) during the computer task by condition. LLC = low beliefs about losing control condition. HLC = high beliefs about losing control condition.

* $p < .05$.

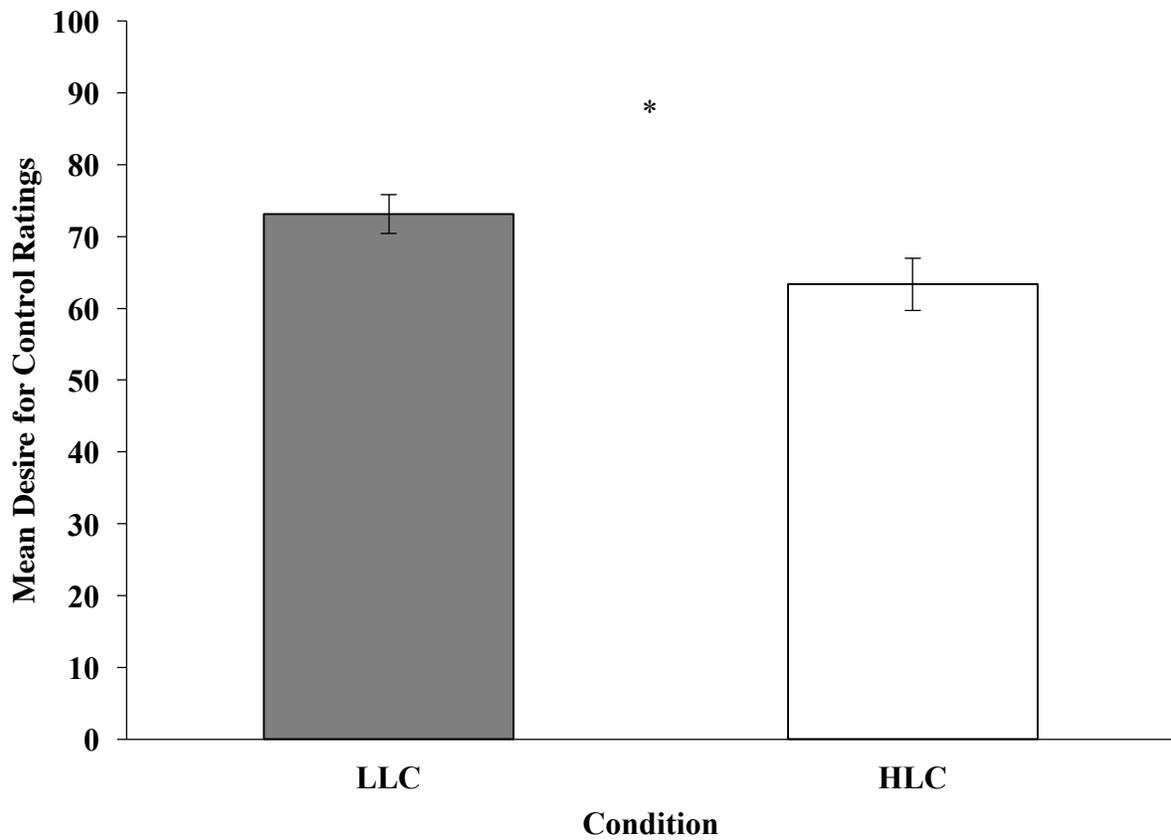


Figure 3. Mean ratings of desire for control following the computer task by condition. LLC = low beliefs about losing control condition. HLC = high beliefs about losing control condition.

* $p < .05$.

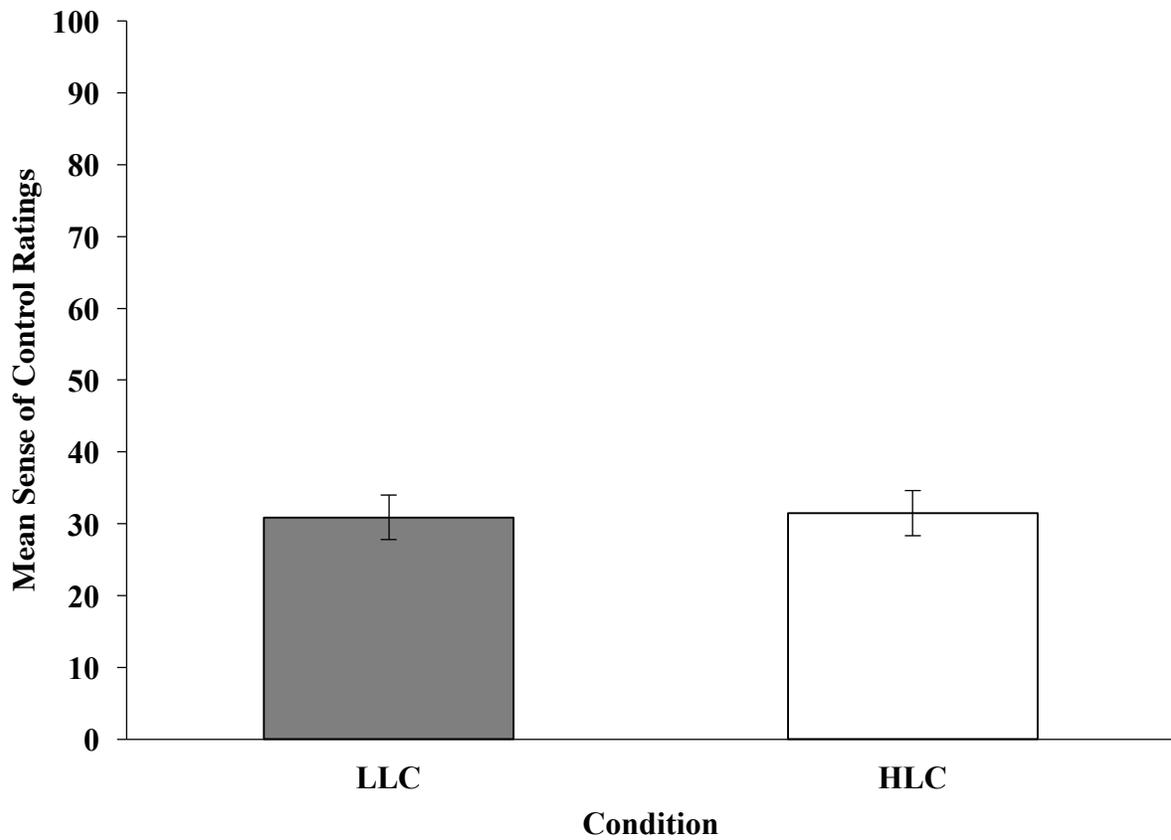


Figure 4. Mean ratings of sense of control following the computer task by condition. LLC = low beliefs about losing control condition. HLC = high beliefs about losing control condition.

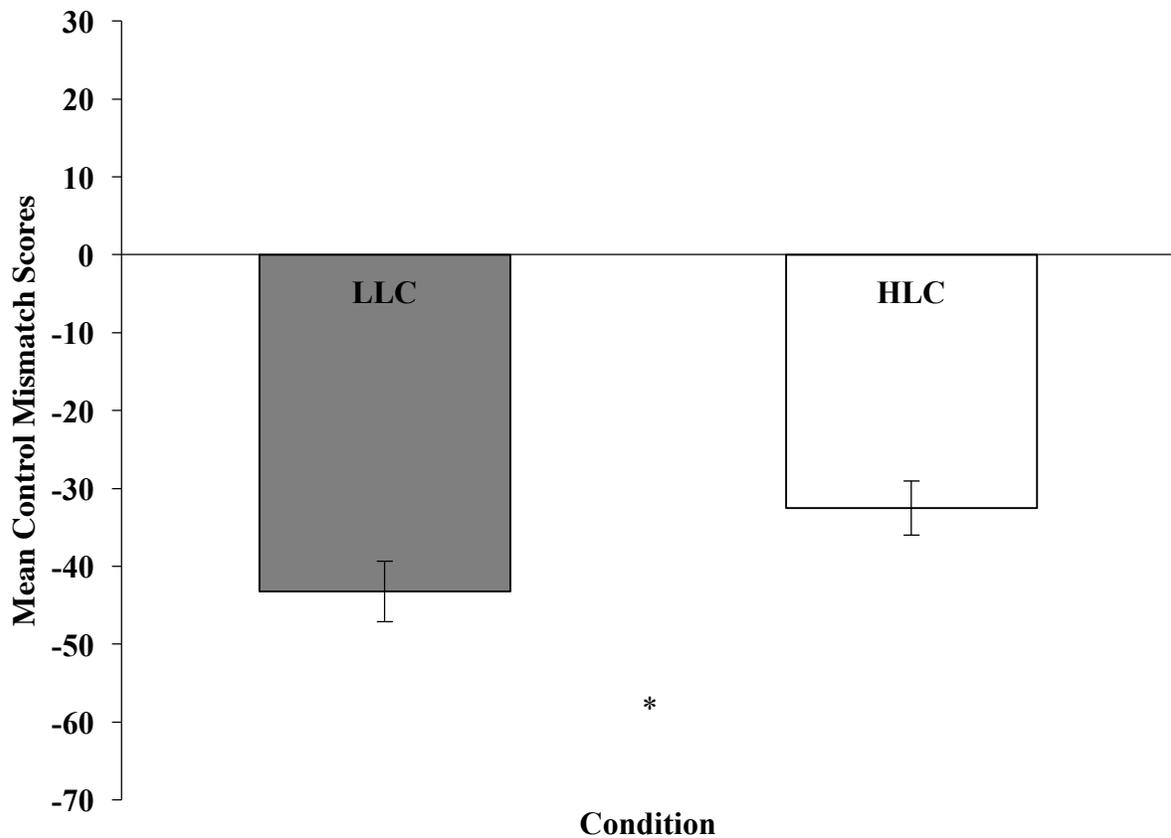


Figure 5. Mean control mismatch scores by condition. Scores computed by subtracting desire for control scores reported following the computer task from sense of control scores reported following the computer task (with more negative discrepancies indicating a more pronounced control mismatch). LLC = low beliefs about losing control condition. HLC = high beliefs about losing control condition.

* $p < .05$.

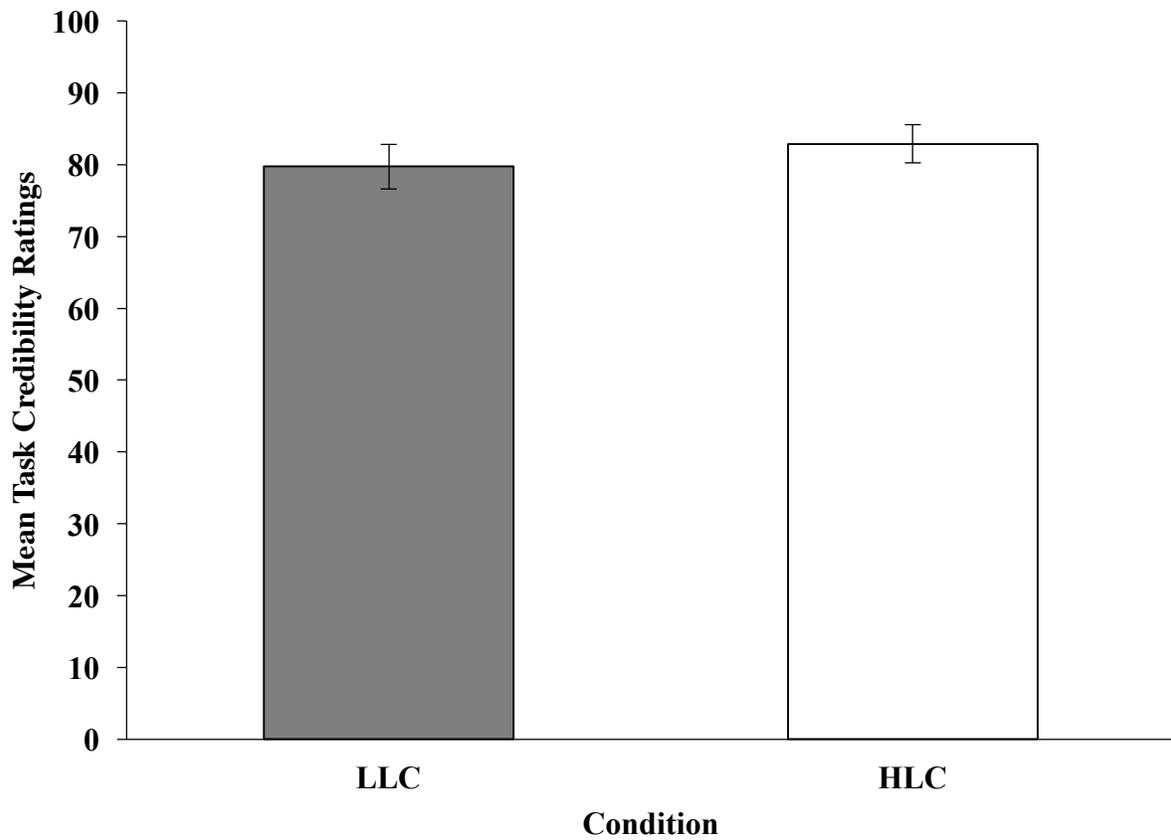


Figure 6. Mean ratings of task credibility by condition. LLC = low beliefs about losing control condition. HLC = high beliefs about losing control condition.

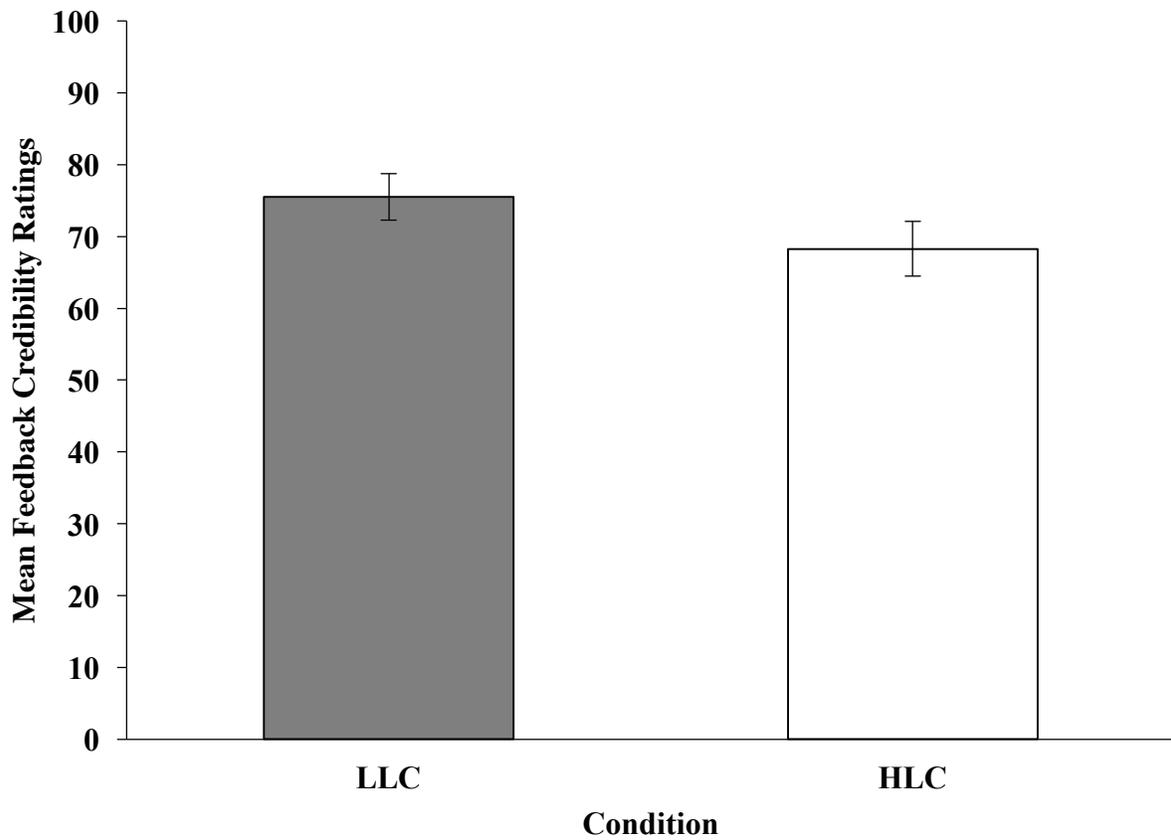


Figure 7. Mean ratings of feedback credibility by condition. LLC = low beliefs about losing control condition. HLC = high beliefs about losing control condition.

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Appendix A

Questionnaires:

Demographic Questionnaire

Vancouver Obsessional Compulsive Inventory (VOCI)

Obsessive Beliefs Questionnaire (OBQ-44)

Depression Anxiety Stress Scales (DASS-21)

Internal-External Questionnaire, Adapted Self-Control Subscale (IEQ-SC)

EEG Recording Session Feedback Questionnaire

Demographic Questionnaire

1. What is your date of birth?
2. What is your biological sex?
 - a. Female
 - b. Male
3. To which gender do you identify to?
4. What is your ethnicity?
 - a. White
 - b. Hispanic or Latino
 - c. Black
 - d. Native American or American Indian
 - e. Asian/Pacific Islander
 - f. Arabic or Middle Eastern
 - g. Other
5. What is your highest level of education completed?
 - a. High School Diploma (secondary school)
 - b. Diploma of College Studies (CEGEP)
 - c. Bachelor's degree
 - d. Master's degree
 - e. Doctorate (e.g., PhD, MD)
 - f. Post-doctorate
6. How many years of university education have you completed?
7. Are you currently working? You can select more than one option.
 - a. Full-time
 - b. Part-time
 - c. Unemployed
 - d. Student
 - e. Home maker
 - f. Other
8. What is your current occupation?
9. What is your mother tongue?
10. Are you in a relationship?
 - a. Yes
 - b. No
11. If yes, how long (in months) have you been in this relationship?

12. What is your civil status?
 - a. Married or common law
 - b. Separated or divorced
 - c. Single
 - d. Widowed

13. How many children do you have?

14. What is your current annual household income?
 - a. Less than \$10,000
 - b. Between \$10,000 and \$25,000
 - c. Between \$25,000 and \$40,000
 - d. Between \$40,000 and \$50,000
 - e. \$50,000 or more
 - f. I do not want to answer

VOCI

Please rate each statement by putting a circle around the number that best describes how much the statement is true of you. Please answer every item, without spending too much time on any particular item.

How much is each of the following statements true of you?	Not at all	A little	Some	Much	Very Much
1. I feel compelled to check letters over and over before mailing them.	0	1	2	3	4
2. I am often upset by my unwanted thoughts of using a sharp weapon.	0	1	2	3	4
3. I feel very dirty after touching money.	0	1	2	3	4
4. I find it very difficult to make even trivial decisions.	0	1	2	3	4
5. I feel compelled to be absolutely perfect.	0	1	2	3	4
6. I repeatedly experience the same unwanted thought or image about an accident.	0	1	2	3	4
7. I repeatedly check and recheck things like taps and switches after turning them off.	0	1	2	3	4
8. I use an excessive amount of disinfectants to keep my home or myself safe from germs.	0	1	2	3	4
9. I often feel compelled to memorize trivial things (e.g., licence plate numbers, instructions on labels).	0	1	2	3	4
10. I have trouble carrying out normal household activities because my home is so cluttered with things I have collected.	0	1	2	3	4
11. After I have decided something, I usually worry about my decision for a long time.	0	1	2	3	4
12. I find that almost every day I am upset by unpleasant thoughts that come into my mind against my will.	0	1	2	3	4
13. I spend far too much time washing my hands.	0	1	2	3	4
14. I often have trouble getting things done because I try to do everything exactly right.	0	1	2	3	4
15. Touching the bottom of my shoes makes me very anxious.	0	1	2	3	4

16.	I am often upset by my unwanted thoughts or images of sexual acts.	0	1	2	3	4
17.	I become very anxious when I have to make even a minor decision.	0	1	2	3	4
18.	I feel compelled to follow a very strict routine when doing ordinary things.	0	1	2	3	4
19.	I feel upset if my furniture or other possessions are not always in exactly the same position.	0	1	2	3	4
20.	I repeatedly check that my doors or windows are locked, even though I try to resist the urge to do so.	0	1	2	3	4
21.	I find it very difficult to touch garbage or garbage bins.	0	1	2	3	4
22.	I become very tense or upset when I think about throwing anything away.	0	1	2	3	4
23.	I am excessively concerned about germs and disease.	0	1	2	3	4
24.	I am often very late because I can't get through ordinary tasks on time.	0	1	2	3	4
25.	I avoid using public telephones because of possible contamination.	0	1	2	3	4
26.	I am embarrassed to invite people to my home because it is full of piles of worthless things I have saved.	0	1	2	3	4
27.	I repeatedly experience the same upsetting thought or image about death.	0	1	2	3	4
28.	I am often upset by unwanted thoughts or images of blurting out obscenities or insults in public.	0	1	2	3	4
29.	I worry far too much that I might upset other people.	0	1	2	3	4
30.	I am often frightened by unwanted urges to drive or run into oncoming traffic.	0	1	2	3	4
31.	I almost always count when doing a routine task.	0	1	2	3	4
32.	I feel very contaminated if I touch an animal.	0	1	2	3	4
33.	One of my major problems is repeated checking.	0	1	2	3	4
34.	I often experience upsetting and unwanted thoughts about losing control.	0	1	2	3	4

35.	I find it almost impossible to decide what to keep and what to throw away.	0	1	2	3	4
36.	I am strongly compelled to count things.	0	1	2	3	4
37.	I repeatedly check that my stove is turned off, even though I resist the urge to do so.	0	1	2	3	4
38.	I get very upset if I can't complete my bedtime routine in exactly the same way every night.	0	1	2	3	4
39.	I am very afraid of having even slight contact with bodily secretions (blood, urine, sweat, etc.)	0	1	2	3	4
40.	I am often very upset by my unwanted impulses to harm other people.	0	1	2	3	4
41.	I spend a lot of time every day checking things over and over again.	0	1	2	3	4
42.	I have great trouble throwing anything away because I am very afraid of being wasteful.	0	1	2	3	4
43.	I frequently have to check things like switches, faucets, appliances and doors several times.	0	1	2	3	4
44.	One of my major problems is that I am excessively concerned about cleanliness.	0	1	2	3	4
45.	I feel compelled to keep far too many things like old magazines, newspapers, and receipts because I am afraid I might need them in the future	0	1	2	3	4
46.	I repeatedly experience upsetting and unacceptable thoughts of a religious nature.	0	1	2	3	4
47.	I tend to get behind in my work because I repeat the same thing over and over again.	0	1	2	3	4
48.	I try to put off making decisions because I'm so afraid of making a mistake.	0	1	2	3	4
49.	I often experience upsetting and unwanted thoughts about illness.	0	1	2	3	4
50.	I am afraid to use even well-kept public toilets because I am so concerned about germs.	0	1	2	3	4
51.	Although I try to resist, I feel compelled to collect a large quantity of things I never actually use.	0	1	2	3	4

52. I repeatedly experience upsetting and unwanted immoral thoughts.	0	1	2	3	4
53. One of my major problems is that I pay far too much attention to detail.	0	1	2	3	4
54. I am often upset by unwanted urges to harm myself.	0	1	2	3	4
55. I spend far too long getting ready to leave home each day because I have to do everything exactly right.	0	1	2	3	4

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OBS-44

This inventory lists different attitudes or beliefs that people sometimes hold. Read each statement carefully and decide how much you agree or disagree with it.

For each of the statements, choose the number matching the answer that *best describes how you think*. Because people are different, there are no right or wrong answers.

To decide whether a given statement is typical of your way of looking at things, simply keep in mind what you are like *most of the time*.

Use the following scale:

1	2	3	4	5	6	7
Disagree very much	Disagree moderately	Disagree a little	Neither agree nor disagree	Agree a little	Agree moderately	Agree

In making your ratings, try to avoid using the middle point of the scale (4), but rather indicate whether you usually disagree or agree with the statements about your own beliefs and attitudes.

1. I often think things around me are unsafe. 1 2 3 4 5 6 7
2. If I'm not absolutely sure of something, I'm bound to make a mistake. 1 2 3 4 5 6 7
3. Things should be perfect according to my own standards. 1 2 3 4 5 6 7
4. In order to be a worthwhile person, I must be perfect at everything I do. 1 2 3 4 5 6 7
5. When I see any opportunity to do so, I must act to prevent bad things from happening. 1 2 3 4 5 6 7
6. Even if harm is very unlikely, I should try to prevent it at any cost. 1 2 3 4 5 6 7
7. For me, having bad urges is as bad as actually carrying them out. 1 2 3 4 5 6 7
8. If I don't act when I foresee danger, then I am to blame for any consequences. 1 2 3 4 5 6 7
9. If I cannot do something perfectly, I should not do it at all. 1 2 3 4 5 6 7
10. I must work to my full potential at all times. 1 2 3 4 5 6 7
11. It is essential for me to consider all possible outcomes of a situation. 1 2 3 4 5 6 7

12. Even minor mistakes mean a job is not complete. 1 2 3 4 5 6 7
13. If I have aggressive thoughts or impulses about my loved ones, this means I may secretly want to hurt them. 1 2 3 4 5 6 7
14. I must be certain of my decisions. 1 2 3 4 5 6 7
15. In all kinds of daily situations, failing to prevent harm is just as bad as deliberately causing harm. 1 2 3 4 5 6 7
16. Avoiding serious problems (for example, illness or accidents) requires constant effort on my part. 1 2 3 4 5 6 7
17. For me, not preventing harm is as bad as causing harm. 1 2 3 4 5 6 7
18. I should be upset if I make a mistake. 1 2 3 4 5 6 7
19. I should make sure others are protected from any negative consequences of my decisions or actions. 1 2 3 4 5 6 7
20. For me, things are not right if they are not perfect. 1 2 3 4 5 6 7
21. Having nasty thoughts means I am a terrible person. 1 2 3 4 5 6 7
22. If I do not take extra precautions, I am more likely than others to have or cause a serious disaster. 1 2 3 4 5 6 7
23. In order to feel safe, I have to be as prepared as possible for anything that could go wrong. 1 2 3 4 5 6 7
24. I should not have bizarre or disgusting thoughts. 1 2 3 4 5 6 7
25. For me, making a mistake is as bad as failing completely. 1 2 3 4 5 6 7
26. It is essential for everything to be clear cut, even in minor matters. 1 2 3 4 5 6 7
27. Having a blasphemous thought is as sinful as committing a sacrilegious act. 1 2 3 4 5 6 7
28. I should be able to rid my mind of unwanted thoughts. 1 2 3 4 5 6 7
29. I am more likely than other people to accidentally cause harm to myself or to others. 1 2 3 4 5 6 7
30. Having bad thoughts means I am weird or abnormal. 1 2 3 4 5 6 7

- | | | | | | | | |
|---|---|---|---|---|---|---|---|
| 31. I must be the best at things that are important to me. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 32. Having an unwanted sexual thought or image means I really want to do it. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 33. If my actions could have even a small effect on a potential misfortune, I am responsible for the outcome. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 34. Even when I am careful, I often think that bad things will happen. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 35. Having intrusive thoughts means I'm out of control. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 36. Harmful events will happen unless I am very careful. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 37. I must keep working at something until it's done exactly right. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 38. Having violent thoughts means I will lose control and become violent. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 39. To me, failing to prevent a disaster is as bad as causing it. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 40. If I don't do a job perfectly, people won't respect me. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 41. Even ordinary experiences in my life are full of risk. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 42. Having a bad thought is morally no different than doing a bad deed. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 43. No matter what I do, it won't be good enough. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 44. If I don't control my thoughts, I'll be punished. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |

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DASS-21

Please read each statement and circle a number (0, 1, 2 or 3) which indicates how much the statement applied to you *over the past week*. There are no right or wrong answers. Do not spend too much time on any statement.

The rating scale is as follows:

- 0 Did not apply to me at all
- 1 Applied to me to some degree, or some of the time
- 2 Applied to me to a considerable degree, or a good part of time
- 3 Applied to me very much, or most of the time

1. I found it hard to wind down	0	1	2	3
2. I was aware of dryness of my mouth	0	1	2	3
3. I couldn't seem to experience any positive feeling at all	0	1	2	3
4. I experienced breathing difficulty (e.g., excessively rapid breathing, breathlessness in the absence of physical exertion)	0	1	2	3
5. I found it difficult to work up the initiative to do things	0	1	2	3
6. I tended to over-react to situations	0	1	2	3
7. I experienced trembling (e.g., in the hands)	0	1	2	3
8. I felt that I was using a lot of nervous energy	0	1	2	3
9. I was worried about situations in which I might panic and make a fool of myself	0	1	2	3
10. I felt that I had nothing to look forward to	0	1	2	3
11. I found myself getting agitated	0	1	2	3
12. I found it difficult to relax	0	1	2	3
13. I felt down-hearted and blue	0	1	2	3
14. I was intolerant of anything that kept me from getting on with what I was doing	0	1	2	3
15. I felt I was close to panic	0	1	2	3
16. I was unable to become enthusiastic about anything	0	1	2	3
17. I felt I wasn't worth much as a person	0	1	2	3
18. I felt that I was rather touchy	0	1	2	3

19. I was aware of the action of my heart in the absence of physical exertion (e.g., sense of heart rate increase, heart missing a beat)	0	1	2	3
20. I felt scared without any good reason	0	1	2	3
21. I felt that life was meaningless	0	1	2	3

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[http://dx.doi.org/10.1016/0005-7967\(94\)00075-U](http://dx.doi.org/10.1016/0005-7967(94)00075-U)

IEQ-SC

Please rate each statement by selecting the option that best describes how much the statement is true of you. Please answer every item, without spending too much time on any particular item.

Use the following scale:

1	2	3	4	5	6	7
Doesn't apply to me at all	Not usually	Rarely	Don't know	Sometimes	Usually	Always applies to me

In making your ratings, try to avoid using the middle point of the scale (4), but rather indicate whether you usually disagree or agree with the statements.

1. Even when there is nothing forcing me, I worry that I sometimes will do things I really do not want to do.	1 2 3 4 5 6 7
2. I worry that I sometimes will impulsively do things, which at other times I definitely would not let myself do.	1 2 3 4 5 6 7
3. I fear that there will be moments when I cannot subdue my emotions and keep them in check.	1 2 3 4 5 6 7
4. I worry that people cannot always hold back their personal desires: they will behave out of impulse.	1 2 3 4 5 6 7
5. I worry that something I cannot do is have complete mastery over all my behavioral tendencies.	1 2 3 4 5 6 7
6. I fear it will be very difficult for me to not have mastery over the way I behave.	1 2 3 4 5 6 7
7. I worry that I will frequently find that when certain things happen to me I cannot restrain my reaction.	1 2 3 4 5 6 7
8. Even if I try not to submit, I worry that I will often find I cannot control myself from some of the enticements in life such as over-eating or drinking.	1 2 3 4 5 6 7

Reid, D., & Ware, E. E. (1974). Multidimensionality of internal versus external control: Addition of a third dimension and non-distinction of self versus others. *Canadian Journal of Behavioural Science*, 6, 131-142. <http://dx.doi.org/10.1037/h0081862>

Tiggemann, M., & Raven, M. (1998). Dimensions of control in bulimia and anorexia nervosa: Internal control, desire for control, or fear of losing self-control? *Eating Disorders*, 6, 65-71. <http://dx.doi.org/10.1080/10640269808249248>

EEG Recording Session Feedback Questionnaire

Please take the time to complete this short survey. We would like to get some feedback on the EEG recording session as this is a new procedure in our laboratory. Thank you!

1. On a scale from 0 to 100, did you find the EEG headset comfortable when you were wearing it? (0 = it was not comfortable at all; 100 = it was very comfortable)
2. On a scale from 0 to 100, did you think the EEG recording session was too long? (0 = the session was way too long; 100 = the duration of the session was too short)
3. On a scale from 0 to 100, how hard was it not imagining anything (and only having verbal intrusive thoughts) during the EEG recording session? (0 = it was very easy not imagining anything; 100 = it was very difficult not imagining anything)
4. On a scale from 0 to 100, do you believe it is possible for you to lose control of your thoughts and behaviour? (0 = I do not believe at all it is possible for me to lose control of my thoughts and behaviour; 100 = I completely believe it is possible for me to lose control of my thoughts and behaviour)
5. Have you ever worn this type of EEG headset before?
 - a. Yes
 - b. No
6. Do you have any other comments about the EEG recording session?

Appendix B

Laminated Brochure

ELECTROENCEPHALOGRAPHY RECORDING SESSION INFORMATION

People with obsessive-compulsive disorder (OCD) often have intrusive thoughts causing a lot of distress (American Psychiatric Association, 2013). That said, we also know that people in the normal (non-clinical) population also experience intrusive thoughts (e.g., Rachman & de Silva, 1978; Radomsky, Alcolado, Abramowitz, Alonso, Belloch, Bouvard, ... & Garcia-Soriano, 2014). The difference is that non-clinical populations interpret these thoughts differently and are usually not as anxious about them.

Today, we want to examine the associations between normal intrusive thoughts and the capacity to stay in control of one's thoughts. For example, we are asking the question: Are people with fewer intrusive thoughts better at staying in control of their thoughts and behaviour?

To help us answer this question, you will undergo a non-invasive electroencephalography (EEG) recording session that focuses on the brain activation of the frontal lobe. This part of the brain—the right inferior frontal cortex—is known to be responsible for a variety of executive functions such as inhibition (Aron, Robbins, & Poldrack, 2004). Inhibition is the function of the brain that helps you block other functions. For example, it prevents you from saying certain words or from thinking about certain things. By focusing on the brain waves of the frontal lobe (e.g., P300 waves), we will examine how well you can engage in inhibition (i.e., how well you can stop yourself from thinking about a certain thought; Roberts, Rau, Lutzenberger, & Birbaumer, 1994).

The device you will wear today is a Mindwave™ Mobile EEG headset created by NeuroSky®. It is a non-invasive Bluetooth EEG device that safely measures frontal lobe brain waves and that can also monitor attention, eye-blinking, and different states of awareness. The specifications of the product can be found below.

Specifications of the NeuroSky® Mindwave™ Mobile EEG Headset

- Weighs 90g
- Sensor arm up: (h)225mm x (w)155mm x (d)92mm
- Sensor Arm down: (h)225mm x (w)155mm x (d)165mm
- 2.420 – 2.471GHz RF frequency
- 6dBm RF max power
- 250kbit/s RF data rate
- 10m RF range
- 5% packet loss of bytes via wireless
- UART Baudrate: 57,600 Baud
- 1mV pk-pk EEG maximum signal input range
- 3Hz – 100Hz hardware filter range

Picture of the NeuroSky® Mindwave™ Mobile EEG Headset



Recommended Readings

- Aron, A. R., Robbins, T. W., & Poldrack, R. A. (2004). Inhibition and the right inferior frontal cortex. *Trends in Cognitive Sciences*, 8, 170-177.
- Rachman, S., & de Silva, P. (1978). Abnormal and normal obsessions. *Behaviour Research and Therapy*, 16(4), 233-248.
- Radomsky, A. S., Alcolado, G. M., Abramowitz, J. S., Alonso, P., Belloch, A., Bouvard, M., ... Garcia-Soriano, G. (2014). Part 1—You can run but you can't hide: Intrusive thoughts on six continents. *Journal of Obsessive-Compulsive and Related Disorders*, 3, 269-279.
- Roberts, L. E., Rau, H., Lutzenberger, W., & Birbaumer, N. (1994). Mapping P300 waves onto inhibition: Go/No Go discrimination. *Electroencephalography and Clinical Neurophysiology*, 92, 44-55.

Appendix C

Scripts:

Introduction and Purpose of the Study

EEG Recording Session

Computer Task Instructions

Debriefing

Introduction and Purpose of the Study

Hello! Thank you very much for coming in today. My name is Jean-Philippe Gagné, and I am a graduate student here in the Anxiety and Obsessive-Compulsive Disorders Laboratory.

Before asking you to carefully read and sign the consent form that is in front of you, I would like to tell you a bit about the study that you will be taking part in today.

Our lab focuses a lot on research related to obsessive-compulsive disorder or OCD. We know that people with OCD often have intrusive thoughts causing a lot of distress. That said, we also know that people in the normal population also experience intrusive thoughts. The difference is that they are usually not as anxious about them. What is less clear, however, is how these normal intrusive thoughts are related to capacities associated with staying in control. In other words, we are interested in examining the associations between normal intrusive thoughts and the capacity to stay in control of one's thoughts, as assessed by a non-invasive brain activity device. For example, we are asking the question: Are people with fewer intrusive thoughts better at staying in control of their thoughts and behaviour? The focus of this study is on normal thoughts and our sample is composed of healthy participants.

Your participation in this study is entirely voluntary. You will receive 1 participation pool credit for participating. You can withdraw from this study at any time without any negative consequences whatsoever. In other words, you will still receive your participation credit.

All of your information and data will be kept strictly confidential, and will only be accessible to my research supervisor, the research assistants working on this study, and me. Your name and identifying information will not be associated with the data. Your data will only be associated with your participant ID number. Your identifying information will not be included in any posters, reports, or presentations resulting from this study. The data will be stored for seven years under lock and key in the research laboratory, and any electronic files will be stored in password-protected files on computers that are only accessible to laboratory members. After the seven-year period, the data will be confidentially shredded and erased. Do you have any questions about the procedures?

The consent form in front of you has the information I just told you about with additional details. Please read it carefully and, if you agree, sign the document.

EEG Recording Session

You will now undergo an EEG recording session that focuses on the activation of the frontal lobe of the brain. Basically, the device will pick up the electrical activity—what we call “brain waves”—that comes with the process of thinking. The results will allow us to see how well you can inhibit your thoughts, and how well you can stay in control of your thoughts, mind, and behaviour. Right after the EEG session, I can let you know how well you performed.

The device you will wear today is called a Mindwave™ Mobile EEG headset, which is created by NeuroSky®. It is a non-invasive Bluetooth EEG device that safely measures frontal lobe brain waves and that can also monitor attention, eye-blinking, and different states of awareness. But today we will mainly focus on brain waves of the frontal lobe.

I am now going to ask you to read this laminated brochure that provides more information about what we are specifically looking at during the EEG recording session and about the headset. Please let me know when you are done and if you have any questions about the procedure. After that, I will tell you the instructions and we will begin the EEG session.

[Calibration of the EEG headset.]

I will now ask you to stay seated silently. Please do not move too much unless it is necessary. For the next 10 minutes, try not to think about any specific images. You can only have thoughts that are verbal. For example, you can think about words or you can talk to yourself, but you cannot imagine specific things or events. This will allow us to see how well you can engage in inhibition, and how well you can stay in control of your thoughts and behaviour as compared to a normative sample. I can let you know how well you did after.

[Random assignment followed by false feedback.]

Computer Task Instructions

You will now play a computer task that assesses different cognitive skills. First, I will explain the task but I still want you to read the instructions carefully afterwards. Basically, different pictures will appear on the screen. Each picture will appear for a random amount of time. Your job is to control the pictures by decreasing the duration of the presentation of each picture. In other words, you have to try to make the pictures disappear faster than they normally would.

To control the duration of the appearance of each picture, you have to find the right combinations of eight specific keyboard presses. Different combinations of these eight specific keyboard presses will produce different presentation times. Each combination you try should have a minimum of 3 keys and a maximum of 8 keys. For example, if the keyboard presses were the keys from 1 to 8 (although they are not, this is only an example), you could try several combinations like 1-2-8, or 3-1-4-6, or even 8-6-7-3-1-2-4-5. It's really up to you. You can select some of the keys or all of the keys, and change their order as you go, but there should always be a minimum of 3 keys. The keys you really should be using during the computer game will appear in the instructions. Basically, try to find the combinations that shorten the presentation of the pictures the most.

If you cannot remember which eight keys you should be using to control the duration of the pictures, you can press the space bar at any time during the task, and the eight keys will appear on the screen as a reminder.

Between each picture, a blue plus (+) sign will appear. This basically means that a new picture will appear soon. If need be, you can check which keys you should be using when the blue plus sign appears by pressing the space bar, but you should only be starting your combination of keys when the picture appears, not between pictures.

Please read the instructions carefully before starting the computer task.

Debriefing

Thank you very much for participating in this experiment today! I would now like to provide you with some information about the study.

First, you were told that the purpose of this study was to examine the associations between intrusive thoughts and the capacity to stay in control of one's thoughts and behaviour. In reality, we are interesting in seeing if beliefs about losing control can lead to checking behaviour (as seen in OCD). If you had known the real purpose of the study, it would have necessarily influenced your behaviour during testing and the way you responded to the task.

Second, you were asked to read background literature on the EEG procedure to have a better idea of what we were examining. In reality, we were not drawing on this literature. You were also told that the EEG device was monitoring your ability at controlling your thoughts, which was again untrue. The EEG headset is usually used for entertainment purposes (although it can read brain waves). Following the bogus EEG session, you were provided with bogus feedback about your performance. Whether you were told that you were very good or very bad at inhibiting your intrusive thoughts or that you were more likely or less likely to lose was not true. You had already been randomly assigned to either the "high" or "low" beliefs about losing control condition and you received false feedback accordingly. It was a way to manipulate participants' beliefs about losing control, and if you had known from the start that the feedback was false, the experimental manipulation would have necessarily failed.

Third, you were told that it was possible to control the duration of the presentation of each picture during the computer task and that your cognitive abilities were assessed. In reality, the task was pre-programmed and it was used to assess how much you 1) wanted to control the pictures and 2) felt that you were controlling the pictures. That way, it was possible for us to assess your *desire for control* and *sense of control* toward the pictures. If you had known the real purpose of this pre-programmed task, you would have not reported any desire for control nor sense of control toward the pictures, and it would have been impossible to assess these constructs adequately.

I want you to understand that we had to use these elements of deception in order to tests our hypotheses without biasing your behaviour and ways of responding. Specifically, we hypothesized that participants in the high (*versus* low) beliefs about losing control would check more often which keys they should be using to control the pictures during the computer task. This would show that negative beliefs about losing control cause checking behaviour (as seen in OCD). We are also interested in examining the relationships among beliefs about losing control, desire for control, and sense of control.

Given the deception involved in this study, I would appreciate if you did not tell your friends and classmates about these specific elements of the study. Nevertheless, you are free to tell them that the study involves an EEG recording session, questionnaires, a computer task, and that our laboratory focuses on OCD and intrusive thoughts. Thanks again!

Appendix D

Consent Forms:

Initial Consent Form

Post-Debriefing Consent Form

Debriefing Form

Initial Consent Form



Participant ID: _____

INFORMATION AND CONSENT TO PARTICIPATE IN A RESEARCH STUDY

Study Title: The role of inhibition in intrusive thoughts

Researcher: Jean-Philippe Gagné, B.Sc.

Researcher's Contact Information: 514-848-2424 ext. 5965; jean_ga@live.concordia.ca

Faculty Supervisor: Adam Radomsky, Ph.D.

Faculty Supervisor's Contact Information: 514-848-2424 ext. 2202; adam.radomsky@concordia.ca

You are being invited to participate in the research study mentioned above. This form provides information about what participating would mean. Please read it carefully before deciding if you want to participate or not. If there is anything you do not understand, or if you want more information, please ask the researcher.

A. PURPOSE

The purpose of the research is to gain knowledge on intrusive thoughts (as seen in obsessive-compulsive disorder; OCD) by examining normal intrusive thoughts in a healthy population. We are particularly interested in the associations between normal intrusive thoughts and the capacity to stay in control of one's thoughts and behaviour as assessed by a non-invasive brain activity device.

B. PROCEDURES

If you participate, you will be asked to sign this consent form, complete several questionnaires, undergo a non-invasive EEG recording session (using a NeuroSky® Mindwave™ Mobile EEG headset), complete a computer task, and provide several ratings. Afterwards, you will be compensated for your participation by receiving 1 point toward the participant pool.

In total, participating in this study will take 1 hour.

C. RISKS AND BENEFITS

To the best of our knowledge, there are no risks associated with this study. If you experience distress at any point during testing, please let us know immediately.

You might or might not personally benefit from participating in this research. Potential benefits include: receiving 1 point toward the participant pool; understanding how psychological research is conducted; and helping to increase our understanding of OCD in general and therefore contributing to the development of psychological treatments for this disorder.

D. CONFIDENTIALITY

By participating, you agree to let the researchers have access to the data that you will have provided during the study. This information will be obtained from the questionnaires you will complete, the computer task you will complete, the ratings you will provide, and the EEG recording session.

We will not allow anyone to access the information, except people directly involved in conducting the research, and except as described in this form. We will only use the information for the purposes of the research described in this form.

The information gathered will be coded. That means that the information will be identified by a code. The researcher will have a list that links the code to your name.

We will protect the information by storing the data collected under lock and key for a period of seven years, at which point it will be shredded. Data collected electronically will be saved using password-protected files. They will also be deleted after a period of seven years. Access to this information will be made available only to members of Dr. Radomsky's research team.

We intend to publish the results of the research. However, it will not be possible to identify you in the published results.

In certain situations, we might be legally required to disclose the information that you provide. This includes situations where you indicate a serious risk of doing harm to yourself or to someone else. If this kind of situation arises, we will disclose the information as required by law, despite what is written in this form.

E. CONDITIONS OF PARTICIPATION

You do not have to participate in this research. It is purely your decision. If you do participate, you can stop at any time. You can also ask that the information you provided not be used, and your choice will be respected. If you decide that you don't want us to use your information, you must tell the researcher at any time between now and 24 hours after the end of the study.

As a compensatory indemnity for participating in this research, you will receive 1 participation pool point. If you withdraw before the end of the research, you will receive the same compensation anyway.

There are no negative consequences for not participating, stopping in the middle, or asking us not to use your information.

F. PARTICIPANT'S DECLARATION

I have read and understood this form. I have had the chance to ask questions and any questions have been answered. I agree to participate in this research under the conditions described.

NAME (please print) _____

SIGNATURE _____

DATE _____

If you have questions about the scientific or scholarly aspects of this research, please contact the researcher. Their contact information is on page 1. You may also contact their faculty supervisor.

If you have concerns about ethical issues in this research, please contact the Manager, Research Ethics, Concordia University, 514.848.2424 ext. 7481 or oor.ethics@concordia.ca.

Post-Debriefing Consent Form

Participant ID: _____

POST DEBRIEF ACKNOWLEDGEMENT

As you have just been informed, it was necessary for us to lead you to believe that the purpose of the study was to look at the associations between normal intrusive thoughts and the capacity to stay in control of one's thoughts, that the background literature on the EEG device and procedure was useful to read, that the EEG device was monitoring your thoughts, that the feedback following the EEG session was true, that the computer task was assessing your cognitive abilities, and that the pictures of the computer task could be controlled.

The use of this deceptive information was essential for us to determine if beliefs about losing control can lead to checking behaviour.

Do you agree to let us use your results as part of our analysis?

Yes

No

By signing below, you indicate that you have been informed of the deception involved in this research, and agree not to disclose or discuss the true intent of this study with anyone outside of those immediately involved as part of the research team.

Signature _____

Witness _____

Date _____

If you have any questions concerning this study, please feel free to ask the experimenter or call the laboratory at 514-848-2424 ext. 2199.

Adam S. Radomsky, Ph.D., Professor, Department of Psychology
Jean-Philippe Gagné, B.Sc., M.A. Student, Department of Psychology

Debriefing Form

Thank you very much for participating in this experiment today!

As described during the laboratory session, this experiment was designed to shed light on the mechanisms associated with intrusive thoughts, maladaptive beliefs, and obsessive-compulsive disorder in general. To do so, you completed a variety of questionnaires, a task with a NeuroSky® Mindwave™ Mobile EEG headset, and a task with pictures appearing on a computer monitor.

Today, you received 1 participation pool credit. Furthermore, by participating, you helped us increase our understanding of obsessive-compulsive disorder and related problems, and contributed to the development of psychological treatments for mental health issues.

Thank you again for your participation! If you have any questions or comments about this study, please contact Jean-Philippe Gagné (jean_ga@live.concordia.ca; 514-848-2424, ext. 2199) or Dr. Adam Radomsky (adam.radomsky@concordia.ca).

Further Readings:

Gelfand, L. A., & Radomsky, A. S. (2013). Beliefs about control and the persistence of cleaning behaviour: An experimental analysis. *Journal of Behavior Therapy and Experimental Psychiatry, 44*, 172-178.

Moulding, R., & Kyrios, M. (2007). Desire for control, sense of control and obsessive-compulsive symptoms. *Cognitive Therapy and Research, 31*, 759-772.

Reuven-Magril, O., Dar, R., & Liberman, N. (2008). Illusion of control and behavioral control attempts in obsessive-compulsive disorder. *Journal of Abnormal Psychology, 117*, 334.

Mental Health:

In our research, we ask you many questions about feelings related to anxiety and sadness. If at any time you feel that you need help related to these feelings or other problems, please go to the treatment manual on our website for information on local resources (see below). Also, please do not hesitate to contact us at the laboratory with any questions or concerns you might have.

<http://psychology.concordia.ca/fac/radomsky/TSI/TSI%20manual%202015.pdf>