When it's at: An examination of *when* cognitive change occurs during cognitive therapy for compulsive checking in obsessive-compulsive disorder

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Abstract

Background and Objectives: The cognitive theory of compulsive checking in OCD proposes that checking behaviour is maintained by maladaptive beliefs, including those related to inflated responsibility and those related to reduced memory confidence. This study examined whether and when specific interventions (as part of a new cognitive therapy for compulsive checking) addressing these cognitive targets changed feelings of responsibility and memory confidence.

Methods: Participants were nine adults with a primary or secondary diagnosis of OCD who reported significant checking symptoms (at least one hour per day) on the Yale-Brown Obsessive-Compulsive Scale. A single-case multiple baseline design was used, after which participants received 12 sessions of cognitive therapy. From the start of the baseline period through to the 1 month post-treatment follow-up assessment session, participants completed daily monitoring of feelings of responsibility, memory confidence, and their time spent engaging in compulsive checking.

Results: Results revealed that feelings of responsibility significantly reduced and memory confidence significantly increased from baseline to immediately post-treatment, with very high effect sizes. Multilevel modelling revealed significant linear changes in feelings of responsibility (i.e., reductions over time) and memory confidence (i.e., increases over time) occurred *following* the sessions when these were addressed. Finally, we found that improvements in these over the course of the treatment significantly predicted reduced time spent checking.

Limitations: The small sample size limits our ability to generalize our results.

Conclusions: Results are discussed in terms of a focus on the timing of change in cognitive therapy.

Keywords: Compulsive Checking; Obsessive-Compulsive Disorder; Cognitive Therapy; Responsibility; Memory Confidence

When it's at: An examination of *when* cognitive change occurs during cognitive therapy

Obsessive-compulsive disorder (OCD) is characterized by recurrent obsessions and/or compulsions that are time-consuming (lasting at least one hour per day) and cause marked distress and/or significant impairment in functioning (American Psychiatric Association, 2013). It is a common psychiatric disorder, estimated to affect 0.5 to 3.5% of the population (Angst et al., 2004; Grabe et al., 2000; Ruscio, Stein, Chiu, & Kessler, 2010), and the associated impact on quality of life (e.g., impaired work functioning and family dysfunction; Norberg, Calamari, Cohen, & Riemann, 2008) has led OCD to be considered a highly disabling condition (Bobes et al., 2001; Murray, Lopez, & World Health Organization, 1996).

Compulsive checking is the most common form of OCD; in a study by Foa et al. (2005), compulsive checking was the most prevalent compulsion and was reported by 28.8% of patients, followed closely by compulsive washing (26.5%). Although a majority of individuals with OCD engage in checking behaviour, *compulsive* checking is commonly understood as extreme and often incapacitating attempts to reduce distress by preventing harm from occurring to oneself and/or others. Typical examples include repeatedly checking that potentially threatening objects (e.g., kitchen appliances) are safe, frequently re-tracing the route that one has driven to confirm that one has not killed or injured a pedestrian, and repetitively checking that the doors and windows are securely closed. Importantly, compulsive checking can be immensely time consuming (Radomsky, Shafran, Coughtrey, & Rachman, 2010), requiring hours to complete each day, which is frustrating for the individual (as well as their friends and family) and significantly disrupts their everyday functioning.

The cognitive theory of compulsive checking was proposed by Rachman (2002) as an attempt to explain why and when checking behaviour becomes compulsive, and to explain how

compulsive checking is maintained. According to this theory, three cognitive components cause compulsive checking and are therefore targets for treatment: a) inflated estimates/perceptions of the *probability* of a misfortune (e.g., that a fire is likely to be caused by a stove), b) inflated estimates/perceptions of the *seriousness* of the predicted misfortune (e.g., that a fire caused by a stove will do serious and significant damage), and c) an inflated sense of personal *responsibility* (e.g., that the individual feels personally responsible in preventing the fire from occurring). Inflated responsibility is proposed to amplify estimates/perceptions of the probability and seriousness of the feared misfortune and is therefore a key target of treatment (Rachman, 2002). The theory then proposes that the checking behaviour caused by these cognitive components paradoxically increases feelings of responsibility, reduces confidence in one's memory for the check (which in turn leads to negative beliefs about memory; Alcolado & Radomsky, 2016) and impairs attention, which promotes further checking thereby maintaining compulsive checking in a self-perpetuating cycle. As such, memorial distrust and impaired attention are also targets of treatment.

Empirical support for this model has accumulated over the years, although the current manuscript will focus only on two of its components: inflated responsibility and memory distrust. Following its initial identification by Salkovskis (1985), the role of inflated responsibility in compulsive checking has received wide support (e.g., Arntz, Voncken, & Goosen, 2007; Haring, 2005; Ladouceur, Rheaume, & Aublet, 1997; Lopatka & Rachman, 1995; Radomsky, Rachman, & Hammond, 2001; Shafran, 1997; van den Hout & Kindt, 2004). To summarize, deliberate increases in responsibility are followed by substantial increases in compulsive checking. These results have been found in patients with OCD (Arntz et al., 2007; Lopatka & Rachman, 1995; Shafran, 1997) and in analogue studies with non-clinical participants

(Haring, 2005; Ladouceur, Leger, Rheaume, & Dube, 1996). In the absence of significant levels of responsibility, minimal or no checking occurs (Haring, 2005).

There is also consistent empirical support for the proposal that compulsive checking in OCD is maintained by the following self-perpetuating mechanism: that checking reduces confidence in memory which then increases checking and so on (Rachman, 2002; Radomsky et al., 2010). In a series of well-controlled experiments, van den Hout and Kindt (2003a, 2003b) found that non-clinical participants instructed to repeatedly check a virtual gas stove reported significantly reduced vividness and confidence in their memory for gas rings of the stove that were checked. Importantly, memory accuracy did not differ between groups. This relationship between checking and reduced memory confidence has been replicated using a real (rather than virtual) stove (Radomsky, Gilchrist, & Dussault, 2006) and in a clinical sample (Boschen & Vuksanovic, 2007). In a further extension of the stove-checking task, Coles, Radomsky, and Horng (2006) manipulated the number of checks performed on this task and found that even relatively low numbers of checks could decrease memory confidence. More recently, Alcolado and Radomsky (2011) manipulated beliefs about memory and examined the consequent effects on urges to check. Participants led to believe that their memories were poor or faulty reported significantly greater urges to check compared to participants led to believe that their memories were excellent; these experiments led to the preliminary development of cognitive-behavioural strategies to target negative beliefs about memory and enhance memory confidence (Alcolado & Radomsky, 2016). Together, this research suggests that strategies that help patients achieve an accurate (and positive) view of their own memory abilities would be effective in reducing compulsive checking.

To this end, we have developed a cognitively-based treatment package targeting compulsive checking (described in Radomsky et al., 2010 and in the Methods section). This treatment follows from the cognitive theory of compulsive checking (Rachman, 2002) and emphasizes interventions (particularly behavioural experiments) targeting the components described above, including inflated responsibility and the self-perpetuating mechanism of memory distrust. Behavioural experiments are a cognitively-driven treatment strategy in which patients are asked to conduct an experiment in which they alter their behaviour in order to acquire new information about some aspect of their problem. These are arguably different from behavioural treatment strategies for OCD such as exposure and response prevention (ERP; Franklin & Foa, 2011), which involves repeatedly exposing the patient to their obsessional stimuli (e.g., inappropriate sexual thoughts, contaminants) while encouraging them to not engage in their compulsions (e.g., counting backwards, washing their hands) for prolonged periods of time, with the primary goal of helping the patient habituate to their obsessional anxiety and/or to facilitate inhibitory learning (Craske, Treanor, Conway, Zbozinek, & Vervliet, 2014). Compared to ERP, behavioural experiments primarily emphasize the acquisition of helpful information to test the validity of a (maladaptive) belief, rather than habituation to anxiety. As such, behavioural experiments need not be carried out repeatedly, and are typically shorter than exposure exercises (Bennett-Levy et al., 2004), which may be more acceptable for patients. Although the intervention strategies described in Radomsky et al. (2010) are theoretically-, and empirically-based, there is a need for them to be evidence-based.

Most research examining the effectiveness of specific interventions do so in randomized controlled trials where the outcomes of participants receiving one treatment are compared against those of participants receiving a similar treatment with the novel interventions included. Indeed,

this type of components analysis is common in treatment research for OCD and other psychological disorders. Although this type of components analysis can assess the effectiveness (i.e., symptom reduction) and acceptability of a *group* of intervention strategies not shared by the treatments being compared, it does not speak to whether or not an *individual* intervention strategy actually modifies its intended target when it is introduced. This represents a novel way to assess the effectiveness of an intervention with a focus on the nature and timing of proposed mechanisms underlying the intervention. Few studies have examined this facet of intervention effectiveness, even though most cognitive and behavioural treatment programs described in randomized controlled trials are structured into discernible modules (typically centred on specific intervention strategies), which are delivered at similar times across all participants receiving the treatment. In honour of Arnoud Arntz's outstanding contributions to our understanding of experimental psychopathology, and of critical psychological mechanisms underlying both the expression and treatment of OCD, we are delighted to report on our findings based on a single-case design approach to the assessment of how and *when* responsibility and memory confidence change during a 12-session course of cognitive therapy for compulsive checking.

Aims and hypotheses

The aim of the current study was to assess whether and when specific cognitive interventions targeting an inflated sense of responsibility and decreased memory confidence (within a new cognitive therapy for compulsive checking) produced changes in their targets on a session-by-session basis through a multiple baseline single-case design. We first hypothesized that participants diagnosed with OCD who struggle with compulsive checking would experience significant, marked, and sustained improvements in both inflated responsibility and memory confidence during treatment. Importantly, for our second hypothesis, we expected that

improvements in these components would occur *when* they are directly addressed in therapy. For our third hypothesis, we predicted that improvements in these components over treatment would significantly predict reductions in time spent engaging in checking behaviour.

Method

Participants

Participants were recruited through local advertisements and flyers in and around Montreal clinics, as well as via online ads. Thirteen individuals that met DSM-IV criteria for an OCD diagnosis and reported significant checking symptoms (at least one hour each day) as assessed by the Yale-Brown Obsessive-Compulsive Scale (Y-BOCS; Goodman et al., 1989), were enrolled in this study. Exclusion criteria for the study were the presence of psychotic disorders, bipolar disorder, acute suicidality, and current substance abuse. Of the 13 participants, 1 was removed from the study due to alcohol abuse that began after the commencement of treatment, 1 was removed due to washing/cleaning symptoms that exceeded the distress caused by the checking symptoms. To minimize the potential influence of order effects on the interpretation of our results, an additional 2 participants were removed from the statistical analyses due to the therapists administering the treatment in a different sequence/order. Participants received financial compensation for the assessment sessions they attended (i.e., baseline, post-treatment, and 1 month follow-up). Unusually, none of the participants was taking any medication at the beginning and/or during the study. The study was approved by the institution's ethics board, and participants provided informed consent to participate in the study. Participants' sociodemographic characteristics are presented in Table 1.

Measures

Anxiety Disorders Interview Schedule for DSM-IV (ADIS-IV; Brown, diNardo, & Barlow, 1994). This semi-structured interview assesses a variety of current lifetime symptoms associated with anxiety and other (e.g., mood, somatoform, substance abuse, psychotic) disorders (including OCD), according to DSM-IV criteria (American Psychiatric Association, 2000). The ADIS-IV has been widely used in both clinical and research contexts and it has been demonstrated to have good to excellent inter-rater reliability when assessing depression (κ = 0.67) and OCD (κ = 0.85) (Brown, diNardo, Lehman, & Campbell, 2001). All interviewers on the ADIS-IV had an undergraduate degree in psychology and/or were completing graduate level studies in clinical psychology. Interviewers received rigorous training on the ADIS-IV and were required to match with another interviewer's primary and secondary diagnoses (as well as severity ratings) made on 3 training videos and 3 live interviews conducted with actual participants. These interviews were administered under the supervision of the first author (ASR), who is a trained clinical psychologist. Interviewers were also blind to the treatment processes that were being investigated in the current study.

Yale-Brown Obsessive-Compulsive Scale (Y-BOCS; Goodman et al., 1989). This 10-item clinician-administered measure consists of two subscales, which assess the severity of participants' obsessions and compulsions, respectively. Subscale scores are summed to derive a total Y-BOCS score. The Y-BOCS has been shown to have excellent inter-rater reliability (all intra-class correlations > 0.86 for the total Y-BOCS score and for each item), as well as good convergent and divergent validity (Goodman et al., 1989). The same interviewers on the ADIS-IV administered the Y-BOCS after receiving rigorous training on using the instrument.

Daily monitoring forms. Between the date of the intake assessment and the date of the 1 month follow-up assessment, participants were asked to make daily ratings of the time spent

checking that day (in minutes) and to rate the following on a 0 to 100 scale: severity of doubt, feelings of responsibility, probability/likelihood of harm coming to themselves or a loved one, severity of harm that could come to themselves or a loved one, and confidence in their memory ('How confident are you in your memory today?'). For the purposes of the current study, only ratings of time spent checking, feelings of responsibility, and memory confidence were considered.

Procedure

Participants were screened by telephone and if eligible, were invited to Concordia University for the first assessment approximately one week later. During this session, participants completed the full ADIS-IV and Y-BOCS with a trained assessor, as well as the other measures included in this study[1]. Participants were also given a monitoring booklet (containing the daily monitoring forms described above) to be filled in until the first treatment session (i.e., the baseline assessment period), throughout treatment, and until the 1 month post-treatment follow-up assessment. At the end of the baseline assessment period, participants received 12 weeks of cognitive-behaviour therapy for compulsive checking by two doctoral level therapists (LG and JS) who were supervised by the first author (ASR). Each session was video recorded.

Treatment description. The treatment closely followed the protocol described in Radomsky et al. (2010) in a 12-session format with the first 10 sessions occurring weekly, and the last two sessions at a tapered frequency of 10 days to 2 weeks apart. This treatment followed a cognitive approach with the complete absence of ERP. Emphasis was placed on addressing

[1] The Y-BOCS was also administered during an assessment session at mid-treatment (i.e., immediately following Session 6), one week following the last session (Session 12), and at 1 month post-treatment follow-up. Please note that the primary outcome data for this trial, which includes the Y-BOCS, will be reported in a separate manuscript, in progress at the time of this submission.

beliefs about responsibility, memory, threat, and those related to the personal significance of checking symptoms (Rachman, 1997, 1998, 2003). To confirm adherence to treatment procedures, therapists were supervised weekly by the first author (ASR), and all sessions were videotaped and later reviewed to ensure treatment fidelity. Therapist competence was not assessed.

Each session began with a review of the monitoring information completed since the previous session. The first two sessions of the treatment were introductory, and included psychoeducation about compulsive checking in OCD, as well as the collaborative development of an idiosyncratic model of the participant's checking problem based on the cognitive model of compulsive checking (Rachman, 2002). Sessions 3 to 5 included a focus on the modification of beliefs about inflated responsibility. Different responsibility-reducing strategies were used such as the classic 'responsibility pie chart' (estimating and allocating responsibility between the patient and other parties for preventing a negative outcome; Whittal & McLean, 1999), the continuum technique (depicting on a spectrum the patient's and other individuals' appraisals or actions), conducting surveys to collect (accurate) information from relevant people, and responsibility contracts where responsibility is temporarily transferred to another person (e.g., roommate, partner, therapist; Lopatka & Rachman, 1995; Radomsky et al., 2001; Shafran, 1997). Sessions 6 and 7 focused on recalculating the probability of harm and the severity of harm (described in Radomsky et al., 2010). Sessions 8 and 9 focused on negative beliefs about memory which includes addressing memory confidence (see Alcolado & Radomsky, 2011, 2016). Exercises and behavioural experiments about the consequences of repeated checking (as described in Radomsky et al., 2010 and following from van den Hout & Kindt, 2003a,b; Radomsky et al., 2006) , as well as behavioural experiments to help participants accumulate new

and corrective information about their memories (based on Alcolado & Radomsky, 2011) were used. The next sessions focused on consolidating and summarizing the work done in previous sessions, attending mostly to the personal significance of any intrusive thoughts and generalizing treatment gains to related yet not necessarily targeted domains, such as guilt (Mancini & Gangemi, 2004), hypervigilance (Wiggs, Martin, Altemus, & Murphy, 1996), self-doubting (Alcolado & Radomsky, 2011), reassurance seeking , and mental checking (Radomsky & Alcolado, 2010). The final treatment session focused on relapse prevention. All sessions were followed by an assigned behavioural experiment as the between-session homework activity.

Statistical analyses

Multilevel modelling was used to test all our hypotheses. To examine our first hypothesis, that participants would experience significant and sustained improvements in both inflated responsibility and memory confidence, we conducted a multilevel model with the fixed model part consisting of dummy-coded variables defining comparisons between baseline (coded 0) and post-treatment (coded 1) and between baseline (coded 0) and 1 month follow-up (coded 1).

To examine our second hypothesis, that improvements in inflated responsibility and memory confidence would occur when they are directly addressed in therapy, we conducted another multilevel model comparing the linear change in ratings of responsibility feelings and memory confidence both before and during/after the treatment sessions when these cognitive targets were specifically addressed (also known as an interrupted time series analysis). The fixed model part consisted of a) an effect-coded variable defining a general linear time effect starting with 0 indicating the baseline assessment period, 1 to 12 indicating the average of the measurements taken daily after each session, and 13 for the 1 month follow-up assessment (14

measurements in total); b) a dummy-coded variable defining the sessions and assessment periods prior to when these targets were addressed (coded 0) and the sessions and assessment periods during/after these targets were addressed (coded 1); and c) an interaction term defined by the product of a) and b). The random model part consisted of a random intercept and slope to allow for between-subject variation in time effects, of which the within-subject covariance structure was defined as heterogeneous first-order autoregressive (ARH1). This model was repeated for the whole sample (Model 1) and for each participant (Models 3 to 11).

A separate multilevel model (Model 2) was conducted to understand the interaction term obtained from Model 1 for ratings of responsibility and memory confidence (i.e., simple slope analysis). That is, we wanted to examine the linear change in these cognitive targets within the period before these were specifically targeted (pre-intervention) and within the period during/after these were specifically targeted (post-intervention). For this model, the fixed part consisted of effect-coded and centred variables indicating general linear time effects within pre-intervention and within post-intervention. To illustrate, for the time-within-pre-intervention variable, the 3 measurements of responsibility feelings prior to the sessions when these were specifically targeted would be coded -1, 0, 1 and all other measurements would be coded 0. For the time-within-post-intervention variable, the 11 measurements of responsibility feelings during/after the sessions when these were specifically targeted would be coded -5, -4, -3, -2, -1, 0, 1, 2, 3, 4, 5 and all other measurements would be coded 0. The random model part was the same as in Model 1.

To examine our third hypothesis, that improvements in inflated responsibility and memory confidence would significantly predict reductions in time spent engaging in checking behaviour, a final multilevel model was conducted to predict time spent checking from the linear

change in responsibility ratings and memory confidence over treatment. The fixed model part consisted of responsibility or memory confidence ratings. The random model part consisted of a random intercept and slope to allow for between-subject variation in responsibility/memory confidence ratings, of which the within-subject covariance structure was defined as ARH1.

Results

Hypothesis 1 – Treatment effectiveness in improving feelings of responsibility and memory confidence

Means, standard deviations, and comparison statistics of the assessment periods on feelings of responsibility and memory confidence are presented in Tables 2 and 3, respectively. Multilevel modelling showed a significant reduction in responsibility ratings between the baseline and post-treatment ($p < 0.001$; 95% confidence interval = 27.93 to 57.61), and a significant reduction between baseline and 1 month follow-up ($p < 0.001$; 95% confidence interval = 32.50 to 60.22). We similarly found a significant increase in memory confidence between baseline and post-treatment ($p = 0.05$; 95% confidence interval = -50.26 to -0.63), and a significant increase between baseline and 1 month follow-up ($p = 0.04$; 95% confidence interval = -52.05 to -3.44).

Hypothesis 2 – Linear change in cognitive targets before and after they were specifically addressed

Feelings of responsibility. Figure 1 shows the aggregate and individual responsibility ratings for the 9 participants averaged daily across 2 weeks of the baseline assessment period, the days following each treatment session, and at 1 month follow-up. Visual inspection suggests decreases in responsibility ratings for all participants during/after beliefs about responsibility were specifically targeted in sessions 3 to 5. Multilevel modelling (see Table 4) revealed that the

time-by-intervention interaction was a marginally significant predictor of feelings of responsibility for the whole sample ($p = 0.07$; Model 1). Together with the simple slopes analysis (Table 4, Model 2), it suggests that the lack of linear change in responsibility ratings over the measurements prior to the responsibility intervention ($\beta = 0.45$, $p = 0.91$; 95% confidence interval = -7.44 to 8.33) changed to a significant decrease in responsibility ratings over time following the introduction of the intervention ($\beta = -4.56$, $p < 0.001$; 95% confidence interval = -6.35 to -2.77).

Confidence in memory. Figure 2 shows the aggregate and individual ratings of memory confidence for the 9 participants averaged daily across 2 weeks of the baseline period, the days following each treatment session, and at 1 month follow-up. Visual inspection suggests increases in memory confidence for 6 out of 9 participants during/after this cognitive component was specifically targeted in sessions 8 and 9. Multilevel modelling (see Table 5) revealed that the time-by-intervention interaction was a significant predictor of memory confidence for the whole sample ($p = 0.01$; Model 1). Together with the simple slopes analysis (Table 5, Model 2), it suggests that the lack of linear change in memory confidence over the measurements prior to the memory confidence intervention ($\beta = 0.43$, $p = 0.38$; 95% confidence interval = -0.53 to 1.38) changed to a significant increase in memory confidence over time following the introduction of the intervention ($\beta = 1.7$, $p = 0.02$; 95% confidence interval = 0.24 to 3.17).

Hypothesis 3 – Change in cognitive targets predicting changes in compulsive checking

For the whole sample, multilevel modelling revealed that reductions in responsibility feelings over the course of the study significantly predicted reductions in time spent checking ($\beta = 1.27$, $p = 0.002$; 95% confidence interval = 0.60 to 1.95). Similarly, multilevel modelling

revealed that increases in memory over the course of the study significantly predicted reductions in time spent checking ($\beta = -1.57$, $p < 0.001$; 95% confidence interval = -2.14 to -1.00).

Discussion

Our primary aim in this study was to assess the degree to which targets of cognitive therapy for compulsive checking were addressed during treatment, with particular emphasis on when changes in these targets took place. Compulsive checking is one of the most common forms of OCD and is associated with high levels of anxiety and distress (Foa et al., 2005). Although several studies have demonstrated the effectiveness of cognitive therapy in reducing symptoms of OCD (Cottraux et al., 2001; Ost, Havnen, Hansen, & Kvale, 2015), to the best of our knowledge, none have focused on compulsive checking specifically, and aside from a robust and influential literature on sudden gains in CBT (e.g., Aderka et al., 2012; Norton, Klenck, & Barrera, 2010; Tang & DeRubeis, 1999), few if any studies have assessed the timing of cognitive change during therapy. Therefore, the purpose of the current study was to investigate whether specific cognitive interventions addressing an inflated sense of responsibility and decreased memory confidence, two cognitive constructs empirically shown to maintain compulsive checking, produced changes in these domains *when* the interventions were provided.

We first hypothesized that participants who struggle with compulsive checking would experience significant, marked, and sustained improvements in both inflated responsibility and memory confidence. Our findings supported this prediction such that participants experienced a significant improvement (with large effect sizes) in these cognitive components immediately following treatment relative to baseline, which was maintained at a 1 month follow-up assessment.

Importantly, we found general support for our second hypothesis such that changes in these cognitive constructs occurred when they were expected to happen. That is, reductions in feelings of responsibility and increases in memory confidence were observed when the interventions targeting these were introduced, and not before. Furthermore, improvements in feelings of responsibility and memory confidence were relatively consistent from the moment they were targeted up until one month after the end of treatment. Notably in both cases, the non-significant time effect in our multilevel models suggests that the observed changes in feelings of responsibility and memory confidence were not simply due to the passage of time or common therapy factors, but due to the introduction of specific interventions targeting these cognitive components.

In a more detailed analysis, approximately half of the participants did not show significant improvements in these components when the interventions were introduced. A visual inspection of these participants' data revealed that in the case of feelings of responsibility, participants who did not experience significant intervention-related changes reported moderately low feelings of responsibility at baseline (e.g., 50 – 60/100), and so any gains received from the cognitive intervention may have been minimal (i.e., floor effect). Similarly, a ceiling effect may have been observed for participants who did not experience significant intervention-related changes in memory confidence due to them reporting moderately high memory confidence at baseline (e.g., 70 – 90/100). The therapy followed the same session structure for each participant in order to control for any order effects on results. Although there are strengths to this type of design, this could have affected the results for some participants as they may have benefited from an idiosyncratic order of sessions which prioritizes targeting their most maladaptive belief. This semi-structured approach to treatment is more representative of what occurs in therapy outside of

research settings and future studies could allow for more flexibility in the session order determined by the participants' most relevant concerns. However, as raised earlier in the Methods section, while this would allow for a more ecologically valid examination of *overall* treatment effectiveness, changes in session order may introduce confounds in our interpretation of the specific timing of cognitive change (i.e., whether these change *when* they are addressed in therapy).

Importantly, the discussion above highlights that the theory-driven interventions in our treatment could be further refined by accounting for the particular profile of cognitive beliefs within each participant, which can be heterogeneous even within a largely accepted and well-established OCD domain such as compulsive checking. Future studies could thus examine whether participants with varying levels of responsibility and memory beliefs would benefit from a specific intervention order or an entirely different intervention altogether. For example, an individual with equally elevated levels of responsibility and memory beliefs might benefit more from a behavioural experiment that simultaneously targets both (e.g., testing predictions around the accuracy of their memory for having turned off their stove while challenging their personal responsibility for ensuring that it is turned off). Indeed, in addition to identifying *when* cognitive change occurs, research in this field should move towards understanding *for whom* these interventions work best.

Finally, there was also support for our third hypothesis, such that improvements in these cognitive components significantly predicted reductions in time spent engaging in checking behaviour. These findings are consistent with a study by Alcolado and Radomsky (2016), who demonstrated that the same 2-session intervention targeting maladaptive beliefs about memory was effective in reducing time spent checking. In sum, our results provide support to previous

suggestions that these cognitive components can and should be targeted in treatments for compulsive checking (e.g., Radomsky et al., 2010; Shafran, Radomsky, Coughtrey, & Rachman, 2013).

Limitations and future directions

The small sample size in the current study limits our ability to generalize our results. Nevertheless, it is noteworthy to mention that since the treatment delivered in this study incorporated new interventions, it is necessary to first assess its effectiveness and refine them in a small and controlled group of participants before conducting a larger scale randomized controlled trial. Future studies should therefore include a larger sample size to replicate the findings of this study. In addition, we propose that investigations of the timing of cognitive, behavioural and emotional change could contribute substantially to an understanding of key mechanisms of change underlying evidence-based psychological treatments.

Conclusion

Our findings suggest that interventions targeting beliefs about responsibility and memory are effective in modifying these and at reducing compulsive checking in OCD. Using a multiple baseline single case design approach, we identified *when* change occurred in these cognitive components throughout the therapy. Randomized controlled trials with larger sample sizes are now warranted to assess cognitive and behavioural symptom change on a broader scale.

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Declaration of interest

The authors declare no conflicts of interest.

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Table 1

Participant Sociodemographic Characteristics (*N* = 9)

Variable		Mean (*SD*) / Number (Percentage)
Age	Range (19 – 56)	32.89 (11.70)
Gender	Female	4 (44.4)
	Male	5 (55.6)
Civil status	Single	7 (77.8)
	Married or common law	2 (22.2)
Educational level	University degree	2 (22.2)
	College diploma	6 (66.7)
	High school diploma	1 (11.1)
Ethnicity	Caucasian	5 (55.6)
	South Asian	1 (11.1)
	Multi-Ethnic	1 (11.1)
	Indo-Canadian	1 (11.1)
	Middle Eastern	1 (11.1)
Employment status	Full-time employee	3 (33.3)
	Part-time employee	3 (33.3)
	Student	2 (22.2)
	Unemployed	1 (11.1)
OCD Severity (Y-BOCS)	Obsessions	11.33 (2.95)
	Compulsions	12.44 (2.69)
	Total	23.78 (5.16)
Primary ADIS diagnosis	OCD	8 (88.9)
	Specific Phobia	1 (11.1)
Secondary ADIS diagnosis	OCD	1 (11.1)
	Panic Disorder with Agoraphobia	2 (22.2)
	Social Phobia	1 (11.1)
	Generalized Anxiety Disorder	1 (11.1)
	Dysthymia	1 (11.1)
Tertiary ADIS diagnosis	Panic Disorder with Agoraphobia	1 (11.1)
	Social Phobia	2 (22.2)
	Generalized Anxiety Disorder	2 (22.2)
	Dysthymia	1 (11.1)
Quaternary ADIS diagnosis	Specific Phobia	2 (22.2)
	Major Depressive Disorder	1 (11.1)
	Dysthymia	1 (11.1)
Quinary ADIS diagnosis	Post-Traumatic Stress Disorder	1 (11.1)
Previous CBT	For OCD	3 (33.3)

Table 2

Means, Standard Deviations, and Test Statistics of Comparisons between Assessment Periods on Feelings of Responsibility (*N* = 9)

Assessment period	Responsibility Ratings		Baseline vs Post-treatment			Baseline vs Follow-up		
	M	*SD*	*t* (1, 9)	95% CI		*t* (1, 9)	95% CI	
Baseline	66.02	16.45						
Post-treatment	23.25	17.76	6.52***	27.93	57.61	7.57***	32.50	60.22
Follow-up	19.67	13.79						

Note. *** $p < 0.001$.

Table 3

Means, Standard Deviations, and Test Statistics of Comparisons between Assessment Periods on Memory Confidence (*N* = 9)

Assessment period	Memory Confidence Ratings		Baseline vs Post-treatment			Baseline vs Follow-up		
	M	*SD*	*t* (1, 9)	95% CI		*t* (1, 9)	95% CI	
Baseline	57.37	31.82						
Post-treatment	82.81	19.44	-2.32*	-50.26	-0.63	-2.58*	-52.05	-3.44
Follow-up	85.11	14.23						

Note. * $p < 0.05$.

Table 4

Results of Multilevel Modelling – Responsibility Rating (*N* = 9)

	Parameter	β	*SE*	df	*t*	*p*	95% CI for β
Model 1: Whole Sample	Intercept	67.00	7.09	12.95	9.45	<0.001	51.68 , 82.33
	Time	0.45	2.77	116.08	0.16	0.87	-5.03 , 5.93
	Intervention	9.12	4.69	108	1.94	0.06	-0.18 , 18.42
	Time-by-intervention interaction	-5.01	2.73	108	-1.84	0.07	-10.42 , 0.40
Model 2: Whole Sample	Time-within-pre-intervention	0.45	3.98	123	0.11	0.91	-7.44 , 8.33
	Time-within-post-intervention	-4.56	0.90	123	-5.05	<0.001	-6.35 , -2.77
Models 3 to 11: Individual Participant (time-by-intervention interaction)	1	-13.51	5.79	10	-2.33	0.04	-26.40 , -0.61
	2	5.54	1.48	10	3.75	0.004	2.25 , 8.83
	3	-6.56	7.16	10	-0.92	0.38	-22.52 , 9.40
	4	-5.88	1.27	10	-4.65	0.001	-8.70 , -3.06
	5	-21.93	9.80	10	-2.24	0.05	-43.76 , -0.09
	6	-2.42	5.55	10	-0.44	0.67	-14.79 , 9.95
	7	-1.17	3.96	10	-0.30	0.77	-10.00 , 7.65
	8	-5.90	11.65	10	-0.51	0.62	-31.86 , 20.07
	9	6.75	3.29	10	2.05	0.07	-0.57 , 14.07

Note. For Models 1 and 3 to 11, predictors were coded as follows – effect coding for Time (0, 1, 2, … 13) with 0 for the baseline assessment period, 1 to 12 indicating the average of the measurements taken daily after each session, and 13 for the 1 month follow-up; dummy coding for Intervention (1, 0) such that the sessions and assessment periods prior to when responsibility was addressed were coded 0 and the sessions and assessment periods during/after the sessions when responsibility was addressed were coded 1. Model 1 intercept variance (BS) was 342.63, error variance (WS) was 177.53, ARH1 rho = -0.76.

Table 5

Results of Multilevel Modelling – Confidence in Memory (*N* = 9)

	Parameter	β	*SE*	df	*t*	*p*	95% CI for β
Model 1: Whole Sample	Intercept	56.73	12.22	9.21	4.64	0.001	29.17 , 84.28
	Time	0.85	1.11	12.85	0.77	0.46	-1.55 , 3.26
	Intervention	-13.71	8.49	108	-1.62	0.11	-30.54 , 3.12
	Time-by-intervention interaction	2.55	0.92	108	2.77	0.01	0.73 , 4.38
Model 2: Whole Sample	Time-within-pre-intervention	0.43	0.48	123	0.88	0.38	-0.53 , 1.38
	Time-within-post-intervention	1.70	0.74	123	2.30	0.02	0.24 , 3.17
Models 3 to 11: Individual Participant (time-by-intervention interaction)	1	-1.02	1.29	10	-0.79	0.45	-3.89 , 1.86
	2	1.01	0.48	10	2.13	0.06	-0.05 , 2.07
	3	0.13	0.47	10	0.28	0.78	-0.92 , 1.19
	4	-1.09	1.62	10	-0.68	0.52	-4.70 , 2.52
	5	12.67	4.70	10	2.69	0.02	2.19 , 23.14
	6	-1.13	0.68	10	-1.67	0.13	-2.63 , 0.38
	7	-1.26	1.52	10	-0.83	0.43	-4.65 , 2.13
	8	9.17	0.85	10	10.83	<0.001	7.29 , 11.06
	9	4.49	0.66	10	6.76	<0.001	3.01 , 5.97

Note. For Models 1 and 3 to 11, predictors were coded as follows – effect coding for Time (0, 1, 2, … 13) with 0 for the baseline assessment period, 1 to 12 indicating the average of the measurements taken daily after each session, and 13 for the 1 month follow-up; dummy coding for Intervention (1, 0) such that the sessions and assessment periods prior to when memory confidence was addressed were coded 0 and the sessions and assessment periods during/after the sessions when memory confidence was addressed were coded 1. Model 1 intercept variance (BS) was 1305.48, error variance (WS) was 626.84, ARH1 rho = -0.88.

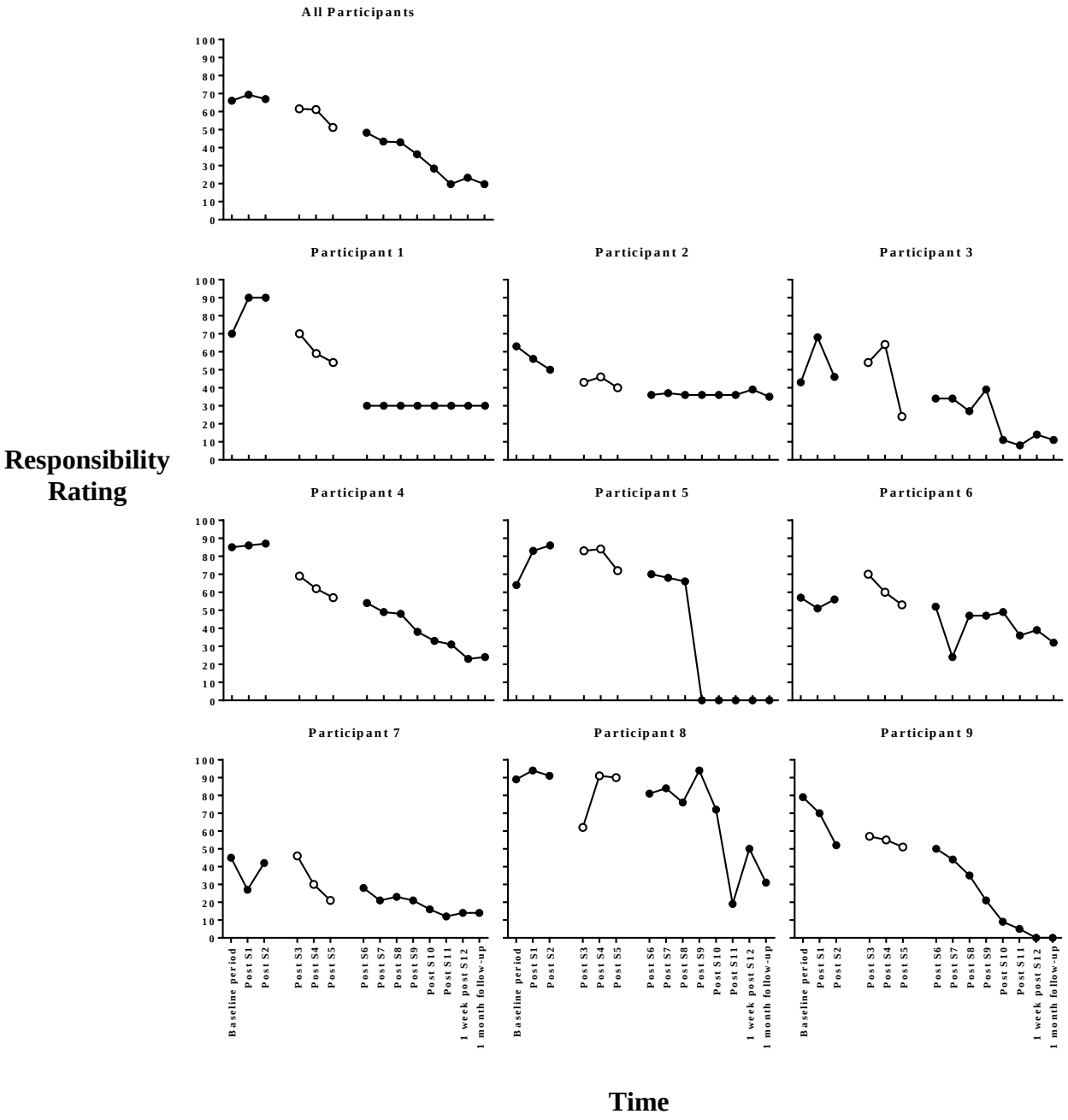

Figure 1. Ratings of responsibility averaged daily across 2 weeks of the baseline assessment period, the days following each treatment session, and at 1 month follow-up for all participants. The white circles indicate the sessions where beliefs about responsibility was directly targeted (i.e., sessions 3 to 5).

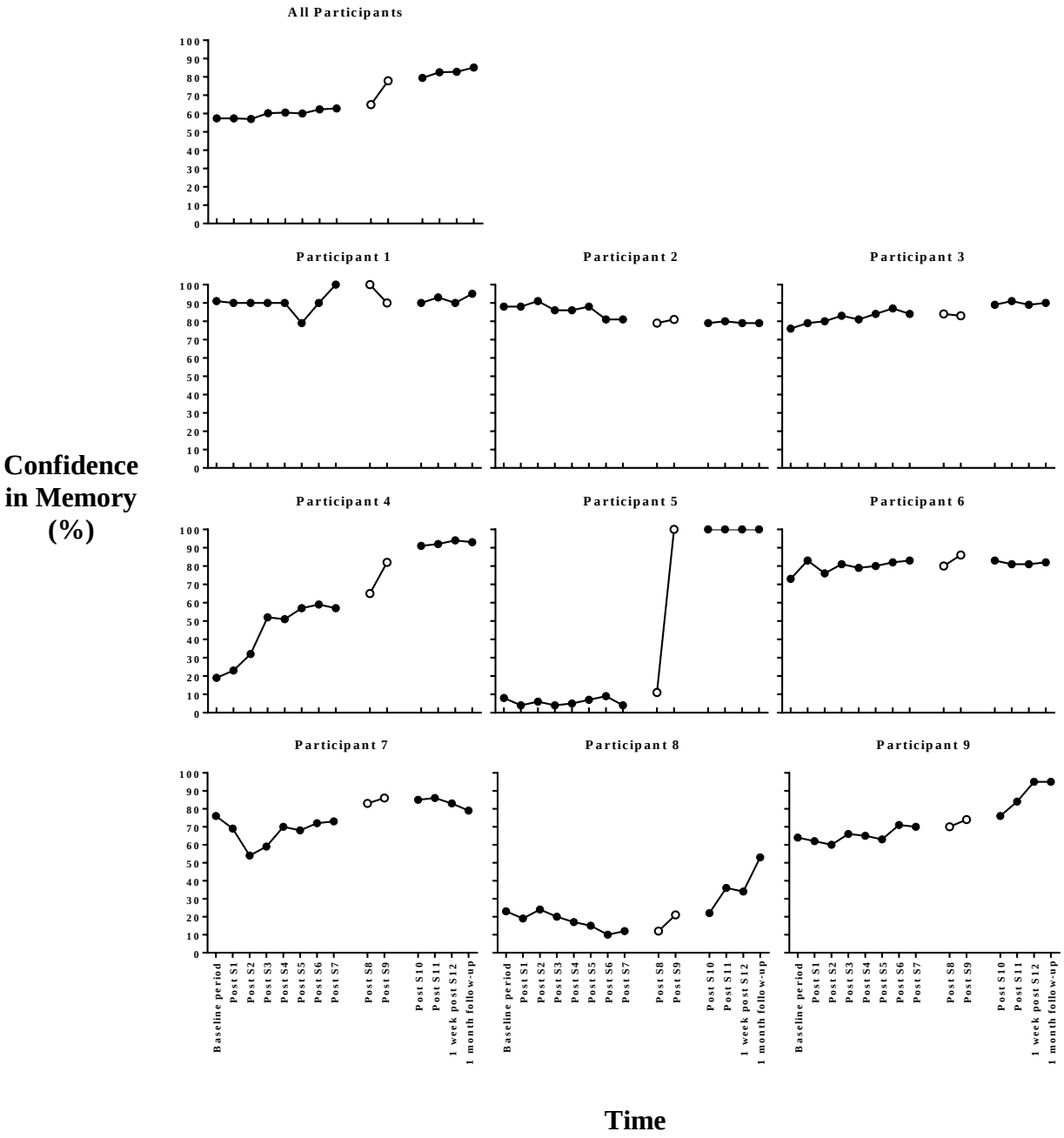

Figure 2. Ratings of confidence in memory averaged daily across 2 weeks of the baseline assessment period, the days following each treatment sessions, and at 1 month follow-up for all participants. The white circles indicate the sessions where confidence in memory was directly targeted (i.e., sessions 8 and 9).