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## Thought suppression across time: Change in frequency and duration of thought recurrence\*

Ann E. Lambert\*, Yueqin Hu, Joshua C. Magee, Jessica R. Beadel, and Bethany A. Teachman

University of Virginia, Box 400400, Charlottesville, VA 22904, USA

### Abstract

Some studies have found that trying to suppress thoughts increases their long-term recurrence, a phenomenon associated with psychopathology, particularly obsessive-compulsive disorder. However, effect sizes in thought suppression studies have often been small and inconsistent. The present study sought to improve thought suppression conceptualization and measurement by examining two distinct dimensions of thought recurrence – frequency and duration of a thought's return – and how they evolve over time. After a thought focus period, 100 adults were assigned to either suppress or monitor the recurrence of an unpleasant thought for 4 min. Then, during a second four-minute period, *all* participants were asked to monitor the thought's recurrence. Hierarchical linear modeling indicated that thought *frequency* declined across time and the rate of decline slowed as time went on. Initially, the extent of thought *duration* remained short and stable for those asked to suppress, and increased linearly over time for those asked to monitor. Later, this pattern reversed. Duration increased linearly for those initially asked to suppress but was short and stable for those who initially monitored. Accounting for change over time and means of measuring recurrence (frequency vs. duration) may help elucidate past mixed findings, and improve thought suppression research methodology.

### Keywords

Thought suppression; Intrusive thoughts; Frequency; Duration; Time; Recurrence

## 1. Introduction

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Intrusive, unwanted thoughts are common occurrences, experienced by approximately 90% of the population (Clark & Purdon, 1995). Often, individuals react to these thoughts by attempting to suppress them (Barnes, Klein-Sosa, Renk, & Tantleff-Dunn, 2010; Salkovskis & Campbell, 1994). In the short term, this strategy can be effective (Magee, Harden, & Teachman, 2012); however, in the long term, thought suppression attempts may lead to a relative increase in thought recurrence. This phenomenon is known as *rebound* (Wegner, 1994). In part because of this ironic rebound effect, thought suppression has been linked to various forms of psychopathology, particularly emotional disorders, like obsessive-compulsive disorder, that involve the persistent return of unwanted thoughts (Purdon, 1999).

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\*Corresponding author. Tel.: +1 434 243 7646; fax: +1 434 982 4766. ael4n@virginia.edu (A.E. Lambert).

Meta-analyses (Abramowitz, Tolin, & Street, 2001; Magee et al., 2012) have confirmed the thought suppression rebound effect, but the overall size of the effect is small and not reliably present across studies. Many studies have explored possible moderating variables to explain these mixed results, including the presence of psychopathology (see Magee et al., 2012), thought valence (Harvey & Bryant, 1998), and personal relevance of the thought (Kelly & Kahn, 1994), among others. While these investigations have been useful, the moderators examined to date have not been able to account for much of the variance in recurrence (e.g., Magee et al., did not find that clinical populations experienced greater rebound than non-clinical populations). In the present study, we examine two variables, time (i.e., how the extent of thought recurrence changes over the course of a thinking period) and thought recurrence measurement (i.e., frequency of recurrence vs. duration of recurrence), that are theoretically likely to improve our understanding of when and how thought suppression attempts lead to the ironic return of unwanted thoughts.

### 1.1. Thought suppression outcomes across time

Thought suppression has been extensively studied using a modified thought suppression paradigm developed by Wegner, Schneider, Carter, and White (1987). While variation in the paradigm exists, the method typically begins by asking participants to focus on a thought. Next, participants are randomly assigned to either intentionally suppress (i.e., try *not* to think about the thought) or to simply monitor the occurrence of the thought (i.e., think about whatever they want) for a period of time. Finally, both groups undergo a thought monitoring period where thought recurrence is freely monitored (with no suppression instructions). During these two sequential thinking periods, both groups are asked to record whether the thought comes to mind. A common finding is a rebound effect whereby participants who were asked to initially suppress the thought tend to experience more thought recurrence during the final thought monitoring period relative to the control monitoring group. This rebound effect is theorized to be the result of two cognitive processes: a volitionally controlled operating process that intentionally tries to suppress occurrences of unwanted thoughts (possibly by searching for unrelated distractor thoughts), and an unconscious, uncontrollable monitoring process that scans thought content for suppression failures, bringing these failures into conscious awareness when encountered (Wegner, 1994). Ironically, the activity of the operating process can increase the likelihood of later recurrence by taxing controlled processing resources, making subsequent suppression more difficult (Gordijn, Hindriks, Koomen, Dijksterhuis, & Van Knippenberg, 2004; Wegner, 1994). Because the operating process is thought to be resource dependent, thought suppression attempts are expected to be less successful when cognitive resources are low.

Within this thought suppression paradigm, thought recurrence and the cognitive processes responsible for this recurrence play out continuously across time; however, most studies examine the total or mean frequency of thought recurrence per period, collapsing across time. This potentially obscures critical information. Examining thought suppression failures across time provides a more ecologically valid approach that may help reveal the processes underlying suppression success and failure, such as by identifying the point during thinking periods when suppression vs. monitor instructional condition differences emerge or detecting when recurrence is likely to peak during thinking periods. For example, it is known that active thought suppression attempts place demands on working memory capacity (see Brewin & Beaton, 2002) and deplete cognitive resources (Gailliot et al., 2007; Muraven, Tice, & Baumeister, 1998; Muraven, Collins, & Neinhuis, 2002). As a result, longer thought suppression periods may lead to stronger rebound effects that incrementally escalate over time, a pattern that could only be observed when analyses examine patterns of change across time.

## 1.2. Thought suppression outcome measurement: frequency vs. duration

If and when a rebound effect is observed may vary based on how thought recurrence is measured. Frequency of thought recurrence has been the most commonly used outcome variable to determine the impact of thought suppression instructions on subsequent unwanted thoughts (see Magee et al., 2012). Using thought frequency to study recurrence makes intuitive sense and may be the simplest dimension of recurrence to measure, but it is not the only potentially important measure of recurrence. Once an unwanted thought has entered awareness, the duration of time it remains in awareness may also be important (Purdon, 2004). As Purdon points out, evaluating thought recurrence based solely on the frequency of thought return is problematic because it is confounded with the duration of the thought's recurrence. For example, an individual may experience a single instance of a thought that persists for an entire thinking period, thus resulting in a very high duration and a very low frequency. While Wegner et al. (1987) discussed the duration of thought recurrence in their seminal paper, the variable has since received minimal attention. In a meta-analysis spanning 33 studies, Magee et al. identified just two studies that measured thought duration as it occurred (as opposed to by retrospective report). The present study examines both thought frequency and thought duration as they occur continuously across time because, as we will argue, the cognitive processes that give rise to the frequency of thought recurrence may be very different than those that sustain or limit the thought's duration.

We argue that frequency can be conceptualized as thought *onset* because, regardless of the length of time the thought remains active in consciousness, the onset of each thought will be counted as one instance of recurrence. In this way, thought frequency can be conceptualized as the tendency of a thought to enter conscious awareness. Within the cognitive literature, when a thought is retrieved from memory and brought to conscious awareness, it is generally considered to be a function of automatic spreading activation (though it is likely not a purely automatic process; see Bargh, 1994; Jacoby, 1991; Logan & Cowan, 1984), which dissipates as time goes on unless reactivation occurs (Anderson, 1983). In particular, activation of intrusive thoughts seems to largely reflect unintentional processing (a core feature of automaticity; Bargh, 1994), given that intention reflects “whether one is in control over the instigation or ‘start up’ of processes” (Bargh, 1994, p. 16). Notably, within the thought suppression paradigm, whether the onset of a thought is considered to occur unintentionally presumably depends on the assigned instructions. Under thought suppression instructions, onset of the thought is partly, by definition, unintentional because the participant is explicitly attempting to prevent activation of the thought using suppression (assuming the participant followed instructions). However, under thought monitoring instructions, it is unclear whether the onset of the thought is unintentional because no activation goal was assigned. In summary, when participants are actively attempting to suppress, thought frequency may reflect primarily automatic cognitive processing.

The few studies that have examined duration have used different measurement approaches, including retrospective self-report; however, methods that allow thought duration to be measured as it occurs presumably confer greater accuracy because they assess online thought duration. If measured in this way, thought duration during suppression can be conceptualized as a thought's *ease of disengagement* or, in other words, indication of an individual's ability to alter or halt processing once the thought is activated (Purdon, 2004). During suppression, we expect that the duration of time it takes to eliminate a thought from awareness likely occurs in large part as a function of controllability, which reflects the ability to counteract (e.g., alter or stop) the influence of an accessible construct (Bargh, 1994). However, as with frequency, controllability is less clear when participants are given monitoring instructions because the instructions do not set a goal to stop processing the

thought. Under thought monitoring instructions, we cannot assume participants are motivated to eliminate the thought from conscious awareness, so it is less clear that duration reflects controllability. Thus, when participants are actively attempting to suppress, thought frequency may reflect primarily controlled cognitive processing.

Construing thought frequency and duration as, in part, indicators of unintentional processing and controlled processing, respectively, can help guide predictions about when we should expect rebound effects and how the variables might change over time. Depletion of controlled processing resources during thought suppression is theorized to lead to rebound effects (Wenzlaff & Wegner, 2000). Because we conceptualize frequency as being driven less by controlled processing than duration, we expect that frequency will not be as influenced by resource depletion as duration. Thus, we predict an absent or reduced rebound effect for frequency, relative to duration. Further, because thought frequency may be partially driven by automatic spreading activation, we predict that frequency of recurrence for those participants assigned to suppress will decline across time as activation naturally dissipates due to habituation. In contrast, because we believe that duration may reflect the impact of controlled processing limits more than unintentional processing, we predict that, under instructions to suppress (i.e., control) the unwanted thought, the duration of recurrence will remain relatively brief and stable across thought periods to the extent that participants are able to employ controlled processing. However, if the suppression period is sufficiently long, participants may deplete their limited controlled processing resources and thought disengagement may become more difficult, leading to rebound effects in the form of increasingly longer durations of recurrence as time goes on.

It is somewhat harder to make predictions for the monitoring condition, when participants are not instructed to actively suppress, because participants may use a wide variety of responses to the thought, including spontaneously attempting to suppress even when they were not instructed to do so. Nonetheless, for frequency, when participants are not actively attempting to suppress, we expect an absent or attenuated rebound effect and a decline in recurrence across time. This is because we argue frequency is more a reflection of automatic processing, which should theoretically be less depleting than controlled processing, and hence, cue relatively less unwanted thought return over time. For duration, when participants are not actively attempting to suppress (vs. attempting to suppress), we predict that they will show longer instances of recurrence during the first thinking period because suppression is typically somewhat successful initially. However, during the second thinking period, we do not expect as much of a rebound effect because they did not previously engage controlled processing in the service of attempted suppression.

### 1.3. Summary

The current study uses hierarchical linear modeling (HLM: Bryk & Raudenbush, 1992) procedures to examine change over time on two conceptualizations of thought recurrence – frequency and duration. HLM is useful when observations are nested, as occurs for repeated measures observed within each participant. Further, it allows us to examine possible linear and non-linear changes in frequency and duration across time, which may be missed by analytic approaches that aggregate across observations.

When participants are initially attempting active suppression, we hypothesize that intrusive thought frequency will decrease across time, consistent with natural decline in automatic (unintentional) activation over time. In contrast, thought duration is expected to initially remain brief and relatively stable when resources to control or disengage from the thought are available, but duration will later increase as resources are depleted. When participants are not initially attempting to actively suppress, we hypothesize that patterns of intrusive thought frequency will be relatively similar to those actively suppressing, because we

assume that frequency is more indicative of unintentional processing (which is not expected to differ greatly across conditions). For duration, we predict that those who are not actively suppressing will show longer initial instances of recurrence; however, later, we do not expect a strong rebound effect because of relatively minimal previous engagement of controlled processing in this monitoring condition.

## 2. Method

### 2.1. Participants

The current study reanalyzed data from adults participating in a broader examination of age differences in response to intrusive thoughts (see Magee & Teachman, 2012, for more information). Participants in the original study ( $N=100$ ) were recruited from the community, with the solicited age groups being 18–30 or 65 and above. All participants were evaluated for cognitive impairment with the Mini Mental Status Exam (MMSE; Folstein, Folstein, & McHugh, 1975), and scored above the screening cutoff score of 24, indicating they did not have significant cognitive impairment (as cited in Tombaugh & McIntyre, 1992). For the current analyses, participants were excluded if they did not provide complete thought recurrence data ( $N=6$ ) or reported thought recurrence lasting an entire thinking period ( $N=6$ ), likely indicating inaccurate responding. The final sample consisted of 88 adults (45 younger and 43 older); see Table 1 for sample demographics, including gender and race.

### 2.2. Measures

**2.2.1. Thought stimulus and thinking instruction condition assignment**—For the thinking periods, an experimenter provided participants with a thought that was intended to parallel real-life intrusive thoughts by being high in unpleasantness and perceived immorality (Rachman & de Silva, 1978). The thought, “I hope my friend is in a car accident,” was used, following past research (Magee & Teachman, 2007; Rachman, Shafran, Mitchell, Trant, & Teachman, 1996).

After encountering this thought stimulus during an initial focus period, participants were randomly assigned to one of two conditions. In the *thought suppression* condition, participants were instructed: “For this period, I would like you to try not to think about the thought you just focused on. If you do think about that thought, please mark that you did because this is very important information for us, but try your best not to think about that thought.” Participants in the *monitoring* condition were told: “For this period, think about whatever you would like – it could be the thought you thought about before, or it could be anything else. If you do think about the thought, please mark that you did because this is very important information for us.” In the second thinking period, all participants were given the monitoring instructions.

**2.2.2. Thought recurrence**—During the focusing and thought monitoring/suppression periods, participants recorded two measures of thought recurrence by pressing and holding the space bar on the computer keyboard to record each instance of the experimental thought. *Frequency* was indexed by summing the number of separate times the space bar was pressed during a thinking period. *Duration* was computed by summing the length of all space bar presses (accuracy of each press to at least a tenth of a second). Data from the focusing period was not used in analyses, following standard practice (Abramowitz et al., 2001).

### 2.3. Procedure

After informed consent, participants completed a baseline measure of affect. Next, during the focusing period, participants wrote out the thought, “I hope my friend is in a car accident”, and then focused on that thought for 40 s while recording the frequency and

duration of each thought occurrence using the space bar. Participants lifted their fingers and pressed nothing whenever they thought about anything other than the assigned thought.

Next, participants were randomly assigned to receive either thought suppression or monitoring instructions for the four-minute experimental thinking period. During this period, participants once again tracked each thought recurrence using the space bar. Next, participants completed a second four-minute thinking period. For this period, all participants received the monitoring instructions, described previously, and again recorded thought recurrences. Participants then reported demographic information (and completed a packet of questionnaires as part of another study<sup>1</sup>) and were debriefed.

#### 2.4. Analytic plan

Across the two thinking periods, the presence of the thought (indicated by a space bar press) was coded as 0 (absent) or 1 (present) every 0.1 s. Within each minute, the total number of space bar presses was summed and represented our *frequency* variable, and the total amount of time the space bar was depressed divided by the frequency represented our *duration* variable, which is equivalent to the mean duration of each thought. If no thought recurrence occurred in a given one-minute period, then *frequency* and *duration* were zero. If a thought from one minute overlapped into the subsequent minute, the overlapping portion was included in the duration of the subsequent minutes. We chose to divide total duration by *frequency* in order to express *duration* as a proportion of time spent per occasion of thought. This was necessary because of the confounded nature of the two variables (frequency and duration). For example, consider three hypothetical participants. Imagine that the first participant experiences a single thought that is very difficult to disengage from and lasts for 30 s but also has 5 other thoughts that are easier to disengage from and last only three seconds each. The second participant has 5 thoughts that each last 9 s. The third participant has only one thought that lasts for 45 s total. For all three participants, the total duration is almost exactly the same but their ability to disengage from unwanted thoughts appears to differ. By dividing the total duration by frequency, we are able to account for this apparent difference in controllability between participants.

To test our hypotheses, we conducted two HLMs, one for frequency (see Eq. (1)) and one for duration (see Eq. (2)). We used hierarchical models because repeated measures were nested within each individual, and were not independent of one another. We chose to use HLM instead of dynamical time series modeling because we wanted to describe the trajectories of frequency and duration across time, rather than determine how the current status of the variables influences their next status. Each model involved two levels of regression. The first level was within individuals and within thinking period, with time predicting frequency or duration. The variable time was coded from 0 to 3, representing the 4 min within each thinking period. Thus, the intercept represents the frequency or duration for the first minute, the slope represents the linear change of frequency or duration across time, and the curvature represents the non-linear change. The second level includes variables that describe the features of each time point, such as which thinking period and which condition they belong to; thus, the second level was between individuals or between thinking periods, where the intercept, slope, and curvature obtained from the first level were predicted by the variables thinking period (first period coded as 0, second period coded as 1)

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<sup>1</sup>Upon completion of each of the experimental four-minute thinking periods, participants provided several ratings that are not reported here, including suppression effort, perceived difficulty controlling the intrusive thought, and affect. Also, the following questionnaires were completed: Obsessive-Compulsive Inventory-Revised (Foa et al., 2002), State-Trait Anxiety Inventory-Trait Anxiety scale (Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983), Center for Epidemiological Studies-Depression scale (Radloff, 1977), a modified version of the Unusual Thoughts Checklist (Woody, 2007); derived from Kyrios, 2000 and Rachman & de Silva, 1978), Age-relevant Meaning of Intrusive Thoughts (Magee & Teachman, 2012), and the Trail-making subtest of the Delis-Kaplan Executive Function System (Delis, Kaplan, & Kramer, 2001).

and condition assignment (group initially assigned to monitor coded as 0, group initially assigned to suppress coded as 1). Frequency and duration were modeled separately, but, because the two variables are related, the frequency model controlled for duration, and the duration model controlled for frequency. These are the “control ( $\beta_c$ ” effects noted in Tables 2 and 3. Because age differences were not of interest in the present study, we collapsed across age for all reported analyses.<sup>2</sup>

### 3. Results

#### 3.1. Descriptive statistics

Means and standard deviations of the variables’ frequency and duration grouped by minute and condition assignment (suppress vs. monitor) are shown. The correlation between total frequency and average duration across all minutes was not significant,  $r = -0.04$ ,  $p = 0.29$ .

#### 3.2. Frequency

An HLM (Eq. (1)) was used to examine how frequency changed across time, and whether thinking period and condition assignment influenced its change pattern. The Level 1 regression analysis used time and its quadratic term as predictors, and  $u$  for the error term. The Level 2 regression analysis used thinking period, condition assignment, and their interactions as predictors. In this model, we controlled for the effect of duration (see Fig. 1 for the scatter plot between frequency and duration). The model’s coefficients, including the coefficients for this control variable, are shown in Table 2.

$$\begin{aligned} \text{Level 1: } & \text{Frequency} = \beta_0 + \beta_1 \text{ time} + \beta_2 \text{ time}^2 + \beta_c \text{ Duration} + u \\ \text{Level 2: } & \beta_0 \sim \text{period} + \text{condition} + \text{period} \times \text{condition} \\ & \beta_1 \sim \text{period} + \text{condition} + \text{period} \times \text{condition} \\ & \beta_2 \sim \text{period} + \text{condition} + \text{period} \times \text{condition} \end{aligned} \quad (1)$$

We found significant effects of time,  $B = -1.92$ ,  $p < 0.001$ , and  $\text{time}^2$ ,  $B = 0.40$ ,  $p < 0.001$ , indicating that the change in frequency over time was non-linear. After removing the effects that failed to reach significance (following Bryk & Raudenbush, 1992), we refitted the model. The results from the post-hoc model are also shown in Table 2. In the post-hoc model, as expected, frequency declined across time,  $B = -2.00$ ,  $p < 0.001$ , and the rate of decline slowed as time progressed,  $B = 0.38$ ,  $p < 0.001$ . Also consistent with prediction (though we recognize the difficulties with predicting a null effect), the main or interactive effects of condition assignment did not influence this pattern of change, indicating that the change over time did not differ for those initially assigned to suppress vs. monitor. However, thinking period did influence the change pattern. Specifically, during the first minute of Period 1, frequency was higher than during the first minute of Period 2,  $B = -1.38$ ,  $p < 0.001$ , and frequency during Period 1 declined faster than in Period 2,  $B = 0.36$ ,  $p < 0.001$ . These patterns of change are presented in Fig. 1, with lines representing the model’s predicted values and points representing observed group means.

#### 3.3. Duration

Similar to the analysis for frequency, an HLM (Eq. (2)) was used to examine how *duration* changed across time, and whether condition assignment and thinking period influenced its change pattern. As with frequency, the Level 1 regression analysis used time and its

<sup>2</sup>We also ran the model in which participants’ age was included in Level 2 to test whether age influences the change pattern of thought recurrence. We did not find any significant main or interactive age effects. Thus, given age is not the focus of this study, we did not include age in the analyses reported here. For full details of these additional analyses, please contact the second author.

quadratic term as predictors, and the Level 2 regression analysis used thinking period, condition assignment, and their interaction as predictors. In this model, we controlled for the effect of frequency. The coefficients estimating results are shown in Table 3.

$$\begin{aligned}
 \text{Level 1: } & \text{Duration} = \beta_0 + \beta_1 \text{ time} + \beta_2 \text{ time}^2 + \beta_c \text{ Frequency} + u \\
 \text{Level 2: } & \beta_0 \sim \text{period} + \text{condition} + \text{period} \times \text{condition} \\
 & \beta_1 \sim \text{period} + \text{condition} + \text{period} \times \text{condition} \\
 & \beta_2 \sim \text{period} + \text{condition} + \text{period} \times \text{condition}
 \end{aligned} \tag{2}$$

A significant effect of time was found,  $B=4.46$ ,  $p=0.033$ , indicating that duration changed across time; however, there was no significant effect of curvature,  $B=-0.87$ ,  $p=0.177$ , suggesting that duration changed in a linear fashion. After removing effects that failed to reach significance and refitting the model, the results presented in Table 3 were obtained. Overall, duration increased in a linear fashion across time,  $B=1.80$ ,  $p=0.005$ . As predicted, thinking period ( $b=-1.87$ ,  $p=0.018$ ) and its interaction with condition assignment ( $B=2.71$ ,  $p=0.015$ ) significantly influenced this pattern. Specifically, during the first minute, the group assigned to monitor during Period 1 did not differ from the group assigned to suppress,  $B=-1.84$ ,  $p=0.293$ . However, for the slope across Period 1, the group assigned to monitor increased their duration as time elapsed,  $B=1.80$ , whereas those assigned to suppress did not change,  $B=1.80-1.54=0.26$ . In Period 2, the pattern was reversed, such that those assigned to suppress experienced increased durations as time progressed,  $B=1.80-1.87-1.54+2.71=1.10$ , whereas those assigned to monitor did not change,  $B=1.80-1.87=-0.07$ . This reversal in Period 2 is consistent with our predictions, representing a classic rebound effect, which is graphically represented in Fig. 2. Here again, the lines represent the models' predicted values, and the points represent the group means.

#### 4. Discussion

This study examined how the frequency and duration of thought return, when conceptualized as reflecting relatively more automatic and controlled processing respectively, demonstrate changes in thought recurrences over the course of time. Examining change across time yielded valuable information that would have been overlooked had frequency and duration been examined in aggregate.<sup>3</sup> For frequency, the first minute of each thinking period was critical; recurrence during this period started high but quickly habituated in a non-linear fashion such that the subsequent second, third, and fourth minutes were typified by low *frequency* of recurrence and little change. This pattern did not vary based on thought instruction assignment, and there was no rebound effect. In other words, the same basic pattern played out during both thinking periods – albeit, frequency in the second period did not start out as high as it did in the first and did not decline as quickly. For duration, recurrence changed linearly across the two thinking periods and thought instruction assignment determined recurrence patterns. During thinking Period 1, those initially assigned to suppress were better able to limit the duration of thought recurrences relative to those initially assigned to monitor, and the monitoring group experienced gradually increasing durations of thought recurrence. During thinking Period 2, this pattern reversed, revealing a rebound effect. Those initially assigned to suppress

<sup>3</sup>Duration data were also examined by aggregating the four time points of duration in period 1 and the four time points of duration in period 2. We then conducted a repeated measured ANOVA to test the effects of thinking period and condition assignment. Main effects of thinking period ( $F(1, 86)=1.14$ ,  $p=0.288$ ,  $\eta^2 p=0.013$ ) and condition assignment ( $F(1, 86)=0.59$ ,  $p=0.445$ ,  $\eta^2 p=0.007$ ) were not significant, but the interaction between thinking period and condition assignment was significant ( $F(1, 86)=6.09$ ,  $p=0.016$ ,  $\eta^2 p=0.066$ ). Follow-up analyses indicated that, in period 1, those initially assigned to suppress experienced longer thought durations than those initially assigned to monitor ( $t(86)=2.17$ ,  $p=0.033$ ,  $\eta^2 p=0.052$ ), but in period 2, no significant differences were observed between the two instruction conditions ( $t(86)=-0.87$ ,  $p=0.338$ ,  $\eta^2 p=0.009$ ).



experienced escalating durations of recurrences, whereas those initially assigned to monitor experienced short durations of recurrences that remained stable across the second thinking period.

These findings are mostly consistent with our hypotheses. For frequency, both the similarity in recurrence patterns during Periods 1 and 2 and the absence of a rebound effect support the idea that the frequency of thought recurrence is more a product of automatic than controlled processing. According to our logic, had controlled processing played a more prominent role, we would have expected a rebound effect in Period 2 for those initially assigned to suppress. The habituation in frequency observed following the first minute of each thinking period is also consistent with more automatic processing, whereby initial activation dissipates over time if it is not specifically reactivated. In contrast, the period by condition assignment cross-over interaction observed for duration displays a classic rebound effect, consistent with the idea that duration may be driven more by controlled than automatic processes. During the first thinking period, duration of thought recurrence remained relatively brief and stable for those assigned to active suppression. However, in Period 2, when these participants were not actively attempting suppression, duration of thought return increased linearly. Opposite patterns were observed for those assigned to monitor their thoughts during the first thinking period. This rebound effect can be plausibly interpreted as evidence of the role of controlled processing because it was observed only for those who presumably engaged in the resource depleting activity of suppression.

While we did not observe a rebound effect for frequency, many studies have detected such an effect (see Abramowitz et al., 2001 or Magee et al., 2012). This raises an important interpretive issue as to why these studies found a rebound effect for frequency if it is, as we posit, a reflection of more automatic processing. While the present data do not afford an answer to this question, one consideration is that past studies tended to use frequency as their only metric of recurrence. In this situation, it is very possible that frequency and duration were confounded, such that participants repeatedly indicated a thought's presence during the entire time it was present in their consciousness. If this is the case, one could speculate that a thought of long duration would be recorded as many frequent intrusions. This could lead to what would appear to be a rebound effect in frequency.

Another consideration is that neither frequency nor duration is process pure. In other words, while frequency may be the result of relatively more automatic processing and duration the result of relatively more controlled processing, controlled processing may still nonetheless influence frequency and automatic processing may still influence duration. When semantic activation or priming is presented long enough or explicitly enough for conscious awareness, both automatic and controlled processes are typically active (see Neely, 1991 for a review). Further, recent research examining event-related potentials in semantic priming paradigms challenge the traditional notion (Posner & Snyder, 1975) that non-conscious, automatic spreading activation is elicited autonomously and proceeds without the influence of attentional control (Hill, Strube, Roesch-Ely, & Weisbrod, 2002; Kiefer & Brendel, 2006). Thus, the extent to which frequency reflects some controlled processing and duration reflects some automatic processing may vary based on a variety of individual difference and contextual factors. These include thought content (e.g., valence, personal relevance), motivation, length of thinking period, and the specificity of suppression vs. monitor instructions, to name a few.

#### **4.1. Methodological and clinical implications**

These results have important implications for thought suppression research methodology. If frequency of return is the primary variable of conceptual interest, our results suggest that the first 60 s of Periods 1 and 2 are of primary importance. After the first 60 s, researchers

should be aware that they are likely observing habituation in frequency; therefore, time-sequence analyses are advisable. Further, thought frequency may be best thought of as the degree of thought activation driven by mostly automatic processing. If duration of thought return is the primary variable of conceptual interest, our results suggest that longer thinking periods are advisable because the divergent trajectories of those initially assigned to suppress and those initially assigned to monitor evolved slowly over the course of the 4-minute periods. Moreover, the differences in these change patterns from Period 1 to Period 2, in the form of a rebound effect, suggest that thought duration may be best thought of as an indicator of control based on ease of disengagement (an individual's ability to alter or halt processing once the thought is activated).

These results also carry important clinical implications. Using duration as a measure of ease of disengagement from a thought may help to better understand the role of thought suppression in psychopathology like OCD. Little work has directly examined duration of thought return or conceptualized it as ease of disengagement, and, to our knowledge, none has done so using the classic thought suppression paradigm. Purdon, Gifford, McCabe & Antony (2011) did examine ease of disengagement (which they referred to as *dismissability*) in a thought replacement task comparing dismissability of obsessional thoughts in OCD to panic-relevant thoughts in panic disorder (PD). They found that the OCD group experienced more disorder-relevant target thoughts and appraised them more negatively than the PD group; however, contrary to Purdon et al.'s speculations, there were no effects for group involving thought dismissability. Interestingly, lower levels of controlled processing have been documented for both OCD and PD (Bannon, Gonsalvez, Croft, & Boyce, 2006; Hovland et al., 2012), possibly explaining why Purdon et al. failed to find differences in dismissability between the two groups. Our results would suggest that comparing a sample with OCD to either a healthy sample or an alternate clinical sample without the same controlled processing deficits would more likely yield group differences in dismissability.

Our separation of frequency and duration also may aid understanding of differences in thinking patterns across different clinical conditions. For example, because deficits in effortful processing are often noted in depression (Hasher & Zacks, 1979), a condition like depression might be associated with minimal effort put into disengaging from the thought, rendering duration as a key indicator. In contrast, in a condition like OCD, which is often characterized by strong, immediate control attempts, both frequency and duration would likely be important.

#### 4.2. Limitations and future directions

One important limitation was the absence of a suitable cognitive processing measure. While a test of neuropsychological executive functioning deficits in cognitive set shifting was included (the Trail-Making subtests 2 and 4 from the Delis-Kaplan Executive Function System; Delis et al., 2001), we did not have measures of executive function that are particularly relevant to thought suppression, such as sustained attention, working memory, or goal maintenance. However, given that all participants were relatively high functioning as indexed by their MMSE scores, neuropsychological deficits would not be expected in this sample. Future research employing measures of executive function that are sensitive to individual variability within healthy populations and relevant to thought suppression outcomes, such as an Operation Span test of working memory (Brewin & Beaton, 2002; Brewin & Smart, 2005), could provide additional evidence in support of the idea that frequency references more automatic processing and duration more controlled processing. Another interesting way that future research could address this issue is through manipulation of cognitive resources via dual-task performance costs or suppression instructions under cognitive load. Finally, because this was a reanalysis of Magee and Teachman's original

data, which used an extreme groups design to address aging specific questions, the sample was unusual with respect to age. While age did not seem to dramatically affect the patterns observed in the present study (see Footnote 2), future research employing a continuous lifespan sample will be useful.

## 5. Conclusions

Using a thought suppression paradigm that assessed both frequency and duration of thought return across time, the results were consistent with the expectation that frequency of thought return may be a reflection of more unintentional, automatic processing, while duration of thought return may reflect more controlled processing. The findings further suggest that if frequency of thought return is the primary variable of interest, 60 s thinking periods are sufficient to observe recurrence effects; however, if duration of thought return is the primary variable of interest, longer thinking periods (in this case, 4 min) are necessary to observe the complete pattern.

Obsessional thoughts are a primary component of OCD, and cognitive theories of OCD link the frequent return of obsessional thoughts with thought suppression attempts (Salkovskis, & Campbell, 1994). Variations of the thought suppression paradigm have typically relied only on frequency of thought return as a metric of thought suppression failure (see Magee et al., 2012). The present analyses suggest that thought duration may be equally important, particularly if one is interested in *ease of disengagement* from intrusive thoughts. Indeed, Purdon (2004) notes that phenomenological reports of OCD often focus on subjective feelings of inadequate control over intrusive thoughts. In this light, examining duration of thought return, which may better tap controllability, and doing so across a sufficiently long time period, may yield valuable insight into when and for whom attempted thought suppression may contribute to obsessional thinking.

## Acknowledgments

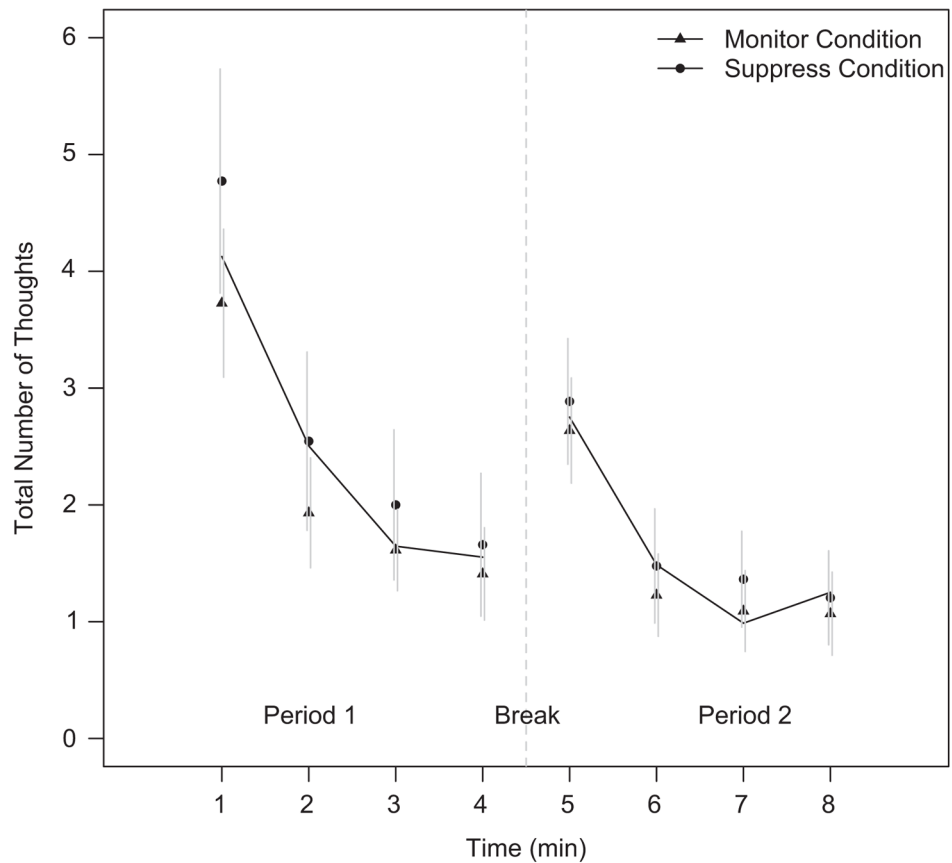
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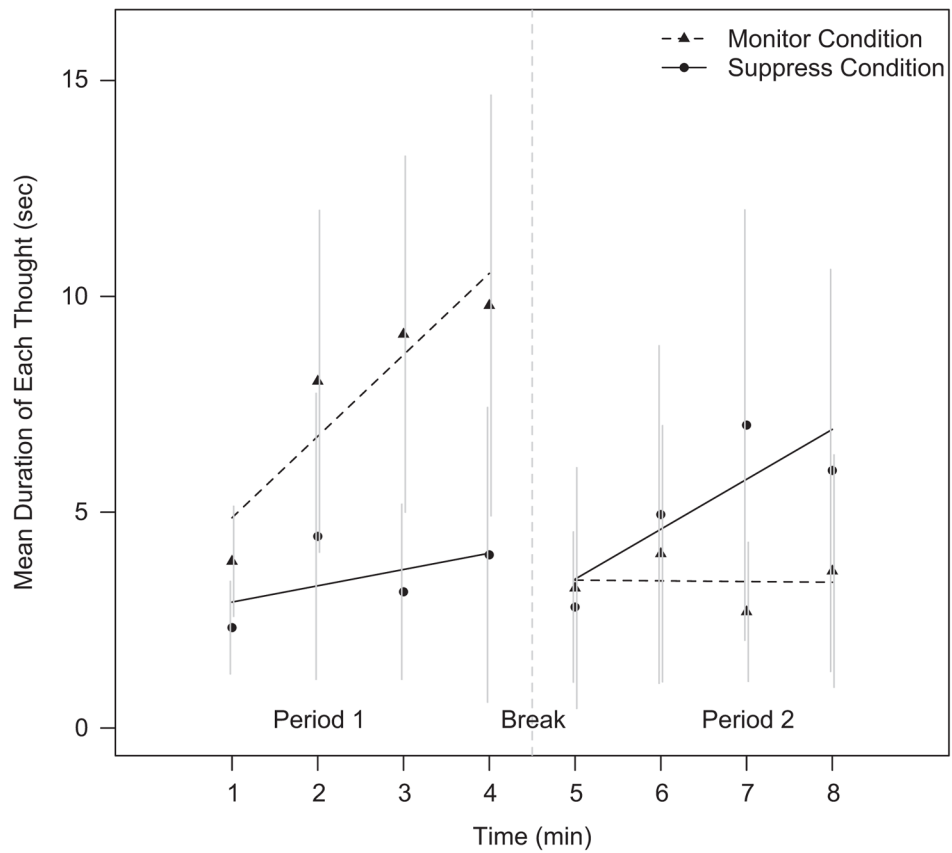
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**Fig. 1.** Change in frequency across time in suppress and monitor conditions. *Note:* The triangle and circle data points represent group means for frequency at every minute for each condition, the vertical gray lines depict the group means' 95% confidence interval, and the black lines represent the model predicted frequency. Given condition has no significant effect on frequency, monitor and suppress conditions share the same predicted line.



**Fig. 2.** Change in duration across time in suppress and monitor conditions. *Note:* The triangle and circle data points represent group means for duration at every minute for each condition, the vertical gray lines depict the group means' 95% confidence interval, and the black lines represent the model predicted duration, separated by condition.

**Table 1**

Descriptive statistics for sample demographics and cognitive functioning by condition assignment.

	Condition assignment					
	Suppression ( <i>n</i> =43)		Monitoring ( <i>n</i> =45)		Total ( <i>N</i> =88)	
	<i>M or n</i>	<i>SD or %</i>	<i>M or n</i>	<i>SD or %</i>	<i>M or n</i>	<i>SD or %</i>
Age	46.29	26.81	48.02	26.32	47.18	26.42
Gender (Female)	22	52%	28	62%	50	58%
Race						
Caucasian	33	77%	33	73%	66	76%
African-American	5	12%	5	11%	10	12%
Asian	2	5%	3	7%	5	6%
Other	2	5%	4	9%	6	7%
MMSE	28.58	2.00	29.11	1.11	28.85	1.62

*Note:* There were no significant condition assignment group differences in any of the listed variables. MMSE=Mini-Mental Status Exam. One adult in the suppression instruction group did not report gender or race. The percentages for races do not sum to 100% in the suppression and total columns due to rounding.



Table 2

Multilevel regression of frequency on time, thinking period and condition assignment.

Model	Level 1 parameter	Level 2 parameter	Estimate	S.E.	t	
Saturated model	1st min ( $\beta_0$ )	Intercept	3.657**	0.306	11.963	
		Period	-1.080**	0.257	-4.203	
	Slope ( $\beta_1$ )	Condition	1.040*	0.431	2.412	
		Period $\times$ condition	-0.799*	0.364	-2.198	
	Curvature ( $\beta_2$ )	Intercept	-1.923**	0.305	-6.304	
		Period	0.399	0.414	0.964	
		Condition	-0.481	0.430	-1.119	
	Post-Hoc model	1st min ( $\beta_0$ )	Period $\times$ condition	0.550	0.585	0.940
			Intercept	0.398**	0.094	4.215
		Slope ( $\beta_1$ )	Period	-0.052	0.132	-0.391
Condition			0.074	0.133	0.551	
Curvature ( $\beta_2$ )		Period $\times$ condition	-0.107	0.187	-0.575	
		Intercept	0.00	0.01	0.17	
Control ( $\beta_c$ )		1st min ( $\beta_0$ )	Intercept	4.129**	0.213	19.370
			Period	-1.375**	0.156	-8.798
		Slope ( $\beta_1$ )	Intercept	-2.003**	0.164	-12.201
			Period	0.358**	0.836	4.278
	Curvature ( $\beta_2$ )	Intercept	0.382**	0.048	7.979	
		Intercept	-0.001	0.005	-0.114	

Note: For variable *period*, 0=1st period, 1=2nd period. For variable *condition*, 0=monitor condition, 1=suppress condition.\*  $p < 0.05$ .\*\*  $p < 0.001$ .

Table 3

Multilevel regression of duration on time, thinking period and condition assignment.

Model	Level 1 parameter	Level 2 parameter	Estimate	S.E.	t
Saturated model	1st min ( $\beta_0$ )	Intercept	4.101**	1.558	2.632
		Period	-0.563	1.729	-0.326
	Slope ( $\beta_1$ )	Condition	-1.362	1.880	-0.724
		Period $\times$ condition	0.556	2.427	0.229
	Curvature ( $\beta_2$ )	Intercept	4.459*	2.091	2.133
		Period	-4.631	2.750	-1.684
		Condition	-3.209	2.894	-1.109
		Period $\times$ condition	6.890	3.889	1.772
		Intercept	-0.865	0.640	-1.351
		Period	0.912	0.878	1.038
Post-Hoc model	1st min ( $\beta_0$ )	Condition	0.564	0.896	0.629
		Period $\times$ condition	-1.401	1.242	-1.128
	Slope ( $\beta_1$ )	Intercept	-0.029	0.227	-0.128
		Intercept	5.257**	1.422	3.697
	Control ( $\beta_3$ )	Period	-1.567	1.495	-1.048
		Condition	-1.839	1.748	-1.052
		Period $\times$ condition	1.894	2.096	0.904
		Intercept	1.801**	0.638	2.825
		Period	-1.875*	0.792	-2.367
		Condition	-1.540	0.875	-1.761
Control ( $\beta_3$ )	Period $\times$ condition	2.709*	1.119	2.422	
	Intercept	-0.118	0.220	-0.536	

Note: For variable *period*, 0=1<sup>st</sup> period, 1=2<sup>nd</sup> period. For variable *condition*, 0=monitor condition, 1=suppress condition.

\*  $p < 0.05$ .

\*\*  $p < 0.001$ .