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Abstract

The ironic effect of thought suppression refers to the phenomenon in which individuals trying to rid their mind of a target thought ironically experience greater levels of occurrence and accessibility of the thought compared to individuals that deliberately concentrate on the thought (Wegner, 1994). Ironic effects occurring *after* thought suppression, also known as rebound effects, have been consistently detected by previous meta-analyses. However, ironic effects that occur *during* thought suppression, also known as immediate enhancement effects, have been found to be largely absent. In the current meta-analysis, we test Wegner's original proposition that detection of immediate enhancement effects is dependent on the cognitive load experienced by individuals when enacting thought suppression. Given that thought suppression is an effortful cognitive process, it is proposed that the introduction of additional cognitive load would compete for the allocation of existing cognitive resources and impair capacity for thought suppression. Studies (k = 31) consistent with Wegner's original thought suppression paradigm were analysed. Consistent with our predictions, rebound effects were observed regardless of cognitive load while immediate enhancement effects were only observed in the presence of cognitive load. Implications are discussed in light of ironic process theory and suggestions for future thought suppression research provided.

Keywords: thought suppression, ironic effect, immediate enhancement effect, rebound effect, cognitive load

Ironic Effects of Thought Suppression: A Meta-Analysis

People regularly experience unwanted intrusive thoughts (Rachman & de Silva, 1978). Such thought intrusions can interfere with attention and executive functioning, and impair performance on everyday tasks (Posner & Snyder, 1975). Intrusive thoughts can also compromise attempts to break habits like drinking or overeating (e.g., Erskine & Georgiou, 2010), manage social prejudices (Macrae, Bodenhausen, Milne, & Jetten, 1994), or cope with negative emotions like anger (Quartana & Burns, 2007). As a consequence, the ability to effectively manage unwanted thoughts is adaptive and can promote task performance and behavioral regulation. Thought suppression is an effective mental control strategy that can be used to control unwanted thoughts (Najmi, Riemann, & Wegner, 2009). Thought suppression may be useful for minimizing the interference of intrusive thoughts and can assist in promoting task performance and effective behavioral regulation.

However, evidence stemming from Wegner's (1994) ironic process theory suggests that there are occasions where individuals engaged in suppressing an undesirable thought do not merely fail to do so, but, ironically, find themselves thinking of the very thought that they are trying to avoid (Wegner, 2009). Thus, for example, dieters trying to avoid thinking of processed foods may ironically find themselves thinking of processed foods, which may instigate food cravings, and smokers trying to quit smoking and suppress thoughts of having a cigarette may find themselves thinking of cigarettes, which may activate a desire to smoke. In essence, thought suppression is a fundamental constituent of human cognition (Wegner, 1994), and its success and failure has implications on a wide range of broad life domains, such as emotion regulation (Beevers & Meyer, 2008), memory (Macrae, Bodenhausen, Milne, & Ford, 1997), self-control (Hagger, Wood, Stiff, & Chatzisarantis, 2010), and rumination (Erber & Wegner, 1996).

Wegner (1994) coined the term 'ironic effect' to describe the uncontrollable preoccupation with a 'to-be-supressed' thought that individuals experience during and after thought suppression. In experimental studies, the ironic effect *during* thought suppression, also known as the 'immediate enhancement effect', is confirmed when participants instructed to suppress a target thought[1] exhibit higher levels of accessibility or occurrence of that thought than individuals who are instructed to concentrate on the same thought. The effect is labelled 'ironic' because the goal of thought suppression is to reduce target thought occurrence and accessibility, yet those engaged in suppression experience higher levels of target thought occurrence and accessibility compared to those actually concentrating on the thought itself. Interestingly, such ironic effects manifest not only in thought suppression, but in a variety of other mental control endeavours. For example, studies have suggested that individuals trying to fall asleep as quickly as possible ironically fall asleep more slowly than individuals trying to stay awake (Ansfield, Wegner, & Bowser, 1996). Furthermore, individuals trying to resist persuasion by product advertisements ironically report greater beliefs in the effectiveness of the advertised product compared to individuals trying to believe in its effectiveness (Houston & Wegner, 1993). In research on stereotyping, exposing individuals to positive stereotypes toward social groups (e.g., African Americans are superior athletes) resulted, ironically, in increased application of prejudicial beliefs and negative stereotypes (e.g., beliefs in biological underpinnings of athleticism); Kay, Day, Zanna, & Nussbaum, 2013).

While ironic effects during mental control appear to be a pervasive phenomenon across multiple life domains (Wegner, 1994), previous research in the thought suppression domain have failed to support such ironic phenomena. In fact, previous syntheses have revealed opposite effects to those predicted by Wegner's (1994) ironic process theory. Specifically, two meta-analyses found that thought suppression reduces, rather than increases, the occurrence and accessibility of target thoughts during thought suppression relative to concentration (Abramowitz, Tolin, & Street, 2001; Magee, Harden, & Teachman, 2012). However, we contend that these analyses provide misleading estimates of thought suppression and the immediate enhancement effect because the meta-analytic estimates

[1]In the present article, we used the terms 'to-be-suppressed thought' and 'target thought' interchangeably. This is because the control group is instructed to concentrate on, rather than suppress, a thought. Since 'to-be-suppressed thought' only pertains to the suppression group, it was more appropriate at times to use the more generic term 'target thought'.

were derived from samples of studies that did not satisfy specific theoretical preconditions, which, according to Wegner (1994), give rise to the immediate enhancement effect. Specifically, we contend that, like ironic effects of mental control more broadly, valid tests of the immediate enhancement effect of thought suppression should be conducted under conditions of cognitive load. In the present article, we report an updated meta-analysis of articles that provide valid tests of Wegner's (1994) ironic process theory. Specifically, we present evidence supporting the immediate enhancement effect when thought suppression experiments conform to the conditions specified by Wegner (1994). Our analysis will demonstrate the importance of cognitive load in inducing the immediate enhancement effect, and offer guidance to researchers on effective means to test and detect immediate enhancement effects in thought suppression experiments.

Ironic Process Theory: Mechanisms and Boundary Conditions

According to ironic process theory, the immediate enhancement effect is the result of two cognitive processes working in synergy to produce mental control (Wegner, 1994). The first process is governed by an *intentional* system - a conscious, effortful process that is inefficient because it requires considerable allocation of cognitive resources for effective operation (Wegner, 2009). The main function of the intentional process is to search and generate 'self-distracting' thoughts, or distractors, that are semantically unrelated to the target thought individuals are trying to suppress. For example, a dieter may actively search for unrelated thoughts such as future holiday plans, and concentrate on the unrelated thoughts in order to avoid thinking of palatable foods. The second process is a monitoring system. Unlike the intentional process, the monitoring system is an unintentional, non-conscious processes that requires minimal cognitive resources to operate and is relatively fast and efficient (Bargh, 1994; Wegner, 2009). This process is responsible for the immediate enhancement effect because during thought suppression operations, the monitoring system continuously and automatically searches for the to-be-suppressed thought (Wegner, Erber, & Zanakos, 1993). For example, attempts to suppress 'sad thoughts' may be subverted during thought suppression by the monitoring system that is hypersensitive to, and automatically searching for, sad thoughts (Wegner et al., 1993).

In addition to the immediate enhancement effect, ironic process theory (Wegner, 1994) has been influential in explaining the ironic phenomenon *after* thought suppression operations, also known as the 'rebound' effect (Wegner, 2009; Wegner, Shortt, Blake, & Page, 1990; Wenzlaff, Wegner, & Roper, 1988). The rebound effect is characterized by the higher levels of post-suppression resurgence and accessibility of the target thought experienced by individuals engaged in thought suppression relative to individuals who did not suppress the target thought in the first place. In laboratory settings, the rebound effect is tested by prompting participants assigned to the thought suppression and concentration groups to concentrate on the same target thought in the post-suppression period. A rebound effect is confirmed if participants in the thought suppression condition report higher occurrence and accessibility of the target thought in this period than participants in the concentration condition. It is important to note that thought preoccupation, the dependent variable of interest in thought suppression experiments, has typically been inferred through either (a) self-reports of thought occurrence, such as having individuals record each occurrence with a dash and tallying the total (e.g., Wang, Chatzisarantis, & Hagger, 2017), or (b) implicit measures of thought accessibility using timed tasks such as the sentence unscrambling task where the proportion of target thought-related vs. target thought-unrelated sentences unscrambled reflects levels of accessibility of the target thought (e.g., Beevers & Meyer, 2008). The rebound effect occurs because directing attention to distractors during thought suppression leads to the formation of cognitive associations between the unwanted thought and the distractors (Wegner, Schneider, Carter, & White, 1987). These associations facilitate activation of the target thought during the subsequent concentration period through a 'negative cueing' mechanism (Wegner et al., 1987; Wenzlaff et al., 1988). For example, individuals suppressing the thought of a 'white bear' may direct their attention to objects in their surroundings such as a computer, which becomes implicitly labelled as a 'white bear-unrelated thought'. During the subsequent concentration period, the computer may act as a reminder cue that activates thoughts of the white bear, thereby increasing its occurrence and accessibility.

In introducing ironic process theory, Wegner (1994) suggested that one of the central variables that determines the immediate enhancement effect is the availability of mental resources. From this perspective, thought suppression is likely to be successful when individuals have adequate mental resources to search for distracting thoughts (Muraven, Tice, & Baumeister, 1998; Wegner, 2009). The reason for this is that when individuals have sufficient mental resources, the intentional system operates effectively and 'populates' the stream of consciousness with thoughts unrelated to the target thought – a process known as 'self-distraction'. This increased level of attentional engagement prevents individuals' attention from straying and encountering target-related thoughts, and hence minimizes the monitoring system's opportunities of detecting these thoughts (Wenzlaff & Wegner, 2000). However, when mental capacity is reduced by the imposition of cognitive load during suppression such as stress, time pressure, a concurrent task, or any source of external distraction that diverts individuals' attention from the suppression task (Wegner, 2009), suppressors are likely to experience an immediate enhancement effect (Slepian, Oikawa, & Smyth, 2014). This is because the process underpinning the intentional search for distractors is effortful and dependent on mental resources (Mitchell et al., 2007). Since cognitive load partially occupies a portion of an individual's mental resources, the capacity of their intentional system to generate distractors is impeded. Given the effortless nature of the monitoring system, the increased sensitivity to target-related thoughts and the undermined intentional system, individuals are more likely to encounter target-related thoughts in their stream of consciousness, leading to an immediate enhancement effect. The centrality of cognitive load as a boundary condition in self-distraction failures and hence immediate enhancement effects has been supported by experimental evidence. For example, Wegner and Erber (1992) demonstrated that while suppressors experienced lower levels of target thought preoccupation compared to concentrators under no cognitive load, suppressors ironically experienced greater levels of target thought preoccupation compared to concentrators when cognitive load was imposed.

It is important to note that although the manifestation of the immediate enhancement effect depends on the presence of cognitive load, according to ironic process theory, the rebound effect should manifest regardless of cognitive load. The reason for this is that in the absence of cognitive load, individuals can find distractors without difficulty. A rebound effect is, therefore, likely to be observed due to the negative cueing mechanism mentioned earlier, that is, cognitive associations formed between distractors and the target thought (Wegner et al., 1987). Under conditions of cognitive load on the other hand, the increased difficulties and subsequent failures that individuals encounter in searching for distractors can temporarily exacerbate accessibility of the target thought. Increased accessibility of the target thought in turn facilitates the rebound effect because, by definition, individuals are more sensitive to accessible than less accessible thoughts (Bargh, 1994).

Limitations of Previous Meta-Analytic Findings

To date, a considerable number of studies have examined ironic effects of thought suppression during and after thought suppression periods (e.g., Denzler, Forster, Liberman, & Rozenman, 2010; Guiliano & Wicha, 2010; Slepian et al., 2014). While meta-analytic research has consistently observed the rebound effect after thought suppression, they have not always provided unequivocal support for the immediate enhancement effect during suppression (Abramowitz et al., 2001; Magee et al., 2012). The lack of support for the immediate enhancement effect cannot be attributed to methodological differences across studies because variations in methodological factors, such as target thought emotional valence, have been corrected for in previous meta-analyses (Abramowitz et al., 2001; Magee et al., 2012). However, a limitation of previous meta-analyses is that they did not systematically test the immediate enhancement effect in the presence and absence of cognitive load separately (Abramowitz et al., 2001; Magee et al., 2012). This may explain why previous meta-analytic data failed to find support for the immediate enhancement effect – cognitive load is a precondition that facilitates emergence of the effect during thought suppression according to ironic process theory (Wenzlaff & Wegner, 2000). As such, results of previous primary and meta-analytic research that excludes cognitive load as a precondition may lead researchers to incorrectly reject the immediate enhancement effect of thought suppression. Analogously, a number of studies have observed immediate enhancement effects under conditions of cognitive load (Slepian et al., 2014; Wegner & Erber, 1992; Wegner et al., 1993). In order to resolve the inconsistency in previous thought suppression research, we conducted a meta-analysis re-examining the immediate enhancement effect in studies in which participants were prompted to suppress thoughts under cognitive load. The analysis will provide a ‘good faith’ test of the immediate enhancement effect consistent with ironic process theory (Wegner, 1994).

Overview and Hypotheses

The primary purpose of the present meta-analysis was to re-examine whether research testing ironic effects during and after thought suppression yielded findings consistent with Wegner’s (1994) ironic process theory. Specifically, we synthesized immediate enhancement and rebound effects in research on thought suppression in the presence and absence of cognitive load during thought suppression. We predicted that the immediate enhancement effect would be observed among studies in which cognitive load was present, while the effect would be no different from zero, or negative, when cognitive load was not induced. We reasoned that the immediate enhancement effect would only be evident when the effectiveness of the intentional system in searching for distractors is compromised, as Wegner (1994) suggested, and therefore expected that the immediate enhancement effect would only be observed in studies that tested thought suppression under cognitive load. The reason for this is that cognitive load impedes the effectiveness of the resource-dependent intentional system in finding distractors. In contrast, we predicted that the rebound effect would be observed regardless of whether cognitive load was imposed, consistent with previous research. This is because rebound effects do not rely on availability of mental capacity and the corresponding effectiveness of the intentional system in finding distractors.

Method

Search Strategy

A systematic literature search was performed of four electronic databases (PsycINFO, PubMed, Medline and ERIC) as well as ProQuest dissertations and theses from their inception to December 2018. This search targeted English language experimental studies and dissertations involving thought suppression and some measure of target thought occurrence or accessibility during or after thought suppression. In addition, the reference lists of two previous thought suppression meta-analyses (Abramowitz et al., 2001; Magee et al., 2012) were searched for eligible studies. We also contacted key authors for any unpublished thought suppression studies. To facilitate a comprehensive search, a broad search string ("thought suppression" AND "distract" OR "intrusion" OR "rebound") was used for all database searches.

Eligibility Criteria

Studies had to satisfy a series of criteria for inclusion in the present analysis. First, only experimental studies with at least one thought suppression (excluding focused-distraction[2]) condition were considered. This meant that cross-sectional studies that examined correlations between thought suppression habits and frequencies of thought occurrence were not included (e.g., Malinowski, 2017). Second, studies needed to have a valid quantitative dependent measure of thought occurrence or accessibility either during or after suppression. This includes explicit measures such as participants' tallies of their target thought occurrence (e.g., Magee & Zinbarg, 2007), and implicit

[2]Unlike standard thought suppression instructions in which participants are simply asked not to think about a target thought, focused-distraction instructions require participants to focus on a single predetermined distractor thought in order not to think about a target thought. This method was originally introduced in an attempt to elucidate the mental processes underlying self-distraction and ironic effects, rather than to elicit ironic effects (Wegner et al., 1987). In fact, focused-distraction is fundamentally different from standard thought suppression because it seeks to mitigate ironic effects by shifting suppressors' 'thought avoidance' mentality into a 'thought approach' mentality (Wegner, 1994). This makes focused-distraction arguably more similar to concentration in nature, rather than suppression. Given that the present study is concerned with detecting ironic effects rather than making comparisons between suppression and focused-distraction, only thought suppression studies adopting this design were included.

measures of target thought accessibility such as word association tasks that sought to capture participants' sensitivity to the target thought (e.g., Wegner & Erber, 1992).

Finally, a key methodological issue in thought suppression research, and one that is particularly relevant to synthesizing thought suppression effects across studies, is choosing the appropriate control condition (Wenzlaff & Wegner, 2000). Many experiments include multiple control conditions against which suppression of the unwanted target thought is compared (e.g., Erskine, 2008; Litvin, Kovacs, Hayes, & Brandon, 2012). The pre-eminent control condition in thought suppression experiments is a concentration control condition in which participants are asked to concentrate on the target thought (Wegner, 1994). However, an alternative control condition used in some thought suppression experiments involves asking participants to simply think about anything freely; a 'free thought' control (e.g., Gillie, Vasey, & Thayer, 2015). Both suppression and concentration are different from 'free thought' in that they are effortful processes that involve a goal state and an undesired state (Wegner, 1994). This means that it is possible, especially under conditions of cognitive load, for both suppression and concentration processes to fail, and, ironically, yield thought occurrences opposite to that of the individual's goal, hence the term 'ironic' effects (Wegner, 2009). Studies have shown that under cognitive load, ironic effects result from the contrast between increased target thought preoccupation among suppressors and decreased target thought preoccupation among concentrators (Wegner & Erber, 1992; Wegner et al, 1993). Given that 'free thought' is not vulnerable to failures or ironic effects, and that the focus of the present study is to precisely test ironic effects, only studies that utilized an expression control condition in which participants were asked to deliberately focus on a target thought were included. The search strategy and process of identifying eligible studies are presented in Appendix A (Supplemental Materials). The search and selection process yielded 31 studies with 83 unique effect sizes eligible for inclusion.

Data Extraction and Effect Conceptualizations

Some studies provided information for more than one comparison, for example, comparisons between suppression and control groups for both an anxious sample and a non-clinical sample (Magee & Zinbarg, 2007). Effect sizes from these comparisons were included as separate samples where data were available. Methods used to induce cognitive load during thought suppression included tasks in which participants were asked to concurrently engage in a word association task under time pressure (Wegner & Erber, 1992, Experiment 1), memorize a number string (Magee & Zinbarg, 2007; Slepian et al., 2014; Wegner & Erber, 1992, Experiment 2), or tolerate pain (Cioffi & Holloway, 1993). Cognitive load, when present, was only induced during, not after, thought suppression.

We encountered two barriers to data extraction. First, some studies measured accessibility or occurrence of target thoughts using more than one type of dependent measure. For example, Giuliano and Wicha (2010) asked participants to suppress a target thought and used both self-reported target thought occurrence and electrophysiological responses associated with target thought occurrences as dependent measures. In these cases, we calculated effect sizes from direct measures of thought occurrences, such as self-reports of target thought occurrences, rather than data from indirect measures, such as electrophysiological measures used to infer target thought occurrences. Second, in cases where critical data were not reported, such as failure to report effect size data or the sample sizes separately for the suppression and control conditions, we contacted the authors to check whether these data were available. In cases where effect size data were unavailable and the authors could not be contacted, the study was omitted (see Appendix B, Supplemental Materials). In cases where effect size data were available, but data on sample size for each experimental group were unavailable after contacting authors or the authors could not be contacted, equal sample size across conditions was assumed and noted (see Appendix C, Supplemental Materials).

It is important to note that depending on their specific research question, researchers have typically conducted thought suppression experiments using between-participants, within-participants, or cross-over study designs. Between-participants studies refer to studies in which suppression and expression participants have been separated into independent groups and tested using a paradigm involving an initial period (suppression instructions vs expression instructions) followed by a rebound period (both conditions receive expression instructions) (e.g., Tong, Ang, & Chua, 2013). Within-participant studies, on the other hand, only examine one group of participants using a baseline, suppression and rebound phase (e.g., Rutledge, Hancock, & Rutledge, 1996). Cross-over studies refer to studies where both groups of participants have been asked to engage in suppression and expression periods, but in reverse order, resulting in an initial suppression group and an initial expression group (e.g., Bourdon, McKelvie, & Stout, 2001). For between-participant studies, immediate enhancement and rebound effects were conceptualized as the difference between the two groups during the suppression and the rebound periods respectively. For cross-over studies, the same conceptualization was adopted for the immediate enhancement effect while the rebound effect was conceptualized as the difference in the outcome measure during the expression period for the initial suppression group and the initial expression group (Bourdon et al., 2001). For within-participant studies, the immediate enhancement effect was conceptualized as the difference between suppression period outcomes and baseline period outcomes, while the rebound effect was conceptualized as the difference between the rebound period outcomes and baseline period outcomes (Rutledge et al., 1996). A schematic representation of the three study designs and how immediate enhancement and rebound effects are conceptualized is presented in Figure 1.

---Insert Figure 1 here---

Meta-Analytic Strategy[3]

Effect size computation. Cohen's *d* was used as the effect size metric (Hunter & Schmidt, 2004). Our preferred method of computing effect sizes involved subtracting the concentration group mean from the suppression group mean, and dividing this difference by the pooled standard

[3]Data files, analysis scripts and output files are available online at: https://osf.io/eqmwt/?view_only=6e0ad20c2a5c48b296e61d37079a5fba

deviation (SD). This required the means, *SD*s, and sample sizes for each condition. In cases where this information was not available, effect sizes were calculated using *t*- or *F*-values using appropriate formulae (Ray & Shadish, 1996). Furthermore, studies adopting within-participant designs require the correlation between the pre- and post-experimental measures to calculate the effect size. Attempts were made to obtain these values from authors. In cases where these data were unavailable, we used a conservative estimate of the pre-post correlation (r = .50; Borenstein, Hedges, Higgins, & Rothstein, 2009). Finally, we were unable to obtain sufficient data to compute effect sizes from the authors of several studies. In these cases, we consulted data from a previous meta-analysis where available (Abramowitz et al., 2001).

In the context of the present meta-analysis, a positive effect size is indicative of an immediate enhancement or rebound effect as it indicates higher target thought occurrence or accessibility in the suppression group compared to the concentration group. A negative or null effect size, on the other hand, supports the absence of immediate enhancement or rebound effect as it indicates that the suppression group performed more successfully than, or no different from, the control group in reducing target thought occurrence or accessibility.

Meta-analytic method. We computed the overall weighted mean effect size (d^+) and variability estimates of the immediate enhancement and rebound effects across studies using the metafor package (Viechtbauer, 2010) in R using a random effects model and the restricted maximum likelihood estimator (Raudenbush, 2009; Viechtbauer, 2005). A random effects model was assumed because effect sizes likely come from different populations of studies, and the assumption of a single overarching population mean effect size, as assumed by a fixed effects model, does not fit the historical records of thought suppression studies, which often yield inconsistent findings (Abramowitz et al., 2001; Magee et al., 2012). The restricted maximum likelihood estimator has demonstrated low bias and high precision, particularly in variance estimates, in simulation studies with continuous data (Veroniki et al., 2015).[4]

We also computed the 95% confidence intervals (CI) about the mean effect size. In addition, we calculated a number of heterogeneity statistics, which allowed us to determine the variability in effect sizes across the pool of studies remaining after controlling for sampling error. These estimates are informative of the extent to which bias correction accounts for the observed variability in the effect sizes across studies, and whether the effect size is likely subject to extraneous moderator variables. Cochrane's (1952) Q and I^2 values provide an indication of the extent to which observed variability in the effect sizes can be attributed to true heterogeneity rather than sampling error. Values of less than 25%, between 25% and 50%, and greater than 50% for the I^2 correspond to small, medium, and high levels of heterogeneity, respectively (Higgins & Thompson, 2002). Finally, τ^2 is presented as an estimate of between-study variance.

To address our primary research question that the immediate enhancement effect would only be observed under cognitive load, we computed bias-corrected effect size estimates in groups of studies that incorporated some form of cognitive load and those that did not, and compared the averaged effect sizes using the confidence interval of the difference in effect size estimates. A confidence interval about the difference in effect sizes that does not include zero would provide confirmation that the effect size estimates differed across the load and no load groups, verified by a formal significance test (Schenker & Gentleman, 2001). If, however, no moderation effect is detected, the overall effect size will be interpreted, as suggested by Aiken and West (1991).

Small study bias. Computed effect sizes in meta-analyses are sometimes subject to small study bias. A primary source of such bias is publication bias, which is the result of publication outlets tending to prioritize publication of underpowered studies reporting statistically significant, and often disproportionally large, effects. Means to estimate small study bias are based on 'funnel' plots, which

[4]Fixed-effect estimates are provided for comparison

plot the effect size from each study against a precision estimate, usually the standard error of the effect size. For groups of studies without bias, the plot should resemble a distinct ‘funnel’ shape. A formal test is provided by regressing the precision estimate on the effect size estimate, which also provides a corrected estimate of the effect size in the absence of bias (Egger, Smith, Schneider, & Minder, 1997). We provided two variations of the regression test for small study bias in our analyses, the precision effect test (PET) and the precision effect estimate with standard error (PEESE). The estimates were computed using the PETPEESE function in R (Carter, Schönbrodt, Hilgard, & Gervais, 2017). Corrected effect size estimates based on the PET and PEESE analyses for each effect size were computed, with corresponding *t*-tests for the presence of bias and significance tests of bias corrected effect sizes from zero. These analyses are based on fixed effects estimates, and simulation studies suggest that when the average bias-corrected effect size from PET is not statistically significant (i.e., when the estimate is not distinguishable from zero), the PET estimate should be taken, and when the average bias-corrected effect size from PET is statistically significant, the PEESE estimate should be taken (Stanley & Doucouliagos, 2014).

Results

Preliminary Analyses

We identified six studies with bias-corrected effect sizes for the immediate enhancement or rebound effect that were beyond three standard deviations from the averaged effect size. These outliers were not excluded as sensitivity analyses confirmed that their exclusion made no substantive difference to the averaged effect size and variability estimates. The 31 studies included in the present meta-analysis were published between 1987 and 2015. In total, these yielded 83 unique effect sizes that captured the suppression group’s target thought occurrence or accessibility relative to that of the expression group during the thought suppression (k = 42; n = 1892) and the rebound period (k = 41; n = 1636) respectively.

Main Analysis

Results of the meta-analysis are presented in Table 1. Consistent with Wegner's (1994) theory and our predictions, results supported the hypothesis that cognitive load is a precondition for the manifestation of immediate enhancement effects. This is because while the overall immediate enhancement effect size was negative and statistically significant (d^+ = -1.10, 95% CI [-1.53, -0.67]), subsequent analyses of studies with and without cognitive load yielded different effect sizes. Specifically, our analysis of studies without cognitive load yielded a statistically significant negative effect size (d^+ = -1.38, 95% CI [-1.84, -0.93]), with confidence intervals that did not encompass zero. In contrast, our analysis of studies incorporating cognitive load yielded a significant positive effect size (d^+ = 0.34, 95% CI [0.07, 0.61]), with confidence intervals that did not encompass zero. Critically, confidence intervals about the difference in the effect sizes in groups of studies with and without cognitive load did not include zero (d_{diff}^+ = 1.73, 95% CI [1.19, 2.26], t = 6.35, p < .001). Taken together, these findings indicate that participants in suppression conditions experienced fewer target thought occurrences or lower accessibility during the suppression task compared to participants in expression control conditions when cognitive load was absent. When cognitive load was imposed however, participants in suppression conditions not only failed to suppress the target thought, but, ironically, experienced greater levels of occurrence and accessibility of the thought during the suppression task compared to participants in expression control conditions. Results also supported our prediction for the rebound effect. Specifically, a significant overall rebound effect was observed (d^+ = 0.19, 95% CI [0.02, 0.35]) with overlapping confidence intervals for studies with (d^+ = 0.08, 95% CI [-0.75, 0.90]) and without (d^+ = 0.19, 95% CI [0.02, 0.36]) cognitive load (d_{diff}^+ = -0.12, 95% CI [-0.95, 0.72], t = -0.27, p = .789). Given that cognitive load does not seem to significantly moderate rebound effects, the overall rebound effect was interpreted (Aiken & West, 1991). We conclude that participants who previously suppressed a target thought generally experienced greater levels of target thought occurrence or accessibility during the rebound period compared to those who previously concentrated on the same thought.

The moderation effect of cognitive load on immediate enhancement effects was also corroborated by heterogeneity statistics, presented in Table 1. These show that categorising studies based on the presence of cognitive load seem to reduce the observed heterogeneity in effect sizes across studies to a trivial level. However, given the different numbers of studies in the cognitive load and no cognitive load categories, it remains unclear whether the heterogeneity statistics were biased or a reflection of true homogeneity.

Small Study Bias

As results from the main meta-analysis and PET analyses indicated non-zero effects, the PEESE estimate was taken as an estimate for the effect of small study bias on effect sizes (Stanley & Doucouliagos, 2014). Results suggest that significant small study bias is present for both immediate enhancement and rebound effects. While the bias-corrected PEESE estimate did not reveal a different pattern of results with respect to the direction and significance of the immediate enhancement effect, the same cannot be said for the rebound effect. Specifically, the bias corrected PEESE estimate for the rebound effect was not significantly different from zero. One possibility for this difference is that PET-PEESE tests assumes a fixed effects model, rather than a random effects model on which the main meta-analysis was based. Furthermore, Carter et al. (2017) suggested that the precision of PEESE estimates can be attenuated under conditions of high heterogeneity in the effect size, and therefore does not provide conclusive evidence for the presence of bias.

---Insert Table 1 here---

Discussion

Control over unwanted thoughts through suppression is an important human function that may lead to adaptive outcomes in multiple domains, such as inhibiting stereotypical judgements (Galinsky & Moskowitz, 2007), smoking cessation (Erskine, Georgiou, & Kvavilashvili, 2010), dieting (Erskine & Georgiou, 2010), and psychological well-being in general (Wenzlaff & Wegner, 2000). However, theory and research has suggested that the act of thought suppression may be counterproductive as a means to control thoughts (e.g., Slepian et al, 2014; Wegner 1994). Studies have demonstrated ‘ironic’ effects of thought suppression in which active avoidance of a target thought leads to greater preoccupation with that thought compared to deliberately concentrating on the same thought, both during and after thought suppression (Cioffi & Holloway, 1993). While meta-analytic research has supported the ‘rebound’ effect after thought suppression, there has not been concomitant support for the ‘immediate enhancement’ effect during suppression (Abramowitz et al., 2001; Magee et al., 2012). However, according to Wegner (1994), a necessary precondition to observe the immediate enhancement effect is the presence of sufficient cognitive load, which limits individuals’ capacity to generate and focus on distractors in order to suppress the unwanted thought. Previous meta-analyses either did not test the immediate enhancement effect under conditions of cognitive load (Abramowitz et al., 2001), or did not provide separate immediate enhancement effect sizes in the presence and absence of this critical moderator (Magee et al., 2012). Both analyses also concluded that the overall immediate enhancement effect size was in the opposite direction to that predicted by Wegner (1994), suggesting an absence of the effect. In the current meta-analysis, we tested whether previous research supports the immediate enhancement effect by accounting for cognitive load during thought suppression. Specifically, we systematically examined the role of cognitive load in facilitating immediate enhancement effects by including cognitive load as a moderator variable in an updated meta-analysis of research on ironic effects in thought suppression.

Findings show that when cognitive load was not accounted for, the immediate enhancement effect was absent, a result consistent with previous meta-analytic findings, which led researchers to conclude that the immediate enhancement effect does not exist (e.g., Abramowitz et al., 2001; Magee et al., 2012; Purdon, Rowa, & Antony, 2005). However, our meta-analysis identified an immediate enhancement effect among studies that imposed cognitive load during suppression, consistent with our predictions and the original proposals of Wegner (1994). We also found a small but significant rebound effect that is not moderated by presence of cognitive load. As such, while rebound effects appear to be consistent across studies, previous meta-analytic findings indicating that the immediate enhancement effect is absent are misleading as they do not account for cognitive load during suppression. Our analysis is the first to identify the importance of cognitive load as a precondition in producing the immediate enhancement effect.

The present findings have clear theoretical implications for thought suppression. Consistent with Wegner's (1994) reasoning, the absence of an immediate enhancement effect in conditions of no cognitive load indicates that when the intentional system is not burdened by cognitive load, thought suppression is usually effective. However, the immediate enhancement effect observed under cognitive load suggests that when the intentional system is pre-occupied, individuals suppressing a thought not only fail, but ironically experience greater frequency of occurrence and accessibility of the unwanted thought. As Wegner predicted, cognitive load appears to be a catalyst for intentional system failure and therefore a precondition for the manifestation of immediate enhancement effects. Our study is the first to confirm this prediction of Wegner's theory in a synthesis of findings across studies and confirm the role of the intentional system in thought suppression and its vulnerability to impedance when processes compete for mental resources.

The lack of a moderation effect of cognitive load on rebound effects also supports theoretical predictions. While the immediate enhancement effect can be attributed to failure of the intentional system, rebound effects are conceptualized to be the result of the negative cueing mechanism (Wegner, 1994; Wegner et al., 1987). Our findings suggest that intentional system failure is only implicated in immediate enhancement effects but not rebound effects, giving support to the notion that the two effects are driven by different mechanisms. However, an important caveat to these conclusions is that the estimate of effect size for the rebound effect under cognitive load was based on a very small sample of studies (k =3) with significant heterogeneity. The effect size should not, therefore, be considered highly reliable. In summary, our findings are the first to provide confirmation of both the immediate enhancement effect and rebound effect across thought suppression experiments.

Interestingly, based on studies that demonstrated an immediate enhancement effect under cognitive load (Cioffi & Holloway, 1993; Slepian et al., 2014; Wegner & Erber, 1992; Wegner et al., 1993), we speculate that the nature of the dependent measure of thought suppression may moderate thought suppression effects. This is because one feature that studies demonstrating the immediate enhancement effect under cognitive load have in common is their employment of non-self-report dependent measures. For example, rather than asking participants to recall how many times the target thought crossed their mind (Wang, Chatzisarantis, & Hagger, 2018), these studies mostly used implicit measures of target thought accessibility such as through Stroop reaction times (Slepian et al., 2014)[5]. On the other hand, the only study that did not demonstrate the immediate enhancement effect under cognitive load adopted a self-report measure of target thought occurrences (Magee & Zinbarg, 2007). These observations are consistent with Wegner's (2009) theory which suggests that, in addition to the pre-requisite of cognitive load, reliable detection of immediate enhancement effects may be contingent on using "measures of thought that are sensitive to automatic, uncontrollable indications of the thought" (Wegner, 2009, p. 48). Our speculation is supported by previous theoretical suggestions that self-report measures may be less conducive to detecting immediate enhancement effects as participants may be motivated to under-report their target thought occurrences during suppression to reflect conformity to task instructions (Abramowitz et al., 2001; Purdon & Clark, 2000; Purdon & Clark, 2001). Non-self-report measures of thought suppression may not be subject to such bias, and may be more conducive to tapping into the automatic, uncontrolled, and impulsive nature of intrusive thoughts, as Wegner (2009) suggests. Type of measure may be another important moderator of immediate enhancement effects alongside cognitive

[5]It is important to note is that in his comprehensive review, Wegner (1994) mentioned a few additional unpublished experiments (e.g., Wegner, Erber, & Bowman, 1993) that supported the immediate enhancement effect under cognitive load. However, we were unable to obtain sufficient data from these experiments for effect size calculations and therefore do not make any predictions on the effect that these experiments may have on the present results were they included in the meta-analysis.

load. Future studies should, therefore, systematically explore the moderating effect of dependent variable measure (i.e., self-report vs non-self-report) on thought suppression under cognitive load.

The present meta-analytic findings have important implications for researchers in the field of thought suppression. Given the crucial role of cognitive load in engendering immediate enhancement effects, researchers aiming to test immediate enhancement effects should incorporate cognitive load into their study designs for a fair and valid test of Wegner's (1994) predictions. In addition, researchers tasked with judging the quality of thought suppression studies should take the findings of the present study into consideration. Specifically, studies that do not impose cognitive load should not be considered valid tests of the immediate enhancement effects. Tests of the rebound effect should not be subject to such restrictions.

At the applied level, the findings of the present meta-analysis suggest that the value of thought suppression as a mental control strategy is contingent on the criteria used to evaluate its effectiveness. In the short term, thought suppression appears to be adaptive if individuals are unburdened by cognitive load, but maladaptive and counterproductive if cognitive load is present. In the long term, thought suppression appears, overall, to be maladaptive as a means for controlling unwanted thoughts as individuals engaging in suppression tend to experience an exacerbated level of preoccupation with the once-suppressed target thought to those that do not engage in suppression in the first place. However, given the relatively small effect size of the rebound effect, it could be argued that the insidious effects of thought suppression may be overstated (Najmi et al., 2009). This is especially noteworthy since studies have generally only measured rebound effects over periods equal in duration to the thought suppression period (Magee et al., 2012). It is, therefore, unclear how long rebound effects persist beyond the first 10 minutes post-suppression. Future researchers are therefore encouraged to investigate the longevity of the post-suppression rebound effect.

It is important to note that while thought suppression is relevant to many of the tasks and behaviors that people experience in their everyday lives, findings in this domain have been criticized for their lack of generalizability. For example, thought suppression endeavors in naturalistic contexts are mostly spontaneous and self-initiated, while experimental manipulations of thought suppression are usually externally prompted (Wenzlaff & Wegner, 2000). It is therefore possible that the immediate enhancement effects observed in laboratory experiments are inflated by reactance – individuals' tendency to act in a way that is opposite to how they have been instructed (Brehm, 1966). As such, to increase generalizability of findings to natural settings, future thought suppression studies should seek to utilize more ecologically-valid protocols. In a similar vein, no studies to date have examined the influence of cognitive load on the immediate enhancement effect using thought suppression paradigms lasting longer than 10 minutes or repeated across multiple episodes. It is not, therefore, known whether cognitive load is an equally important boundary condition for detecting the immediate enhancement effect in long term thought suppression endeavors. Interestingly, Wegner (1994) has speculated that the effortful intentional system may become more automated and hence less resource demanding over time. If this is the case, then thought suppression in the long term, should, in principle, be less vulnerable to the diverting of mental resources by cognitive load. As such, to further delineate the specific conditions under which cognitive load would engender the immediate enhancement effect, future studies are encouraged to utilize lengthier thought suppression protocols.

Application of analyses designed to detect small study bias indicated the presence of bias, mostly concerning the robustness of the rebound effect, which, even in previous meta-analyses (Abramowitz et al., 2001; Magee et al., 2012), was shown to be small in size. Specifically, it seems that correction for bias raises questions over the true magnitude and even the existence of the effect. This has also been demonstrated in high profile cases in which meta-analytic estimates were found to be subject to substantive bias using these techniques (Carter, Kofler, Forster & McCullough, 2015; Hagger & Chatzisarantis, 2014). There are, however, important caveats to these analyses, and it would be unwise to draw definitive conclusions as to the existence of the effect based on the present findings alone. First, small study bias tests provide statistical predictions and do not confirm the actual presence or magnitude of small study bias (Borenstein et al., 2009). Second, recent research has highlighted limitations of the PET-PEESE technique in correcting for bias in groups of studies with moderate levels of heterogeneity or greater (Stanley, 2017). As such, large-sample, high-powered single and multilab preregistered replication studies are encouraged to resolve this issue. Such research may confirm the significance and magnitude of the rebound effect. Similarly, given the small number of studies incorporating cognitive load in tests of the immediate enhancement phenomenon, large-scale pre-registered studies adopting factorial designs to test independent and interactive effects of suppression and cognitive load on the manifestation of immediate enhancement effects should be considered a priority for future research.

Limitations and Future Directions

While the present analysis contributes to the existing thought suppression literature by identifying the importance of cognitive load in detecting the immediate enhancement effect, some limitations should be noted. First, while some of the studies manipulated cognitive load as a within- or between-participants effect (Wegner & Erber, 1992), most cognitive load inductions were part of the overall paradigm and did not include a manipulation (Magee & Zinbarg, 2007; Slepian et al., 2014). As a consequence, the current analysis compared sets of studies that tested the rebound and immediate enhancement effects under cognitive load with those that did not. We did not, therefore, test the effect of manipulating cognitive load on thought suppression. This should be acknowledged as a limitation of the current analysis, and there is a need for further studies that systematically manipulate the presence of cognitive load and examine their effects on thought suppression, both during and after suppression.

Second, the small number of studies that incorporated cognitive load also precluded evaluation of meaningful moderators of the immediate enhancement effect in studies incorporating cognitive load. Other methodological parameters might be expected to mitigate or augment the effects of cognitive load on immediate enhancement effects, such as sample characteristics, target thought characteristics, and cognitive load characteristics. For example, type of cognitive load may be a key moderator of the immediate enhancement effect – some load tasks may engage individuals' cognitive resources more extensively that others, particularly those required for attention to, and suppression of, the target thought. It is important to note that means to manipulate cognitive load varied across studies (e.g., pain tolerance tasks, word association tasks under time pressure, memorization tasks). The disparate nature of these tasks and the relatively small number of studies that included cognitive load precluded moderator analyses testing the effects of these different types of cognitive load task on the immediate enhancement effect. As the literature matures, future analyses should seek to test the type or degree of cognitive load as a moderator of the immediate enhancement effect. Nevertheless, evidence stemming from previous primary and meta-analytic studies have documented some methodological parameters to moderate the effect of thought suppression (Abramowitz et al., 2001; Purdon & Clark, 2001). For example, occurrence and accessibility of the target thought during thought suppression are suggested to increase when these dependent measures are recorded in an implicit manner, or when the suppression task is longer in duration. Importantly, if factors other than cognitive load moderate effects of thought suppression in conditions of no cognitive load then it is plausible that they will also exert the same moderation effect in conditions of cognitive load, ultimately affecting the manifestation of the immediate enhancement effect.

An additional limitation is the interpretation of rebound effect sizes from cross-over studies. Specifically, rebound effect sizes from cross-over studies are calculated by comparing target thought occurrences or accessibility between the expression periods in both the 'initial suppression' group and the 'initial expression' group. While this method of effect size extraction was chosen in accordance with the original conceptualization of the rebound effect in Wegner et al.'s (1987) study, this comparison has been considered problematic because instruction type is confounded by the number of thinking periods in which participants are required to engage (Clark, Ball, & Pape, 1991). For example, when the expression period takes place in the first five minutes of the experiment in one group but in the second five minutes in a second group, one cannot be certain that the between-group difference in target thought occurrences is the result of the rebound effect rather than fatigue. As such, rebound effect sizes from cross-over studies should be interpreted with caution. Immediate enhancement effect sizes from cross-over studies on the other hand, do not suffer from the same problem since the first thinking period from both the suppression condition and expression condition are compared.

A final limitation of the current analysis is that the included studies did not directly confirm activation of the intentional system during cognitive load, which is the purported mechanism for the moderating effect of cognitive load on the immediate enhancement effect. Rather, implicating the intentional system as an explanation for the effect is inferred indirectly through the manipulation of cognitive load. Although neuroimaging studies have identified brain regions responsible for thought suppression (Butler & James, 2010; Noreen, O'Connor, & MacLeod, 2016; Wyland, Kelley, Macrae, Gordon, & Heatherton, 2003), none have specifically examined the neurological correlates of intentional system activation and effects of cognitive load during thought suppression. Future research should adopt neuroimaging methods to explore the role of the intentional system as the mechanism by which cognitive load moderates the immediate enhancement effect.

Conclusion

Given the inconsistencies between Wegner's (1994) ironic process theory and previous meta-analytic findings (Abramowitz et al., 2001; Magee et al., 2012) on the presence of the immediate enhancement effect, the present meta-analysis sought to bridge this gap by offering a 'good faith' test of this ironic effect. We believed that previous meta-analytic findings suggesting an absence of the immediate enhancement effect are misleading (Abramowitz et al., 2001; Magee et al., 2012) because they had not taken into account cognitive load, which, according to Wegner (1994), is an essential precondition to observing the immediate enhancement effect. Converging with Wegner's (1994) predictions, and those of our own, our findings indicate that individuals consistently experience higher levels of target thought preoccupation *after* suppressing the target thought when compared to individuals that concentrate on the target thought. Ironic increases in unwanted thought preoccupation *during* suppression, on the other hand, emerged only under cognitive load. This finding suggests a pivotal role for the intentional system in the search for distractors during attempts to avoid unwanted thoughts, and the detrimental effects of diverting mental resources away from this resource dependent process. Future researchers should consider cognitive load as a precondition for the emergence and detection of the immediate enhancement effect. Finally, tests of small study bias seem to indicate potential bias in the rebound effect across studies. These data suggest that large-scale multilab pre-registered replication attempts using standardised protocols are needed to confirm the robustness and magnitude of the rebound phenomenon.

In summary, current theory and empirical evidence suggests that while thought suppression may be an effective mental control strategy when individuals devote their undivided attention to suppressing a particular thought, ironies during thought suppression (Wegner, 1994) will emerge if this attention is divided. Specifically, when intentional search of distractors is burdened by cognitive load, individuals will be more preoccupied with, and vulnerable to, forbidden thoughts during an active period of thought suppression than if they actually concentrated on the same thought.

Author contributions: D. Wang and N. L. D. Chatzisarantis conceived the study concept. D. Wang performed the literature search and study coding. Analyses were performed by D. Wang and M. S. Hagger. D. Wang drafted the manuscript. N. L. D. Chatzisarantis and M. S. Hagger provided critical revisions. All authors approved the final version of the manuscript for submission.

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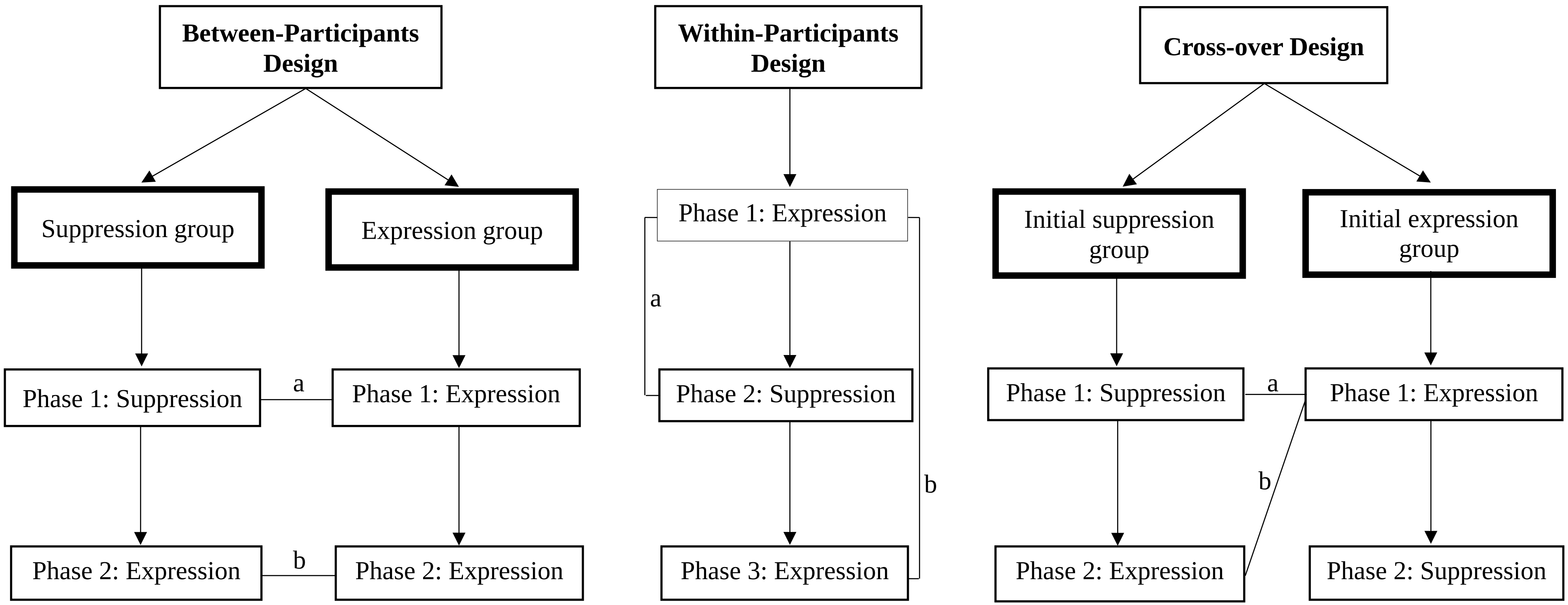


Figure 1. Study designs used in thought suppression experiments. Immediate enhancement effects are conceptualized as the difference in target thought occurrences or accessibility between groups/phases marked *a* in the figure. Rebound effects are conceptualized as the difference in target thought occurrences or accessibility between groups/phases marked *b* in the figure

Table 1

Results of Meta-Analysis Testing Ironic Process Theory and Corresponding Bias Statistics

Effect	*k*	N	Fixed d^+	d^+CI$_{95}$		Random d^+	d^+ CI$_{95}$		*Q*	I^2	T^2	Bias statistics		
				LL	*UL*		*LL*	*UL*				d^+PET	d^+PEESE	*p*-BIAS
Immediate enhancement effect (overall)	42	1892	-1.10***	-1.53	-0.67	-1.10***	-1.53	-0.67	445.97***	96%	1.82	-0.261***	-0.391***	< .001
Immediate enhancement effect (no cognitive load)	35	1537	-0.80***	-0.89	-0.72	-1.38***	-1.84	-0.93	335.28***	96%	1.72	-0.315***	-0.528***	< .001
Immediate enhancement effect (cognitive load)	7	355	0.35**	0.14	0.56	0.34*	0.07	0.61	10.86	32%	0.04	0.641	0.523**	.366
Rebound effect (overall)	41	1636	0.19*	0.02	0.35	0.19*	0.02	0.35	112.57***	72%	0.16	-0.183**	-0.068	< .001
Rebound effect (no cognitive load)	38	1555	0.03	-0.04	0.10	0.19*	0.02	0.36	105.19***	73%	0.16	-0.198**	-0.080	< .001
Rebound effect (cognitive load)	3	81	0.22	-0.23	0.67	0.08	-0.75	0.90	6.71*	68%	0.36	3.527**	1.919**	.011

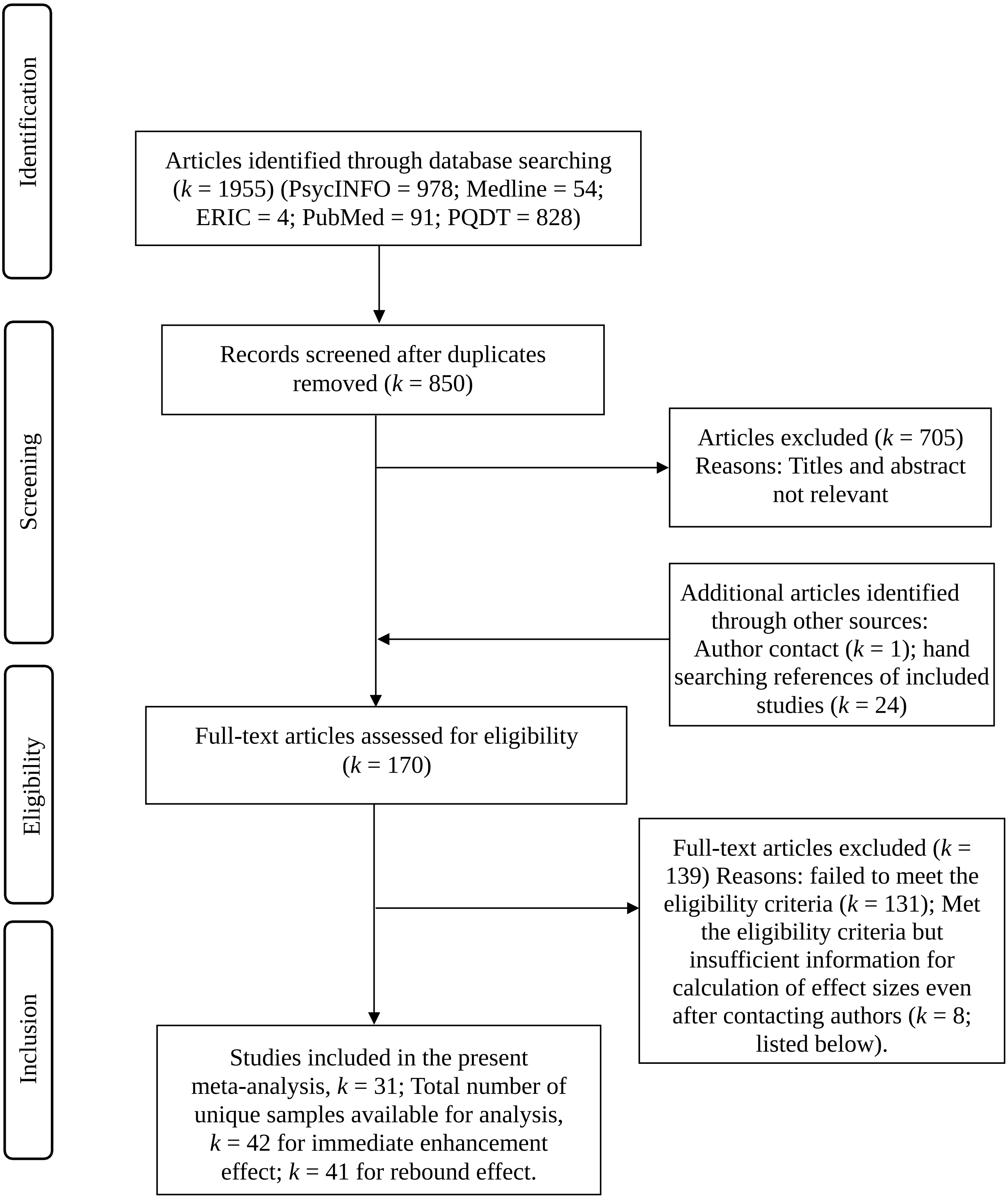
Note. *k* = number of unique effect sizes in meta-analysis; N = total sample size in meta-analysis; d^+ = weighted standardized difference effect size; CI$_{95}$ = 95% confidence interval; *LL* = Lower limit of confidence interval; *UL* = Upper limit of confidence interval; Fixed = fixed effect model; Random = random effects model; *Q* = Cochran's (1952) *Q* Statistic; I^2 = Higgins and Thompson's (2002) I^2 statistic; T^2= Absolute heterogeneity statistic; d^+PET = Bias corrected effect size estimate using the precision-effect estimate technique; d^+PEESE = Bias corrected effect size estimate using the precision-effect estimate with standard error technique; *p*-BIAS = Probability value for effect of precision estimate on effect size in regression analysis.

* $p < .05$ ** $p < .01$ *** $p < .001$

Supplemental Materials

Appendix A

PRISMA Flow Diagram for Study Search and Inclusion Strategy



Appendix B

List of Eligible Studies Not Included in the Present Meta-Analysis Due to Insufficient Information for the Calculation of an Effect Size

Cook, D. A. (1995). *Confronting and subduing the beast within: The struggle for the cognitive control of prejudice and the effects of suppressing racist thoughts* (Unpublished doctoral dissertation). University of Arkansas, Fayetteville.

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Appendix C

Characteristics and Effect Sizes of Studies Included in the Present Meta-Analysis

Study	Sample type	N	Study design	Cognitive load	DV recording method	Suppression duration[a]	IE	R
Andersson et al. (2006)	TIN	30	B	No	SR	5	-1.03	-0.39
Bates (2006)[bc]	NC	38	B	No	SR	5	-1.62	0.81
Behar et al. (2005)	NC	16	B	No	SR	5	-3.39	0.63
	NC	20	B	No	SR	5	-2.23	-0.44
	NC	17	B	No	SR	5	-5.25	0.48
	NC	18	B	No	SR	5	-2.65	-0.10
Blechman (2002)[c]	OCD	48	C	No	SR	5	0.01	-0.07
Bourdon et al. (2001)	NC	20	C	No	SR	5	-1.22	-0.57
	NC	18	C	No	SR	5	-1.77	0.64
Cioffi & Holloway (1993)[b]	NC	42	B	Yes	NSR	-	0.81	0.80
Erskine (2008)	NC	87	B	No	SR	5	-1.95	-0.12
Galinsky & Moskowitz (2007)[a]	NC	18	B	No	SR	5		1.17

Gilhooly et al. (2015)	NC	126	B	No	SR	3	-1.36	
Giuliano & Wicha (2010)	NC	20	B	No	SR	2	-1.57	0.64
Guinote (2007)	NC	39	C	No	SR	5	-0.99	1.05
	NC	45	C	No	SR	5	-0.71	0.47
Hedt (2005)[c]	PTSD	32	B	No	SR	10	-2.06	-0.04
Lowery (2002)[c]	OCD	31	B	No	SR	5	-2.55	-0.97
	NC	30	B	No	SR	5	-4.74	0.06
Magee & Zinbarg (2007)	ANX	19	B	Yes	SR	5	-0.28	-0.27
	NC	20	B	Yes	SR	5	-0.65	-0.47
Matthews & Milroy (1994)	ANX	20	B	No	SR	5		-0.32
	NC	20	B	No	SR	5		0.16
Merckelbach et al. (1991)	NC	29	C	No	NSR	5	0.99	0.75
Muris et al. (1998)	NC	49	B	No	SR	-	0.52	0.65
	SP	35	B	No	SR	-	-0.56	-0.02
Raffield (1998) [c]	NC	56	W	No	SR	5	-1.37	0.11
Rassin et al. (2005)	NC	40	B	No	SR	5	-1.48	
Roemer (1995) [c]	ANX	30	B	No	SR[c]	5	-1.85	0.37

	NC	30	B	No	SR[c]	5	-3.28	-0.99
Roemer & Borkovec (1994)	NC	30	C	No	SR	5	-0.94	-0.35
	NC	30	C	No	SR	5	-4.68	0.68
	NC	30	C	No	SR	5	-1.73	0.86
Rutledge et al. (1996)	NC	134	W	No	SR	9	-0.51	-0.13
	NC	144	W	No	SR	9	-0.53	-0.12
Rutledge (1998)	NC	109	W	No	SR	9	-0.83	-0.19
Rutledge et al. (1993)[b]	NC	22	C	No	SR	5	-1.45	-0.55
	NC	21	W	No	SR	5	-0.88	-0.19
Slepian et al. (2014)[b]	NC	96	B	Yes	NSR	5	0.45	
	NC	99	B	Yes	NSR	5	0.20	
Tong et al. (2013)	NC	42	B	No	NSR	-		0.94
	NC	66	B	No	NSR	-		0.60
Trinder & Salkovskis (1994)	NC	32	B	No	SR	4 days	1.67	
Wegner & Erber (1992)	NC	56	B	Yes	NSR	-	0.54	
	NC	23	B	Yes	NSR	-	0.76	
Wegner & Gold (1995)	NC	49	B	No	SR	8		0.78

Wegner et al. (1987)	NC	34	C	No	SR	5		-0.55	0.57
Wegner et al. (1991)	NC	47	B	No	SR	5		.53	.76

Note. Cells without values indicate that this information did not have a fixed value, usually due to individual differences in time taken to finish task. We did not report mean age statistics above because this information was usually only provided for entire experiments, rather than groups used in each comparison listed above. All comparisons that incorporated cognitive load utilised the number memory task as the cognitive load, except Wegner & Erber (1992; Exp1) and Cioffi & Holloway (1993), in which time pressure and a pain tolerance task served as the cognitive load respectively. [a]Duration in minutes; [b]Studies for which participant splits could not be obtained (or that they include missing values) and therefore it was assumed that the experimental and non-suppression control groups had equal sample sizes (or the missing value was assumed to be distributed evenly amongst conditions of relevance; [c]Unpublished study. NC = Non-clinical sample (usually of students); OCD = Participants with Obsessive-Compulsive Disorder symptoms; PTSD = Participants with Post-Traumatic Stress Disorder symptoms; SP = Participants with Specific Phobia symptoms; ANX = Participants with other anxiety symptoms such social anxiety and generalised anxiety*;* B = Studies adopting a between-participants design; W = Studies adopting a within-participants design; C = Studies adopting crossover design; DV = Dependent variable; SR = Self-report/overt/explicit; NSR = Non-self-report/covert/implicit; IE = immediate enhancement effect size (*d*); R = rebound effect size (*d*).