The role of monitoring in the activation of mental concepts.

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ABSTRACT

Four experiments are reported to address the theory that monitoring for a target word increases activation of that target. Previous research has found some evidence for this proposition, but has been compromised by demand characteristics. To avoid this, the present study depended upon the weak demand characteristics of the lexical decision task and the expectancy effect. It was found that priming due to monitoring in the lexical decision task was (1) not affected by stimulus onset asynchrony; (2) could be voluntarily increased by participants, and (3) was reduced by mental load. Additionally, it was found that (4) instructions not to prime were effective until mental load was introduced.

Wegner's theory of ironic processes holds that the process of monitoring could be responsible for the difficulty some people report with the suppression of unwanted thoughts. His theory was supported in that monitoring for target words activated those words but the automaticity of that process was brought into question by evidence for some strategic control.

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INTRODUCTION

The purpose of this thesis is to investigate the role of monitoring processes in the activation of mental concepts. Wegner (1994) has suggested that the very act of monitoring for a given object may activate its mental representation, making it more accessible or more likely to enter consciousness. For example, if I monitor my thoughts to see if I am thinking about a cat, this direction of attention may in and of itself activate my representation of a cat. Monitoring is ubiquitous and has already received a lot of study: the present study examines the contention that the activation of target thoughts by monitoring could be a significant contributor to the challenges of everyday mental control. For example, could monitoring for thoughts of a cat lead to obsessive thoughts about cats? Could monitoring for thoughts about food lead to the collapse of a diet?

This introduction contains 1) a description of Wegner's theory of ironic processes, 2) experimental evidence relating to this theory, 3) a selective review of the broader literature on monitoring and attention, and 4) a discussion of the relationship between that literature and Wegner's theory.

Wegner's theory of ironic processes

According to Wegner's theory of ironic processes (Wegner, 1994), any effort at mental control necessitates two processes, one that is conscious and controlled, and a second that is unconscious and automatic. First, a conscious effort is made to direct attention to a desired state. For example, the instruction 'don't think about cats' entails trying to think about something other than a cat. This effort is complemented by a relatively automatic process that monitors against re-occurrences of the unwanted state. For example, repeatedly asking onself 'is that a cat I'm thinking of?'. This latter process

will tend to activate that unwanted state. Similarly, if I am unhappy, I might direct attention to happy thoughts, but I will also keep checking myself for unhappiness at the same time.

According to Wegner, the balance between these two efforts, the strategic and the automatic, explains why mental efforts sometimes fail and why, when they fail, it is in a direction completely contrary to our wishes.

The theory is of interest because it implies that mental control outcomes can be predicted on the basis of the relative contributions of conscious efforts of attention and the counterproductive side-effect of unconscious monitoring efforts. It directly links our interest in real world outcomes with the easily studied process of monitoring, and suggests that a study of the relationship between monitoring and activation may provide insight into both fundamental cognitive processes and practical problems of mental control.

Wegner's evidence for the ironic processes theory

There are two strong predictions made by the theory of ironic processes. The first is that an effort to suppress a thought will lead to its increased activation whenever a mental load interrupts strategic processing but leaves automatic monitoring to proceed unimpeded. This is called the hyper-accessability effect. It comes about because the strategic ability to decrease activation by directing attention away from a target thought is vulnerable to interruptions of many kinds, whereas the automatic monitoring processes that increase activation of target thoughts over time are held to be less vulnerable (e.g., Wegner, 1994; Wegner & Erber,1992; Wenzlaff & Wegner, 2000). This

effect may even be responsible for obsessive thinking about target objects (e.g., Ehlers, Mayou, Bryant, 1998; Morgan, Matthews, Winton, 1995; Muris, Merckelbach, Horselenberg, Susenaar, Leeuw, 1997; Trinder & Salkovskis, 1994; Wegner, 1994; but see Purdon, 1999 for a critical review). The studies of hyper-accessibility provide critical support for the theory of ironic processes because the hyper-accessibility of 'suppressed' thoughts is a necessary feature of the mental control failures that the theory describes. These studies are of special interest (e.g. Purdon & Clark, 1999; Rassin, Merckelback & Muris, 2000) because the finding of hyper-accessibility is both counter-intuitive and contrary to findings in areas of research such as the study of vigilance or that of memory (e.g. Cave & Wolfe, 1990; Treisman, 1991).

The second prediction is that a combination of an attempt to suppress with a failure of strategic control may cause a 'suppressed' thought to reoccur more frequently than a thought which is concentrated upon. This is called the 'rebound effect' because the cessation of suppression efforts causes an apparent rebound of target thought frequency. Such a rebound occurs because the target thought continues to become increasingly active over time (due to monitoring) while the effort to direct attention elsewhere continues to weaken. This could lead to such things as bingeing while on a diet or mental health problems(e.g., McCabe, 2000; Pennebaker, 1993; Polivy, 1998). The studies of rebound are presented to demonstrate the relevance of the particular claims of ironic process theory as the rebound phenomena are uniquely predicted by Wegner's ironic processes theory.

Studies of the hyper-accessibility effect

A study by Wegner and Erber (1992) provides the strongest evidence for hyper-accessibility of monitored words. In experiment I, participants were given a target word (one of house, child, mountain, or car) and asked either to think (concentrate) or not think about (suppress) this word for a period of five minutes. At the end of this period, they were asked to free associate to words which were either related or unrelated to the target word, all the while continuing to either think or not think about the target. The authors argue that the instructions to 'not think' about the target created an implicit demand for self-monitoring in order to determine if that thought had recurred. According to the theory, this has the effect of increasing the activation of the target thought. Decreases in target thought activation result from efforts to direct attention away.

The balance between the two can be adjusted by adding a cognitive load. Almost any load will compromise the conscious avoidance effort more than the unconscious monitoring effort. Cognitive loads should increase the chance of failing to suppress a thought when suppression is desired. In Wegner and Erber (1992), experiment I, cognitive load was manipulated by giving half the participants a response deadline of ten seconds and only three seconds to the other half. Time pressure was assumed to consume attentional resources. It was hypothesized that the loss of these resources would not affect the automatic monitoring component, but would compromise the controlled direction of attention.

With no time pressure, participants in the concentrate group gave more associates to target related words than did those in the suppression group. For

example, participants asked to think about 'mountain' were more likely to provide words associated to 'mountain' (hill, high, top and climb) than those trying not to think about it. This pattern was reversed such that under time pressure it was the suppression group which provided more associates. Presumably, trying not to think about a word actually made related words more accessible when there was a cognitive load created by time pressure.

In experiment II of the same paper (Wegner & Erber, 1992), participants were again asked either to concentrate on or to suppress a target word for five minutes. They were then given a key-press Stroop task in which the target word, target related words and neutral words were all presented in either red or blue. Cognitive load was manipulated by asking participants to remember either a single digit number (low load) or a six digit number (high load).

When cognitive load was low, participants asked to suppress a target word had similar reaction times to both target and non - target words; the authors interpreted this as successful suppression. When cognitive load was high, reaction times to 'suppressed' target words were slower; the authors interpreted this result as being due to hyperaccessibility of the target words. The load itself was presumed to change only the balance between this activating trend and the inhibiting trend of the suppression efforts.

My primary critique of this study is that its methods are not well suited to its conclusion. First of all, the two-colour key-press Stroop task typically produces a relatively small interference effect (Cohen's f <.25) even for colour words such as 'Red'

or 'Blue'. Stroop interference is larger for colour words than for non-colour words (MacLeod, 1991). Since the target words, 'Mountain', 'Child', etc.. were not colour words and no response competition was created in this experiment, the amount of Stroop interference would be expected to be smaller than that found with colour words in a comparable experiment; perhaps 10-15 ms of interference. In fact, although Wegner and Erber (1992) report a medium size effect, I was not able to reliably replicate their experiment II with fifty participants.

Second, the Zeigarnik effect suggests that if the instructions to suppress motivate participants to pay more attention to target words than do instructions to concentrate, this would also produce interference just as would 'hyper-accessibility'(James & Kendall, 1997).

Finally, if the demand characteristics of the experimental situation cause some participants to engage in meta-cognition on some trials when they are confronted by the target, the resultant delay would also be attributed to activation of the target word. For example, participants might spend time reacting to the fact that the presented stimuli is the target word of their monitoring effort. The Stroop paradigm cannot distinguish between these causes of delayed response to target words. In other words, the demand characteristics associated with combining instructions to give special attention to a target word and the presentation of that word will definitely contribute to Stroop interference, but one cannot be certain that any interference is specifically attributable to monitoring caused by those instructions.

Alternative paradigms have provided converging evidence, but are themselves even less restricted to Wegner's ironic process interpretation. For example, Wenzlaff, Wegner and Klein (1991) examined the connection between suppression and mood. They hypothesized that suppression targets become linked to the mood in which they occur. The thoughts of a depressed person could lead back to depression should they reoccur. The Wenzlaff, Wegner, and Klein (1991) study demonstrated that an attempt to suppress a thought can lead to stronger availability both of that thought and of an associated mood, consistent with previous findings of state-dependant memory.

Participants listened to upbeat or somber music while either thinking or not thinking about a white bear for nine minutes. During this time they were asked to write a stream of consciousness. They were then asked to spend fifteen minutes unscrambling anagrams and then to complete a brief questionnaire to rate their mood before being asked to try to think about a white bear for a final nine minute period, again accompanied by music.

Participants given initial instructions to suppress thoughts of a white bear reported more white bear thoughts in the final period than those who had originally been asked to concentrate upon it. This difference was considerably larger for those who were exposed to the same type of music during both periods than for those exposed to a musical contrast. The authors argue that music induced a mood which was then associatively linked with the suppression target. Playing the same type of music helped reinstate the context of thoughts which were linked with the target thought, and lead to intrusions of the thought in the final stage.

In experiment II of the same paper (Wenzlaff, Wegner, & Klein, 1991) the final period was not accompanied by music. Mood ratings suggested that the 'suppression' group rated their mood at the end as being similar to the mood of the music provided in the first period. Participants who had been asked to express thoughts about a white bear in the initial period demonstrated no systematic link to the initial mood. The authors argued that the linkage between mood and thought was mediated by activation, again caused by the monitoring demands of suppression. Yet this linkage depends both on supposing that the demand to suppress a thought leads to its immediate enhancement and on the assumption that no suppression ever took place.

The ecological validity of asking participants to track their thoughts was balanced by the method's obvious demand characteristics. That is, one cannot be certain that a particular mood was induced or whether participant's ratings were biased by an overt expectation caused by the music. Similarly, the obvious pairing of music and target could have been noticed more frequently by those subjects trying to suppress the thought than by those participants given the instruction to express their thoughts. Because the act of suppression is difficult, participants asked to suppress may have been more meta-cognitive or reflective whereas those asked to concentrate may have been better able to concentrate on the task. The latter group showed less mood manipulation from the music.

Wegner, Shortt, Blake and Page (1990) assessed suppression efforts using less subjective means. In experiment I, they asked participants to record their thoughts into a tape recorder while trying either to think or not think about a target word. When the

target word was 'sex', measured skin conductance level (S.C.L.) was dramatically higher than for the neutral topics of 'dancing', 'mom' or 'their dean'. There was no difference in either S.C.L. or number of reported thoughts on the topic between those in the suppression and the concentration conditions. It seems then, that both concentration and suppression efforts directed towards an exciting topic increased S.C.L. However, as the authors suggest, it is also possible that short time periods do not provide a good test of mental control.

In experiment III, participants were again asked to either mention or suppress all occurrences of either an exciting thought ('sex') or a neutral thought ('weather') . In this case, each participant was asked to try two thirty minute periods, one on each topic. Regardless of instruction, participants dealing with the topic of 'sex' showed higher S.C.L. in the first three minutes than did those dealing with weather. Across all thirty minutes the difference was not significant.

The critical finding lies in two significant correlations. For participants asked to suppress thoughts of sex, the number of times a participant mentioned the topic was positively correlated with S.C.L., and S.C.L. was correlated with the rated amount of time on target. This could only have come about if S.C.L., hence activation, was higher for those participants who had difficulty suppressing thoughts of 'sex'. No significant connection between verbal responses and S.C.L. was found for participants expressing thoughts of 'sex' or responding in either way to 'the weather'. The advantage of this study is that it employed a comparatively objective measure of the relative impact of instructions to think or not think about something. The limitation is that excitement or

stress upon receipt of those instructions may not be reflective of the presence of a thought itself. The instructions themselves may be causing interest, effort, or anxiety quite apart from the assigned thought topic. S.C.L. measures are not sensitive to the presentation of individual words because the minimum time period for reliable measurement usually exceeds the time of reaction to some individual word.

In summary, the finding that efforts to suppress exciting thoughts can lead to elevated S.C.L. is in agreement with Wegner's thesis and relevant to mental control efforts, but is also open to other interpretations. Combined with other positive results, there is evidence that instructions to suppress a target can cause priming. Whether or not this amounts to hyper-accessibility is debatable.

Evidence for the rebound effect

Wegner's theory of ironic processes predicts that even 'successful' efforts at mental control can be followed by failure, because activation caused by the ongoing monitoring process leads to even more thinking about a target than was present before suppression. This is known as the rebound effect. The experimental investigation of the rebound effect has lead to both positive and negative findings. The positive findings are reviewed first.

In a study by Wegner, Schneider, Carter and White (1987), participants were asked to either suppress or express all thoughts of a white bear for five minutes, and then asked to do the opposite for a second five minute period (Experiment I). During both periods, they were asked to dictate their thoughts into a microphone and, additionally, to ring a bell every time they thought about a white bear.

The 'express' group recorded more instances of a white bear than those asked to 'suppress'. Those participants asked to express their thoughts in the first period and to suppress in the second recorded progressively fewer instances of 'white bear thoughts'. Those asked first to suppress and then to express showed an increase in target frequency; expressing more thoughts of a white bear than those asked to express in their first period.

Experiment II of that same study (Wegner, et al. 1987) reproduced the results of experiment I and added the following condition. Some participants were asked to use the specific thought of a 'red Volkswagen' as a distraction during the suppression period. This focused distraction eliminated the rebound effect, and participants who successfully concentrated upon this object showed no special tendency to think about the white bear.

The authors argue that participants asked to suppress thoughts of a white bear are, even while successful, building up activation of that concept. When they are subsequently asked to express such thoughts, this activation becomes apparent. The 'rebound' is a result of target thought activation. Presumably, participants asked to think about a red Volkswagen monitored their thoughts for this distraction instead of the nominal target.

The finding of activation of a 'suppression' object during a second period of effort (and one with a different set) is not predicted by simple theories of attention. The critical comparison of initially suppressed and initially expressed targets shows a difference between groups of participants each asked to direct their attention at the target.

Wegner, Erber and Zanakos (1993) examined the possibility of rebound in the control of emotion. In experiment II, participants took part in two sessions, one week apart. In one session, they were asked to write a short piece about a recent and personally meaningful success. In the other, they were asked to start by writing about a failure. After each recall session, they were asked to write down their thoughts for a five minute period. Half were asked to try to think about the event during this period. The other group were asked to try not to think about it. At the end of each period they were instructed to continue trying to either think or not about that event while completing a two-colour keypress version of the Stroop task. The Stroop stimuli included the word 'success', some success related words, the word 'failure', and words related to failure. On each trial, participants were asked to remember a number to be reported after the colour of the target word. For half the participants this was a two digit number (low mental load) and for the other half it was a nine digit number (high mental load).

The high mental load slowed participants' responses; more importantly, it interacted with instruction (think or don't think about) and type of word (target related or unrelated). When a participant had been asked to think or not to think about a successful life event, 'success' was the target word. In the other session 'failure' was the target. With low cognitive load, responses were slower to the target and target related words than to unrelated words regardless of instructional condition. However, under high cognitive load, responses to target and target related words were much slower for participants instructed to suppress than for those instructed to think about their experience.

The authors argue that increased Stroop interference from a to-be-suppressed word is evidence of that word's activation, and it can be interpreted as mental control failure. Less Stroop interference for target than for non-target words when asked to think about an experience is an example of ironic rebound. If the mental load was simply distracting the participant, there should be no difference between target and non target words. However, the finding that there was less interference from the words related to what was supposed to be thought about than for that which was supposed to be suppressed suggests that suppression attempts confounded by mental load can fail ironically.

The weakness of this study is that Stroop responding cannot be interpreted as a pure measure of concept activation (MacLeod, 1991). Relative to the low load condition, all high load instruction and word type combinations showed relatively slow reaction times. The comparative rapidity of the responses to target words in the high load and 'think about' condition may have reflected the relative attention participants in this condition gave to the target words. Altogether, participants had been asked to think about an experience, remember a number, and make Stroop responses. Additionally, they would have been self-monitoring their performance to ensure success on each task. The Wegner et al. (1993) interpretation matches only one of several logical possibilities. For example, participants overly challenged by paradoxical demands to suppress may have dedicated their monitoring efforts to the number task more often than those asked to concentrate.

In summary, the rebound effect predicted by Wegner (1994) has been found in several different contexts. These results support the unique prediction of the ironic processes theory and suggest broad implications, although the paradoxical nature of instructions both to suppress and to report thoughts of some target make it unlikely that one could ever be certain if people actually suppressed material in the first place.

Related evidence from other sources

Evidence from other sources supports the contention that thought suppression is difficult and prone to failure, but fails to support the ironic processes model in some crucial respects. For example, although at least eight studies have replicated the general finding of a rebound effect, the number of studies which have failed to do so is at least as large. The studies have used a variety of methods and stimuli, but no systematic difference between the groups of studies has yet been uncovered (Gildson, 1998; Purdon & Clark, 2000; Wenzlaff & Wegner, 2000).

Trinder and Salkovskis (1994) asked participants to identify a recently occurring negative intrusive thought and to record every instance of it for four days. Some participants were given an additional instruction either to suppress the thought every time it occurred, or to spend time thinking about it. The 'think about' group did not differ in the number of reported target thought occurrences from a control group who were asked only to record the thought when it occurred. In contrast, the suppression group reported more instances than the other two. They also rated their discomfort with the thought (across the period) as being higher than did those asked only to record each instance.

Trinder and Salkovskis (1994) interpret their results as agreeing with Wegner about the difficulties of suppression, but they disagree about the existence of a rebound effect. Specifically, they agree that efforts to suppress a target thought lead to its activation; but the difficulty of this suppression did not increase over time as would be predicted by the theory. Unlike the Wegner experiments, neither mental load nor changes in instructions (such as asking for concentration after a period of suppression) were provided, so that the value of their objections to the theory of ironic processes is limited.

Their study represents a case in which the attempt to suppress a thought lead to a higher rate of reoccurrence than did thinking about it, but this was not caused by a lifting of the instruction to suppress. It also has considerable ecological validity, because it used a longer time span and addressed thoughts which might be relevant to real life mental control issues. Unfortunately, the results provide only weak evidence for Wegner's theory because it is impossible to identify self-monitoring behavior as the crucial variable. For example, the unwanted thoughts may have interacted with the instruction to suppress by engaging better prospective memory for the thought reporting task than was present under the control condition. Alternately, instructions to suppress might cause immediate enhancement of a target instead of rebound, a finding consistent with other research (e.g. Lavy, van Oppen & van den Hout, 1994; Salkovskis & Campbell, 1994).

Rebound effects with neutral stimuli were also found by Clark, Ball and Pape (1991) and replicated in Clark, Winton, and Thynn (1993). In both cases, participants

listened to an emotionally neutral but memorable story from a tape. Participants asked to suppress all thoughts of the story for five minutes reported more thoughts about the story in a second five minute period for which they were instructed to think freely.

Finally, Bryant and Harvey (1996) investigated rebound in hospital in-patients recovering from car accidents. Instructions to suppress the highly salient and negative thoughts of their recent accident lead to both hyperaccessibility and rebound as predicted. However, in addition to the demand characteristics common with other such studies, these participants might also have been suffering from something quite close to obsessive rumination to begin with. The instructional manipulation could then have created a 'rebound' effect simply by interfering with the natural thought control mechanisms already being taxed by the situation.

Contrary experimental evidence

There is a general bias against the publication of negative results. Since there are no (current) theoretical positions that argue against the link between monitoring and activation of mental representations, there may have been little effort to pursue this issue. Nonetheless, several studies of the rebound effect have reported (instead) examples of successful suppression (e.g., Clark, Ball & Pape, 1991; Lavey & van den Hout, 1990).

Gildson (1998) reviewed a total of seven experiments in this paradigm with negative results and contributed three of her own. She attempted to reproduce the general results of Wegner et al. (1987) without success, measuring target thought frequency in participant's written stream of consciousness preceded by a five minute

period of either suppression or expression. Gildson's studies employed the original stimuli of a white bear, as well as two text passages. Her conclusion attributes the original rebound effect to experimental artifact. This in itself is not sufficient to attack the theory as it might be applied to emotional charged stimuli, especially since other experimenters have found rebound effects.

Mathews and Milroy (1994) recruited thirty excessive worriers and asked them to spend five minutes either a) worrying about the topic that generally worried them the most, b) avoiding thoughts about what worried them, or c) thinking about something that did not worry them. At the end of the first period, all participants were instructed to think freely about whatever they wished for fifteen minutes. During this period, they were occasionally polled to write down their current thought. No mental load was imposed.

Overall, worriers reported far more occurrences of their worrying thought than did a control group, regardless of instruction. More importantly, those asked to try suppression for five minutes did not show any rebound of worry. In fact, all three priming conditions lead to similar numbers of 'worry' responses in the test period. The authors concluded that instructions to suppress per se do not necessarily cause later intrusions of a negative thought.

Some studies have found that efforts to suppress a thought lead to an immediate increase in its frequency. This contradicts the rebound effect, and raises the question of whether participants were actually suppressing the desired thought. Muris, Merckelback, van den Hout, and de Jong (1992) found no evidence of either initial enhancement or rebound effects when participants were asked to suppress thoughts of

an unpleasant narrative. However, participants asked to read and then suppress thoughts of a neutral version of the same story showed an immediate increase in the number of target related thoughts over participants asked to express such thoughts.

Not only did the failure to find a rebound effect with negative materials contradict other evidence (Wenzlaff, Wegner, & Roper, 1988), it is particularly damaging in that the emotionally charged story should have produced exactly those conditions of motivation and high activation that would be expected to cause rebound.

Lavey and van den Hout (1990) also found an immediate increase in reported target thought frequency when participants were asked to suppress such thoughts. Using a presentation of a short piece of text as a prime (as per Clark, Ball and Pape, 1991; Clark, Winton, Thynn, 1993), they asked participants to either suppress their thoughts or suppress their thoughts using a specific distraction. In both cases there were no significant rebound effects, although the number of reported thoughts was higher for those suppressing without a distraction. Wegner's theory of ironic processes predicts that after making a suppression effort there should have been activation of that target thought, whereas the inclusion of a specific distractor would be expected to be helpful (Wegner, et al., 1987; Wegner, 1994). The discrepancy between these studies and that of Clark, Ball and Pape (1991) will be referred to again in the discussion of the attention literature.

In summary, there is evidence for the difficulty of suppression and its tendencies for failure as predicted by Wegner but there are no reported direct replications of Wegner and Erber (1992), and there are studies which failed to do so. It seems that, at

best, the ironic processes theory predicts the failure of suppression efforts but does not describe the circumstances leading to failure with enough precision to resolve empirical disagreements.

Monitoring and attention

Wegner's theory stands alone as the only cognitive theory created to explicitly account for difficulties of mental control. However, its predictions are based upon several claims about the characteristics of monitoring processes. Specifically, the theory of ironic processes depends upon the strategic and effortful qualities of attention and the automaticity and resource-free nature of monitoring. Previous research has employed attention and monitoring in a wide variety of tasks; the findings are contrasted with the claims of Wegner (1994).

Vigilance

Historically, the limitations of vigilance were first seen in dichotic listening experiments. Participants asked to monitor messages presented to one ear while a second message was played to the other could easily remember the attended message but not that of the 'ignored' one (Wood & Cowan, 1995). In this sense monitoring seems to be effortful and voluntary. And 'to be ignored' material does not become accessible.

The evidence from visual search tasks also contradicts Wegner's (1994) claim that continued monitoring increases activation of a target. Visual searches are so efficient that some authors suggest that they may be carried out in parallel, yet they typically show effects of fatigue instead of hyperaccessiblity. That is, having to carry out a visual search will usually become more difficult over time, and sensitivity decreases

when tasks are made more difficult or load is imposed (e.g. Treisman, 1991; Cave & Wolfe, 1990).

The question for this thesis is whether a self directed and implicit monitoring process has the characteristics of being automatic and relatively effortless as proposed by Wegner (1994). These characteristics are opposite to those of monitoring processes described in the vigilance and attention literature. There are two reasons to suppose that self directed monitoring might not be different; (1) theoretical simplicity and (2) that the availability of such an effortless and privileged process would have been evident in studies where paying attention to a target was actually compromised by cognitive load (e.g. Fisk & Schneider, 1981).

Memory

Thought suppression has been represented in the memory literature in several ways. First, the Freudian idea that an unwanted thought may be forgotten or difficult to retrieve has been a topic of perennial interest. Second, the study of directed forgetting, being asked not to remember particular stimuli, seems to parallel the situation of a participant asked not to think about something. Finally, some studies of prospective memory have produced similar results to the thought suppression literature.

Freudian psychology was based on the argument that even when unwanted thoughts can be successfully removed from consciousness, they may continue to have an impact on subsequent thinking. The mechanisms of this process are difficult to study under laboratory conditions because it is unethical to create situations so unpleasant that they are likely to be applied. Although there is a history of looking for evidence of

repression in the laboratory (see reviews by Erdelyi, 1990; Holmes, 1990) the consensus is that it has not been shown.

In a sense, the theory of repression serves as an alternative to the theory of ironic processes because it holds that truly unwanted stimuli will not become more accessible or likely to rebound into consciousness. It is suggestive that the failed repression experiments did not find the effects predicted by ironic processes. Instead, using a variety of methods, they found initial priming of unpleasant test stimuli followed by gradual forgetting. Reconsidering the Bryant and Harvey (1996) study involving people recovering from car accidents, it seems important that there was no test of any long term outcome.

Suppression, the conscious counterpart to repression, is also quite limited in its impact. Simply asking a participant to forget particular stimuli doesn't seem to work. Studies of directed forgetting (e.g. Bjork, 1989) have shown that recall of 'to be forgotten' stimuli is poor relative to 'to be remembered' stimuli, but that the difference is almost certainly (see McLeod, 1997) due to differences in effort at the time of encoding and not to successful inhibition of the stimuli. Apparently, the instruction 'do not remember' does not produce a monitoring process to check to see if stimuli are being remembered. Although, in that there are usually multiple stimuli in a memory test, this is a different form of evidence from that presented by Wegner, there would seem to be a serious contradiction.

The study of prospective memory has also generated results inconsistent with the hypothesis that monitoring is automatic. Participants asked to overtly monitor for the

appearance of a target word while performing a competing task (e.g. McDaniel, Robinson-Riegler, & Einstein, 1998; Einstein & McDaniel, 1996) show priming for that target word and related words. The monitoring does not, however, create ongoing hyperaccessibility of the target or a rebound of its activation. In fact the monitoring target can be forgotten. Overall, prospective memory appears to be sensitive to the same factors as retrospective memory (Brandimonte & Passolunghi, 1994; Maentylae, 1993, Maylor, Chater, & Brown, 2001).

Especially relevant to the present study, Guynn, McDaniel, and Einstein (1998) found that participants asked to monitor for a word showed less priming under divided attention. In short, explicit directions to monitor for a stimulus are sensitive to divisions of attention or other capacity limitations. However, this result is not immediately applicable to mental control situations because the Guynn et al. (1998) study was overtly a memory test. The demand characteristics of their experimental situation may have led to participants making extra efforts to attend under low load but little effort under high load. Additionally, this report on monitoring was based on a small number of observations per participant, with memory accuracy (quite low) as the only measure.

The theory of ironic processes depends upon a difference between implicit and explicit directions to monitor. Explicit directions to do anything lead to strategic and effortful direction of attention; they also lead to automatic monitoring for failures of attention. Wegner (1994) argues that asking a person to suppress a thought will lead to an implicit demand to monitor; experimentally Wegner and Erber (1992) explicitly asked participants to monitor their thoughts while also generating an implicit demand for

monitoring by asking them to suppress. In the Einstein and McDaniel experiments participants were asked to explicitly monitor for a target word without any implicit demand at all. The simplest possibility is that if the same monitoring processes are used in all cases; the balance of evidence would then suggest that monitoring is not automatic or capacity free.

There is one other aspect of prospective memory research which may be considered in light of the theory of ironic processes. Marsh, Hicks and Bink (1998) found priming for target words related to uncompleted scripts. For example, participants were able to recall what target words they were monitoring for even when they were poor at making responses to presentations of the target word. The Marsh et al. (1998; also see Goschke & Kuhl, 1993) results argue that the ongoing and uncompleted demand for reporting could itself create priming of target words. This raises the possibility that when the studies designed to test the theory of ironic processes made explicit demands for reporting the presence of targets words, participants were in fact engaging in a prospective memory task. The supposed requirements for thought monitoring and control may have been overwhelmed by the effect of this overt reporting task. On this interpretation, the only real difference between 'concentrate' and 'suppress' conditions may be in memory for the reporting task.

This explanation is particularly suited for explaining the phenomenon of rebound. If instructions to 'think about' lead to a feeling that the intention has been satisfied or completed, priming will tend to decrease. Instructions to 'not think about', however, could become very well rehearsed and reinforced by participants experiencing difficulty

with suppression. But thinking about the reporting task is thinking about the target and contrary to the theory of ironic processes, the monitoring demands of the task may have little or nothing to do with the results obtained.

Attention

An additional criticism of ironic processes theory may be found in studies of divided attention. Wegner's theory states that any effort at mental control depends upon the premise that the monitoring process is relatively unaffected by other uses of mental resources. The literature which describes divided attention tasks does not entirely support this view; it primarily describes the difficulty of performing more than one task at a time.

Spelke, Hirst, and Neisser, (1976) asked participants to read text passages while taking dictation. Although all participants could perform adequately on each task alone, extensive practice was required before both tasks could be handled simultaneously with any success. The authors contend that the combination of two tasks initially requires more than the available resources. The effect of practice was to automatize each task until fewer attentional resources were required. Wegner's tasks were not as difficult and did not require making overt responses to each at the same time, but the difficulties in Spelke, Hirst and Neisser (1976) are suggestive. Initially, mental control failures might result from limitations of effort in both processes, not only from failure of the effortful direction of attention. However, mental control difficulties should reduce as practice increases the automaticity of both directive and monitoring processes, in which case the theory would be a poor model of long term thought suppression difficulties.

Posner and Snyder (1975) suggest that a process be considered automatic if it is concealed from consciousness, is unintentional, and consumes few attentional resources. Since the Spelke et al., (1976) result, most theoretical perspectives on attention have agreed that multiple tasks can be performed so long as they do not exceed attentional capacity (e.g. Kahneman, 1973). Automatic and controlled processes should normally be concurrently available (Näätänen, 1990).

This is a critical point for the present study. It is important to test how automatic monitoring processes are, and to see if the effect of monitoring claimed by Wegner (1994) can be shown in less complex situations. A test of monitoring under conditions of divided attention would provide the best indication of the interaction of mental load with the activation caused by suppression. McDaniel, Robinson-Riegler, and Einstein (1998) explicitly asked participants to monitor for particular words in a long list. They found that participants detected fewer target words under mental load. This is opposite to the results reported by Clark, Pape and Ball (1991).

Theories of priming distinguish between a fast acting, automatic component and a slow acting controlled component (e.g., Neely, 1991). The fast acting component may operate without conscious awareness (Cowan, Winkler, Teder, & Näätänen, 1993; Marcel, 1983) and certainly without conscious direction (Neely, 1977). It is likely to cause a relatively small priming effect. The slower component is driven by expectation and strategy. Instructing a participant to suppress a thought is likely to generate priming of both types. That is, responses to target words may differ from responses to non-target words both from the activation of target words and the processing strategies

participants may adopt.

The priming literature contains a number of situations analogous to that described by the theory of ironic processes. Foremost, the study of expectation effects seems to relate directly to the monitoring processes involved in Wegner's theory. To expect something is to look for its occurrence, or to hold it in mind in light of its probability of occurring. This is the same as monitoring for something as described by Wegner (1994). However, the priming literature includes demonstrations of strategic effects caused by the implicit demands of expectancy. This is an advantage over the overt and conflicting demand characteristics created in the studies of the ironic process theory.

Neely (1977) presented category word primes (BIRD, BODY, BUILDING, and XXXX) and within category word targets (robin, arm, attic, etc...). This allowed simultaneous testing of both relatedness priming and priming based on expectations formed by pairing words from the BODY category with the prime BUILDING, and those from the BUILDING category with the prime BODY. He found that although there was an effect of relatedness (ie. BIRD primes robin or BODY prime arm) regardless of training, associations between unrelated categories and targets could also cause priming at long (2000 ms) SOA. For example, after repetition, BODY could prime attic and BUILDING could prime arm based on a strategic use of expected association.

Tweedy, Lapinski, and Schvaneveldt (1977) demonstrated a more general method for controlling expectancy. They varied the proportion of primes (e.g. DOCTOR) which were semantically related to targets (e.g. NURSE) in a lexical decision task.

There were no explicit directions to monitor for prime to target relatedness - any monitoring should have been directed towards task performance. They found that priming increased with the proportion of related primes (also found in Neely, Keefe & Ross, 1989; Keefe & Neely, 1990). The authors explained that participants learn to expect target words in the high relatedness proportion conditions. Altering the ratio of words to non-words affects the strength of this relationship (Neely & Keefe, 1989), presumably because non-words proportionately discourage expectation of particular word targets.

The relatedness proportion effect is not without complication. The pattern of priming in which responses to related word targets are facilitated is complimented by priming due to delayed responses to unrelated word targets. The former can be explained by direct activation of target words, whereas the latter is primarily attributed to the effects of expectancy (Keefe & Neely, 1990). There are other post lexical processes which create priming, for example coherence checking (Becker, 1980; de Groot, 1984), backwards priming (Koriat, 1981), cue combination (Ratcliff & McKoon, 1988), and decision speed feedback (Heath, 2000) but the variables which control this type of priming should be constant in the experiments reported later.

The relatedness proportion effect is therefore a perfect test case for theories about monitoring. Strength of expectancy is both controllable and measurable. The demand characteristics of a lexical decision task itself are not great. Participants in lexical decision tasks have not been overtly instructed to monitor for expected target words (Marsh & Landau, 1995) yet show priming of words that are expected, hence

monitored. Finally, the task as stated requires only a single key press response. On this context it should be possible to assess the effect of mental load on monitoring because, unlike the Wegner experiments, one is adding only one additional task.

Critique of Wegner

Even accepting the evidence presented for the theory of ironic processes, there are alternative explanations to consider. Ironic processes theory states that mental control depends upon a particular balance of attention and monitoring; other research has concluded that monitoring is subject to capacity limitations similar to attention. The interpretation of support for ironic processes theory depends upon whether a distinction between implicit and explicit monitoring can be drawn, and whether implicit monitoring is automatic.

Consider the possibility that participants cannot suppress a thought, monitor for its occurrence, and deal with a mental load while recording their thoughts or responding in a Stroop task. In this case, they need not be responding to an aftereffect of monitoring but only to the demand characteristics of the situation. An astute participant could direct all available attention towards the target thought even while giving less effort to the task of reporting its occurrence. Subsequent implicit tests would then bear the appearance of a 'rebound' of activation from artificially low 'censored' levels.

The hyperaccessibility of a 'suppressed' thought may be explained by an implicit demand to look for the target word, but it may also have been caused by the explicit demand to report thought occurrences. More simply, there may have been explicit monitoring of the target word caused by the demand characteristics of the experimental

situations.

It is also important to consider the hypothesis that the instruction to suppress could be more motivating or more interesting than instructions to concentrate. In this case, the monitoring effort which comes with suppression may have nothing to do with the outcome: participants may think about the target because it is more interesting to do so. What is needed is a test with relatively weak demand characteristics and with less splitting of attention over tasks so that the outcome can be more carefully attributed to the instructions given to the participant.

Demand characteristics may arise in other ways as well. Marsh, Hicks, and Bink (1998) found that participants expecting to have to perform actions in the future showed priming of words related to those actions. Instructions to report the occurrence of 'suppressed' thoughts may have lead to priming of the target words in ways not related to monitoring effort. To properly assign the observed priming effects to the operation of monitoring processes, it is critical to generate experiments which lead to monitoring processes without such widespread demands.

Wegner's theory is distinguished by two key predictions. First it leads to the prediction of a rebound effect when attempts to suppress a state are followed by attempts to express it. This agrees with the clinical picture of intrusive unwanted thoughts, but the evidence is mixed on whether this occurs in experimental settings. Second, mental load is predicted to increase the effect of such a rebound effect. This is opposite to the general finding of the divided attention literature which suggests that effort directed towards a second task will either have no effect or will decrease the effort

and effect of monitoring if monitoring capacity is exceeded.

A participant asked to report thoughts, to make key press responses, to suppress thoughts, and expected to monitor them may react to mental load in any number of ways, including the failure of at least one of those efforts. Wegner's own research has assumed that instructions to suppress create an implicit demand for monitoring, but measured the effect of this by adding explicit directions to report 'suppressed' thoughts. These reporting instructions most likely lead to priming themselves. The distinction between implicit and explicit demands made by instructions to suppress or concentrate upon a thought may help link the phenomena to the broader literature - which has been restricted to purely implicit demands. It may also explain some of the variation between studies of the rebound effect. Even though none of the studies reviewed above were based upon participants being explicitly asked to show rebound or hyperaccessibility effects, the instructions in different studies may have varied in the strength of their implicit demand characteristics.

There is also the question of whether all monitoring targets are the same. Erdelyi (1994) suggests that negative stimuli may have a special effect not present with neutral stimuli. As well, complex searches, such as those with multiple targets, are more effortful than simple searches (Treisman, 1991; as admitted in Wegner, 1994). The success of a diet could then hinge upon whether one is attempting to censor all possible thoughts of food or instead just to avoid thinking of a wonderful and available chocolate dessert.

According to Wegner, a general monitoring process is less likely to activate any particular concept, while a specific one is quite difficult to suppress. Any experiment described in terms of the theory of ironic processes could then be described both as a division of effort (monitoring and suppressing and reporting and remembering a number...) and as the outcome of a suppression target being either general or specific. Yet there has been no evidence presented for this latter point. At an orthographic level the word 'car' is quite specific, while at another level it refers to an extremely heterogenous group. This study does not address the point of whether participants asked to suppress a thought are monitoring for a general or a specific event on the supposition that they ought to be unconscious of the effort (as entailed by automaticity). The theory of ironic processes fails to describe the stimuli and situations which are most likely to lead to its predicted effects.

Predictions

The goal of the present study was to examine the contention that monitoring is automatic. To this end, lexical tasks were used to measure priming caused by demands to monitor that were either implicit (experiment I) or explicit (experiments II, III, IV).

Ironic process theory predicts the activation of monitored words. Instructions to monitor, like instructions to think about something, should lead to more activation than instructions not to monitor. However, cognitive load should reverse this pattern. In all cases, the resulting activation would be measurable as priming of lexical decision word targets.

The theory has no real grounds to predict a difference in priming due to changes in the strength of monitoring demand, but is not inconsistent with this. Taken literally, voluntary, explicitly directed, priming should not be stronger than automatic, implicitly directed, priming. Finally, the addition of cognitive load should not affect the magnitude of priming caused by monitoring alone. Since the present study does not direct participants to 'not think' about any particular target, there should be no rebound effect.

In contrast, the general theory of attention does not differentiate between implicit and explicit demands to monitor for stimuli, so priming is predicted to be equal in both cases. Furthermore, attention is generally conceded to be at least somewhat voluntary, implying that explicit directions to prime should be successful, but also that priming due to monitoring should be expected to decrease when there is a cognitive load.

EXPERIMENT I

The goal of the first experiment is to produce priming using only implicit demands to monitor. This provides a basis for comparison (same stimuli) with the explicit demands used in the later experiments. Previous experiments have demonstrated a relatedness proportion effect with the lexical decision task. The relatedness proportion effect occurs because participants are sensitive to the relationship between primes and targets (Neely, 1991). Participants confronted with a high proportion of related pairs come to expect such pairs.

This overall expectation may lead to looking for related targets (a monitoring process) when a prime is presented, or simply holding the prime in mind when considering the target (simple memory). The likelihood of both should increase with

relatedness proportion. However, the effect of each process could potentially change over time. For instance, the longer one engages in monitoring for a target word, the greater the priming for that word (as per Shiffrin & Atkinson, 1969). Memory, be it access to lexical knowledge or simply short term activation, should not be expected to change in its effect within the time frame of a single lexical decision trial. As discussed earlier, several theories successfully predict the relatedness proportion effect (Neely, 1994), but none generally specify the size of the interaction of relatedness proportion and SOA.

Previous research has shown the relatedness proportion effect at a variety of SOA but has not revealed the nature of this interaction clearly enough to predict the strength of any relatedness proportion effect interaction with SOA. Specifically, although the effect is larger at longer SOA, this may be attributable to increased facilitation (e.g. Favreau & Segalowitz, 1983; Neely, Keefe & Ross, 1990) or to increased interference (e.g. de Groot, 1984). This is important for the present study in two ways. First, the pattern of response latencies to related, unrelated and non-word targets may help separate evidence for different theories of the nature of expectancy. If the relatedness proportion effect leads to a cost in responding to unrelated targets, as well as facilitation of related targets, this will help support the notion that monitoring makes a significant contribution to the relatedness proportion effect, a finding which can be usefully generalized in the later experiments. Second, there is a practical aspect to testing which SOA leads to the largest relatedness proportion effect - the larger the effect the better the power for the following studies which share that SOA.

The two SOA to be used are 500 and 1500 ms. The short SOA is longer than needed by an average reader to read the prime word of a lexical decision trial and generate an appropriately related target. The long SOA was chosen pragmatically to give an opportunity for more strategic processing than possible at the short SOA while not extending the time frame of the entire experiment to a length which would confound the two conditions with differential fatigue. An increase in priming at the long SOA would also support the conclusion that monitoring is subject to voluntary control. Experiments II, III, and IV will use the SOA that generates the most priming.

Method

Overview

The experimental design was similar to Neely and Keefe (1989). Participants were asked to make lexical decisions to target strings preceded by primes. Targets were words related to the prime, unrelated to the prime, or nonwords. The difference in average response times between related and unrelated target words is called priming. This experiment varies relatedness proportion and SOA.

Participants

Fifty-four undergraduates from the University of Toronto at Scarborough volunteered to participate in this experiment, receiving either course credit or a payment of five dollars. Since proficiency in English is necessary to show reliable implicit priming, all participants were first asked to fill out a questionnaire (see Appendix B) to report their first language, years using English, and other indicators of English use. Four participants were excluded on the basis of self-reported language deficits. Another five

were excluded on the basis of making more than ten percent errors (errors include response times that were more than three standard deviations slower than the population mean). This left forty-five participants equally divided between three conditions.

Materials

A set of 150 related prime-target pairs (see Appendix A) were selected from the Shapiro and Palermo (1968) norms. All programming was done in C++ using the Borland Graphic Interface. For every participant a random selection of one third of the target words (50) were replaced with nonwords. Depending on the experimental condition, either 20, 50 or 80% of the 100 related word pairs were then scrambled (randomly for each participant) to produce unrelated prime-target pairs. Finally, the order of prime-target pairs was randomized for each participant.

Apparatus

Two IBM PC-compatible (486-66) computers were used, each with 14 inch colour VGA monitors. Responses were made on regular keyboards.

Design

The design was a mixed factorial design with three types of lexical decision target (related word, unrelated word, nonword), two levels of SOA (500 ms and 1500 ms), and three different proportions of prime-target relatedness (20,50,80%). The first two factors were within subject, the last was between subject.

Procedure

Participants were tested individually. They were greeted and asked for their

informed consent. The English use screening questionnaire was administered, followed by computer displayed instructions introducing the lexical decision task:

> "You are going to be asked to make a series of judgements about strings of text like BEECH or BECCH. Your task is to press the YES key if a word has been presented and the NO key otherwise. Each target string will be preceded by a prime to which you make no response. You will be given a demonstration and some practice".

The instructions were repeated out loud by both the experimenter and the participant at this point, after which a demonstration took place. This was in turn followed by a practice period of 30 trials and one last repetition of the instructions.

Each trial was initiated by the presentation of a fixation point for 200 ms. This was followed by presentation of the prime for 250 ms, a blank screen for either 250 ms or 1250 ms (ISI), and the target word, which remained onscreen until a keypress response was made. The main experiment consisted of two counterbalanced blocks of 180 trials, one at each SOA. Non-word targets were presented on one third of all trials. Participants were randomly assigned to conditions in which either 20, 50 or 80% of target words were associatively related to the primes. Responses more than three standard deviations longer than average were removed from the data.

Results

Data from the first 30 trials (practice), and from trials with reaction times shorter than 300 ms or longer than 2.5 standard deviations above each participant's conditional average were all excluded (about 3% of the data). This was done to preserve the

normality of response latencies in each condition for each subject.

An overall analysis of variance found a significant 3 way interaction between relatedness proportion, SOA, and type of target, $F(4,84) = 2.38$, $p=.05$, MSE =8469. Consequently the data are presented separately for the short SOA first (Table 1), the long SOA second (Table 2), and the statistics for the overall effect of SOA presented afterwards.

Table 1

Mean correct response latencies and standard deviations by target type and relatedness proportion in experiment I, SOA 500ms

R.P.(%)	Related	Unrelated	Priming	Nonwords
20	**610**	**638**	**28**	**839**
	(123)	(123)		(199)
50	**643**	**678**	**34**	**804**
	(91)	(127)		(127)
80	**649**	**723**	**74**	**893**
	(88)	(156)		(155)

At the SOA of 500 ms, priming is significant across all conditions, $F(1,42) =36.2$, $p<.01$, MSE = 1289, and there is an interaction between the size of priming (taken as the difference in response latencies when the target is related or unrelated to the prime), and the proportion of related target words, $F(2,42)= 3.66$, $p =.03$, MSE = 1289. The difference between priming at 20 and 50% is not significant, $F<1$, but the average of priming at 20% and 50% is less than that at 80%, $F(1,42) =7.21$, $p=.01$. Priming is significant even at the 20% relatedness proportion, $F(1,14) =22.7$, $p<.01$.

There was no systematic effect of relatedness proportion on reaction times to words, $F(2,42)= 1.18$, $p =.33$, $MSE=24522$ or non-words , $F (2,42) = 1.14$, $p =.33$, $MSE=26685$.

Table 2

Mean correct response latencies and standard deviations by target type and relatedness proportion in experiment I, SOA 1500ms

R.P.(%)	Related	Unrelated	Priming	Nonwords
20	**581**	**628**	**47**	**844**
	(124)	(122)		(208)
50	**651**	**681**	**30**	**848**
	(120)	(130)		(168)
80	**617**	**713**	**96**	**868**
	(103)	(154)		(229)

At the longer SOA, the main effect of priming is again significant, $F(1,42) = 43.9$, $p<.01$, $MSE=1724.38$ and interacts with relatedness proportion, $F (2,42) =5.17$, $p<.01$. Once again, the 20 and 50% relatedness conditions do not differ in priming, $F<1$, but their average does differ from the priming found in the 80% condition, $F(1,42) =9.73$, $p<.01$.

Relatedness proportion did not systematically change reaction times to words, $F(2,42)=1.24$, $p=.3$, $MSE= 30182.04$ or non-words, $F<1$.

Effect of Stimulus Onset Asynchrony

The amount of priming was not systematically affected by SOA, $F (1,42) =1.7$, $p=.199$, $MSE=1016.16$, nor was there a main effect of SOA on reaction times, $F<1$. Block order for SOA did not interact with any other variable, all Fs < 1. The three way

interaction reported at the beginning is best explained as a difference in which relatedness proportion leads to higher variation and slightly more priming at the long SOA than at the short one (the significant interaction is the linear by quadratic contrast).

Error Data

Because participants were removed on the basis of errors, and because very long response times were trimmed from the data, there is no appropriate analysis for error rates. In any case, using ANOVA with the proportion of errors as a dependent measure, the likelihood of lexical decision task errors does not vary significantly by SOA, F (1,42) = 2.04, p = .16, MSE=1.42 or by proportion of related words, F < 1, even when the participants removed from the general results on the basis of errors are considered. There is an effect of target word type, F(2,42)=24.42, p<.01, MSE=3.56 such that there were more errors responding to non-words than to words. Error proportions may be seen in Table 3.

Table 3

Proportion of errors by SOA , RP, and target word type in experiment I

	SOA 500 ms			SOA 1500 ms		
RP	Related	Unrelated	Nonword	Related	Unrelated	Nonword
20	.02	.02	.06	.01	.03	.06
50	.03	.02	.05	.01	.03	.04
80	.02	.03	.07	.02	.02	.07

Discussion

Adding one second to the delay between the prime and target did not change the amount of priming. More importantly, the relatedness proportion effect was present at both the long and short SOA. Specifically, there was considerably more priming when eighty percent of target words were related to their primes than when this was twenty percent.

The presence of a three way interaction of SOA, priming and RP suggests that the apparent difference in pattern of response latencies between the two tables goes a little deeper than a simple difference in priming. This interaction is particularly sensitive to the fact that at the fast SOA the interaction of related word latencies and RP is characterized by a linear increase, while at the longer SOA this is not the case (please see Tables 1 and 2).

For present purposes I will divide the theories of priming in lexical decisions into three classes, and explain how the present data supports the interpretation that monitoring played an important role in the observed priming.

The first theory of lexical decision priming is that of an automatic spread of activation from the prime to related target words. For example, seeing a word such as 'HOT' primes a participant to make a 'word' response to the associated word 'COLD'. This almost certainly contributes to the priming found in the present study, but fails to account for several of the key patterns. First of all, average reaction times are higher when priming (the difference between related and unrelated word targets) is large than when it is small. The facilitation caused by automatic spread of activation should predict

the opposite. Second, the theory does not account for the size of the increase in priming when a high proportion of targets are related to their primes. Finally, automatic spread of activation does not predict priming caused by a cost in responding to unrelated targets. For this reason, the present results, although reflecting automatic spreading activation, can be confidently attributed to differences in strategic processing.

A similar line of reasoning can be used to argue against the importance of post lexical processes in the strategic part of priming (e.g. Ratcliff & McKoon, 1988). A post lexical theory suggests that a lexical decision can be facilitated by information created by the joint cues created by reading both prime and target. For example, noticing that a prime and target are related implies that both are words, which facilitates making a lexical decision. Without otherwise debating the merits of such theories, I will again point out that the maximum priming in the relatedness proportion effect seems to result from a cost imposed on unrelated word targets, not a facilitation of related targets.

This cost is most easily explained by the expectancy theory of priming; that participants given an implicit demand by a high proportion of related primes are motivated to generate associated words when confronted by primes (Keefe & Neely, 1990; Neely, Keefe, & Ross, 1989). When the actual target word is presented some facilitation might occur if it matches, as described by the automatic and post lexical process theories, but the bulk of priming is created as a cost to the 'unexpected' unrelated target words. This is matched by an attendant cost in responding to non word targets as well.

The core of this expectancy explanation is that participants hold a prime associated word in mind, and look for its occurrence on screen as the target word. This monitoring creates priming. The primary result of experiment I is to replicate the relatedness proportion effect, suggesting that an implicit demands to monitor do cause priming, and can be controlled. In contrast to the Wegner paradigm experiments, this demand is both simple and direct. Participants were asked to respond to the lexicality of target strings. Priming was a result of attentive processes initiated by the stimuli themselves. Although the argument might be made that looking for a related target word on the screen is exogenous and therefore different from the endogenous monitoring implied by Wegner (1994), neither ironic processes theory nor its supporting literature has made this distinction in considering previous tests and measures. The second successful aspect of this experiment is simply the finding that the relatedness proportion effect at the long SOA provides ample priming for comparison with experiments II, III, and IV.

There are several shortcomings with the use of an implicit task to direct attention. First, participants may have engaged in a number of possible processes or combinations of processes in order to respond to the lexical decision task (Neely, 1991). Even with confidence that monitoring is involved, the contributions of other processes reduce the ability to relate results from this paradigm to those reported by Wegner. Specifically, while automatic spreading of activation from a prime to a target word should account for roughly the same amount of priming in each condition, post lexical processes also contribute to priming, and their precise contribution can only be inferred

as less than dominant by the difference between increased cost to unrelated primes and facilitation of related targets.

A second shortcoming follows from the argument that an SOA of 500 ms does not test the automaticity of a process. The long SOA condition (1500 ms) clearly falls within the range of strategic processes, however there is no agreed upon lower boundary for the length of time strategic processes should take. Posner and Snyder (1975) found that an animal classification task was not affected by the proportion of positive and negative responses with a SOA of 500 ms. At the time this was argued to indicate that only automatic processes occurred in this time frame. Neely (1991) proposed that attentional processes were ineffective at an SOA of 250 ms, and weak at an SOA of 500 ms. Using methodology like that of experiment I, Den Heyer, Briand, & Dannenbring (1983) failed to find a relatedness proportion effect at a 75 ms SOA. Henik et al (1994) did find a relatedness proportion effect at an SOA of 200 ms, but Stoltz and Neely (1995) did not. Meanwhile, Perea and Gotor (1997) claim to have found the effect at a SOA of 83 ms. This last finding was of a 67 ms priming effect, which, if it had been present, is sizable enough to have been detected with a minimum of .9 probability in any of the other experiments cited. It is possible that this study is not relevant because Spanish may not be a good model for English stimuli because of the phonetic regularity of that language.

The question of automaticity is relevant because of the lack of difference in priming between the two SOAs. If priming at the 500 ms SOA could be interpreted as depending upon relatively automatic processes, then any distinction between Wegner's

automatic and strategic monitoring could be challenged. Since such an interpretation is not possible, it is important to consider whether the present results differentiate any models.

Wegner's hypothesis is that an ongoing monitoring process increases priming. Attentional theory suggests that priming occurs as a result of keeping the relevant item activated - priming should not differ so long as an SOA is long enough to place an item in memory and short enough that the item is likely to remain there. The interaction between SOA, priming, and relatedness proportion can be said to give weak support to the attentional model because the strength of demand to monitor led to changes in priming while length of time during which a target word was monitored did not.

EXPERIMENT II

Priming is usually used in cognitive experiments as a relatively unobtrusive and non reactive way to measure processing differences without giving directive cues to participants. In the context of a mental control experiment there is an obvious advantage in using the demand characteristics of a priming task as part of the experimental manipulation - it simplifies the interpretation of subsequent events considerably. As a criticism of previous studies it was pointed out that having the same word appear on the screen in a priming task after having just asked participants not to think about it for five minutes might not be as neutral and free from demand characteristics as one might hope. Half of the problem can be dealt with by using lexical decision, in which meta-cognitive reactions to target words will slow responses (and make estimates of priming more conservative) as opposed to Stroop tasks, where this

interference is additive to the effect of interest. The other half of the problem is solved by using the lexical decision stimuli as the material for thinking about or not thinking about. This removes any ambiguity as to whether a participant is responding to a target word because of suppression induced hyper-accessibility or because of demand characteristics.

The second experiment used explicit direction of attention in a lexical decision task to encourage participants to control priming as much as they could - either to pay attention to prime and target relatedness or not to pay attention to it. By implication this latter condition might be expected to produce ironic processes itself; discussion of this is deferred until the fourth experiment. The two goals were to test the magnitude of voluntary control over priming and to compare it with the priming produced by implicit demand in experiment I.

Method

Participants

Thirty undergraduates from the University of Toronto at Scarborough volunteered for either course credit or a payment of five dollars. They were screened for English language use.

Materials & Apparatus

The same materials and computer were used as in experiment I, with only the long SOA, and fifty percent relatedness condition represented.

Design

A mixed factorial design was used with target type (related word, unrelated word, and non word) as a within-subject variable and instruction (to prime or not to prime) as a between participant variable.

Procedure

In most respects the procedure matched that of experiment I. On each trial a fixation point was presented for 200 ms, a prime word was presented for 250 ms, and a target word followed after a 1250 ms delay. Target words were related to the prime words on 50 percent of the trials, there were 30 practice and 150 experiment trials.

Half of the participants were instructed as follows:

> "This is a study about priming. Words are going to be presented one after another. Priming occurs when you can deal with related pairs of words faster than unrelated pairs. The computer will present trials one at a time as follows. First, an asterix * will appear to notify you that a trial is beginning. Then, a first word will appear. Think about this word. Thinking about this first word and related words will help you respond to the second word. When the second word appears, press the YES key if it is a proper word and the NO key otherwise. You will be given a demonstration and some practice."

The other half were instructed:

> "This is a study about priming. Words are going to be presented one after another. Priming occurs when you can deal with related pairs of words faster than unrelated pairs. The computer will present trials one at a time as follows.

First, an asterix "will appear to notify you that a trial is beginning. Then, a first word will appear. When you see this word be careful not to think about any other words. You may not ignore the first word, but do your best not to repeat it to yourself or think about any related words. When the second word appears please press the YES key if it is a proper word and the NO key otherwise. You will be given a demonstration and some practice."

Results

The means for correct decision latencies are presented in Table 4. The means are based on data for correct reaction times longer than 300 ms, trimmed at three standard deviations above the participants' mean (less than 3% of the data), with the practice trials removed. No participants were removed from this data set on the basis of either the English use questionnaire or on the basis of errors.

Priming was greater in the 'instructed to prime' condition than in the 'instructed not to prime' condition, F (1,28) =4.48, p=.043, MSE=2250.1. The variability in priming is also much greater in the prime condition than in the don't prime condition, χ^2 = 10.6, p<.01. Post-hoc, the difference between latencies in correct responses to non-words did not differ between conditions, F<1.

Table 4

Mean (and SD) correct response latencies by instruction and target type in experiment II

Instruction	Related	Unrelated	Priming	Nonwords
Prime	598	664	89	797
	(108)	(154)		(144)
Don't Prime	587	602	20	839
	(94)	(98)		(224)

The priming found in the don't prime condition was not significantly different from that found in the 20% and 50% relatedness proportions in experiment I, $F<1$. However, the expected power for this comparison is very low (Beta > .5). Priming in the please prime condition was not significantly different from that found in the 80% relatedness proportion condition of experiment I, $F<1$.

Table 5

Comparison of priming in experiments I (at SOA 1500 ms) and II

	Experiment I	Experiment II	
R.P.		Instruction	
20	47	Prime	Don't prime
50	30	89	20
80	96		

The pattern of priming in which priming appears to be a result of a cost in responding to unrelated targets appears to hold, although there is no terribly strong argument for assuming that the don't prime instructions creates a control condition.

Errors

The number of errors did not differ significantly by condition, $F<1$.

Table 6

Mean proportion of errors by instruction and target type in experiment II

Instruction	Related	Unrelated	Nonwords
Prime	.00	.02	.03
Don't Prime	.01	.02	.04

Discussion

The second experiment differed from the first in that an explicit manipulation of attention was used. The finding was that participants asked to pay attention to the relatedness of prime and target showed more priming than did those asked to not pay attention to it. The implication is that strategic processing of related pairs is voluntary. And, by virtue of the task used, one can be reasonably certain that the strategic processing employed depended upon monitoring for prime related words. First of all, there are no other obvious demands placed upon the participant. There were no other instructions or tasks to engage their attention, and finally, monitoring would be required to explain the pattern of priming by increased cost to unrelated word targets in any case.

Wegner (1994) uses two examples of mental control. In one, a participant is asked to suppress a thought - presumably leading to conscious attention to other thoughts and unconscious monitoring for the reoccurrence of the suppression target. In

the other, a participant asked to concentrate on a thought is presumed to direct their attention to it, while monitoring for other thoughts. In this latter case no justification is given for separating the type of process used to direct one's attention from monitoring as used in the first instance. In both cases a participant is looking for the activation of a word. Wegner's argument depends upon a distinction between automatic and controlled uses of monitoring. Experiment II shows that an explicit direction of attention gives the same effect as an implicit one.

Wegner's characterization of the monitoring process as automatic may not be appropriate. Participants asked to think about related words showed more priming than those asked not to. This demonstration of the voluntary nature of expectation suggests that hyper-accessibility as caused by monitoring may be equally voluntary.

In the broader literature monitoring is always considered to be voluntary. Looking for something requires effort. The result of experiment II is consistent with this view and not with that of Wegner (1994). The popular definition of automaticity (Posner & Snyder, 1975; Neely, 1988) is that a process be unconscious, fast acting and resource free. In this sense, the conscious control demonstrated in this experiment raises a question about the unconscious nature of monitoring. Experiment IV tackles the question of resource dependancy more directly.

EXPERIMENT III

One possible shortcoming of experiment II lies in the possibility that participants asked not to pay attention to prime relatedness chose to ignore the prime rather than read it. This would make a poor test of the ironic processes theory. Experiment III

addressed this possibility by adding a prime animacy task. Requiring participants to respond to the prime on some trials increases the likelihood that they will read the prime. The explicit directions to prime or to avoid priming were left intact.

Method

Overview

This is essentially the same as experiment II, save that a secondary prime task helps ensure participants in the 'do not prime' condition are not ignoring the primes.

Participants

Twenty-six volunteers were recruited from the University of Toronto at Scarborough as per Experiments I and II.

Materials & Apparatus

The materials and apparatus were the same as those used in experiments I and II.

Design

A mixed factorial design was used, with target word type (related words, unrelated words, and non words) as a within factor and instruction as a between factor.

Procedure

The procedure was the same as in experiment II except that after the first three practice trials participants were told additionally instructed that on some trials a '?' would appear after they had made their lexical decision. This was to indicate that they should press the YES key if the prime was something living and NO otherwise. This prompt occurred randomly on 33% of trials.

Results

As per experiments I and II, means are based on correct responses following a practice period (30 trials) and trimmed to three standard deviations above the participants' individual means.

Table 7

Mean response latencies (SD) by target type in experiment III.

	Related	Unrelated	Priming	Nonwords
Prime	761	889	128	890
	(196)	(310)		(253)
Don't Prime	756	777	21	984
	(186)	(207)		(230)

Priming

There was more priming when participants were asked to prime than when they were asked not to, $F(1,25)=5.52$, $p=.027$, $MSE=4841$. The strength of the expected interaction is obvious when one considers that priming exceeded 100 ms in the directed to prime condition, $F(1,13)=9.75$, $p=.008$ and fails to reach significance in the directed not to prime condition, $F(1,12)=1.42$, $p=.256$.

Non-words

The difference in instructions did not lead to any change in the mean time to respond to non-words, $F=1.02$, $p=.322$. This suggests that the effect of instructions is not due to a simple change of response bias.

Error Data

Table 8

Mean number of lexical decision errors by target type in experiment III

	Related	Unrelated	Nonwords
Prime	.01	.01	.04
Don't Prime	.01	.02	.03

Overall, errors occurred on about 3% of trials. The difference in pattern between the two conditions is not significant, F (2,24)= 1.48, p=.22. A post hoc test of the effect of condition on unrelated target error rates shows no difference, F<1.

Prime animacy judgement

The average accuracy in prime animacy judgements exceeded 95%, a clear ceiling effect which was not related to condition, F<1. Judging from the elevated lexical decision error rates and slower overall reaction times, the participants were most likely concentrating on the animacy task at the expense of the lexical decision task.

Discussion

Experiment III reproduced the most important result of experiment II - that priming in this experiment is at least partly voluntary. Adding the prime animacy task created three salient differences. First, we have higher confidence that participants made an effort to read the primes in all cases. Second, mean reaction time was considerably slower for related and unrelated word targets than was the case in experiment II. Finally, priming in the 'please prime' condition was increased.

One interpretation of the slowed response times is that the requirement to remember whether the prime was animate acted as a mental load. Within this interpretation, the finding that priming could actually increase in the presence of a load is sufficiently provocative to warrant experiment IV, in which the lexical decision task is combined with a mental load not related to the primes.

Another interpretation is that participants literally paid less attention to the explicit directions to attention. The support for this notion comes from the fact that the combination of 'please don't prime' instructions and an additional task do not decrease priming, even though the tertiary task should have improved distraction from prime target relatedness.

Attention theory cannot account for an increase in priming under mental load, since any effect of such a load would be to remove attentional resources from consideration of prime target relatedness. Wegner's theory, on the other hand, suggests that mental load should not affect priming caused by monitoring. The third possibility, that priming really does increase in this situation is not explicitly dealt with by either theory, but is consistent with previous evidence for hyper-accessibility and rebound effects.

EXPERIMENT IV

According to the first three experiments, implicit and explicit instructions to monitor relatedness between primes and targets seem to have the same impact. Since it is more parsimonious to hypothesize a single type of monitoring used as needed in all tasks than to hypothesize different kinds of monitoring appearing in each experiment, it

is reasonable to use explicit instructions to produce monitoring on demand, and expect the results to generalize across situations since the theory of ironic processes is a general theory of mental control. In test of that theory, a small mental load is added to the directions to monitor. According to Wegner (1994), monitoring should be relatively unaffected by additional mental load.

Method

Overview

This experiment combines explicit directions to prime or to not prime with a mental load.

Participants

Twenty volunteers were recruited from the University of Toronto at Scarborough.

Materials and Apparatus

The materials and apparatus were the same as in experiments I, II, and III.

Design

A mixed factor design was used with target type as a within factor and instruction condition as a between factor.

Procedure

The procedure was the same as in experiment II except that the presentation of each lexical decision trial was preceded by the display of a randomly generated four digit number. The number stayed on the screen until the participant pressed a key. After the lexical decision they were then required to type the number in.

Results

The data are presented in Table 9. Once again, means are based on correct latencies after a practice period (30 trials) trimmed to 3 standard deviations above the participants' individual mean. Errors were present on less than 1% of trials.

There is no significant difference in priming between the two instructional conditions, $F<1$. Post hoc, no instructional differences were found between reaction times for related, unrelated, or non-word targets, $F<1$. But, overall priming was significant, $F(1,18)=17.2$, $p<.001$, $MSE= 333$.

Table 9

Mean response latency by target type in experiment IV

Instruction	Related	Unrelated	Priming	Non-word
Please	**873**	**934**	**61**	**1088**
Prime	(174)	(182)		(183)
Please.	**822**	**868**	**46**	**996**
Don't	(204)	(183)		(262)

Comparison to experiments I,II, and III is difficult because the overall latencies are so much slower in experiment IV. On the basis of the magnitude of priming alone, voluntary priming is not significantly less under load in experiment IV than in experiment II, $F(1,28)=3.03$, $p>.05$, $MSE= 518$. Using the general ANOVA error term, the reduction is significant $F(1,28)=4.01$, $p<.05$. The observed results are consistent with a decrease in priming in .87 of bootstrap samples. Priming in the please don't prime condition of experiment IV was not different than that in the low demand conditions of experiments I and II, all Fs <1.

Discussion

The fourth experiment again used the same method as experiment II, save that participants were also asked to remember a random four digit number on each trial. This task was not difficult - participants made errors on fewer than one percent of trials - but did influence priming. In fact it eliminated the difference between priming in the two instructional conditions.

The simplest explanation for equal priming in both instructional conditions is that the mental load disabled explicit direction of attention (following of instructions) but left the demand characteristics (using the obvious presence of related pairs) intact. Based on experiment I, a participant given only implicit instructions about relatedness and a proportion of related prime-target pairs being fifty percent might be expected to show about 45 ms of priming (this is based on a best linear unbiased estimate using data from both SOA). If the relatedness proportion places an implicit demand to either pay little, some, or a lot of attention to relatedness, and mental load disabled the explicit demands made by the instructions, then the simplest explanation is that the priming in experiment IV is essentially the same as the implicitly requested priming of experiment I. The fit between the two reaction times is again held to be almost exactly as expected given the relatively slower reaction times present in experiment IV.

The theory of ironic processes suggests that efforts at concentration or suppression are both susceptible to ironic effects of mental load. On the face of it, the decrease in intentional priming and increase in unwanted priming fit this description perfectly. In previous experiments, a participant asked not to think about something was

hypothesized to be monitoring for its activation. In the present experiment, a participant monitoring for a target word is offered a distraction yet shows increased priming. Did the instruction to not prime set up an automatic monitoring process for prime and target relatedness?

A positive response concludes that priming in the please don't prime condition of experiment IV would be lower without the mental load. There is no statistical evidence for the claim, but the mean priming is higher and this remains a possibility to be investigated in future research.

A better question is whether the instructions to the participants actually set up opposing processes. When a participant is asked to prime, they are led to first generate a target word, then to look for it's presentation. Had they been asked to suppress this word, there may be both an operating process trying to think of other things and an automatic monitoring process activating this target word. In the present situation, asking participants to expect and look for related word targets may lead to equivalently opposing processes. In this case, one might expect that a mental load could tilt the balance in favour of more or less priming. But explicit demands to not prime do not result in priming different from the less complex case of a weak implicit demands to prime, suggesting that no such opposing balance of processes occurs in response to the explicit demands of experiment II, III, and IV. Additionally, priming did not differ in the 'don't prime' conditions of experiments III and IV, indicating that increases in attention to a target had the same effect as a distraction. It is, therefore, difficult to distinguish between unintentional priming ironically increased by mental load and

priming caused by relatedness and a mental load inspired release from the directive not to prime.

In comparison, attentional theory would predict an overall reduction of strategic priming, as was found. It would also predict that a small mental load would either have a negative impact upon unintentional priming or no impact at all. As already suggested, the increase in priming when asked not to prime may be attributed to participants simply forgetting or neglecting to follow instructions, but the amount of priming (61 ms when asked to prime) is large enough that it would normally have been expected only as a result of conscious strategy and controlled processes. For a point of comparison, the low relatedness condition in experiment I suggests that inattention to prime-target relatedness should lead to priming on the order of 20 ms. Why should participants asked not to pay attention to relatedness do so increasingly when they are kept otherwise busy?

The simple conclusion is that the experiments are somewhat incommensurate due to different target generation and lexical decision criteria shifting at long reaction times. A more balanced response is that the theory of ironic processes simply cannot describe which processes are likely to be involved in any particular task, since the distracting loads in experiments III and IV seem to have quite different effects. For example, not thinking about an unpleasant thought could be difficult if one divided one's attention between monitoring for it and distracting oneself, but the implicit demand not to think about something unpleasant would require no such balance of processes, and would be relatively easy.

General Discussion

According to Wegner (1994), monitoring is automatic in the sense of being unaffected by distractions or mental loads. Wood and Cowan (1995) claim that attention in a monitoring task is limited. This thesis contrasts the two views across a series of experiments, then attempts to link each with the broader literature.

The theory of ironic processes depends upon the claim that a conscious attempt to direct attention will be more compromised by mental load than an automatic monitoring effort. The increase in priming when participants were asked to prime is consistent with both the theory of ironic processes and attentional theory. The decrease in priming when participants were asked not to prime may be interpreted in two different ways. If participants were actively inhibiting or strategically decreasing their priming in experiments II and III, yet unconsciously monitoring (looking for related) target words, then the counter-intuitive increase in priming when a participant asked to not prime is given a mental load was predicted. However, if participants asked not to prime began to prime under mental load because it lead to their increased sensitivity to the demand characteristic created by the proportion of related pairs then the theory is contradicted. No participant ever revealed a strategy for decreasing priming when debriefed. Additionally, the don't prime instruction group did not show the significantly slower reaction times which would indicate such conscious decisions.

The interpretation that the implicit demand characteristics of relatedness proportion in a lexical decision task lead to the processes (including monitoring) necessary for priming is simpler than ironic processes theory. The theory of attention

being driven increasingly by demand characteristics when load interferes with instruction can also be applied to other studies. For example, the interaction of instruction and time pressure in Wegner and Erber (1992) was interpreted to mean that a relative balance of controlled and automatic processes had been differentially affected by time pressure. In fact, the concentration group gave fewer target responses when time pressure was added, but the suppression group gave more. A demand characteristic interpretation would suggest that participants in the concentration group paid attention either to the target or to the deadline, while the suppression group paid attention to the instructions when time pressure was low but paid attention to the target when pressure was high.

Experiment IV does not provide a conclusive test of the ironic processes theory, but it is suggestive of problems with that theory's potential for falsification. It should also be noted that none of the conventional accounts of the relatedness proportion effect (Neely, 1991) would have directly predicted the impact of both instructions and mental load either. Each of those accounts of priming require a participant to attend to the relatedness of prime and target. The claim that such attention is strategic seems at odds with its occurrence both with and without mental load. Assuming (as per experiment I) that priming is primarily a result of expectation of prime target relatedness, and that this expectation lead to the looking for particular target words, then the increase in priming by participants asked to not prime yet given a mental load is again most clearly understood as participants disregarding explicit instructions when challenged but retaining data driven implicit demands. This account is similar to that

used in other cases of conflict between implicit and explicit demands (Erdelyi, 1990).

However, if participants did not disregard the instructions but rather attempted to suppress prime-target relatedness, then the theory of ironic processes predicts and increase in priming - a result which cannot be ruled out with the present data.

Explicit directions to prime were significantly harmed by the digit memory task in experiment IV, relative to experiments II and III. In this sense it appears that monitoring can be interfered with by mental load. Mental load led to an increase in priming when participants were asked not to prime. It is this which presents the greatest challenge to ironic processes theory.

Hyper-accessibility and the rebound effect

In the context of the above results it is important to revisit the phenomena of interest. If priming is a good measure of the hyper-accessibility of target thoughts, then that effect can be generated by experimental demand. Both implicit (RP effect) and explicit instructions lead to this conclusion. However, the assertion that monitoring is unaffected by mental load is only partially supported.

The failure of Gildston (1998) and others (Lavy & van Hout 1994; Conway, Howell, & Giannopoulos, 1991; Merckelbach et al., 1991; Rutledge, Hollenberg, & Hancock, 1993; et cetera) to find the rebound effect can now be attributed to differing levels of experimental demand as well as differences in populations, stimuli, and methods. Most importantly, the rebound effect is unlikely to be either general or common in everyday life.

Wegner and Erber (1992) used the Stroop task to measure priming due to hyper-accessibility. This has turned out to be an unfortunate choice since the longer reaction times to targets could be caused by almost anything (surprise, distraction, meta-cognition). In the lexical decision task, where priming is measured by facilitation of response, all such factors tend to reduce the effect size. The methods of the current study lead instead to the conclusion that hyper-accessibility is voluntary, not automatic. As far as monitoring is impaired by mental load, circumstances in which the theory of ironic processes should be trusted will be incredibly rare. Ordinary life has enough distractions and demands that a precise balance between activating and suppressing processes will almost never occur. For example, as much trouble as one might have trying not to think about a cat, it would be completely obviated by the distraction provided by a television set. If the critical test is simply the level of threat or negative affect afforded by the target thought (imagine trying not thinking about a dissertation) then this is critical to the theory and outweighs any aspects of monitoring and load.

The present study suggests that while monitoring might produce hyper-accessibility, it does not necessarily do so, and that vicious circles of monitoring and activation are not a natural outcome. The theory of ironic processes might describe a circumstance only applicable in laboratories with minimal distraction. Monitoring processes can be used to create a more general description of experimental demand in situations whose characteristics might be more simply explained as opposed or unopposed demands to monitor. For example, emotional Stroop tasks are often done with highly salient context words (food related words for a dieter). More controlled

studies find it difficult to generate interference by mere repetition (activation) of target words. Wegner and Erber (1992), having preceded their Stroop test by a five minute period of monitoring, did find Stroop interference, but cannot discriminate between the causes of interference based on both implicit and explicit demands for attention.

Summary of Results

This thesis has examined evidence for a key premise in Wegner's theory of ironic processes. The theory of ironic processes depends upon the claim that monitoring is an automatic process capable of generating activation in target words. The present study found that priming could be voluntarily controlled in the lexical decision task. This increase could be countered by mental load. The lexical decision task at long SOA provides an opportunity for participants to predict and then monitor for the appearance of an expected target word. The impact of mental load is, therefore, contrary to the assumption of ironic processes theory.

Participants asked not to prime showed increased priming under this same mental load. Unlike the request to suppress a thought, the instruction to not prime was explicitly centred upon the direction of attention. It makes sense that strategic processes involved in avoiding priming could be interfered with by a mental load. The size of the priming which resulted poses a problem for attentional theory, which would not have predicted its increase under mental load.

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Appendix A - Stimuli

Related word pairs	east west	sit stand
boy girl	under over	wet dry
table chair	beautiful ugly	young old
dresser chest	ceiling floor	orange apple
couch sofa	rich poor	plum peach
stool bench	hard soft	pea corn
lamp mirror	find lose	bacon eggs
fridge stove	here there	scotch whiskey
washer dryer	black white	chocolate milk
carpet rug	boy girl	bread butter
up down	shallow deep	salad dressing
high low	hate love	bake cake
hot cold	in out	cabbage lettuce
her him	large small	crust pie
man woman	minor major	vegetable fruit
lost won	live die	mutton lamb
left right	on off	salt pepper
bitter sweet	sell buy	king queen
column row	sickness health	red blue
thin fat	slow fast	doctor nurse
north south	smooth rough	lawyer judge

teacher student
mother father
brother sister
criminal police
captain general
soldier army
coffee tea
early late
hips legs
mouth teeth
eye ear
hand thumb
head foot
heel toe
skin bone
cars trucks
boat plane
dagger sword
gun shoot
run walk
dress shirt
skirt blouse

pants slacks
jacket coat
shoes boots
rifle pistol
cardinal starling
canary dove
dog cat
butterfly moth
morning paper
window sill
door knob
city town
hammer nail
house home
heal wound
jump leap
kind nice
human being
justice peace
leaf tree
loud noise
needle thread

spider web
thief steal
tobacco smoke
whistle blow
dance waltz
toast jam
many some
rubbish waste
print write
spring fall
storm cloud
choir song
land sea
brain wave
bath clean
foggy clear
scissors cut
thirsty water
people crowd
roof top
green grass
few most

library books	stupid smart	beer wine
speak talk	bow arrow	day night
path way	birthday candle	wrist watch
look listen	oyster pearl	moon sun
give take	nose smell	school bus
marriage divorce	minute hour	circle square
birth death	altar church	flower rose
bounce ball	seafood lobster	music jazz
fire place	snack candy	snake cobra
nephew niece	fish salmon	drug heroin
pool swim	money dollar	game chess
scout honour	disease cancer	month april
fork knife	toy doll	metal iron
now never	weather rain	sport hockey
danger safe	bird robin	vehicle truck
heaven hell	fuel oil	winter freeze
saint holy	cloth cotton	lemon sour
goose duck	gem diamond	phone number
ham pork	wedding ring	reality fantasy
empty full	brush hair	mouse cheese
sad happy	maple syrup	anger mad
snow ice	pen pencil	baby cry

bed sleep
bible god
children kids
closer nearer
come go
command order
cottage dock
dark light
make do
he she
hardly ever
faster slower
farther away
eating food
easier harder
dream sleep
trouble bad
to from
they them
then now
that this
street road

you me
with without
who whom
was is
very much
see eyes
so what
nylon stocking
burglar alarm
vitamin mineral
difficulty easily
spin whirl
error mistake
wind blew
stupid jerk
short dwarf
stripes zebra
adjective verb
silk scarf
mass hymn
tie knot
pension retire

wealth power
weak strong
cope endure
sharp dull
cement brick
mitten glove
broom swept
forgive pardon
rule govern
wolf howl
team coach
different alike
begin quit
nun priest
beat whip
turn twist
field meadow
ruler emperor
illusion image
allowance exception
air fan
fear horror

compromise agreement
carve slice
tire rubber
employee staff
borrow lend
differ
contrast
capture trap
shore tide
sheets linen
earth globe
calm anxious
penny copper
good luck
afraid scared
controversy argument
fraud fake
glue stick
grasp hold
grow plant
arm leg
country nation

expose show
foreigner stranger
lift carry
lion tiger
play games
shine shoe
wish want
lining coat
memory think
pavement sidewalk
porthole ship
satellite space
why because
knight gallant
abundance excess
refuse invite
novel author
presidential campaign
independent helpless
alone lonely
mister mistress
office building

cheap costly
continental foreign
sheep shepherd
fiddle violin
weeping willow
wool blanket
officer sergeant
deal offer
dinner supper
aunt uncle
evil darkness
attack assault
fight quarrel
act perform
prince noble
cook kitchen
vacation resort
robber sheriff
direction compass
material fabric
sew button
witty cunning

awake asleep	dispute resolve	withprawn
zoo keeper	train aboard	bintry
poisonous deadly	guard protect	lindow
innocent maiden	weird crazy	hearg
purple amethyst	beef cattle	ficked
argue complain	bald eagle	phistle
antique ancient	education college	welk
fight struggle	dew moisture	geapon
greet welcome	romance passion	waher
scream whisper	critical fatal	suphly
wheat prairie	fashion model	baxy
cross angry	thanksgiving turkey	smode
horse stable	above below	maph
gold silver	Nonwords	soant
wishful envy	zebro	rafety
flawless perfect	youch	galivo
murder victim	yonter	salbow
lightening thunder	yiels	riblon
bore excite	wreng	hatire
leave depart	freck	satip
rot decay	wounp	saxing
freezer frozen	wonger	sawler

scage	cailing	mivil	strikt	taim
scolp	salap	zippet	frewed	trupe
sparlet	salibate	yesterdan	preem	
scraye	bavage	yellop	bispuit	
quatify	acald	seast	baik	
quaster	scotter	feveg	dait	
ranz	irchin	wrinkli	eest	
sandim	seasing	wreech	fome	
betchip	quaprant	worre	fraim	
droblem	quangum	wirking	frute	
oliur	ripine	mitness	gail	
plaik	rarelo	sithdrawal	gote	
hobrid	renge	titch	greef	
pakent	vioneer	galgery	heer	
repont	pouthwash	wadow	jale	
objest	brocure	shele	knea	
zound	meam	shispor	myne	
hinal	mayzem	geight	nale	
cifty	scatab	welfane	neer	
onsect	parrit	beather	saif	
sabogage	harth	weelth	roed	
soddle	plaboon	watar	stoan	

Appendix B - Participant survey

This material will be kept entirely confidential. Furthermore your name will not be attached to this form. If you prefer not to answer any of these questions feel free to skip them.

Age ____
Sex M F
Handedness L R

First language _____
Number of years you have been speaking English _____
Number of years you have been reading English _____
% of your day spent using English as opposed to other languages 10 20 30 40 50 60 70 80 90 100

Which languages did you use in school
[] English schooling only
[] French immersion
[] Primary schooling was in _____

How many English language books do you read for entertainment each year _____.