The Role of Prime Distractor Fluency in Negative Priming

by

Danielle Irène Marie Labossière

A Thesis submitted to the Faculty of Graduate Studies
of

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in partial fulfilment of the requirements of the degree of

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Master's Thesis/Practicum Final Report

The undersigned certify that they have read the Master's Thesis/Practicum entitled:

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submitted by

Danielle Irène Marie Labossière

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The Thesis/Practicum Examining Committee certifies that the thesis/practicum (and oral examination if required) is:

Approved

(Approved or Not Approved)

☑ Thesis ☐ Practicum

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Abstract

Negative Priming (NP) is a cost in speed of response to a target in a probe display, to which a response was withheld during a previous prime display. NP is often attributed to the inhibition of highly interfering intact distractors (Grison & Strayer, 2001). In the current study, the perceptual fluency of the critical items was manipulated in three ways to test whether NP depends on a match in the perceptual form of a prime distractor that repeats as the probe target, or whether it depends on a prime distractor being intact. NP was found to be contingent upon the presentation of the critical items in the same perceptual form, regardless of the perceptual status of the prime distractor. Repetition of form between the critical items was also found to influence NP, separate from the influence repetition of word identity. The findings suggest that NP is a byproduct of memory retrieval processes.

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CHAPTER 1

INTRODUCTION

Negative Priming Effects

In the past, techniques employed to examine the influence of previously ignored information on subsequent performance have consisted of probe events that contain some form of conflict between the attended and ignored dimensions of the stimuli (Fox, 1995). For example, effects similar to those of negative priming (NP) have been observed with the Stroop (1935) colour-word task. In that task, participants are presented with colour words that are either printed in an incongruent font colour (e.g., the word *YELLOW* printed in blue font) or a congruent font colour (e.g., the word *GREEN* printed in green font). The typical finding is that participants are significantly slower in naming the font colour of incongruent than congruent colour words.

A number of Stroop-like tasks have been used to demonstrate and examine NP effects (Dalrymple-Alford & Budayr, 1966; Little & Hartley, 2000; Lowe, 1979, 1985; Milliken, Lupianez, Debner, & Abello, 1999; Neill, 1979; Neill & Westberry, 1987; Tipper & Cranston, 1985). For example, Neill (1977) required participants to identify the colour of successive incongruent Stroop stimuli on each of a series of trials. Two types of trials were used. In the first type, the colour of the current Stroop item matched the identity of the colour word presented in the previous display (e.g., the word *RED* printed in green font presented after the word *GREEN* printed in blue font). In the second type of trial, the colour of the current item was not related to the identity or colour of the word that appeared in the previous display (e.g., the word *RED* printed in green font presented after the word *YELLOW* printed in blue font). Neill observed that colour identification responses to the second display were slower when that response matched the identity of the distracting word in the preceding display, illustrating that current responding can be impaired by having withheld that response during an immediately preceding event.

Flanker tasks have also been used to examine the impact of previously ignored information on current processing. In these tasks, participants must respond to a target item presented in the center of two items that are either the same or different from the central target. When the two flankers are different from the target (e.g., *HSH*), response to the target is slower than when the two flankers are the same as the target (e.g., *SSS*). If during one trial (*QBQ*), the flankers (*Q*s) must be ignored and the target (*B*) named, and in the subsequent trial (*HQH*), *Q* serves as a target to which a response is required, performance will be negatively impacted. In this case, a NP effect reflects how irrelevant flanker items can later impede responding when they are repeated as the probe target in the following trial (Driver & Tipper, 1989; Eriksen & Eriksen, 1974).

NP effects have also been commonly observed with the identity priming procedure, during which a response to a target is required during both an initial prime display and a subsequent probe display. In each display, a to-be-attended target is presented simultaneously with a to-be-ignored distractor. The relationship between the initial display and the display that follows is used to measure both facilitation and impaired responding based on the presence of a stimulus in a prime display. That is, to examine the critical influence that a prime stimulus can have on later processing of an identical target item that appears in a subsequent display (Fox, 1995; Tipper 1985), three conditions are usually employed. First, there are trials for which all items in both the prime and probe displays are unrepeated and unrelated (*unrepeated trials*). Second, there are trials in which the attended target from the prime display repeats as the attended probe target (*attended repetition trials*). Third, in critical trials in which NP typically occurs, the unattended prime distractor repeats in the subsequent probe display as the attended target (*ignored repetition trials*). Typically, mean response times (RTs) are significantly faster on unrepeated than on ignored repetition trials, providing evidence of negative priming. Similarly, mean RTs to probe items on attended repetition trials are often faster than on unrepeated trials, revealing the positive effect of having recently responded to a stimulus on participants' speed at responding to that same stimulus when it appears again as the probe target.

This last procedure was inspired by an experimental task designed by Tipper (1985). In his study, pairs of superimposed line drawings were presented. In a given trial, for instance, the target was drawn with a solid line (traced over twice) and presented in red colour (e.g., a red kite), and the distractor was drawn with a single thin line and presented in green colour (e.g., a green trumpet). The lighter outline of the distractor item was intended to reduce its salience and, thus, interference that the irrelevant drawings could produce. Participants identified the red target item in the prime display, while ignoring the item outlined in green. During the subsequent probe display, participants were again given the task of naming the object outlined in red. Tipper employed four types of conditions to examine how attended and ignored information are differentially processed. In unrepeated trials, both targets and distractors in the prime and probe display were drawings of different objects (e.g., a red trumpet superimposed on a green kite in the prime display, and a red anchor superimposed on a green foot in the probe). During attended repetition trials, the prime consisted of a red target superimposed on a green distractor, and the probe consisted of the same red target as appeared in the prime display, superimposed on a different distractor item (e.g., a red baseball glove and a green kite in the prime, and a red baseball glove and a green anchor in the probe). On ignored repetition trials, the prime contained a green distractor drawing that repeated as a red target in the subsequent probe display (e.g., a red guitar superimposed on a green kite in the prime display, and a red kite superimposed on a green foot in the probe display). Finally, ignored semantically-related trials were similar to ignored repetition trials; however, rather than the green distractor item in the prime repeating as the red target item in the probe, the red probe item was instead semantically related to the green prime distractor (e.g., a red table and a green hammer in the prime display, and a red wrench with a green guitar in the probe display). Tipper found identification responses were slower for ignored repetition trials, when probe targets had been presented as the distracting images during the prime event. Similarly, responses were slower when the probe targets shared a semantic relation with the prime distractors.

Robustness

An abundance of research on the topic of NP has revealed the robust nature of the effect. It has been observed using a variety of stimuli such as letters (Allport, Tipper, & Chmiel, 1985; Tipper & Cranston, 1985), words (Malley & Strayer, 1995), line drawings (Tipper, 1985), nonsense shapes (DeSchepper & Treisman, 1996; Leboe & Milliken, 2004), shapes sharing similar physical characteristics (DeSchepper & Treisman, as cited in Neill, Valdes, & Terry, 1995), and with words (Grison & Strayer, 2001, Malley & Strayer, 1995) or letters (Neill, Lissner, & Beck, 1990) presented in the same case.

Similarly, rather than being observed only during performance of specific tasks, NP is also a phenomenon that has been observed with a number of different tasks, such as word categorization (Tipper & Baylis, 1987; Tipper & Driver, 1988), spatial localization (Milliken, Tipper, Weaver, 1994; Park & Kanwisher, 1994; Tipper, Brehaut, & Driver, 1990), making a lexical decision (Yee, 1991), identification (Allport et al., 1985; Chiappe & MacLeod, 1995; Kane, Hasher, Stoltzfus, Zacks, & Connelly, 1994; Malley & Strayer, 1995; Strayer & Grison, 1999; Tipper, 1985; Tipper & Cranston, 1985; Tipper & Driver 1988), same/different matching (DeSchepper & Treisman, as cited in Neill et al., 1995; DeSchepper & Treisman, 1996; Leboe & Milliken, 2004; Neill et al., 1990; Neill & Valdes, 1992; Wood & Milliken, 1998), reaching (Tipper, Lortie, & Baylis, 1992), and counting (Driver & Tipper 1989). Even more impressive is that the effect has also been observed regardless of participants being required to switch between making vocal or manual responses across trials (Tipper, MacQueen, & Brehaut, 1988), or when prime distractors were first presented in one modality in a prime display (e.g., the spoken word *QUEEN*, heard through earphones) and then presented in a different modality during the probe event (e.g., the word *QUEEN* on a computer screen) (Driver & Baylis, 1993). NP has also been found when the identity of an ignored prime distractor presented as a line drawing (a drawing of a guitar) matches the identity of a probe target word (the word *GUITAR*) (Tipper, 1985; Tipper & Driver, 1988). It has also been documented with purely auditory stimuli (Mondor, Leboe, & Leboe, 2005). Withholding a response to a prime distractor that is semantically related to an attended probe target has also led to NP (Tipper 1985; Tipper & Driver 1988; Yee, 1991). In addition, NP has been observed in a number of studies regardless of there being either a few, or numerous intervening events

(DeSchepper & Treisman, 1996; Milliken, Joordens, Merikle, & Seiffert, 1998; Tipper, Weaver, Cameron, Brehaut, Bastedo, 1991). On the basis of such evidence, NP appears to be a very robust effect, suggesting that it may be produced by a fundamental cognitive mechanism that contributes to performance across a broad range of contexts.

Selective Allocation of Attention

However robust it is, NP is not invariable, and certain conditions have been proposed as necessary for NP to surface. A large portion of the literature on NP has involved the use of selective attention tasks in the study of NP. In these tasks, participants are required to select and respond to a target item while simultaneously ignoring a distractor item during a prime event. For example, in Tipper's (1985) procedure, a participant might be presented with a line drawing of a red table superimposed on a line drawing of a green ball. The participant's task is to attend to the red drawing and identify it aloud. During the subsequent probe event, participants face the same requirement to respond to a target stimulus in the presence of a distractor. When the probe target is the same or is related to the stimulus that was presented as a distractor in the previous display, NP is often observed. Underlying the popular use of selective attention tasks in the study of NP (Neill & Kahan, 1999) is the notion that NP may arise from a mechanism involved in resolving a conflict during the prime event, enabling responses to be determined by the prime target and not the prime distractor (Allport et al., 1985; Lowe, 1979; Tipper & Cranston, 1985). The accomplishment of differentiating between to-be-attended and to-be-ignored items later affects processing of these items (DeSchepper & Treisman, 1996; Tipper, 2001). From this perspective, NP observed at the time of the probe event reflects participants' prior success in ignoring distracting information when responding to the prime target.

Slow responding on ignored repetition trials may reflect the fact that the underlying representation corresponding to an irrelevant item is either temporarily unavailable, or available to a lesser extent, as a function of overt inhibition of the distracting stimulus when it appeared in the prime display (Neill, 1977). It is this suppression that is thought to promote selective processing of the attended target (Tipper, 1985). By implication, the need to respond to a target stimulus in the presence of a distracting stimulus at the time of the prime event was originally considered essential for the observation of NP effects (DeSchepper & Treisman, 1996; Tipper, 1985; Tipper & Cranston, 1985; Treisman, 1969). This framework for accounting for NP effects is often referred to as the distractor inhibition account (Milliken et al., 1998).

One cannot ignore the fact that the allocation of attention greatly influences priming effects. For example, when a cued prime is attended it can lead to facilitation, but to NP when ignored. How to interpret this pattern is more problematic. Some research suggests that attended items are processed to a greater extent and that the internal representations associated with ignored stimuli may be inhibited (Ortells & Tudela, 1996). Similarly, Tipper and Driver (1988) found NP to occur within and across the symbolic domains of pictures and words, and interpreted this as evidence that the images presented as distractors were being inhibited at a level beyond physical characteristics. It is worth noting, however, that such findings only indicate that distractor items are processed more than first assumed. In no way do the findings indicate that such information is necessarily inhibited to prevent further processing. For example, Dark &

Schmidt (2000) presented a distractor word in the prime display that was semantically related to the probe target word. The study examined whether activation of internal representations associated with both items presented during the prime is taking place, with the target selected for further processing and the distractor receiving inhibition. Specifically, the authors investigated whether the inhibition that was applied to the prime distractor would also be applied to the related probe target, giving NP, as would be expected by an account that assumes that inhibition spreads to representations of related concepts in memory. Instead, facilitation was observed, which brings into question the widespread notion that internal representations are activated based on the selection of a prime target, and that they are inhibited to the extent that they match or are related to a distracting prime stimulus.

In addition, a number of studies illustrate that it is actually unnecessary for a prime display to contain both a distractor as well as a target in order for NP to surface during the probe event (Fuentes & Tudela, 1992; Marcel, 1980; Milliken et al., 1998; Milliken & Rock, 1997; Neill, Terry, & Valdes, 1994; Neill, Valdes, Terry, & Gorfein, 1992; Yee, 1991). When a prime display contains both a target and a distractor, however, Milliken and Joordens (1996) have observed that neither selection nor a response is required for NP to occur. Therefore, it appears unnecessary for one to select against a source of distraction, or for there to be any need to respond at all during the prime event, for NP to be observed when responding to a probe target that is related to a preceding prime stimulus (Milliken & Joordens, 1996; Milliken et al., 1998; Neill & Kahan, 1999; Ortells & Tudela, 1996; Wood & Milliken, 1998). Although such factors may indirectly influence the NP effect, processes of attentional selection seem to have a greater impact on the occurrence of NP at the time of the probe event. For instance, when probe targets are presented in the absence of a distracting probe stimulus, NP often fails to occur (Milliken & Joordens, 1996).

Although some researchers have found that selection during the probe display is unnecessary for the occurrence of NP (Neill et al., 1994; Yee, 1991; Neill & Westberry, 1987), the weight of the evidence suggests that NP does in fact depend on the presence of a distractor in the probe display (Allport et al., 1985; Houghton & Tipper, 1994; Lowe, 1979; Milliken & Joordens, 1996; Moore, 1994; Neill et al., 1995; Tipper & Cranston, 1985), during which selection between conflicting items may be critical for the effect to surface (Lowe, 1979; Fox, 1995). These results shed doubt on the original distractor inhibition mechanism that was proposed as the basis for NP effects (e.g., Neill, 1977; Tipper, 1985).

In further support of the idea that NP surfaces as a consequence of processes engaged during efforts to respond to the probe target, the requirements of the probe task can greatly affect NP (Lowe, 1979). Milliken et al. (1999) demonstrated that events from the very onset of a probe display can impact how the same prime event may either facilitate or impair performance of the probe task. In the context of a Stroop-like NP task, participants were first shown a colour word in white font (the prime event), to which they were not required to respond. Subsequently, they were shown a probe target stimulus, and were required to name the font colour of the item. This target was either presented as an incongruent colour word (e.g., the word *RED* printed in green font) or as a solid coloured rectangle. On unrepeated trials, the prime item did not match the probe colour or word. On repeated trials, the prime colour word was the same as the colour of the target item presented in the probe display. For one group of participants, the prime was predictive of the probe font colour 25% of the time, and 75% of the time for a second group.

Milliken et al. (1999) found that even when participants were not required to actively select against the prime word, NP was nevertheless observed when participants identified the colour of incongruent Stroop items in the subsequent probe display. In addition, both positive priming and NP effects were observed, entirely dependent on the selective attention demands of the probe task. When the probe was an incongruent colour word, NP was observed. However, when the probe was a simple block of colour, NP did not occur. Importantly, this demonstrates that the prime event only leads to NP or not as a function of whether distracting information is present in the probe display. Rather than being centered on attentional processes engaged during the prime, NP appears to depend on the processes occurring upon the onset of the probe display.

Another example of how NP is influenced by processes that unfold during the probe event is provided by Milliken et al., (1999, their Experiment 4). Participants were initially presented with a single prime colour word to which no response was required. Subsequently, they were randomly presented with either a probe display that contained distracting information or with one that did not (selection vs. non-selection probe trials). On selection probe trials, the probe display consisted of a coloured rectangle and a separate colour-word distractor. On non-selection probe trials, the probe display consisted of a coloured rectangle only. This ensured that participants could not predict whether selective attention would be required for responding to the probe during the current trial until the probe display appeared. Ensuring that participants cannot predict the nature of the probe display before it occurs is critical for establishing that NP occurs as a consequence of attentional selection at the time of the probe. That is, if participants can predict ahead of time that no selection would be required by the probe task, failure to observe NP might simply reflect participants applying less or no inhibition to the prime word. By this view, inhibition of a prime stimulus might depend not only on the need to respond to a prime target, but also on the need to engage in selective attention when responding to the probe event (see Tipper & Cranston, 1985). Despite participants not being able to predict whether distracting information would be present during the probe event, Milliken et al. (1999) found NP to occur only during probe events that required selection of a target colour in the presence of a distracting incongruent word.

Milliken et al. (1998) provided further evidence that experimental manipulations to the probe display influence NP, whereas NP does not depend on active suppression of a prime distractor. Having first presented participants with a to-be-ignored distractor during an initial prime event, they found that participants demonstrated slowed responding to the target in the probe display when it matched the identity of the prime distractor. This slowed responding occurred even though no response was required during the prime event, and the prime distractor was presented for only 33 milliseconds (ms) and masked, causing participants to be unaware of the distractor's identity (Milliken et al., 1998, Experiments 2A, 2B, 2C). Instead, NP was only eliminated when there was no distractor word presented in the probe display (Milliken et al., Experiment 1B).

In summary, even though selective attention tasks inspired the original distractor inhibition account of NP, NP effects do not appear to depend on the requirement to suppress a prime distractor as a way to assist in directing attention to the prime target. Rather, NP effects seem to depend primarily on processes associated with responding to the probe event. The next section will discuss alternative accounts of NP that involve the application of episodic memory principles to understanding the phenomenon.

An Episodic Alternative

Some of the most compelling evidence in favour of an alternative to the distractor inhibition account of NP has been provided by demonstrations of NP effects for stimuli that were actually attended during a prior exposure. For example, in Experiment 1A, Wood and Milliken (1998) asked participants to complete three phases. During the initial study phase, participants were shown a series of individual abstract geometrical shapes. During this phase, the authors manipulated the depth of encoding that participants used in studying the items by having one group write down the number of angular corners for each shape (relatively shallow encoding), whereas another group wrote down what they thought the shape resembled (a much deeper, more elaborate mode of encoding). This manipulation was intended to affect the extent to which the shapes would be memorable during the later recognition phase. During the second phase, participants judged whether green target shapes superimposed on red distractor shapes were the same or different from black standard shapes that were presented next to them. The green targets were superimposed with red distractor shapes. On half of the presented trials, the green targets were shapes that were presented during the earlier study phase, whereas green targets were novel shapes on the remaining trials. In the final phase, participants made a recognition judgment as to whether each shape presented in Phase 2 had also been presented during the initial study phase.

Wood and Milliken (1998) reported that participants made slower same-different judgments for items that had been encountered in the study phase, with the slowest judgments occurring when participants had encoded shapes by counting their corners during that phase, which consisted of a different response than that required at test. Most critically, this demonstrates that despite the fact that shapes had been attended during the initial study phase, NP was still observed with such items during the same-different discrimination phase. Thus, the findings indicate that it is not necessary to directly attend an item for later responding to that item to be impaired.

A comparable finding was obtained by MacDonald, Joordens, and Seergobin (1999). In one block of trials, participants were required to respond to a target word while ignoring a distracting word in response to both the prime and probe displays (the selective attention condition). Another group of participants were required to generate a response that required attending to both of two words that appeared in each of the prime and probe displays (the size judgment condition, where the size of one animal was to be judged relative to another). For both blocks, each stimulus display consisted of two animal names. Participants were required to respond only to red items in the selective attention condition and to identify the larger of the two animals in the size judgment condition. As an example, in the selective attention block, participants would be asked to name the red item *GOAT* and ignore the white item *FLEA*. In the size decision condition however, participants would have been required to name the word *BEAR*, for instance, when it was presented next to the word *TURTLE*.

Replicating a host of prior studies, an NP effect was observed in the selective attention condition. Relative to when there was no overlap between prime and probe words, participants were slower at identifying probe targets when they matched the preceding distractor in the prime display. More importantly, however, MacDonald et al. (1999) proposed that, if the NP effect depends on ignoring a prime distractor, it should only appear in the selective attention condition. Instead, in the size judgment condition, when the name of the smallest animal (the attended distractor) in the prime display matched the name of the largest animal (the target) in the probe display, the NP effect observed was actually four times greater than in the selective attention condition. This finding demonstrates that, under some conditions, attending to a prime stimulus can cause even greater impairment for subsequent responding to that same stimulus than ignoring a prime stimulus.

The observation of NP effects for previously attended stimuli is not readily explained by a distractor inhibition account. Instead, this type of result has led to the proposal that NP is produced via the retrieval of a prior episodic memory representation involving a stimulus that is being currently processed. The retrieval of the prior experience may involve the retrieval of information on having withheld a response to the stimulus. To the extent that the prior experience and the processes engaged in during that experience are inappropriate for completing the current task, retrieval of the event can lead to interference with, and impairment in the production of a response to a currently processed stimulus. This view of NP effects relies on principles known to contribute to performance on explicit memory tasks, such as recall and recognition. In particular, NP effects seem to follow the principle of transfer-appropriate processing (Morris, Bransford, & Franks, 1977). That is, the impaired responding to a repeated stimulus that is observed in most studies of NP might occur because retrieving a memory representation for having just ignored a stimulus conflicts with the requirement to respond to that stimulus when it appears as the probe target (Neill & Mathis, 1998).

The idea that NP involves retrieval of processes that are inappropriate for the current task can also explain observations of NP for previously attended stimuli. For instance, recall that in Experiment 1B of Wood and Milliken (1998), performance at making a same-different judgment was slower in response to items that had been earlier attended during the prime phase and that had been studied by performing a shallow encoding task of counting angular corners on the shapes. Wood and Milliken attribute the slower responses to be a consequence of the inappropriateness of having encountered shapes during the study phase for the later requirement to make same-different judgments in response to those same shapes in the presence of a distracting shape. To the extent that such distractor presence prevents the integration of a memory representation for studied shapes with the presentation of those same shapes during the same-different discrimination task, a cost to performance was incurred.

Similarly, the findings of MacDonald et al. (1999) can be accounted for by principles of transfer-inappropriate processing. Recall that in this study, NP effects were much larger in the size judgment condition, when participants were required to attend to both targets and distractors, relative to the selective attention condition, when they were required to attend to targets only. Although such a result is not readily explained by a distractor inhibition account of NP, it may have been the product of a processing conflict between the prime and probe events. For instance, if in the size judgment condition, a probe display consisted of the words *TURTLE* and *MOUSE*, participants would be required to name the word *TURTLE* (the larger animal) aloud. In that case, performance at making that response may be impaired by the retrieval of a representation for a prime episode involving the word *TURTLE* paired with the word *ELEPHANT*, requiring the participant to name *ELEPHANT* aloud as the larger animal. That is, having just treated the word *TURTLE* as the relatively smaller animal in the prime episode could interfere with efforts to treat this same item as the relatively larger animal of the two presented during the probe event.

That NP can occur when both target and distractor stimuli in a prime are attended is problematic for an inhibitory view of NP. Similarly though, a traditional episodic retrieval account which postulates that NP results from having to respond to a stimulus that was just ignored is also weakened by the finding (Neill & Mathis, 1998). On the other hand, an episodic account that incorporates the principle of transfer-appropriate processing can effectively account for a NP effect that occurs in response to an item that was attended previously, as well as conventional demonstrations of slowed responding to a previously ignored prime distractor. For example, Neill and colleagues suggested that in the context of a selective attention task, NP might result because the act of ignoring a stimulus is a component of the memory representation for that stimulus. Upon onset of the probe display, retrieval of that representation could impair responding to that item as the probe target (Neill, 1997; Neill et al., 1992). In this way, the act of ignoring a stimulus as a prime distractor could later cause sufficient interference with the requirement to both attend and respond to that stimulus. Clearly, ignoring a prime distractor is inappropriate for the subsequent task of generating a response to that same stimulus when it is encountered as the probe target.

It has become increasingly evident that the likelihood of retrieving a prior processing experience critically influences the occurrence and magnitude of NP (Neill & Mathis, 1998). The retrieval of episodic memories was originally suggested to occur on the basis of similarity between an encoding event and a retrieval event (Tulving, 1983). Many studies have since supported the idea that, depending on the similarity between the prime and probe events, stimuli in a probe display will cue the retrieval of the prime episode, increasing the likelihood of observing NP effects (Lowe, 1998; Neill et al., 1994; Neill & Valdes, 1992; Neill et al., 1992). For example, Neill (1997) demonstrated that NP is sensitive to the contextual manipulations of a distractor's onset in both prime and probe displays. During the trials in which a prime distractor repeated as a probe target in his study, the onset of distractors in each prime and probe display was either simultaneous, or set at a delay of 400 ms. Neill found that NP was greatest on trials for which the onset of the distractor in the probe display matched that in the prime display. This result illustrates that contextual similarities between a probe display and a prime display can promote the retrieval of information in this last display, impairing responding to the probe target on ignored repetition trials.

Other contextual characteristics have also been found to influence the retrieval process that many researchers now consider responsible for NP effects. For example, during both prime and probe displays, Fox and de Fockert (1998) required participants to identify target letters that were flanked with distractor letters (e.g., *HWH*). The letters were presented in such a way that they appeared to be either in high contrast (white letters on black) or low contrast (gray letters on black) with the background. Although contrast alone affected reaction times with slower responding to low contrast displays, a match in prime-probe display contrasts resulted in the largest NP effect. Regardless of whether stimuli were easier or harder to read, then, the magnitude of NP depended on the consistency in contrast between the displays (Fox & de Fockert, 1998). Similarly, NP has also been found to surface when prime-probe display pairs are presented in the same case, but not in a different case (Neill et al., 1990, and see Neill et al., 1995 for a review).

Apart from the role of matches between features of the prime and probe displays, the temporal relationship between the probe event and the preceding prime event is also known to determine the likelihood of retrieving the prime episode. This influence on NP effects has been demonstrated by studies that involve the manipulation of the time that elapses between responding to a prime display and the onset of the probe display (the pre-probe response-stimulus intervals or *pre-probe RSI*). Neill et al. (1992) found that, if in a given trial, the pre-probe RSI matches the time that elapses between responding to the preceding probe event and the onset of the next (the *pre-prime RSI*), a consistent NP effect occurs, regardless of the duration of pre-probe RSI. However, the observation of NP effects can depend on differences between the pre-probe and pre-prime RSIs. The basis for this influence is that, separate from a match between the features of the prime and probe events, two other factors also increase the likelihood of retrieving the prime episode when the probe display appears.

The first of these factors is how recently a memory trace was formed, and the second is how discriminable that event is from other representations in memory. There is an increased likelihood of retrieving the memory representation for an event if it occurred recently in time, and can be easily discriminated from other experiences stored in memory (Baddeley, 1976). To test the role of the recency and discriminability of the prime episode on NP, Neill et al. (1992) presented trials in which the pre-prime RSI was either greater than, the same as, or shorter than the pre-probe RSI. Although NP occurred when the two RSIs in a given trial were identical, the effect was even larger when the pre-prime RSI was greater than the pre-probe RSI (i.e., 4,000 ms pre-prime RSI/500 ms pre-probe RSI condition). In contrast, the NP effect was smallest when the pre-prime RSI was shorter than the pre-probe RSI (i.e., 500 ms pre-prime RSI/4,000 ms pre-probe RSI). That the delay prior to a prime event can so strongly influence cost in performance during the probe event makes evident the involvement of episodic memory retrieval in NP. To the extent that the prime event is recent, and especially easy to discriminate from other events like it during earlier trials, retrieval of it is most likely to occur, thereby enhancing the NP effect.

In a trial for which a short pre-probe RSI is preceded by a longer pre-prime RSI, the large pre-prime RSI renders the prime event more discriminable from the memory representation created by the probe event for the preceding trial. In addition, the recency of the prime event heightens the likelihood of retrieving a memory representation for that event at the time of the probe display for the current trial. A high likelihood of retrieving the prime episode should lead to particularly impaired responding to the probe target on ignored repetition trials. Accessing a memory representation during which one withheld a response to the prime distractor is inappropriate for the requirement to respond to that same stimulus as the probe target. If a long pre-probe RSI is preceded by a short pre-prime RSI, the memory representation for the prime episode will be less discriminable from the probe event corresponding to the preceding trial. In that case, the prime episode will also be further away in time from the probe event for the current trial.

As a result, the likelihood of retrieving a memory representation for the prime episode will be minimized on these trials, resulting in the observation of a smaller NP effect (Neill et al., 1992).

A Closer Look at Inhibition

So far, the greater part of the research presented suggests that memory retrieval processes initiated at the time of the probe event are often responsible for the NP effect. However, the notion that inhibition of an irrelevant distractor during the prime event later hinders processing of that stimulus when it becomes the probe target has persisted. Recent research suggests that the cause of NP is a combination of both an inhibitory mechanism operating at the time of the prime event, and of memory retrieval. For example, Tipper (2001), and Grison, Tipper, & Hewitt (2005) propose that the inhibitory processes associated with an irrelevant stimulus encountered during the prime event are retrieved as an attribute of that item upon presentation of that same stimulus during the probe event. The outcome is impaired responding to the stimulus when it appears as the probe target.

As mentioned above, the idea that an inhibitory process operating during the selection of a prime target is responsible for NP is questionable, however, since NP effects have been observed for stimuli that were not previously ignored (MacDonald et al., 1999; Wood & Milliken, 1998). Even so, it is possible that those instances of NP are unique and that an inhibitory process still lies at the base of more conventional demonstrations of the NP effect.

Support for the contribution of an inhibitory process at the time of the prime event in producing the more conventional NP effect has been provided in a study by Grison and Strayer (2001). In their experiments, participants were presented with a word pair during both a prime display, and a subsequent probe display. In each display, one word was printed in blue font, whereas the other was printed in green font. In response to each display, participants were required to name the blue word (the target), while withholding a response to the green word (the distractor). On attended repetition trials, the target stimulus in the prime display repeated as a target in the probe display. On control (unrepeated) trials, the four stimuli presented in the prime and probe displays were different and unrelated. On ignored repetition trials, the stimulus presented as a distractor in the prime display became the target in the probe display.

Apart from the relationship between the prime and probe displays, two other important factors were also manipulated. First, the prime and probe stimuli were either presented many times across experimental trials (frequently presented words), or prime and probe stimuli were presented no more than twice during the experimental session (rarely presented words). It was expected that frequent repetition of words would enhance the ease with which the items were perceived (*perceptual fluency*), resulting in maximal activation of internal representations associated with those stimuli. The second, most critical manipulation was that in every prime display, either the target or the distractor was perceptually degraded via the removal of 20% of its pixels. The reduction in visual quality of the stimulus was an attempt to more deliberately reduce the ease with which the item was perceived, with the expectation that a harder to perceive prime distractor (low-fluency word) would result in less activation of the internal representation associated with that stimulus, in contrast to the greater activation of the internal representation that would occur if the stimulus was an intact, high-fluency word.

Participants were found to respond faster to prime displays that contained frequently presented items relative to those that contained rarely presented novel items. Across both novel and often presented items, however, responding was fastest when the distractor in a prime display was degraded relative to when the target was degraded (and the distractor intact). More importantly, however, was the observation that the NP observed on ignored repetition trials was only significant when the distractor in the prime display was intact (high-fluency form). NP did not emerge when a degraded prime distractor was repeated as the probe target.

In Experiment 2, Grison and Strayer (2001) strengthened their manipulation of perceptual degradation by removing 35% of the pixels from either the prime distractor or the prime target, rendering degraded items even lower in perceptual fluency. In addition, items in the frequently presented word condition did not appear as often as in Experiment 1. A pattern of results similar to that of Experiment 1 was obtained, except that responses on ignored repetition trials were generally slower in Experiment 2.

Following an inhibitory account of their NP effects, Grison and Strayer (2001) proposed that degraded distractors required less inhibition than non-degraded (i.e., intact) distractors. As a result, the activation levels of internal representations associated with degraded distractors were inhibited less than those associated with intact distractors. Consequently, arriving at a response to formerly degraded distractors on ignored repetition trials required less activation at the time of the probe display than did formerly intact distractors.

Nevertheless, there is reason to question this inhibitory interpretation of Grison and Strayer's (2001) results. By their account, if a distracting stimulus is inhibited as a function of how easily it is processed and how easily the internal representation for that stimuli is activated, then increasing the degradation of distracting stimuli in Experiment 2 should have led to a greater difference in the size of the NP effect between degraded distractor/intact target and degraded target/intact distractor trials. In Experiment 1, the response time cost observed on ignored repetition trials when measured against control trials was 20 ms on distractor intact trials and 12 ms on distractor degraded trials. When degradation of the prime distractor was 35% in Experiment 2, the NP effect was 13 ms on distractor intact trials and only 5 ms (non-significant NP) on distractor degraded trials. From these results, it appears that enhancing the degradation of prime targets and distractors did reduce the nominal difference in RTs on ignored repetition and control trials overall, while it also slightly enhanced the difference in NP observed for distractor intact and distractor degraded trials. This was taken as support for the idea that the size of NP directly depends on how readily a prime distractor activates its internal representation. However, the greater proportional difference in NP between the degraded prime distractor and degraded prime target condition in Experiment 2 cannot be entirely attributed to the stronger degradation manipulation that was used. In Experiment 2, items in the repeated condition were presented less frequently than were the items in the repeated condition in Experiment 1. The influence of degradation on RTs and repetition were thus confounded, making it unclear which of these led to a reduction in the difference between ignored repetition and control trials in Experiment 2. In fact, the effect of enhanced degradation of prime targets and distractors may instead imply a role for an episodic retrieval process. Increased degradation of the prime target or prime distractor should maximize the difference between presentation of stimuli in the prime and probe displays, since neither probe targets nor probe distractors were ever degraded in Grison and Strayer's study. Causing the prime and probe displays to be more different in this way could have reduced the likelihood of retrieving the prime episode at the time of the probe event, causing an overall decrease in the size of priming effects that were observed in Experiment 2. Moreover, it is possible to interpret Grison and Strayer's results based on an episodic retrieval approach to NP, without any reference to an inhibitory process at the time of the prime event.

As described earlier, there is evidence that overlap between present conditions and a prior experience enhances retrieval of prior episodes stored in memory both in remembering tasks (Tulving & Thomson, 1973) and in investigations of NP (Neill, 1997). To the extent that overlap between a probe target and a prime stimulus can promote retrieval of a representation for the prime episode stored in memory, interference due to a mismatch between the current requirement to respond to a stimulus and a previous experience of having withheld a response to that stimulus could be a source of NP. With regards to Grison and Strayer's (2001) findings, since the probe display always contained intact target words, the likelihood of retrieving the prime episode may have been much greater when the distractor stimulus was intact, relative to when it was degraded. That is, on ignored repetition trials, an intact probe target would overlap more perceptually with an intact prime distractor than with a degraded prime distractor. To illustrate, presentation of an intact version of the word, *TABLE*, might differ enough from an episodic memory representation for the degraded version of *TABLE* as a prime distractor to discourage retrieval of the prime episode. In contrast, retrieval of the prime episode might be relatively enhanced on ignored repetition trials by the perceptual similarity of an intact probe target that follows presentation of an intact version of the same word as the prime distractor. If so, less NP would be expected on degraded prime distractor trials because the prime episode would be less accessible to interfere with making a response to the probe target.

CHAPTER 2

THE CURRENT STUDY

The current study was designed to differentiate distractor inhibition and episodic retrieval accounts of NP, and to evaluate the results reported by Grison and Strayer (2001). If an episodic retrieval approach is most appropriate in explaining both, then NP should occur regardless of whether the prime distractor is intact, or presented in a less fluent perceptual form. In addition, the magnitude of the NP effect should depend on the presence of a match between the perceptual features of the prime distractor and probe target on ignored repetition trials.

The purpose of Experiment 1 was to test whether, and to what extent, NP depends on a match in perceptual form between a prime distractor and a probe target. Experiment 2 directly investigated Grison and Strayer's claim that NP effects are more pronounced on trials where the prime distractor is intact, rather than degraded, as a function of the greater inhibition afforded by a more salient distractor. In addition, the possible influence of match in perceptual form between the prime distractor and the probe target was not examined in Grison and Strayer's study, in which the presentation of a degraded prime distractor was always followed by the presentation of an intact probe target on repetition trials. Consequently, Experiment 2 tested match in perceptual form of a prime distractor and probe target could account specifically for Grison and Strayer's findings. Across trials of Experiment 2, both prime distractors and probe targets appeared in either perceptually degraded or non-degraded forms. This procedure allowed for an evaluation of whether Grison and Strayer observed smaller NP effects for prime distractors that were low in perceptual fluency because: 1) less fluent prime distractors required less inhibition, or, 2) less fluent distractors were never presented in the same perceptual form as probe targets. The episodic retrieval approach to NP emphasizes the role of overlap between the prime and probe events in optimizing the likelihood of retrieving the prime episode upon onset of the probe display. When the prime distractor repeats as the probe target, retrieval of the prime episode should impair responding because not responding to the prime distractor interferes with the need to respond to that same stimulus as the probe target. Consequently, this account would predict that any NP effect observed when the prime distractor is perceptually degraded should be comparable to the size of NP effects obtained when the prime distractor is not perceptually degraded, as long as the prime distractor and probe target appear in the same perceptual form.

The results of Experiment 2 did not provide compelling evidence in favour of either the distractor inhibition or episodic retrieval approaches to NP. As a result, Experiment 3 was conducted with a stronger manipulation of both the perceptual fluency of stimulus presentations and the degree of difference between perceptually degraded and intact stimuli with respect to their perceptual forms. The results of this experiment were most consistent with an episodic retrieval approach, revealing that the size of NP effects depends on a match in the perceptual form of a prime distractor word and presentation of that same word as the probe target. In contrast, this experiment did not produce any evidence in support of Grison and Strayer's claim that the size of NP effects depend on the ease of perceiving a prime distractor.

Experiment 1

In Experiment 1, the prime distractor and probe target of a trial were either presented in the same perceptual form, or in different perceptual forms. When they appeared in the same form, they were either both in form A, starting with the first letter in lower case (qUeEn), or both in form B, starting with the first letter in upper case (QuEeN). The presentation of stimuli in alternating case is a common method for increasing the difficulty of word perception (e.g., Whittlesea & Jacoby, 1990). Thus, reducing how perceptually fluent an item is by presenting all the items in the displays in alternating case tested the prediction afforded by an episodic retrieval approach to NP, that NP would occur on ignored repetition trials even when the prime distractor appeared in one of two reduced-fluency forms of presentation. More importantly, it also tested the prediction that the magnitude of NP would be greatest when a prime distractor presented in one perceptual form (*WaGoN*) appeared as the probe target in the same perceptual form (*WaGoN*), than when it appeared as the probe target in a different form (*wAgOn*). Such an outcome would suggest that a match in the perceptual properties of a prime distractor word that repeats as the probe target word is a critical influence on the magnitude of NP effects.

Method

Participants

Fifty-eight participants (21 males and 37 females, *M* age = 20.66) were recruited from the undergraduate subject pool, consisting of students enrolled in an introductory psychology course. All participants were required to have normal or corrected to normal vision. Students received partial course credit in exchange for their participation. For one group of 27 participants (Group 1), 66% of the experimental trials were ignored repetition trials, and 33% were unrepeated trials. For a second group of 31 participants (Group 2), 33% of the trials were ignored repetitions, another 33% of the trials were unrepeated, and the remaining 33% were attended repetition trials.

Stimuli and Apparatus

Using 4 five-letter words of high frequency in the English language, 8 stimulus items were derived by presenting all words in alternating case, either beginning with the first letter in lower case (*Form A*), or with the first letter in upper case (*Form B*). The following stimulus set resulted: *bEnCh, BeNcH*, *qUeEn*, *QuEeN*, *sToNe*, *StOnE*, *wAgOn*, *WaGoN*. Each word was non-rhyming, and orthographically dissimilar from other items in the set. Items were presented in 44-point, Times New Roman font.

Stimulus pairs were presented to participants on the center of a 17-inch flat screen Radion X300 series colour monitor with a resolution of 1280 x 1024 pixels, located at a viewing distance of approximately 70 cm. The experiment was programmed using E-prime programming software (Psychology Software Tools, 2002) on a Dell Dimension 4700 computer. Participants were asked to make manual key press responses using a Dell keyboard placed before them. Labels consisting of the first letter of each of the four words presented throughout the study, *Bb* for bench, *Qq* for queen, *Ss* for stone, *Ww* for wagon, were placed on the keys *V*, *B*, *N*, and *M*, respectively. Response latencies and accuracy were recorded for each experimental trial.

Procedure

During each of a series of trials, participants were presented with a prime display followed by a probe display. The beginning of each trial was initiated by the participant pressing the spacebar. A fixation cross at the center of the display was then presented for 500 ms. The prime display then followed, containing both a target stimulus in green font, to which participants were to respond by pressing a key on the key board labeled with the first letter of the word, and a distractor stimulus in red font, which participants were required to ignore. The items appeared against a white background. The letters of the target and distractor words for both prime and probe displays were interleaved, with each being either partly above or below the vertical center point of the monitor. The appearance of targets in the above or below location occurred at random with the constraint that, across trials, both the prime and probe targets appeared equally often in both locations. The prime display remained on the monitor until a response was recorded on the keyboard, or until 3000 ms had elapsed. Following the participants' response to the target item in the prime display, the prime words disappeared from the screen. If the response made was correct, the screen remained clear for 500 ms. When the response was incorrect, the message, "Incorrect!!!", appeared briefly on the top left corner of the monitor, followed by a 500 ms delay. If no response was made within 3000 ms, the message, “No response detected!!!”, was displayed, followed by a 500 ms delay. Next, the probe display appeared, again requiring a response to a target stimulus in the presence of a distracting word. Again, feedback was provided for incorrect and undetected responses, following the same procedure as incorrect and undetected responses to the prime display. A fixation-cross then appeared on the screen for 500 ms, followed by appearance of the prompt, “Press the space bar to begin the next trial”. Once participants pressed the spacebar, the next trial began.

The only time a word was presented twice during a trial was when the prime distractor (for ignored repetition trials) or prime target (for attended repetition trials) repeated as the target in the subsequent probe display. As the focus of Experiment 1 was to test whether NP effects can be modulated by match in perceptual form of the repeated stimulus, each item of a display was presented either in alternating case starting with the first letter in lower case (form A), or starting with the first letter in upper case (form B). The stimulus that repeated from the prime display to the probe display was either presented in the same perceptual form both times (both in form A or both in form B), or in different perceptual forms from the prime to the probe display (one in form A, and the other in form B).

At the beginning of each session, participants were instructed to respond as quickly and accurately as possible to each stimulus display and were informed that both the speed and accuracy of their responses would be recorded for subsequent analysis. The RTs to both prime and probe targets were defined as the elapsed time between the onset of either the prime or probe display and the participants’ key press.

Prior to data collection, 1152 trials were generated in order to factorially counterbalance the assignment of the four words in the stimulus set to the roles of: 1) prime target, 2) prime distractor, 3) probe target, and, 4) probe distractor across the three repetition conditions (ignored repetition vs. attended repetition vs. unrepeated), the two perceptual forms (form A vs. form B), and ensuring that both prime and probe targets appeared equally above and below the centre of the computer screen. This set of trials was then divided randomly into four versions, consisting of 288 trials each. For the first group of participants (Group 1), one-third (96) of these trials were classified as unrepeated trials, and two-thirds (192) were classified as ignored repetition trials. For a second group of participants (Group 2), one-third (96) of the trials were unrepeated trials, one-third (96) were ignored repetition trials, and the remaining one-third (96) of trials were defined as attended repetition trials. On unrepeated trials, the prime distractor and target always differed from each other and from the probe target and distractor. On attended repetition trials, the probe target was the same as the prime target, whereas the prime and probe distractors differed from each other and from both the prime and probe targets. Finally, on ignored repetition trials, the probe target was the same as the prime distractor, whereas the prime target and probe distractor differed from each other and from both the prime distractor and probe target. Within each of these repetition conditions (unrepeated, attended repetition, and ignored repetition), the four words used in the experiment were assigned equally often to every possible role of prime and probe target and distractor, and contributed equally often to every combination of form A and form B prime target, prime distractor, probe target, and probe distractor. Each of these possible trial types for each of the different repetition conditions were presented in random order. For the condition involving attended repetition trials, the factorial manipulation of whether prime and probe words appeared in form A or form B generated 48 trial types: 2 (prime target form A vs. form B) X 2 (prime distractor form A vs. form B) X 2 (probe target form A vs. form B) X 2 (probe distractor form A vs. form B) X 3 (unrepeated vs. ignored repetition vs. attended repetition). In the condition for which attended repetition trials were absent, there were 32 trial types: 2 (prime target form A vs. form B) X 2 (prime distractor form A vs. form B) X 2 (probe target form A vs. form B) X 2 (probe distractor form A vs. form B) X 2 (unrepeated vs. ignored repetition). The most critical factors, however, involved the effect of match versus mismatch in the form of repeated words within trials on RTs and response accuracy when evaluated against the appropriate baseline condition. As a result, for the first group of participants, each of these combinations contributed 2 trials for the unrepeated conditions and 8 trials for the ignored repetition trials. For the second group of participants, each combination contributed 6 trials for each of the three repetition conditions.

On 25% of ignored repetition trials, the prime distractor and probe target were both presented in alternating case beginning with a lower case letter (prime distractor /probe target form A condition), whereas on another 25% of trials both appeared in alternating case beginning with an upper case letter (prime distractor/probe target form B condition). On the remaining 50% of ignored repetition trials, the prime distractor differed from the probe target in its perceptual form. On half of those trials, the prime distractor was presented in alternating case starting with a lower case letter and the probe target was presented in alternating case starting with an upper case letter (prime distractor form A/probe target form B condition). On the remaining half of those trials, the prime distractor was presented in alternating case, starting with an upper case letter, and the probe target appeared in alternating case, starting with a lower case letter (prime distractor form B/probe target form A condition). An equal number of unrepeated trials corresponding to the four prime distractor form A/form B and probe target form A/form B conditions formed a baseline condition for measuring ignored repetition effects.

On 25% of the attended repetition trials, the prime and probe targets both appeared in alternating case letters, starting with a lower case letter (prime and probe target form A condition). On another 25% of trials, both prime and probe targets appeared in alternating case letters, starting with an upper case letter (prime and probe target form B condition). During the remaining 50% of attended repetition trials, the prime target was presented in a different perceptual form than the probe target. On half of those trials, the prime target was presented in form A, while the probe target was presented in form B (prime target form A/probe target form B condition). The prime target was presented in form B and the probe target appeared in form A (prime target form B/probe target form A condition) for the remaining half of those trials. An equal number of unrepeated trials corresponding to these four prime target form A/form B and probe target form B/form A conditions formed a baseline condition for measuring attended repetition effects.

Design and Analysis

Ignored repetition effects on participants' mean correct probe RTs and the proportion of incorrect probe responses were analyzed using separate 2 X (2 X 2 X 2) repeated-measures Analysis of Variance (ANOVAs), treating presence versus absence of attended repetition trials as a between-participants factor and prime distractor (form A vs. form B), probe target (form A vs. form B), and repetition condition (ignored vs. repeated) as within-participants factors. In the condition that included attended repetition trials, 2 X 2 X 2 repeated-measures ANOVAs were also conducted to determine attended repetition effects on both mean correct probe RTs and the proportion of incorrect responses to the probe display, treating prime target (form A vs. form B), probe target (form A vs. form B), and repetition condition (attended repetition vs. unrepeated) as within-participants factors. Analyses of mean correct probe RTs and the proportion of incorrect responses were conditional upon participants having made a correct response to the preceding prime display in the trial.

Results and Discussion

Mean correct RTs and error rates in response to probe displays of ignored repetition trials and attended repetition trials, collapsed across participants, are presented in Table 1 and Table 2, respectively. No significant main effects or interaction effects emerged as a consequence of whether or not the experimental session contained attended repetition trials ($p > .10$ in all cases). Consequently, I collapsed across this between-participants factor in displaying the results for ignored and unrepeated trials in Table 1. In the present experiment, and in all subsequent experiments reported, trials for which response latencies were longer than 2000 ms, were excluded from the analysis, resulting in the elimination of less than 3% of observations. The first 24 trials of each session consisted of practice trials during which participants developed the correct stimulus-response mappings, and were also excluded from further analysis.

Table 1

Mean correct response times (RTs) in milliseconds (ms) and error rates (ERR) when responding to probe target displays in Experiment 1, as a function of repetition condition (ignored vs. unrepeated), and prime distractor/probe target form (form A/form A vs. form B/form B vs. form A/form B vs. form B/form A).

	Repetition Condition					
	Ignored		Unrepeated		Difference	
Prime Distractor/ Probe Target Form	RT	ERR	RT	ERR	RT	ERR
Same						
Form A /Form A						
Group 1	951		916		-35	
Group 2	958		931		-27	
Combined	**954**	**.035**	**924**	**.042**	**-30**	**.007**
	(17.7)	**(.007)**	**(16.7)**	**(.008)**	**(10.5)**	**(.009)**
Form B /Form B						
Group 1	975		959		-16	
Group 2	963		927		-36	
Combined	**968**	**.042**	**942**	**.035**	**-26**	**-.006**
	(19.2)	**(.005)**	**(16.8)**	**(.006)**	**(11.6)**	**(.006)**
Different						
Form A /Form B						
Group 1	905		892		-13	
Group 2	882		902		20	
Combined	**893**	**.044**	**898**	**.031**	**5**	**-.013**
	(15.8)	**(.007)**	**(18.6)**	**(.005)**	**(8.6)**	**(.009)**
Form B /Form A						
Group 1	904		882		-22	
Group 2	909		890		-19	
Combined	**906**	**.048**	**886**	**.035**	**-20**	**-.013**
	(15.4)	**(.007)**	**(16.4)**	**(.006)**	**(9.96)**	**(.007)**

SE = Between-participant standard error of the mean RTs and error rates for the ignored repetition and unrepeated trials, and for the mean difference in RTs and error rates between ignored and unrepeated trials.
Group 1 = participants assigned to the condition containing ignored repeated and unrepeated trials only.
Group 2 = participants assigned to the condition containing ignored repeated, unrepeated, and attended repetition trials.

Table 2

Mean correct response times (RTs) in milliseconds (ms) and error rates (ERR) when responding to probe target displays in Experiment 1, as a function of repetition condition (attended vs. unrepeated), and prime target/probe target form (form A/form A vs. form B/form B vs. form A/form B vs. form B/form A).

	Repetition Condition					
	Attended		Unrepeated		Difference	
Prime Distractor/ Probe Target Form	RT	ERR	RT	ERR	RT	ERR
Same						
Form A /Form A	649 (14.9)	.015 (.005)	913 (25.3)	.048 (.010)	264 (21.1)	.033 (.010)
Form B /Form B	609 (15.7)	.010 (.004)	914 (28.6)	.036 (.008)	305 (21.5)	.026 (.008)
Different						
Form A /Form B	709 (19.5)	.013 (.005)	916 (28.8)	.044 (.010)	207 (20.8)	.031 (.010)
Form B /Form A	685 (16.2)	.029 (.010)	908 (28.7)	.057 (.012)	223 (21.7)	.028 (.014)

SE = Between-participant standard error of the mean RTs and error rates for the attended repetition and unrepeated trials, and for the mean difference in RTs and error rates between attended and unrepeated trials.

Ignored Repetition Effects

In the analysis of ignored repetition effects on RTs, there was a significant main effect of repetition. Participants were about 19 ms slower on ignored repetition trials than on corresponding unrepeated trials (931 ms vs. 912 ms), $F(1,57) = 9.98$, $MS_e = 3{,}890.48$, $p < .01$, replicating the typical negative priming effect. A significant interaction also emerged between repetition (unrepeated vs. ignored repetition condition), prime distractor form (form A vs. form B), and probe target form (form A vs. form B), $F(1,57) = 4.71$, $MS_e = 2{,}521.31$, $p < .05$.

To investigate the source of this interaction, separate 2 X 2 ANOVAs were performed with RT data from trials in which the prime distractor and probe target were presented in the same form (both form A and both form B), and for trials in which they were presented in different form (prime distractor = form A; probe target = form B and prime distractor = form B; probe target = form A), with repetition (ignored repetition vs. unrepeated) and probe target form (form A vs. form B) as within-participants factors. These analyses revealed that the source of the interaction effect was that significant NP only occurred when the prime distractor and probe target appeared either both in form A or both in form B. On those trials, participants were about 29 ms slower at responding on ignored repetition trials than on unrepeated trials (962 ms vs. 933 ms), $F(1,57) = 13.67$, $MS_e = 3{,}423.67$, $p < .001$. When the prime distractor and probe target differed in perceptual form, participants were only 8 ms slower at responding on ignored repetition trials than on unrepeated trials (900 ms vs. 892 ms), and this difference was not statistically significant, $F(1,57) = 1.30$, $MS_e = 2{,}988.12$, $p = .26$.

Separate repeated-measures ANOVAs were also conducted on the RT data for unrepeated and ignored repetition trials, treating prime distractor form (form A vs. form B) and probe target form (form A vs. form B) as within-participants factors to further clarify the effect of match in stimulus form between the prime distractor and probe target. A significant interaction between prime distractor form and probe target form was found for both unrepeated trials, $F(1,57) = 35.15$, $MS_e = 2{,}826.10$, $p < .001$, and ignored repetition trials, $F(1,57) = 72.66$, $MS_e = 3{,}030.07$, $p < .001$. On ignored repetition trials, responses were 62 ms slower when the prime distractor and probe target appeared in the same form than when they appeared in different forms (962 ms vs. 900 ms), $F(1,57) = 74.58$, $MS_e = 2{,}984.85$, $p < .001$. This impairment in responding to probe targets that match the prime distractor both in perceptual form and word identity makes it difficult to know whether a match in perceptual form alone might produce a NP effect. However, on unrepeated trials, participants were also 41 ms slower when the prime distractor and probe target were presented in the same form than when they were presented in different forms (933 vs. 892), $F(1,57) = 34.03$, $MS_e = 2{,}850.36$, $p < .001$, reflecting only a form-specific influence on negative priming. This result demonstrates that ignoring a prime word presented in one form (i.e., QuEeN) can impair responding to a different probe word that is presented in the same form (i.e., StOnE). There were no other significant main effects or interaction effects in the analysis of ignored repetition effects. There were also no significant effects in the analysis of ignored repetition effects on error rates (p >.05 in all cases).

Attended Repetition Effects

The analysis of attended repetition effects on RTs revealed a main effect of repetition, with RTs on attended repetition trials 250 ms faster than on unrepeated trials (663 ms vs. 913ms), $F(1,30) = 202.74$, $MS_e = 19{,}083.66$, $p < .001$. Thus, not surprisingly, participants speed in responding to probe targets benefited from having just responded to the same word when it appeared in the preceding prime display. The analysis also revealed a significant interaction between repetition condition, prime target form, and probe target form, $F(1,30) = 35.92$, $MS_e = 2{,}068.76$, $p < .001$.

To investigate the source of this interaction, separate 2 X 2 ANOVAs were performed with RT data from trials in which the prime and probe targets were presented in the same form (both form A and both form B), and for trials in which they were presented in a different form (prime target = form A; probe target = form B and prime target = form B; probe target = form A), with repetition condition (attended repetition vs. unrepeated) and probe target form (form A vs. form B) as within-participants factors. These analyses revealed that attended repetition effects were larger when the prime and probe targets appeared in the same form, with participants responding on average 285 ms faster on attended repetition trials than on unrepeated trials (629 ms vs. 914 ms), $F(1,30) = 219.63$, $MS_e = 11{,}418.41$, $p < .001$. In contrast, when the prime and probe targets differed in form, participants were only 215 ms faster on attended repetition trials than on unrepeated trials (697 ms vs. 912 ms), $F(1,30) = 147.47$, $MS_e = 9{,}734.00$, $p < .001$. Thus, a mismatch in the form of a prime target word that repeated as a probe target somewhat reduced, but did not eliminate, the response time benefit that was observed on attended repetition trials.

Unlike the ignored repetition effects, the positive effects of repetition on attended repetition trials were specific the same word being presented as the prime and probe target. A repeated-measures ANOVA that was conducted on the RT data for unrepeated trials, treating prime distractor form (form A vs. form B) and probe target form (form A vs. form B) as within-participants factors produced no significant effects (all Fs < 1). When performed on RTs of the attended repetition trials, the same ANOVA revealed a significant interaction between prime and probe distractor form, originating from the larger benefit of repetition when the prime and probe targets matched in form than when they differed in form. Participants were about 68 ms faster at responding on attended repetition trials when the prime and probe targets matched in perceptual form than when they differed in perceptual form (629 ms vs. 697 ms), $F(1,30) = 83.74$, $MS_e = 1{,}703.78$, $p < .001$. There were no other significant attended repetition effects on RTs.

The analysis of attended repetition effects on error rates yielded a significant main effect of repetition condition (attended repetition vs. unrepeated), owing to a 2.9% higher rate of errors on unrepeated trials than on attended repetition trials (.046 vs. .017), $F(1,30) = 21.71$, $MS_e = .003$, $p < .001$. There was also a main effect of probe target form (form A vs. form B) on error rates, $F(1,30) = 4.60$, $MS_e = .002$, $p < .05$, in that participants were on average 1.1% more likely to make an error when the probe target was presented in form B, when the first letter was upper case, than when it was presented in form A, when the first letter was lower case (.037 vs. .026). The source of this 1.1% difference in errors is unclear. The main difference between words presented in one form or the other is that words in form A contained two upper case letters and three lower case letters (i.e., sToNe), whereas items in form B contained three upper case letters and two lower case letters (i.e., StOnE). On this basis, it is possible that participants visually extracted the identity of an item based on the subset of letters within the word that appeared in the prevalent letter case (either the three letters in lower case or the three letters in upper case). In turn, items containing three lower case letters may have provided more cues as to the identity of the item than did words containing three upper case letters, as entire words are more frequently encountered in lower case letters than in upper case letters in the English language. As a result, more errors may have occurred in response to items presented in form B. A more obvious indicator of whether the two perceptual forms used in Experiment 1 were in fact equivalent in perceptual fluency or whether one afforded more effortful processing over the other would have been reflected in a difference between RTs to probe targets presented in one form versus another. However, no such difference emerged in the analysis of RTs. Participants' speed of response to the probe targets in attended repetition trials did not differ as a function of the form in which the items were presented, ruling out the possibility of a speed-accuracy tradeoff in response to probe targets presented in form B. No other significant effects emerged in the analysis of attended repetition effects on errors.

Recall that Experiment 1 was a test of whether NP would occur as a function of the prime distractor being presented in the same perceptual form as the probe target on ignored repetition trials, regardless of whether both items were presented in one perceptual form or another, as the forms were equivalent in the perceptual fluency they afforded. The main effect of repetition condition revealed that NP did indeed occur even though the prime distractor was always presented in alternating case. More importantly, the finding that significant NP only occurred on trials for which the perceptual form of the prime distractor word matched the perceptual form of that word when it was repeated as the probe target lends support to the idea that retrieving a memory representation of the processing engaged during the prime episode depends on the presence of overlap in both the identity and perceptual form of a prime distractor and probe target. In turn, this enhanced accessibility to a representation for the prime event on ignored repetition trials interferes with participants' effort to respond to the probe display. Retrieval of a memory representation that contains information on having withheld a response to an item when it appeared as a prime distractor conflicts with the goal of responding to that same item when it appears subsequently as a probe target.

An unexpected outcome of Experiment 1 was the observation of impaired responding not only on trials involving presentation of a distracting prime word as the probe target, but also when different prime distractor and probe target words were presented in the same perceptual form. For instance, having just withheld a response to a prime distractor word in form A, *wAgOn*, leads to slower responding to a different word that appears as a probe target that is also presented in form A, such as *bEnCh*. This finding reveals a class of NP effects that do not depend on stimulus identity repetition. Such NP effects demonstrate that the repetition of the general visual form of a distracting stimulus as an attribute of a different, subsequently encountered stimulus to which a response is required, acts as a strong cue for the retrieval of processing that was engaged during the prime display.

Experiment 2

The occurrence of NP was found to depend on a match in the perceptual form of the prime distractor and the probe target in Experiment 1. Experiment 2 addressed the influence of perceptual fluency on NP when a different form of perceptual degradation was used than that employed by Grison and Strayer (2001), and more directly tested whether the influence of match in perceptual form between a prime distractor and probe target on NP could also account for the pattern of NP effects observed in Grison and Strayer's study. They accounted for their observation of NP when prime distractors were presented intact and not when they were presented in a perceptually degraded form, by suggesting that degraded distractors are perceived less fluently than intact prime distractors. Less fluent perception of degraded prime distractors requires them to be inhibited less during participants' efforts to respond to the prime target, resulting in the absence of NP. Experiment 2 allowed the test of a second possibility based on an episodic retrieval approach to NP. From this perspective, NP effects did not occur for degraded prime distractors in Strayer and Grison's study because their perceptual form did not match the perceptual form of probe targets, which were always presented in a non-degraded form. In attempting to distinguish between the distractor inhibition and episodic retrieval accounts of Strayer and Grison's study, both prime distractors and probe targets either appeared in alternating case (*qUeEn*) or in uniform lower case (*queen*). This allowed for presentation of the prime distractor and probe target words in matching perceptual form (prime distractor and probe target both presented in alternating case or prime distractor and probe target both presented in lower case) or mismatching perceptual forms (prime distractor = alternating case; probe target = lower case and prime distractor = lower case; probe target = alternating case). Independent of the effect of presenting prime distractors and probe targets in the same perceptual form, this design also allowed for measuring the effect of presenting a prime distractor in a degraded (alternating case) or non-degraded form (uniform case). The expectation was that the magnitude of NP would not depend on presentation of the prime distractor in alternating or uniform letter case, consistent with the results of Experiment 1 in which NP still occurred when prime distractors always appeared in a degraded form. This result would contradict the idea that degraded prime distractors should produce smaller NP effects because it is less necessary to apply inhibition to a distracting stimulus that is difficult to perceive. In contrast, following the episodic retrieval explanation for NP, the expectation was that larger NP effects should be observed when the prime distractor and probe targets appeared in the same perceptual form.

Method

Participants

A new group of fifty-eight participants (26 males and 32 females, *M* age = 20.24) were recruited from the same subject pool as in Experiment 1, and received partial course credit in exchange for their participation. All participants reported normal or corrected to normal vision. As in Experiment 1, approximately half (28) of the participants were presented with experimental trials comprising 66% ignored repetition trials, and 33% unrepeated trials. For the other 30 participants, experimental trials consisted of an equal proportion of ignored repetition trials, unrepeated trials, and attended repetition trials.

Stimuli and Apparatus

From four common five-letter English words, 8 stimulus items were again derived, this time by presenting words in either uniform lower case (high perceptual fluency items) or in alternating case (low perceptual fluency items). Consequently, the non-rhyming, orthographically dissimilar, stimulus set consisted of the items *apple*, *aPpLe*, *glass*, *gLaSs*, *queen*, *qUeEn*, *stone*, *sToNe.* Apart from the labels affixed to the letter *V*, *B*, *N*, and *M* on the keyboard now corresponding to the first letters of these stimuli (a, g, *q*, and *s*, respectively), all other apparatus were the same as in Experiment 1.

Procedure

The experimental procedure for Experiment 2 was identical to that of Experiment 1, with the following exceptions. In the previous experiment, the main focus was on whether NP would occur despite the prime distractor appearing in degraded form at all times, and whether the magnitude of NP would depend on a match between the perceptual form of the prime distractor and the probe target on ignored repetition trials. In contrast, the focus of the present experiment was to simultaneously evaluate whether NP effects depend on: 1) prime distractor degradation, or, 2) a match in the perceptual form of the prime distractor and probe target. Therefore, in Experiment 2, rather than presenting prime distractors and probe targets in one of two degraded perceptual forms, each word within prime and probe displays were presented either in a degraded perceptual form (alternating letter case starting with the first letter in lower case), or a non-degraded perceptual form (uniform lower case). This way, on ignored repetition trials, the stimulus that repeated from the prime display to the probe display was either presented in the same perceptual form both times (both in alternating case or both in uniform case), or in different perceptual forms (one in alternating case and the other in uniform case). As a result of this new manipulation, trials were generated in a way that was identical to that of Experiment 1, except that the form B presentation of words in that condition was replaced by the presentation of words in uniform lower case.

Design and Analysis

As in Experiment 1, ignored repetition effects on participants' mean correct probe RTs and the proportion of incorrect probe responses were analyzed using separate 2 X (2

X 2 X 2) repeated-measures ANOVAs, with presence vs. absence of attended repetition trials as a between-participants factor. Prime distractor form (alternating vs. uniform), probe target form (alternating vs. uniform), and repetition condition (ignored repetition vs. unrepeated) were treated as within-participants factors. In addition, mean correct probe RTs and the proportion of incorrect responses to the probe display were submitted to separate 2 X 2 X 2 repeated-measures ANOVAs, treating prime target (alternating vs. uniform), probe target (alternating vs. uniform), and repetition (attended repetition vs. unrepeated) as within-participants factors, for the analysis of attended repetition effects in the condition which included all three repetition conditions. Analyses of mean correct probe RTs and the proportion of incorrect responses were again conditional upon participants having made a correct response to the preceding prime display.

Results and Discussion

Mean correct RTs and error rates in response to probe displays, collapsed across participants, are presented in Tables 3 and 4 for ignored repetition and attended repetition trials, respectively. There were again no significant main effects or interaction effects that emerged based on whether or not the experimental session included attended repetition trials ($p > .05$ in all cases). Thus, Table 3 represents mean correct probe RTs and error rates for ignored repeated and unrepeated trials obtained by collapsing across this between-participants factor.

Table 3

Mean correct response times (RTs) in milliseconds (ms) and error rates (ERR) when responding to probe target displays in Experiment 2, as a function of repetition condition (ignored vs. unrepeated), and prime distractor/probe target form (alternating/alternating vs. uniform/uniform vs. alternating/uniform vs. uniform/alternating).

	Repetition Condition					
	Ignored		Unrepeated		Difference	
Prime Distractor/ Probe Target Form	RT	ERR	RT	ERR	RT	ERR
Same						
Alternating /Alternating						
Group 1	834		804		-30	
Group 2	879		869		-10	
Combined	**857**	**.037**	**837**	**.036**	**-20**	**.000**
	(17.8)	**(.006)**	**(18.9)**	**(.006)**	**(7.7)**	**(.006)**
Uniform /Uniform						
Group 1	858		830		-28	
Group 2	904		887		-17	
Combined	**881**	**.045**	**859**	**.037**	**-22**	**-.008**
	(18.5)	**(.007)**	**(18.1)**	**(.006)**	**(8.8)**	**(.009)**
Different						
Alternating /Uniform						
Group 1	784		768		-16	
Group 2	845		814		-31	
Combined	**816**	**.047**	**792**	**.039**	**-24**	**-.009**
	(18.0)	**(.007)**	**(16.6)**	**(.006)**	**(8.2)**	**(.009)**
Uniform /Alternating						
Group 1	771		763		-8	
Group 2	811		813		2	
Combined	**792**	**.031**	**789**	**.028**	**-3**	**-.003**
	(16.4)	**(.005)**	**(16.9)**	**(.005)**	**(7.9)**	**(.007)**

SE = Between-participant standard error of the mean RTs and error rates for the ignored repetition and unrepeated trials, and for the mean difference in RTs and error rates between ignored and unrepeated trials.
Group 1 = means of participants assigned to the condition containing ignored repeated and unrepeated trials only.
Group 2 = means of participants assigned to the condition containing ignored repeated, unrepeated, and attended repetition trials.

Table 4

Mean correct response times (RTs) in milliseconds (ms) and error rates (ERR) when responding to probe target displays in Experiment 2, as a function of repetition condition (attended vs. unrepeated), and prime distractor/probe target form (alternating/alternating vs. uniform/uniform vs. alternating/uniform vs. uniform/alternating).

	Repetition Condition					
	Attended		Unrepeated		Difference	
Prime Distractor/ Probe Target Form	RT	ERR	RT	ERR	RT	ERR
Same						
Alternating /Alternating	669 (27.0)	.010 (.005)	830 (27.3)	.013 (.007)	161 (14.6)	.021 (.008)
Uniform /Uniform	673 27.9)	.016 (.007)	854 (30.8)	.035 (.008)	181 (15.3)	.019 (.010)
Different						
Alternating /Uniform	669 (31.1)	.017 (.005)	846 (27.6)	.029 (.007)	177 (10.3)	.012 (.009)
Uniform /Alternating	654 (22.7)	.014 (.005)	852 (33.4)	.037 (.010)	198 (17.3)	.023 (.010)

SE = Between-participant standard error of the mean RTs and error rates for the attended repetition and unrepeated trials, and for the mean difference in RTs and error rates between attended and unrepeated trials.

Ignored Repetition Effects

As anticipated, the analysis of ignored repetition effects on RTs revealed a main effect of repetition, representing a significant NP effect, where responses on ignored repetition trials were on average 18 ms slower than on unrepeated trials (837 ms vs. 819 ms), $F(1,57) = 22.32$, $MS_e = 1{,}596.99$, $p < .001$. Surprisingly, there was also a significant main effect of probe target form. Although it had been anticipated that slower responses would be made to probe targets presented in alternating case as a function of the manipulation of perceptual fluency, participants were instead about 18 ms slower at responding to trials containing uniform probe targets than alternating probe targets (837 ms vs. 819 ms), $F(1,57) = 11.96$, $MS_e = 3{,}170.03$, $p < .001$. This finding suggests that the presentation of words in alternating case was not a successful way to reduce the perceptual fluency of words that were supposed to be degraded, and that instead, the manipulation facilitated responding to these items.

An interaction between prime distractor form and probe target form was also significant, $F(1,57) = 87.72$, $MSe = 5{,}032.95$, $p < .001$. The source of this interaction was investigated with two separate repeated-measures ANOVAs on probe RTs of ignored repetition trials, one for trials in which the probe target was presented in alternating case, and one for trials in which the probe target was presented in uniform case, treating repetition (ignored vs. unrepeated), and prime distractor form (alternating vs. uniform) as within-participants factors. These analyses produced two significant effects of prime distractor form. When the probe target appeared in alternating case, across both ignored repetition and unrepeated trials, participants responded approximately 56 ms slower when the prime distractor also appeared in alternating case than when it appeared in uniform case (847 ms vs. 791 ms), $F(1,57) = 58.89$, $MS_e = 3{,}150.95$, $p < .001$. When the probe target was intact, participants responded approximately 67 ms slower to trials for which the prime distractor had appeared in uniform case than when it appeared in alternating case (871 ms vs. 804 ms), $F(1,57) = 60.74$, $MS_e = 4{,}264.04$, $p < .001$. Since there was no significant prime distractor form X probe distractor form X repetition condition interaction, $F < 1$, presentation of the prime distractor and probe target in the same perceptual form impaired the speed of responding to the probe target by about the same magnitude whether the identity of the prime distractor and probe target were the same or different. Additionally, failure to obtain this last interaction revealed that the size of NP effects observed when the prime distractor word repeated as the probe target did not depend on a match in their perceptual form. No other significant effects of ignored repetition on RTs were observed.

The finding that NP is separately influenced by: a) repetition of the prime distractor as the probe target, and, b) match in perceptual form between the prime distractor and probe target weakens, but does not rule out the prediction held by an inhibitory account that ignored information becomes inhibited during the prime display. The results, however, do suggest that the irrelevant content of a prime display, such as the form of the prime distractor, and the response that was made to it (e.g., withholding of a response), form part of a memory representation for the prime event that remains accessible until presentation of the probe display. In turn, the act of making a response to the probe display may be interfered with.

In combination, the finding that RTs were significantly slower, regardless of repetition condition, on trials where an intact probe target was presented (i.e., queen), is peculiar. Clearly, this difference can not in any way be attributed to a greater likelihood of retrieving the memory representation for the prime distractor for either normal or alternating case probe targets. However, it is possible that probe targets presented in alternating case led to the development of distinct memory representations for each of those items relative to the others (aPpLe vs. gLaSs vs. qUeEn vs. sToNe), whereas the memory representations formed for lower case items were relatively less distinctive from one another (i.e., apple vs. glass vs. queen vs. stone). As a result, lower case items may have required more effortful processing, resulting in slower identification and response to them. More importantly, however, is that participants were not slower in response to items that were intended to be more degraded, low-fluency stimuli that was more difficult to perceive than items presented in uniform lower case letters, suggesting that perceptual fluency was not successfully manipulated by presenting items in uniform lower case versus alternating case letters.

The analysis of ignored repetition effects on error rates yielded a significant effect of probe target degradation (degraded vs. intact) on RTs. Participants made an average of 0.89% more errors in response to trials that contained an intact probe target (.042 vs. .033), $F(1,57) = 6.32$, $MS_e = .00$, $p < .05$. There were no other significant effects detected in the analysis of the error data.

Attended Repetition Effects

The analyses of attended repetition effects on RTs revealed a main effect of repetition (attended vs. unrepeated), with RTs 179 ms faster on attended repetition trials than on unrepeated trials (667 ms vs. 846 ms), $F(1,29) = 143.78$, $MS_e = 13,412.20$, $p < .001$, indicating an overall benefit in responding to a probe target that was just presented as a prime target.

In contrast to Experiment 1, in the present experiment, there was no significant interaction between prime target form (alternating vs. uniform), probe target form (alternating vs. uniform), and repetition condition (attended repetition vs. unrepeated), $p > .05$, nor any further significant effects of attended repetition on RTs. Apparently the manipulation of alternating versus uniform letter case was not strong enough to influence the magnitude of attended repetition effects in speeding responses to probe targets. There was also no significant 2-way interaction between prime target form and probe target form, $p > .05$. Thus, when the prime and probe targets were different words, there was no response time benefit arising from presentation of probe targets in the same perceptual form as the preceding prime target. The results of both this experiment and Experiment 1 revealed that there is a response time cost associated with presentation of a different word as the prime distractor that matches the probe target in perceptual form. This influence of a match in perceptual form independent of a match in stimulus identity did not have any impact on response time benefits on attended repetition trials in either Experiment 1 or in the current experiment. This pattern of results suggests that the general visual form of a stimulus presented in the prime display only influences speed of response to a probe target when the general visual form that repeats as an attribute of the probe target was an attribute of the irrelevant stimulus in the prime display (i.e., prime distractor in ignored repetition trials). As an attribute of the relevant stimulus (i.e., prime target in attended repetition trials), the general visual form of a word does not seem to influence speed of response to a probe target. One possible source for this difference is that upon onset of the probe display in an attended repetition trial, retrieval of the memory representation for the prime target may be supported by cues that have become salient via attentional processes (i.e., word identity or word meaning). In turn, these cues may have a stronger influence on what processing information is retrieved from the prime display than more peripheral retrieval cues (i.e., the general visual form of a stimulus).

A significant main effect of repetition condition (attended vs. unrepeated) emerged in the analysis of attended repetition effects on error rates, owing to a 1.9% higher rate of errors made on unrepeated trials than on attended repetition trials (.033 vs. .014), $F(1,29) = 15.60$, $MS_e = .001$, $p < .001$, suggesting that not only were participants faster, but also slightly more accurate at responding to probe targets on attended repetition trials than on unrepeated trials. There were no other significant main effects or interaction effects in the analysis of the error data.

In Experiment 2, participants were slower in responding to probe targets on ignored repetition trials than on unrepeated trials, and faster in responding to probe targets on attended repetition trials than on unrepeated trials, suggesting that the procedures employed were successful in producing patterns of positive and negative priming commonly observed in the literature. However, the purpose of the experiment was to directly compare the impact of an intact distractor to that of a perceptually degraded distractor on NP. In doing so, the separate predictions afforded by an inhibitory and an episodic approach were tested. By an inhibitory account of NP, greater inhibition should have been required by intact prime distractors. If that were true in Experiment 2, participants' RTs would have been more impaired in the ignored repetition condition whenever the prime distractor was presented in uniform case than when it was presented in alternating case, regardless of the perceptual status of the probe target. If so, a significant prime distractor form and repetition condition should have been obtained in the analysis of ignored repetition effects. However, there was no such evidence that the size of NP depended on the presentation of prime distractors in a non-degraded form in Experiment 2. It is tempting to interpret this null result as evidence against Grison &

Strayer's (2001) inhibitory account of NP. It is difficult to challenge the inhibitory account based on the current failure to observe larger NP effects for prime distractors presented in uniform case, however, since there was no evidence that they were perceived more fluently than prime distractors presented in alternating case. Indeed, participants actually responded more slowly to probe targets presented in alternating case.

Applied to Experiment 2, a prediction that would be made based on the episodic retrieval approach to NP is that the presentation of the probe target in the same perceptual form as the prime distractor on ignored repetition trials should lead to the greatest amount of NP, regardless of whether both words were presented in degraded or non-degraded form. The results of Experiment 2 failed to confirm this prediction, although participants were generally impaired in responding to probe targets following the presentation of either the same or different word as the prime distractor. Nevertheless, the results of Experiment 2 do not provide compelling support either for or against the inhibitory or episodic retrieval accounts of NP. Clearly, there were problems with the way Experiment 2 was designed.

The manipulation of perceptual fluency in the present experiment (that of presenting items in alternating case form in order to reduce their perceptual fluency) was not strong enough to lead to slower RTs to probe targets considered as degraded (alternating case words), relative to probe targets considered as intact and perceptually fluent (uniform lower case words). The same four words were presented throughout the experimental session in either alternating case or uniform case. As a result, for words presented in alternating letter case, participants' multiple exposures and responses to those words could have caused the perceptual fluency of those words to be about the same as words appearing in uniform case. The second problem is in the strength of the manipulation of match versus mismatch in perceptual form between presentation of the same word in the prime and probe displays. Consider that between the presentation of an item in alternating case (aPpLe), and the presentation of an item in uniform lower case (apple), only the second and fourth letters of the items differ from one form of presentation to the other, and then they only differ in that the same letters appear in a different case. In contrast, when repeated words mismatched in their perceptual form in Experiment 1, all five letters differed in their letter case. This difference between the two experiments could account for why a match in perceptual form influenced the size of NP effects in Experiment 1, but not in Experiment 2. A hint that the manipulation of match versus mismatch in perceptual form was not strong enough can also be found in the literature on letter priming effects. Very often, repetition priming effects are approximately equivalent whether the same letter appears as both the prime and probe stimulus in the same or a different letter case (see Bowers, 2000, for a review). For these reasons, Experiment 3 was designed to provide a stronger test of the inhibitory versus episodic retrieval accounts of NP. In particular, the goal was to achieve a stronger manipulation of both the perceptual fluency of stimulus presentations and of the degree of match/mismatch in the perceptual form of words when they appeared as both the prime distractor and probe target.

Experiment 3

Experiment 3 tested whether a stronger manipulation of perceptual fluency would provide evidence that NP can occur for a perceptually degraded prime distractor. Also, the goal of Experiment 3 was to provide a stronger test of whether the observation of NP would depend on a match in perceptual form between a prime distractor and a probe target. Whereas Experiment 1 tested whether NP occurs as a function of match in the perceptual form of a prime distractor and probe target, Experiment 2 was meant as a direct comparison of the impact of relatively degraded vs. intact prime distractors on NP. However, the results of Experiment 2 suggest that the manipulation of perceptual fluency through presentation of words in either uniform or alternating case was not strong enough. There was no evidence that participants found words presented in alternating case as more difficult to perceive than words presented in uniform case. Also, in contrast with the results of Experiment 1, NP effects were about the same magnitude whether prime distractors and probe targets matched or differed in their perceptual form on ignored repetition trials. Thus, it seems that the difference in the perceptual form of words presented in alternating versus uniform case was not large enough to influence priming effects.

In Experiment 3, the manipulation of perceptual fluency consisted of presenting each capitalized distractor and target word either in normal orientation, with letters in a left-to-right order, or with letters in reversed order (right-to-left). As presentation of a word in normal orientation (e.g., *Pilot*) is standard in the English language, items presented with letters in reversed orientation (e.g., *wodniW*) were expected to be less fluently perceived than items presented in normal orientation. The physical appearance of words presented with letters in right-to-left order is not frequently encountered in the English language, and should require more effortful processing, thus qualifying the set of words presented in reversed order as low-fluency items. Whether or not this manipulation of perceptual fluency is successful can be evaluated by whether RTs to probe targets presented in reversed form are relatively longer than RTs to probe targets appearing in standard orientation. Thus, since each target and distractor in each prime and probe display were presented either in reversed or normal orientation, the distractor and target of a prime display for ignored repetition and attended repetition trials, respectively, were either presented in the same, or different form of presentation as the form in which the probe target was presented.

Apart from the use of a different manipulation of perceptual fluency, a greater number of stimulus words were used in Experiment 3 than in Experiments 1 and 2. With a larger stimulus set, participants were exposed to the stimulus words less frequently, reducing the chance that perceptual fluency for items presented in reversed form would increase as a result of merely being exposed to the items repeatedly. Thus, use of a larger stimulus set minimizes the chance that the difference in the fluency of degraded versus non-degraded words would be eliminated by participants' multiple exposures to the same words throughout the experiment. In addition, in the present experiment, rather than responding by key press, participants were required to respond verbally, by naming targets aloud, as verbal responses have been found to produce larger NP effects (Neill, 1977, 1978).

Method

Participants

Thirty-six participants (19 males and 17 females, *M* age = 19.22) were again recruited from the undergraduate subject pool, consisting of students enrolled in an introductory psychology course. All participants reported normal or corrected to normal vision. Students' received a portion of course credit toward their final grade in exchange for participation.

Stimuli and Apparatus

Using 14 five-letter words of high frequency in the English language, 28 stimulus items were derived by presenting the letters of 14 words from left to right (high perceptual fluency items), with the first letter capitalized (*House*) and by presenting the letters of the same 14 words backwards, from right to left (low perceptual fluency items), with the first letter of the word, in the final position, capitalized (*esuoH*). Thus, the backward items were rendered relatively lower in perceptual fluency than normally presented items. The complete set of normal and inverted stimuli was: *Laser*, *resaL*, *Pilot*, *toliP*, *House*, *esuoH*, *Queen*, *neeuQ*, Chair, *riahC*, *Apple*, *elppA*, *Table*, *elbaT*, *Flame*, *emalF*, *Wagon*, *nogaW*, *Glass*, *ssalG*, *Stick*, *kcitS*, *Bench*, *hcneB*, *Train*, *niarT*, *Radio*, *oidaR*. Each stimulus word was non-rhyming, and orthographically dissimilar from other items in the set. Items were presented in 20-point, Times New Roman font. Stimulus words were presented against a black background owing to the use of a different program, and appeared in a smaller font size than was used in Experiments 1 and 2, to accommodate for the smaller computer monitor that was used in Experiment 3.

Stimulus pairs were presented to participants on the center of a 15-inch Samtron colour monitor, located at a viewing distance of approximately 70 cm. The experiment was programmed using Mel 2.01 experimental software on a Performance Design computer. Participants were asked to make vocal responses into a microphone placed before them, and response latencies were recorded. Response accuracy was coded manually by the experimenter via pressing of the keys *1* (correct), *2* (spoil), and *3* (incorrect) on the numeric keypad of a Fujitsu keyboard.

Procedure

The procedure was the same as that used in Experiments 1 and 2, except for the following changes. Instead of making key press responses, participants were required to name aloud the green target item in each display. Following the participants' vocal response to the target item in each display, the display cleared until the accuracy of the response was coded. Response accuracy was coded by the experimenter immediately following the first response made to each display. Once the participant correctly named the target item in the display, the experimenter immediately pressed *1* on the numeric keypad of the computer, coding the response as accurate. When the participant named the distractor item of a display, or an item not presented in the display, or if the participant began to give a response (causing the display to clear) but hesitated or paused prior to giving a complete response, the experimenter pressed the *3* key, coding the response as an error. An example of an error could be the response *plant* to a display in which *Pilot* was the target, and *Queen* was the distractor. The response *queen* would also have been coded as an error, as it should have been ignored. A response that began as one sound but was then morphed by the participant into the correct answer was also considered an error response (for example, "pllll…ilot"). If a sound other than the participants' response, such as a deep breath, a cough, or any noise other than a participants' vocal response set off the microphone and caused the display to clear, the response was coded as a spoil by the experimenter pressing the *2* key. If no response was made, the prime display automatically cleared after 2500 ms. Next, the probe display appeared, again requiring a response to a target stimulus, and the distractor stimulus to be ignored. Despite trials being organized into successive prime and probe displays throughout the experimental session, participants were not told about this aspect of the design and the sequence of events associated with the prime and probe events were indistinguishable. As a result, it was expected that participants were not capable of distinguishing between prime and probe displays. Following response to each display, and coding of the participants' response by the experimenter, the next display appeared after a 500 ms delay. This procedure led to longer delays elapsing prior to each prime and probe display compared to in Experiments 1 and 2, during which only 500 ms elapsed prior to each display. Although the absolute duration of pre-prime and pre-probe RSIs were longer in Experiment 3 than in Experiments 1 and 2, the relative similarity of the pre-prime and pre-probe RSIs on any given trial within an experiment remained constant. Thus, the slightly longer RSIs in Experiment 3 were not expected to influence the likelihood of retrieving a memory representation for processes engaged in at the time of the prime display. Finally, trials were divided into 24 blocks consisting of 24 trials each. The first two blocks (48 trials) consisted of practice blocks and the data for those blocks were eliminated from further analysis. Thus, the experimental blocks consisted of the last 21 blocks of the session (a total of 504 trials).

As a result of these changes, each word in every prime and probe display was presented either normally, with letters arranged from left to right (normal presentation), or with the letters presented in reverse order from right to left (reversed presentation), and the form of stimulus repetition across the prime and the probe displays of a trial either matched (with both presentations either normal or both presentations reversed) or mismatched across the prime and the probe displays (with the prime presentation normal and probe presentation reversed or with the prime presentation reversed and the probe presentation normal).

Other than the instruction to respond to each display by naming the target into a microphone rather than by key press, participants were also informed that their response time via the microphone, and accuracy via the experimenter's coding of their response would be recorded. All other instructions given to participants were identical to those given to participants in Experiments 1 and 2. RTs to both prime and probe targets were defined as the elapsed time between the onset of the prime and probe words and the generation of the participant's vocal response.

Owing to differences in the software program used for Experiment 3, prior to data collection there were 384 trials generated such that, for each trial, four of the twelve words in the stimulus set were randomly assigned to the role of: 1) prime target, 2) prime distractor, 3) probe target, and, 4) probe distractor. Of these trials, one-third (128) were unrepeated trials, one-third were ignored repetition trials, and the remaining third were attended repetition trials. Trials within each of these repetition conditions were randomly assigned to every possible combination of the presentation of prime target, prime distractor, probe target, and probe distractor as normal versus reversed. The factorial manipulation of whether the words appeared with letters in normal or backwards order depending on their role within a trial generated 48 trial types: 2 (prime target reversed vs. normal) X 2 (prime distractor reversed vs. normal) X 2 (probe target reversed vs. normal)

X 2 (probe distractor reverse vs. normal) x 3 (ignored repeated vs. unrepeated vs. attended repeated). Each of the cells of this design contributed 4 trials for each of the three repetition conditions, ensuring that exposure to easy and difficult to perceive words was completely counterbalanced within their roles as targets and distractors in the prime and probe displays. However, the primary objective of the current study was to investigate the effect of a match in the perceptual status of words that repeated between the prime and probe displays both on attended and ignored repetition trials. The distribution of trials across and within conditions was the same as in Experiments 1 and 2, except that the factorial manipulation of forms of presentation now consisted of presenting items either in normal orientation, or with letters in reverse order.

Design and Analysis

For ignored repetition trials, the primary factors of interest were repetition condition (ignored repetition vs. unrepeated), prime distractor form (reversed vs. normal), and probe target form (reversed vs. normal). As a result, the effects of ignored repetition on mean RTs, and on the proportion of errors in response to the probe displays were analyzed using separate 2 X 2 X 2 repeated-measures ANOVAs, treating each of these factors as within-participants variables. Attended repetition effects on mean correct probe RTs and the proportion of errors were analyzed with separate 2 X 2 X 2 repeated-measures ANOVAs, treating repetition condition (attended repetition vs. unrepeated), prime target form (reversed vs. normal), and probe target form (reversed vs. normal) as within-participants factors. As for Experiments 1 and 2, the analyses included only mean correct probe RTs and the proportion of incorrect responses for trials on which participants made a correct response to the prime display.

Results and Discussion

Participants' mean correct probe RTs and the proportion of incorrect responses to probe targets are displayed in Tables 5 and 6. Table 5 displays the data for ignored repetition effects and Table 6 displays the data for attended repetition effects.

Table 5

Mean correct response times (RTs) in milliseconds (ms) and error rates (ERR) when responding to probe target displays in Experiment 3, as a function of repetition condition (ignored vs. unrepeated), and prime distractor/probe target form (reversed/reversed vs. normal/normal vs. reversed/normal vs. normal/reversed).

	Repetition Condition					
	Ignored		Unrepeated		Difference	
Prime Distractor/ Probe Target Form	RT	ERR	RT	ERR	RT	ERR
Same						
Reversed	612	.011	599	.007	-13	.000
/Reversed	(12.6)	(.003)	(12.4)	(.002)	(3.5)	(.006)
Normal	538	.007	525	.007	-13	-.008
/Normal	(9.4)	(.003)	(9.4)	(.002)	(3.7)	(.009)
Different						
Reversed	525	.004	522	.001	-3	-.009
/Normal	(9.3)	(.002)	(9.2)	(.001)	(2.5)	(.009)
Normal	603	.008	603	.008	0	-.003
/Reversed	(13.2)	(.003)	(11.8)	(.002)	(4.9)	(.007)

SE = Between-participant standard error of the mean RTs and error rates for the ignored repetition and unrepeated trials, and for the mean difference in RTs and error rates between ignored and unrepeated trials.

Table 6

Mean correct response times (RTs) in milliseconds (ms) and error rates (ERR) when responding to probe target displays in Experiment 3, as a function of repetition condition (attended vs. unrepeated), and prime target/probe target form (reversed/reversed vs. normal/normal vs. reversed/normal vs. normal/reversed).

	Repetition Condition					
	Attended		Unrepeated		Difference	
Prime Distractor/ Probe Target Form	RT	ERR	RT	ERR	RT	ERR
Same						
Reversed /Reversed	558 (10.3)	.001 (.001)	596 (12.5)	.003 (.002)	38 (6.2)	.002 (.003)
Normal /Normal	517 (8.4)	.003 (.002)	522 (9.3)	.004 (.002)	5 (4.3)	.001 (.002)
Different						
Reversed /Normal	598 (11.9)	.012 (.003)	606 (11.6)	.010 (.003)	-8 (4.5)	-.001 (.004)
Normal /Reversed	530 (8.8)	.005 (.002)	525 (9.7)	.004 (.002)	-5 (3.3)	-.001 (.002)

SE = Between-participant standard error of the mean RTs and error rates for the attended repetition and unrepeated trials, and for the mean difference in RTs and error rates between attended and unrepeated trials.

Ignored Repetition Effects

The analysis of ignored repetition effects on probe RTs revealed the anticipated main effect of repetition, indicating that participants' responses to the probe display were on average 6 ms slower on ignored repetition trials than on unrepeated trials (569 ms vs. 562 ms), $F(1,35) = 17.59$, $MS_e = 211.44$, $p < .001$. A main effect of probe target form was also significant, with RTs 77 ms slower on trials when the probe display contained a probe target with the letters in reverse orientation relative to when the probe target was presented in a normal orientation (604 ms vs. 527 ms), $F(1, 35) = 286.41$, $MS_e = 1{,}477.01$, $p < .001$. Thus, the manipulation of perceptual fluency used in the present study appears to have been effective, as RTs were longer in response to low-fluency (reversed) probe targets than to high-fluency (normally presented) probe targets.

The overall interaction between prime distractor form and probe target form was not significant for ignored repetition trials in the present experiment, $F(1, 35) = 2.63$, $MS_e = 779.77$, $p = .11$. Thus, the effect of ignoring a prime distractor presented in one form in impairing response to a probe target presented in the same form did not occur in Experiment 3 as it did in Experiments 1 and 2. The absence of such an interaction may reflect that normally presented and reversed items differed only slightly in overall form. Although every item presented contained a string of lower case letters, depending on the form of the item, either the leftmost letter was capitalized (normally presented items), or the rightmost letter was capitalized (reversed orientation items). This difference might have been too subtle to replicate the form-specific effects obtained in the previous two experiments. The most critical result of Experiment 3 was that repetition condition (ignored repeated vs. unrepeated trials) significantly interacted with prime distractor form (reversed vs. forward) and probe target form (reversed vs. forward), $F(1, 35) = 16.01$, $MS_e = 149.71$, $p < .001$.

Separate 2 X 2 X 2 repeated-measures ANOVAs were performed with RT data from trials in which the prime distractor and probe target appeared in the same perceptual form (prime distractor and probe target both in normal orientation, or both in reversed order), and for trials in which they were presented in a different form one from the other (prime distractor in normal orientation with probe target in reversed order, and prime distractor in reversed order with probe target in normal orientation). Repetition (ignored repeated vs. unrepeated condition), and repeated form (normal orientation vs. reversed order) were specified as within-participants factors. The analyses revealed that participants were significantly about 13 ms slower at responding to the probe target on ignored repetition trials when it was presented in the *same* perceptual form as the prime distractor in the preceding display than on unrepeated trials (574 ms vs. 562ms), $F(1, 35) = 49.78$, $MS_e = 122.14$, $p < .001$. In contrast, the speed of participants' response to ignored repetition versus unrepeated trials was not significantly different when the prime distractor and probe target were presented in perceptual forms that differed (564 ms vs. 562 ms), $F(1, 35) = 0.30$, $MS_e = 239.01$, $p = .59$. The analysis of ignored repetition effects on RTs revealed no further effects as significant.

The analysis of ignored repetition effects on error rates revealed a main effect of probe target form on errors, with a greater proportion of errors having occurred when the probe target was presented in reversed orientation than when it was presented normally (.008 vs. .005), $F(1, 35) = 5.39$, $MS_e = 0.00$, $p < 05$. No other effects reached significance in the analysis of ignored repetition effects on error rates.

One purpose of Experiment 3 was to use a stronger manipulation of perceptual fluency than was used in Experiment 2 in order to directly compare the influence of presenting a high-fluency (normal) prime distractor to that of presenting a low-fluency (reversed) prime distractor. The main effect of probe target form on RTs suggests that reversed items were in fact processed less fluently than items that were presented normally. By inference then, the manipulation of perceptual fluency was successful.

Therefore the present experiment provided an effective comparison of the influence of prime distractors presented in high versus low fluency forms, since a significant NP effect occurred in the ignored repetition condition regardless of the form in which the prime distractor was presented. Moreover, the analysis of probe RTs did not produce a significant interaction between repetition condition and prime distractor form, demonstrating that the pattern of NP effects observed was not influenced by the perceptual fluency of the prime distractor. These results provide direct evidence against Grison and Strayer's (2001) claim that high-fluency distractors cause larger NP effects.

The current manipulation of perceptual fluency was also successful in the demonstration that NP is contingent upon a match in perceptual fluency of the prime distractor and probe target, since NP appeared solely in ignored repetition trials for which the prime distractor and probe target matched in perceptual form (whether they both appeared in reversed or normal orientation). It appears that the failure to produce a similar result in Experiment 2 was a reflection of the inadequate manipulation of perceptual fluency in that experiment, as alternating case words were not responded to more slowly than words presented in uniform lower case, as had been expected.

Attended Repetition Effects

The analysis of attended repetition on RTs revealed a main effect of repetition, with responses on attended repetition trials 11 ms faster than on unrepeated trials (551 ms vs. 562 ms), $F(1, 35) = 18.15$, $MS_e = 528.28$, $p < .001$, demonstrating the typical facilitation effects reported in the literature. A main effect of probe target form on RTs was also significant, with participants responding 65 ms slower on trials when the probe target was reversed than when it was presented in normal orientation (589 ms vs. 524 ms), $F(1, 35) = 281.67$, $MS_e = 1{,}104.93$, $p < .001$. There was also a main effect of prime target form on RTs, with responses about 9 ms slower when the prime target was presented in degraded form than when it was presented in a normal orientation (552 ms vs. 561 ms), $F(1, 35) = 32.06$, $MS_e = 178.44$, $p < .001$. Also significant was an interaction between repetition condition, prime target form, and probe target form, $F(1, 35) = 19.71$, $MS_e = 367.18$, $p < .001$, as had appeared in Experiment 1.

The source of this last interaction was investigated with two further 2 X 2 repeated-measures ANOVAs for trials in which the prime and probe target were presented in the same form (both presented in reverse), and for trials in which they appeared in different forms (one was presented in reverse, and the other was presented normally), treating repetition condition and probe target form as within-participants factors. The analysis indicated that participants were about 21 ms faster at responding on attended repetition trials than on unrepeated trials when the prime and probe targets of a trial were both presented in the same form (either both were presented in reverse, or both appeared normally) (538 ms vs. 559 ms), $F(1, 35) = 27.40$, $MS_e = 611.17$, $p < .001$. There was no difference in the participants' speed of response between attended repetition and unrepeated trials when the items were presented in different perceptual forms (564 ms vs. 565 ms), $F(1, 35) = .29$, $MS_e = 284.28$, $p = .59$. Thus, in the attended repetition trials of the present experiment, the response time benefits were eliminated when the prime target and probe target were presented in mismatching forms.

The analysis of attended repetition effects on error rates revealed a significant effect of prime target form on errors, with about 0.7% more errors occurring when the prime target was presented in reversed form (.007 vs. .014), $F(1, 35) = 5.21$, $MS_e = 0.00$, $p < .05$. A significant interaction between prime target form and probe target form emerged, $F(1, 35) = 10.90$, $MS_e = 0$, $p < .01$. An additional pair of repeated-measures ANOVAs, treating repetition condition and prime target form as within-participants factors, revealed that the source of the interaction was that on attended repetition trials containing degraded probe targets only, participants were about 0.9% more likely to make an incorrect response when the prime target appeared in a normal orientation than when the letters of the prime target were presented in reverse order (.011 vs. .002), $F(1, 35) = 9.18$, $MS_e = 0$, $p < .01$. When the probe target was presented in a normal orientation, participants were about as likely to make incorrect responses whether the letters of the prime target were normally presented or reversed. No other effects reached significance in the analysis of attended repetition effects on error rates.

CHAPTER 3

GENERAL DISCUSSION

The main purpose of the current study was to determine whether a distractor inhibition account, or an episodic retrieval account, is most appropriate in accounting for NP effects. Often, an inhibitory account is adopted in describing the effect, suggesting that when a distractor that is ignored in the prime display repeats as a target in the probe display, slower responding to that item manifests from the word having been inhibited during the prime display, as a function of its irrelevance to the task of processing and responding to, an attended target (Tipper, 1985). On the basis of their finding that larger NP effects occurred when prime distractors were presented in a high-fluency form than in a low-fluency form, Grison and Strayer (2001) elaborated on the inhibitory account, suggesting that a high-fluency prime distractor more strongly activates the representation that exists for it than does a degraded distractor. In turn, greater inhibition is applied against the distractor, making gaining access, and responding to it, more difficult.

In contrast, an episodic retrieval account of NP suggests that slower responding to a probe target results from the retrieval of a recently formed memory representation of having withheld a response to it (Neill, 1997; Neill et al., 1992; Neill & Mathis, 1998). The information retrieved may include the processes that were engaged in during the prior event (Morris, Bransford, & Franks, 1977), which do not transfer well to the current processing situation (Neill & Mathis, 1998). Further, the likelihood of this retrieval process occurring is enhanced, the greater the overlap between present conditions and those of a prior experience increases (the principle of Encoding Specificity, Tulving & Thompson, 1973).

In Experiment 1, prime distractors and probe targets always appeared in one of two equivalent forms of perceptual fluency. On some of the trials, the prime distractor and probe target were presented in matching perceptual forms, and on other trials, the two items were presented in different forms. As a result, NP only occurred when the prime distractor and probe target were presented in the same form, indicating that NP effects are not contingent on the perceptual status of the prime distractor, and that they are instead contingent on a match in perceptual form between a prime distractor and probe target.

By presenting prime distractors and probe targets either in uniform lower case letters or in alternating case letters, Experiment 2 permitted a test of whether the NP effects observed in Grison and Strayer's (2001) study could instead be attributed to the presence of a match in perceptual form when prime distractors were intact (since these matched in form with probe targets, which were always intact). However, a weak manipulation of the difference in perceptual fluency between the items presented in degraded versus intact form produced similar NP for both intact and degraded prime distractors. Further, RTs were no slower on trials for which the probe target was presented in alternating case, suggesting that presenting items in alternating case letters did not reduce the fluency with which those items were perceived. Therefore, the results of Experiment 2 did not contribute conclusive evidence in favour of either an inhibitory or episodic retrieval account of NP.

When a stronger manipulation of perceptual fluency was used in Experiment 3, which was confirmed by slower responding to probe targets presented in the low-fluency form, the same pattern of effects that occurred in Experiment 1 again emerged. NP was contingent on the prime distractor and probe target being presented in the same perceptual form.

In Experiments 1 and 2, the unexpected finding of response costs on trials as a function of match in perceptual form alone, is interesting. NP effects appeared as a result of the sole influence of a repetition in perceptual form of the prime distractor to the probe target, completely independent of a repetition of the actual word itself from the prime display to the probe display. Further, the form specific influence on NP appears to have been much larger than that of the same word repeating from the status of prime distractor to probe target, demonstrating that withholding a response to a stimulus leads to greater response costs as a function of surface features of an irrelevant stimulus (prime distractor), rather than its identity, later being an attribute of a relevant stimulus (probe target). These form specifics effects appear, however, to be sensitive to attentional processes, as they were present on ignored repetition trials, but absent on attended repetition trials. RTs were not faster on attended repetition trials when the prime target repeated as a probe target presented in the same form than when it repeated as the same word in a different form. Thus, the general form of a stimulus in the prime display is processed, and may lead to costs in responding to a different probe target word presented in the same form, only when that stimulus was ignored in the prime display. The disappearance of the form-specific effect in Experiment 3 suggests another possible source of form-specific influences. In Experiments 1 and 2, the manipulations of perceptual fluency that were used led to similar processing of the stimulus words regardless of which of the two perceptual forms they appeared. In Experiment 3, however, when words were printed either in normal or reversed orientation, the processing required in response to an item that was presented in normal orientation may have sufficiently differed from the processing required in response to a stimulus word presented in reversed orientation, in turn reducing the likelihood that a memory representation for processing the prime display was retrieved.

Overall, the results of all three experiments provide evidence against the idea that NP is a by-product of the inhibition of ignored items in the prime display, while strengthening the case for a role of memory retrieval processes in NP effects which are independent of event stimulus repetition. Further, the emergence of identity-specific and form-specific influences on the appearance of NP effects in the current study may be taken as separate demonstrations of the high specificity and perceptual sensitivity characterizing the retrieval processes involved.

The findings illustrate how NP, which appears to be an effect caused by a very specific mechanism, actually reflects the involvement and influence of general principles of memory. First, that NP partly depended on match in the form of presentation of the prime distractor and probe target in the current study demonstrates the principle of encoding specificity at work (Tulving & Thompson, 1973). Due to most of the perceptual qualities of the prime distractor being reinstated for an item in the position of probe target, there was an enhanced likelihood of retrieving the memory representation for having not attended or responded to the prime distractor. In turn, this lead to a conflict with making a response to the probe target. Thus, even perceptual information that is peripheral to that which is being attended to in a prime display, appears to remain accessible in memory, and influences response to a probe target. This is inconsistent with a *Levels of Processing Framework* (Craik & Lockhart, 1972), which would predict that an irrelevant characteristic of an ignored stimulus in the prime display should be inconsequential to making a response to the probe targets. In contrast, such a finding is consistent with the findings of Wood and Milliken (1998) that ignoring an item does not later impair responding to it.

Second, similarity between the prime distractor and the probe target of a prime display and a probe display should encourage retrieval of the processing information associated with the prime event. On trials where the same word is responded to in both the prime and probe displays, as in the attended repetition condition, the outcome should be facilitation, as the retrieval of processes engaged in during the prime is compatible with processing requirements of the current task (Morris, Bransford, & Franks, 1977) of responding to the same item as a probe target. In contrast, on trials where the repeating word is first presented as a prime distractor to which no response is made, and then as a target in the probe display that follows, the outcome is a response cost, as the retrieval of processes engaged in during the prime is now inappropriate, and may interfere with the current task (Neill & Mathis, 1998) of responding to the probe target. It appears that the processing experiences we have had with a stimulus in the past remains available, to offer cognitive savings when we encounter that stimulus again in the future. However, these same experiences are also fully available to interfere with a current processing task involving the same stimulus, though it must be treated differently. What may interrupt either process, however, is how discriminable the item is that is presented in the probe display. If the probe target is a new item, or if it is sufficiently different in form from the prime distractor, then the likelihood of retrieving the memory representation of processes engaged in during the prime should be lesser (Baddeley, 1976), in turn reducing NP.

Future avenues of research in pursuit of understanding further the processes underlying NP effects should investigate how similar the form of a prime distractor must be to that of a probe target, for the likelihood of retrieving a memory representation for the prime display to dwindle. In addition, it would be worth trying to replicate the pattern of form-specific effects observed in the present experiments with stimuli that do not already have the pre-established level of fluency that common English words do. Using a stimulus set for with which participants have not acquired a lifetime of experience, and on to which they have not imposed meaning (i.e., novel shapes), could be helpful in isolating the influence of form-specific influences, as differences in perceptual fluency between items in the stimulus set could be objectively established.

References

Allport, D. A., Tipper, S. P., & Chmiel, N. R. J. (1985). Perceptual integration and postcategorical filtering. In M. I. Posner & O. S. Marin (Eds.), Attention and Performance XI (pp. 107-132). Hillsdale, NJ: Erlbaum.

Baddeley, A. D. (1976). *The Psychology of Memory.* New York, NY: Basic Books.

Bowers, J. S. (2000). In defense of abstractionist theories of repetition priming and word identification. *Psychonomic Bulletin & Review, 7,* 83-99.

Chiappe, D. L., & MacLeod, C. M. (1995). Negative priming is not task bound: A consistent pattern across naming and categorization tasks. *Psychonomic Bulletin & Review*, *2*, 364-369.

Craik, F. I., & Lockhart, R. S. (1972). Levels of processing: A framework for memory research. *Journal of Verbal Learning and Verbal Behavior, 11,* 671-684.

Dalrymple-Alford, E. C., & Budayr, B. (1966). Examination of some aspects of the Stroop color-word test. *Perceptual and Motor Skills*, *23*, 1211-1214.

Dark, V. J., & Schmidt, P. A. (2000). Conceptual activation of distractors during selection is not sufficient to produce negative priming. *Psychonomic Bulletin & Review*, *7*, 126-132.

DeSchepper, B., & Treisman, A. (1996). Visual memory for novel shapes: Implicit coding without attention. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *22*, 27-47.

Driver, J., & Baylis, G. C. (1993). Cross-modal negative priming and interference in selective attention. *Bulletin of the Psychonomic Society*, *31*, 45-48.

Driver, J., & Tipper, S. P. (1989). On the nonselectivity of "selective" seeing: Contrasts between interference and priming in selective attention. *Journal of Experimental Psychology: Human Perception and Performance*, *15*, 304-314.

Eriksen, B. A., & Eriksen, C. W. (1974). Effects of noise letters upon the identification of a target letter in a nonsearch task. *Perception & Psychophysics*, *16*, 143-149.

Fox, E. (1995). Negative priming from ignored distractors in visual selection: A review. *Psychonomic Bulletin & Review*, *2*, 145-173.

Fox, E., & de Fockert, J. W. (1998). Negative priming depends on prime-probe similarity: Evidence for episodic retrieval. *Psychonomic Bulletin & Review*, *5*, 107-113.

Fuentes, L. J., & Tudela, P. (1992). Semantic processing of foveally and parafoveally presented words in a lexical decision task. *The Quarterly Journal of Experimental Psychology A: Human Experimental Psychology*, *45A*, 299-322.

Grison, S., & Strayer, D. L. (2001). Negative priming and perceptual fluency: More than what meets the eye. *Perception & Psychophysics*, *63*, 1063-1071.

Grison, S., Tipper, S. P., & Hewitt, O. (2005). Long-term negative priming: Support for retrieval of prior attentional processes. *The Quarterly Journal of Experimental Psychology A: Human Experimental Psychology*, *58A*, 1199-1224.

Houghton, G., & Tipper, S. P. (1994). A model of inhibitory mechanisms in selective attention. In D. Dagenbach and T. H. Carr (Eds.), *Inhibitory Processes in Attention, Memory, and Language* (pp. 53-112). San Diego, CA: Academic Press.

Kane, M. J., Hasher, L., Stoltzfus, E. R., Zacks, R. T., & Connelly, S. L. (1994). Inhibitory attentional mechanisms and aging. *Psychology and Aging*, *9*, 103-112.

Leboe, J. P., & Milliken, B. (2004). Single-prime negative priming in the shape-matching task: Implications for the role of perceptual segmentation processes. *Visual Cognition, 11, 603-630.*

Little, D. M., & Hartley, A. A. (2000). Further evidence that negative priming in the Stroop color-word task is equivalent in older and younger adults. *Psychology and Aging*, *15*, 9-17.

Lowe, D. G. (1979). Strategies, context, and the mechanisms of response inhibition. *Memory and Cognition*, *7*, 382-389.

Lowe, D. G. (1985). Further investigations of inhibitory mechanisms in attention. *Memory and Cognition*, *13*, 74-80.

Lowe, D. G. (1998). Long-term positive and negative identity priming: Evidence for episodic retrieval. *Memory and Cognition*, *26*, 435-443.

MacDonald, P. A., Joordens, S., & Seergobin, K. N. (1999). Negative priming effects that are bigger than a breadbox: Attention to distractors does not eliminate negative priming, it enhances it. *Memory and Cognition*, *27*, 197-207.

Marcel, A. J. (1980). Conscious and preconscious recognition of polysemous words: Locating the selective effects of prior verbal context. In R. S. Nickerson (Ed.). *Attention and Performance VIII* (pp.435-437). Hillsdale, NJ: Erlbaum.

Malley, G. B., & Strayer, D. L. (1995). Effect of stimulus repetition on positive and negative identity priming. *Perception & Psychophysics*, *57*, 657-667.

Milliken, B., & Joordens, S. (1996). Negative priming without overt prime selection. *Canadian Journal of Experimental Psychology*, *50*, 333-346.

Milliken, B., Joordens, S., Merikle, P. M., & Seiffert, A. E. (1998). Selective attention: A reevaluation of the implications of negative priming. *Psychological Review, 105*, 203-229.

Milliken, B., Lupianez, J., Debner, J., & Abello, B. (1999). Automatic and controlled processing in Stroop negative priming: The role of attentional set. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *25*, 1384-1402.

Milliken, B., & Rock, A. (1997). Negative priming, attention, and discriminating the present from the past. *Consciousness and Cognition*, *6*, 308-327.

Milliken, B., Tipper, S. P., & Weaver, B. (1994). Negative priming in a spatial localization task: Feature mismatching and distractor inhibition. *Journal of Experimental Psychology: Human Perception and Performance*, *20*, 624-646.

Mondor, T. A., Leboe, J. P., Leboe, L. C. (2005). The role of selection in generating auditory negative priming. *Psychonomic Bulletin & Review*, *12*, 289-294.

Moore, C. M. (1994). Negative priming depends on probe-trial conflict: Where has all the inhibition gone? *Perception & Psychophysics*, *56*, 133-147.

Morris, C. D., Bransford, J. D., & Franks, J. J. (1977). Levels of processing versus transfer appropriate processing. *Journal of Verbal Learning and Verbal Behavior*, *16*, 519-533.

Neill, W. T. (1977). Inhibitory and facilitatory processes in selective attention. *Journal of Experimental Psychology: Human Perception and Performance*, *3*, 444-450.

Neill, W. T. (1978). Decision processes in selective attention: Response priming in the Stroop Color-Word task. *Perception and Psychophysics, 23,* 80-84.

Neill, W. T. (1979). Switching attention within and between categories: Evidence for intracategory inhibition. *Memory and Cognition*, *7*, 283-290.

Neill, W. T. (1997). Episodic retrieval in negative priming and repetition priming. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *23*, 1291-1305.

Neill, W. T., & Kahan, T. A. (1999). Response conflict reverses priming: A replication. *Psychonomic Bulletin & Review*, *6*, 304-308.

Neill, W. T., & Westberry, R. L. (1987). Selective attention and the suppression of cognitive noise. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *13*, 327-334.

Neill, W.T., Lissner, L. S., & Beck, J. L. (1990). Negative priming in *same-different* matching: Further evidence for a central locus of inhibition. *Perception & Psychophysics*, *48*, 398-400.

Neill, W. T., & Mathis, K. M. (1998). Transfer-inappropriate processing: Negative priming and related phenomena. In D. L. Medin (Ed.) *The Psychology of Learning and Motivation: Advances in Research and Theory* (Vol. 38, 1-44). San Diego, CA: Academic Press.

Neill, W. T., Terry, K. M., & Valdes, L. A. (1994). Negative priming without probe selection. *Psychonomic Bulletin & Review*, *1*, 119-121.

Neill, W. T., & Valdes, L. A. (1992). Persistence and negative priming: Steady state or decay? *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *18*, 565-576.

Neill, W. T., Valdes, L. A., & Terry, K. M. (1995). Selective attention and the inhibitory control of cognition. In F. N. Dempster & C. J. Brainerd (Eds.), *Interference and Inhibition in Cognition* (pp. 207-261). San Diego, CA: Academic Press.

Neill, W. T., Valdes, L. A., Terry, K. M., & Gorfein, D. S. (1992). Persistence of negative priming: II. Evidence for episodic trace retrieval. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *18*, 993-1000.

Ortells, J. J. & Tudela, P. (1996). Positive and negative priming of attended and unattended parafoveal words in a lexical decision task. *Acta Psychologica*, *94*, 209-226.

Park, J., & Kanwisher, N. (1994). Negative priming for spatial locations: Identity mismatching, not distractor inhibition. *Journal of Experimental Psychology: Human Perception and Performance*, *20*, 613-623.

Psychology Software Tools. (2002). E-Prime (Version 1.1) [Computer software]. Pittsburgh, PA: Author.

Psychology Software Tools. (1988). Micro Experimental Laboratories (Version 2.01) [Computer software]. Pittsburgh, PA: Author.

Strayer, D. L., & Grison, S. (1999). Negative priming is contingent on stimulus repetition. *Journal of Experimental Psychology: Human Perception and Performance*, *25*, 24-38.

Stroop, J. R. (1935). Studies of interference in serial verbal reactions. *Journal of Experimental Psychology*, *18*, 643-662.

Tipper, S. P. (1985). The negative priming effect: Inhibitory priming by ignored objects. *The Quarterly Journal of Experimental Psychology A: Human Experimental Psychology, 37A*, 571-590.

Tipper, S. P. (2001). Does negative priming reflect inhibitory mechanisms? A review and integration of conflicting views. *The Quarterly Journal of Experimental Psychology A: Human Experimental Psychology, 54A*, 321-343.

Tipper, S. P., & Baylis, G. C. (1987). Individual differences in selective attention: The relation of priming and interference to cognitive failure. *Personality and Individual Differences, 8*, 667-675.

Tipper, S. P., Brehaut, J. C., & Driver, J. (1990). Selection of moving and static objects for the control of spatially directed action. *Journal of Experimental Psychology: Human Perception and Performance, 16*, 492-504.

Tipper, S. P., & Cranston, M. (1985). Selective attention and priming: Inhibitory and facilitatory effects of ignored primes. *The Quarterly Journal of Experimental Psychology A: Human Experimental Psychology, 37A*, 591-611.

Tipper, S. P., & Driver, J. (1988). Negative priming between pictures and words in a selective attention task: Evidence for semantic processing of ignored stimuli. *Memory and Cognition, 16*, 64-70.

Tipper, S. P., Lortie, C., & Baylis, G. C. (1992). Selective reaching: Evidence for action-centered attention. *Journal of Experimental Psychology: Human Perception and Performance, 18*, 891-905.

Tipper, S. P., MacQueen, G. M., & Brehaut, J. C. (1988). Negative priming between response modalities: Evidence for the central locus of inhibition in selective attention. *Perception & Psychophysics*, *43*, 45-52.

Tipper, S. P., Weaver, B., Cameron, S., Brehaut, J. C., Bastedo, J. (1991). Inhibitory mechanisms of attention in identification and localization tasks: Time course and disruption. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *17*, 681-692.

Treisman, A. M. (1969). Strategies and models of selective attention. *Psychological Review*, *76*, 282-299.

Tulving, E., & Thomson, D. M. (1973). Encoding specificity and retrieval processes in episodic memory. *Psychological Review*, *80*, 352-373.

Tulving, E. (1983). *Elements of episodic memory.* New York, NY: Oxford University Press.

Wood, T., & Milliken, B. (1998). Negative priming without ignoring. *Psychonomic Bulletin & Review*, *5*, 470-475.

Whittlesea, B. W., & Jacoby, L. L. (1990). Interaction of prime repetition with visual degradation: Is prime a retrieval phenomenon? *Journal of Memory and Language, 29,* 546-565.

Yee, P. L. (1991). Semantic inhibition of ignored words during a figure classification task. *The Quarterly Journal of Experimental Psychology A: Human Experimental Psychology*, *43A*, 127-153.