THE ROLE OF ATTENTION IN THE MODULATION OF RESPONSE SELECTION: ATTENUATING OBJECT-SPECIFIC BENEFITS

By

KARMEN RUTH BLEILE, B.SC. (HONOURS)

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AUTHOR: Karmen R. Bleile, B.Sc. (Honours) (University of Calgary)

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ABSTRACT

Every day we encounter a variety of objects in a complex sensory environment. Some objects are familiar, whereas other objects have never been encountered before or are novel within the current context. Response to a novel object typically requires analysis of current perceptual information of the object. By contrast, retrieving a memory for a prior event is often a useful 'shortcut' to response for a familiar stimulus. However, in some situations a past response is inappropriate for a current object, even if it is similar to an object encountered previously. Consequently, past experience may be a source of interference in response selection under some conditions. In these circumstances, relying on the analysis of current perceptual information of the object may be a more useful approach to response selection. It is proposed in this thesis that attention during the current encounter with a stimulus modulates the contribution that retrieval processes and analytic perceptual processes make to response selection.

The priming method is often used to examine how prior experience influences current responding. To examine the role of attention in modulating response selection, different attentional manipulations were used in a series of priming experiments. The results of a word-naming experiment showed that the appearance of response benefits and costs for repeated stimuli was contingent on the presence or absence of a distracting stimulus in the second of two priming displays. Then, a series of experiments was conducted using a modified version of the procedure employed by Kahneman, Treisman and Gibbs (1992) to compare responses to identical and non-identical repetitions of stimuli (the object-specific preview effect). An object-specific preview benefit was eliminated both when a distractor was included in the second display and when the proportion of repeated trials was reduced below chance. Further, repetition costs emerged for repeated stimuli under the same conditions in which an object-specific preview benefit was not observed. Together, the findings are highly consistent with the proposal that attentional processing during the current encounter with a stimulus influences the contribution that retrieval makes to response selection.

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CHAPTER 1

Introduction

Every day we engage in an array of behaviours in a complex environment. Successful completion of each behaviour is contingent on our ability to process the sensory input from this environment and to determine a response that is appropriate given the current task demands. Many of the objects in any given environment have been encountered previously and are therefore familiar to us. However, at times we are confronted with objects that have never been encountered before, or with objects that have been encountered before but are novel within the current context.

Whether an object is familiar or novel may play a critical role in determining how it is responded to. Experience is likely to have taught us that responses to familiar stimuli can be generated with little effort or care, whereas responses to novel stimuli often require attention to detail. For example, consider a child learning to read. In a child's first experience with the printed word 'CAT', she may attempt to break the word down into individual letters and deliberately sound out each letter. Once satisfied that the sound for each letter is correct, the child tries to blend the individual letter sounds together to create the appropriate spoken response. Thus, the child generates a response to the novel word by analyzing the various parts of the word and then piecing together the information she has extracted from these parts. Determining a response in this way can be a time consuming and effortful process for the beginning reader.

This analytical process of determining a response can be contrasted with the approach adopted by the child after having some practice with the word, 'CAT'. Under these circumstances, the child now sees the word in print and responds quickly and accurately in a single utterance. Apparently, the young reader's ability to read the word 'CAT' is facilitated by her prior experience with that word.

The distinction between processes that underlie responses to novel stimuli and to familiar stimuli has been of considerable interest to researchers in cognitive psychology (e.g., Jacoby, 1978; Logan, 1988). When a response must be determined for a novel stimulus, the processing involved can be characterized as a series of discrete operations (Jacoby, 1978) or an algorithm (Logan, 1988). This analytic response selection strategy may be exemplified by our young reader's attempt to construct a response to the word 'CAT' from the sounds of the individual letters. For the purpose of this thesis, I will call this response selection strategy 'reliance on perceptual analysis'.

When responding to a familiar stimulus, the same type of detailed analysis may be engaged. However, because the response to a familiar stimulus may already be stored in memory as a consequence of previous experience, such analysis may be unnecessary. Therefore, individuals may respond to a familiar stimulus by accessing the response directly from memory (Jacoby, 1978; Logan, 1988). This retrieval-based approach may be exemplified by our young reader's rapid response "cat" upon seeing the word 'CAT', after having had prior experience with that word. I will call this response selection strategy 'reliance on memory retrieval'.

An important assumption that underlies the distinction between the two response selection strategies is that retrieving information from memory enables the observer to bypass some of the processing that would be required if the observer had relied on perceptual analysis; thus, it has been suggested that reliance on memory retrieval may be a more efficient route to response than reliance on perceptual analysis (e.g., Jacoby, 1978; Kahneman, Treisman & Gibbs, 1992; Logan, 1988). As a consequence, responses to familiar stimuli may be determined more rapidly than responses to novel stimuli. In summary then, the relative contributions of perceptual analysis and memory retrieval to response selection may differ for familiar and novel stimuli (Jacoby, 1978; Logan, 1988).

Given that memory retrieval can produce fast responses to familiar stimuli, relying on past experiences to guide current responding can be a highly useful response selection strategy. In some situations however, reliance on memory can be misleading. Returning to the example of the young reader, imagine that the child who has learned the word 'CAT' is now presented with a new word - 'CAP'. This new word is quite similar to the word she has just learned and the physical similarity of the two words may be sufficient to induce the child to rely on memory retrieval. Accordingly, her response to the new word may be "cat" rather than "cap". To correct her error, she must now analyze the details of the word to determine the appropriate response. In this case, the young reader relied on memory in a situation in which it was inappropriate. The appropriate strategy would have led the child to distinguish between 'CAT' and 'CAP', perhaps by increasing the contribution of analytic perceptual processes to response selection.

The present example illustrates that although there are many circumstances in which reliance on memory is appropriate and may serve to expedite responding, relying on memory indiscriminately is not an optimal approach to response selection. If performance is to be optimized, it must be possible to rely on memory retrieval when appropriate and to rely on the analysis of current perceptual information when memory retrieval is inappropriate. Without this control, performance is likely to be inefficient or error-prone; a response selection process that is flexible would allow for the control necessary for efficient interactions with the environment. The fact that most people are capable of successfully completing a wide range of behaviours in a complex environment rather than regularly making memory-based errors implies that individuals can control or modulate the contribution that memory retrieval makes to current responding.

The primary objective of this thesis was to examine more fully the flexibility of the response selection process. In particular, the research described in this thesis focuses on the role of attention in modulating the response selection process. 'Paying attention' to the current task can often help to circumvent the misleading influences of the past. For example, the young reader who pays attention to the current reading task may detect that 'CAP' is a word that she has never encountered before. This detection of a discrepancy between what is perceived and what is known may trigger the appropriate analytic strategy for solving the task correctly rather than remembering a response incorrectly (Jacoby, 1978).

One body of work in which differences in responding to familiar and novel stimuli have been documented is that using the priming procedure. In this procedure, stimuli are presented in both an initial display (the prime) and in a following display (the probe). The relation between stimuli presented in the two displays is manipulated. For example, in a related condition the prime and probe may contain identical words, whereas in an unrelated condition the prime and probe may contain different words. Across a wide variety of priming tasks, responses to related stimuli have been shown to be faster than responses to unrelated stimuli. This response advantage for related stimuli relative to unrelated stimuli is called repetition priming.

The response advantage that occurs for repeated stimuli has been linked to retrieval from memory. A particularly relevant study was reported by Kahneman, Treisman and Gibbs (1992). In a series of experiments, they examined two priming effects - a general response benefit for repeated stimuli relative to more novel stimuli and an object-specific response benefit. The procedure used in these experiments is illustrated in Figure 1.

Insert Figure 1 About Here

In an experiment using stationary frames (Experiment 1a), two prime letters were presented in place-holders that marked locations on the computer screen. Following a brief delay, a single target letter was presented at one of the locations occupied previously

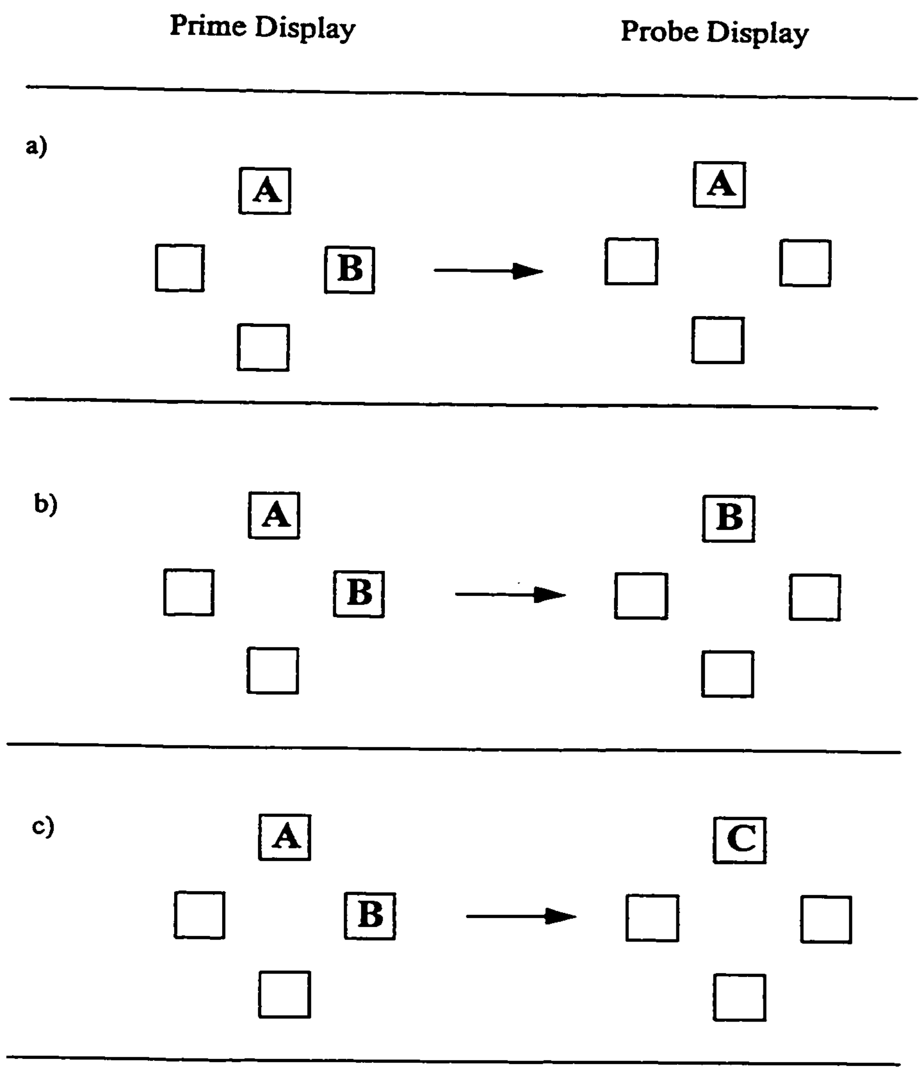

Figure 1. The three types of trials used in Experiment 1 of Kahneman, Treisman and Gibbs (1992). Panel (a) illustrates an identical repetition trial. Panel (b) illustrates a non-specific repetition trial. Panel (c) illustrates a no repetition trial.

in the prime display. This target letter was to be named as quickly as possible. Three types of trials - identical repetition, non-specific repetition and no repetition trials - were used in this experiment.[1] On identical repetition trials (Figure 1, Panel A), the single letter that appeared in the probe display was presented in the location occupied by that same letter in the previous display. On non-specific repetition trials (Figure 1, Panel B), the single letter that appeared in the probe display was presented in a location that was occupied previously by the other letter that was presented in the prime display. Finally, on no repetition trials (Figure 1, Panel C) the probe letter differed in identity from both previewed letters. An equal number of identical repetition, non-specific repetition and no repetition trials were presented throughout the course of the experiment.

One comparison of interest was the difference in response times between identical repetition trials (Figure 1, Panel A) and no repetition trials (Figure 1, Panel C). Consistent with previous priming studies, Kahneman et al. (1992) reported that responses on identical repetition trials were significantly faster than responses on trials in which the probe letter matched neither of the previous prime letters; response to the same stimulus was faster than response to a new stimulus. However, the comparison of most interest was that between identical repetition trials (Figure 1, Panel A) and non-specific repetition trials (Figure 1, Panel B). Kahneman et al. reported a significant response time advantage for identical repetition trials relative to non-specific repetition trials in this experiment (see Gordon & Irwin, 1996 for a similar result). They called this response time advantage for identical relative to non-specific repetitions an "object-specific preview benefit". This effect is called 'object-specific' because the response benefit observed is related to having prior experience with a particular letter at a particular location, rather than simply having encountered that letter previously.

In a subsequent experiment, Kahneman et al. (1992) reported that an object-specific preview benefit also occurs when the letters change spatial location between prime and probe in a way that produces the illusion of apparent motion. Importantly, because the direction of the apparent motion could not be determined until onset of the second display, these repetition benefits had to be determined *backward* in time. This finding suggests that retrieval processes underlie the object-specific preview benefit.

Kahneman et al. (1992) proposed that attending to a current object results in the retrieval of similar temporary episodic representations from memory. They called these temporary episodic representations *object-files* (Kahneman & Treisman, 1984). The current object and the retrieved object-files are then compared for the purpose of establishing whether the current perceptual information belongs to an existing object representation in memory. Spatiotemporal characteristics such as location or temporal delay between the current object and the retrieved object-file are thought to be of particular importance to this correspondence process.

If the current source of information matches an object-file retrieved from memory, the two sources are integrated. By contrast, if the current object and the object-file retrieved from memory do not match sufficiently, the two sources of information are not integrated. In this case, the observer must create a new object-file based on the current perceptual information available. Kahneman et al. (1992) suggested that the integration process is faster than the process of creating a new object-file. This difference in speed for the two processes would account for why responses were faster to repeated stimuli than to novel stimuli. Furthermore, the speed of the integration process is also thought to be influenced by the quality of the match between the two sources of information; the better the match, the faster the integration of current and past information. Presumably, this would account for findings of object-specific preview benefits.

The research of Kahneman et al. (1992) described above supports the contention that memory retrieval can be a faster, more efficient route to response than reliance on analysis of current perceptual information. However, Kahneman et al.'s (1992) work did not examine the potential for flexibility in the response selection process, as all of their experiments were conducted under conditions in which prime information was a valuable source of information regarding the upcoming probe item. In their experiments, the probe letter always appeared in a location occupied in the preceding prime display, and on two-thirds of the trials, the probe letter matched one of the previous prime letters. It is possible that the results observed by Kahneman et al. (1992) reflect performance when memory retrieval is heavily relied upon to guide response selection. If so, then the general conclusions drawn by Kahneman et al. may require qualification, as it is not always the case that reliance on memory retrieval is an appropriate response selection strategy.

If response selection strategy can affect the contribution of memory retrieval to response, then the priming effects reported by Kahneman et al. (1992) should be variable.

Two potential consequences of this variability are the focus of this thesis. One predicted consequence of the flexibility of the response selection process is that the object-specific preview benefit should emerge in some experimental contexts but not in others. Under conditions in which memory retrieval can serve as the basis for response, an object-specific preview benefit may be observed. In contrast, under conditions in which response selection is biased in favour of reliance on perceptual analysis, an object-specific preview benefit may not be observed. In effect, the presence of the object-specific preview benefit may indicate that response selection is dictated by the integration of current and past rather than by the differentiation of current and past.

A second predicted consequence of variability in response selection is that, under some conditions, faster responses to novel stimuli than to familiar stimuli may be observed. Although faster responses may be observed for repeated stimuli than for novel stimuli under conditions in which reliance on memory retrieval is favoured, the converse may be true under conditions favouring reliance on perceptual analysis. If response selection requires the differentiation rather than the integration of a current and a past event, this process may be facilitated to the extent that consecutive stimuli are different rather than similar. In fact, the finding of faster responses to relatively novel stimuli has been documented in the literature on priming effects (e.g., Neill, 1977; Posner & Cohen, 1984; Tipper, 1985), but it has been explained in different terms. This issue is addressed in greater detail in the following chapter.

Finally, it was suggested previously that attention during the current processing of a stimulus may play an important role in modulating the response selection process. Thus, the final objective of this thesis was to demonstrate that attention during the current encounter with a stimulus may play a critical role in determining the two sources of variability cited above. As a result, whether an object-specific preview benefit and a benefit or cost in responding for repeated stimuli relative to novel stimuli occur may depend in large part on attentional processing during the second of two processing events.

Overview of the Thesis

The goal of this thesis was to investigate the role of attention in modulating the response selection process by examining variability in priming effects. To achieve this goal, I examined how attentional manipulations jointly affect the object-specific preview benefit and the relative rates of responding to repeated and novel stimuli. This was accomplished by changing the task used by Kahneman et al. (1992) such that both types of priming effects could be observed within the context of the same experiment. The results described in this thesis demonstrate that these two priming effects are indeed variable; object-specific preview benefits do not occur under all circumstances and under some conditions faster responses to novel stimuli rather than repeated stimuli can emerge. Further, it is shown that faster responses to novel stimuli than repeated stimuli occur precisely when the object-specific preview benefit is not observed.

Chapter 2 of this thesis presents a brief overview of the priming method and highlights evidence that supports the proposal that memory retrieval plays an important role in priming effects. Experiment 1 is then presented to demonstrate that a single process memory retrieval account is insufficient to account for priming effects. Specifically, it is shown that whether repetition benefits or repetition costs are observed can depend upon the presence or absence of distracting information in the second of two stimulus displays.

The series of experiments described in Chapter 3 investigates further the flexibility of the response selection process by examining the object-specific preview benefit. In Experiment 2, it is shown that an object-specific preview benefit can be observed in a task similar to that used by Kahneman et al. (1992). However, it is then demonstrated in Experiment 3 that the object-specific preview benefit is eliminated when a distractor is added to the second of two displays. Further, repetition costs rather than repetition benefits for repeated stimuli relative to novel stimuli are observed under these conditions. Experiments 4 and 5 provide evidence to suggest that the change in attentional demands that accompanies the inclusion of a distractor is responsible for the pattern of results observed not a mismatch in colour or a mismatch in number of items between the prime and probe displays.

The two experiments described in Chapter 4 demonstrate how a different attentional manipulation can influence the appearance of the object-specific preview benefit. In these experiments, the proportion of repeated trials is manipulated. The findings of these experiments are consistent with the findings in Chapter 3, in that the object-specific preview benefit appears under some conditions but not others. An object-specific preview benefit and faster responses to repeated stimuli relative to novel stimuli are observed in Experiment 6 when the proportion of repeated location trials is high. By contrast, the object-specific preview benefit is eliminated and faster responses to novel stimuli relative to repeated stimuli are observed in Experiment 7 when the proportion of repeated location trials is low.

Chapter 5 presents a single experiment (Experiment 8) in which responses are faster to novel stimuli than to repeated stimuli. The results obtained in this task will be compared to the findings of the preceding chapters, but are presented primarily to note the relation of the studies reported here to issues discussed in the literature on another attentional phenomenon called inhibition of return.

The final chapter presents a summary of the experiments reported in this thesis and discusses theoretical issues raised by the findings. The implications of these findings for the investigation of both normal and abnormal cognitive functioning will also be addressed.

CHAPTER 2

Priming and Probe Events: The Attentional Modulation of Retrieval

As mentioned in the Introduction, the experiments described in this thesis used variants of the priming method. The first section of Chapter 2 provides a more extensive introduction to this experimental method. The second section of Chapter 2 provides an introduction to two different accounts of priming effects that have been forwarded. A lingering activation framework, which attributes priming effects to the persisting activation of abstract internal representations, is contrasted with a retrieval-based framework, in which priming effects are attributed to the retrieval of specific prior processing episodes. The third section of Chapter 2 describes empirical evidence that supports a retrieval-based view of priming effects. This section is followed by a discussion of two experiments. The results of these experiments support the contention that retrieval plays a role in priming, but suggest also that a dual process explanation of priming is required. In particular, these experiments suggest that attentional processing during the second of two events in a priming sequence is important in modulating the role that retrieval plays in priming. A dual-process account of priming effects that specifies the importance of attentional processing at the time of the second of two processing events is then discussed.

The Priming Method

Generally speaking, the priming method involves the presentation of a first or 'prime' stimulus followed by a second 'probe' stimulus. The critical manipulation concerns the relation between prime and probe. In a repetition priming procedure, the probe is either identical to the prime or unrelated to the prime. The impact that prior experience with a stimulus has on subsequent performance can then be assessed. For example, the time required to initiate a response to 'CAT' when it is preceded by the word 'CAT' and when it is preceded by the word 'PIG' can be compared. Priming is said to occur when a difference in response latency or accuracy exists between repeated and non-repeated trials.

An abundance of experimental evidence obtained from repetition priming studies shows that prior exposure to a stimulus can facilitate subsequent responding to an identical stimulus. Findings of faster response times to repeated items relative to non-repeated items have been reported in tasks requiring lexical decision (e.g., Scarborough, Cortese & Scarborough, 1977; Scarborough, Gerard & Cortese, 1979), same-different judgments (Posner & Mitchell, 1967; Posner & Snyder, 1975), re-reading inverted text (Kolers, 1975, 1976), recognition memory (Jacoby & Dallas, 1981), letter naming (Eichelman, 1970) and word naming (Scarborough, et al., 1977). In addition to facilitating the speed of responding in priming tasks, repetition has also been shown to enhance the accuracy of responding in tasks such as perceptual identification (e.g., Jacoby, 1983a; 1983b; Jacoby & Dallas, 1981) and word fragment completion (Sloman, Hayman, Ohta, Law & Tulving, 1988; Tulving, Schacter & Stark, 1982). The response advantage afforded a stimulus as a result of prior exposure to an identical stimulus is called the *repetition priming effect.*

Note however, that response benefits are not limited to identical repetitions. Faster response times have also been reported for probe stimuli that are semantically-related to previously presented prime items relative to probe stimuli that are not semantically-related to the prime items (e.g., Marcel, 1980; Meyer & Schvaneveldt, 1971). This effect is called semantic-priming. Thus, facilitated responding can occur for both identical and related primes.

The Cause of Priming Effects: Lingering Activation versus Memory Retrieval

The cause of priming effects has been a contentious issue in experimental psychology. Two markedly different accounts have been forwarded to explain the occurrence of priming effects. One view suggests that priming effects reflect the lingering activation of abstract internal representations of a stimulus. This account contrasts sharply with the alternative view that priming effects are determined upon onset of the probe stimulus by the re-instatement of specific prior processing episodes. Much debate has arisen in the priming literature regarding which of these two theoretical frameworks offers the more effective explanation of priming effects.

A Lingering Activation Framework. One theoretical framework proposes that priming effects reflect the lingering activation of an abstract internal representation that results from prior exposure to the prime stimulus. The appearance of a stimulus is thought to temporarily increase the activation level of the corresponding representation in memory (see Collins & Loftus, 1975; Morton, 1969) and spread to related representations in memory, thereby increasing the activation levels of these representations as well. Once the stimulus representation achieves its' threshold level of activation, the observer is able to perceive and respond to the stimulus.

To account for the appearance of priming effects, it is assumed that the activation level of a stimulus representation does not return to baseline level immediately following response. If the same stimulus or a related stimulus is presented a short time later - before the activation level of the representation has returned to baseline - the internal representation of that stimulus is closer to its' threshold level of activation than if the representation is at baseline upon onset of the second stimulus. Consequently, a repeated stimulus may be responded to more rapidly than a non-repeated stimulus. Thus, repetition priming effects presumably reflect the savings in responding that result from lingering activation of an internal representation of the prime. This interpretation implies that priming effects are determined at the time of the prime and simply measured at the time of the probe display; the probe serves as nothing more than a measuring instrument of prior activation.

An Episodic Retrieval Framework. An alternative to the lingering activation framework attributes priming effects to memory retrieval processes that are initiated upon onset of the probe stimulus (e.g., Jacoby & Brooks, 1984; Kahneman et al., 1992; Logan, 1990; Milliken, Joordens, Merikle & Seiffert, 1998; Neill, 1997; Neill & Mathis, 1998; Neill & Valdes, 1992; Neill Valdes, Terry & Gorfein, 1992; Ratcliff & McKoon, 1988, Whittlesea & Jacoby, 1990). This episodic retrieval framework proposes that each encounter with a stimulus is stored as an individual processing episode or instance in memory (Jacoby, 1983b; Logan, 1988; Whittelsea & Jacoby, 1990). Furthermore, it is assumed that specific details of a processing event are stored as part of the memory episode.

A priming effect may occur when a probe stimulus triggers the retrieval of a related prior processing episode from memory. If the retrieval of a related prime episode is sufficiently fast, response time may be faster following a related prime than following an unrelated prime. The better the match between specific details of the prime and probe episodes, the more likely the prime episode is to be retrieved, and the more likely a priming effect is to be observed.

A critical property that distinguishes the episodic retrieval framework from the lingering activation framework is that for the episodic retrieval framework priming effects are assumed to be determined retrospectively. Because the probe stimulus is thought to serve as a cue to retrieve a relevant episode from memory, it is not simply a measuring tool of prior processing. Rather, probe events are thought to play an active role in determining priming effects.

Specificity Influences Priming: Support for a Retrieval-based Framework of Priming Effects

Although researchers have debated whether a lingering activation or an episodic retrieval framework provides the more effective explanation of priming effects (see Tenpenny, 1995), there is a growing body of evidence that supports a retrieval-based explanation. As mentioned previously, a lingering activation framework proposes that activation of abstract internal representations is responsible for the appearance of priming effects. If abstract mental representations of stimuli underlie priming effects, then specific details of the stimulus or processing event (e.g., font, colour) should be irrelevant and therefore should not influence priming effects. However, there is evidence to suggest that priming effects depend upon the match between specific details of the prime and probe processing episodes. For example, Kolers (1975) reported that participants re-read sentences of inverted text faster if the initial text presentations had also been inverted, than if the initial text presentations had been presented in a normal orientation - an advantage shown to last for over a year (Kolers, 1976). Since the content of the sentences was identical across readings, this finding suggests that surface details of processing episodes play a critical role in priming (see also Eichelman, 1970; Posner & Mitchell, 1967). Thus, such evidence is more consistent with the notion that specific prior processing episodes, rather than abstract mental representations, are involved in priming.

Accuracy of responding has also been shown to be influenced by similarity between the prime and probe conditions. Levy (1983) reported that ability to detect errors in a passage was greater if the typeface of the text was the same between readings, than if the typeface was changed between readings. This result strongly suggests that the specific match between current and past processing episodes is critical to repetition benefits.

Finally, processing similarity between the prime and probe tasks also influences priming effects. Jacoby (1983b) reported that perceptual identification of a single probe word was more accurate if that same word had been read in the prime display (no context condition), than if that word had been in the context of a different word (context condition), or if that word had been generated from its antonym (generate condition) in the prime task. In other words, the accuracy advantage for repeated stimuli was greatest in the condition where the processing requirements of the prime and probe were most similar (i.e., reading a single word after having read a single word). This work provides strong evidence to support the idea that processing similarity of the prime and probe enhances priming.

The apparent importance of specific details of a processing event to priming presents a problem for an account that assumes activation of abstract internal representations underlies priming effects. Rather, such results are more consistent with an episodic retrieval framework. As discussed previously, an episodic retrieval explanation of priming proposes that the onset of a probe stimulus triggers the retrieval of prior processing episodes. The better the match between specific details of the prime and probe episodes, the more likely the prime episode is to be retrieved and the more likely a priming effect is to be observed. This account would not only explain the response advantage for repeated stimuli relative to non-repeated stimuli, but also the finding of faster responses to stimuli that are increasingly similar to the preceding prime. Thus, this single-process account of priming provides a relatively simple way of accommodating the findings of response benefits for prime and probe episodes that are similar rather than different.

Qualitative Differences in Priming Effects: Evidence for Two Processes in Priming

Although the findings discussed above suggest that similarity between a current and a past processing event facilitates response, similarity between a current event and a past event can also result in erroneous responding. For example, if a beginning reader has encountered the word 'CAT' many times, she may have come to learn that simply retrieving the response "cat" is faster than deriving the current response from the perceptual information presently available. However, if the child is not 'paying attention' while reading, she may also respond "cat" to a new word, 'CAP', as a consequence of its similarity to 'CAT'. In this case, relying on a retrieved response is less efficient than deriving the response based on the perceptual information available.

An experiment conducted by Neill and Kahan (1999; Experiment 1a) is particularly relevant to this thesis as it makes a similar point. Their procedure is illustrated in Figure 2.

Insert Figure 2 About Here

In this procedure, the prime always consisted of a single word. However, the probe consisted of either a single target word or a target word and a distractor word presented together. Participants named the probe target word in both cases. Of particular importance was that the two types of probe trials were randomly intermixed across the experiment. Randomly intermixing the trials ensured that there were not systematic differences in the way participants processed the prime item for the two types of trials.

Neill and Kahan (1999; Experiment 1a) reported that on probe trials containing a single target word, responses were faster if the probe target matched the preceding prime than if it was unrelated to the prime. By contrast, on probe trials that contained both a target and a distractor word, slower responses were observed if the probe target matched the preceding prime than if it was unrelated to the prime word. These findings have two important implications.

First, because the nature of the priming effects observed was dependent on the nature of the probe trial, these findings provide critical support for the proposal that processes engaged only after the onset of a probe contribute to priming effects. As mentioned previously, priming effects might be explained by reference to lingering activation of abstract internal representations of prime stimuli. By similar logic, repetition costs for repeated stimuli might indicate that abstract internal representations of previously

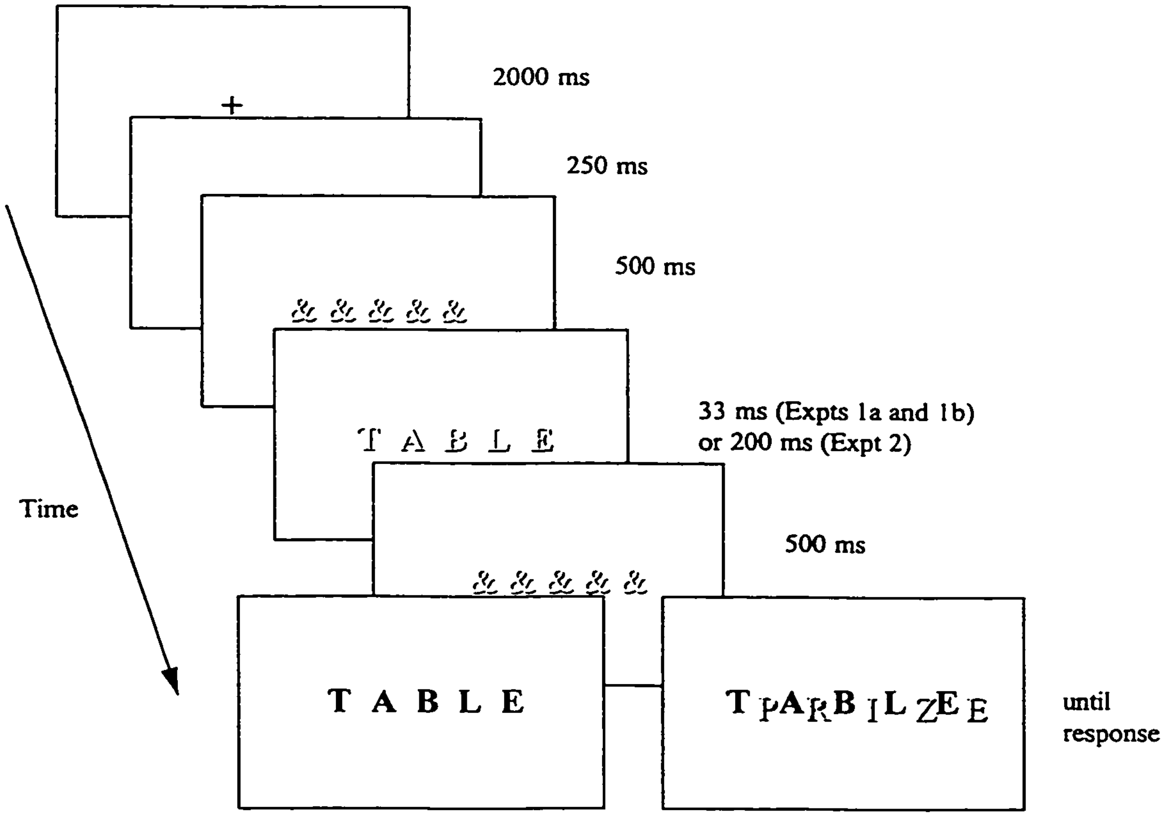

Figure 2. The general procedure used by Neill and Kahan (1999). Participants initiated a trial by pressing the space bar. Following the single masked prime (depicted in white), either a single probe target (depicted in black) was presented or both a probe target (depicted in black) and a probe distractor (depicted in gray) were presented. Participants only named the probe target. In Experiments 1a and 1b, the prime stimulus was presented for 33 ms and in Experiment 2 the prime stimulus was presented for 200 ms.

irrelevant stimuli can be suppressed below baseline levels of activation. The lingering inhibition of an abstract representation would then explain response costs for repeated items (e.g., Neill, 1977; Tipper, 1985). According to this framework, priming effects reflect the activation level of internal representations of stimuli *prior* to the onset of the probe stimulus and therefore, the nature of the priming effects observed should not vary depending upon the nature of the probe trials. Repetition benefits and repetition costs should not both occur within the same experiment. Consequently, this account cannot explain the appearance of repetition benefits and repetition costs in the same experiment when the probe trials are randomly intermixed; how the match between the probe word and prime word influences responding appears to be determined at the time of the probe task. Thus, these findings are more consistent with the proposal that retrieval of prior processing episodes rather than lingering activation of abstract internal representations underlies priming effects.

The second important implication of Neill and Kahan's (1999; Experiment 1a) results is that a single-process retrieval account of priming is not sufficient to explain the full spectrum of priming effects. According to a single-process episodic retrieval account, repetition benefits should have emerged on both types of probe trials, as the prime and probe displays of repeated trials for both single-item and two-item probes were more similar than the prime and probe displays of the corresponding non-repeated trials. Although Neill and Kahan's findings suggest that memory retrieval does play an important role in priming effects, these findings call into question the proposal that similarity between prime and probe events always leads to response benefits.

The appearance of qualitatively different priming effects in the Neill and Kahan (1999; Experiment 1a) work is of particular relevance to this thesis for three reasons. First, the appearance of qualitatively different priming effects strongly suggests that the response selection process is flexible. Second, the appearance of qualitative differences in performance is often taken as evidence for the operation of qualitatively different processes in that task (e.g., Jacoby, 1991; Merikle & Cheesman, 1987), a view that is consistent with the central proposal forwarded here - that memory retrieval and perceptual analysis jointly contribute to response selection. Third, their finding of priming effects that changed with the presence or absence of a probe distractor suggests that attention at the time of the probe plays an important role in modulating the relative contributions of two processes to priming effects.

However, it is important to note that the same pattern of qualitatively different priming effects failed to emerge in two follow-up experiments conducted by Neill and Kahan (1999; Experiments 1b and 2), using procedures similar to that of their Experiment 1a. In both of these experiments, a repetition benefit was observed for probes that contained a single target word, but a repetition cost was not observed for probes that contained both a target and a distractor. This pattern is more consistent with what would be expected if increased similarity between prime and probe always facilitates responding. The equivocal nature of the findings reported by Neill and Kahan are of concern given that the contribution of two processes to priming effects is central to this thesis. As a result, this issue was re-examined empirically in Experiment 1 of this thesis.

Experiment 1: Priming Effects Depend on Probe Events

The motivation for Experiment 1 was to provide another demonstration of qualitatively different priming effects that are contingent on the nature of the second of two displays in the priming sequence. The present experiment was similar to the experiments of Neill and Kahan (1999). In this experiment, a single prime word was followed by either a single probe target or both probe target and probe distractor. Importantly, the nature of the prime display was constant across trials, whereas probe selection requirements were manipulated by randomly intermixing the two types of probes. On half of the trials, the probe target was the same as the preceding prime, whereas on the other half of the trials the probe target and the prime word were unrelated. Responses to repeated and non-repeated stimuli were compared for both types of probes to discern if the nature of the probe task exerts a differential influence on priming effects, as in Experiment 1a of Neill and Kahan.

One potential reason for the difference between the results of Experiment 1a and Experiments 1b and 2 of Neill and Kahan (1999) is that participants in the latter two experiments adopted a less conservative approach to response selection overall than in Experiment 1a. Therefore, some changes were implemented in Experiment 1 in an attempt to ensure that participants adopted a more conservative approach to response selection and therefore were more discriminative in their reliance on memory retrieval in response selection. Two changes were made in an attempt to promote the appearance of repetition costs on selection trials in this type of word-naming task relative to the Neill and Kahan experiments. First, a set of four words was used in the present experiment instead of a set of 12 words like that of Neill and Kahan (1999). The smaller set size was thought to increase the likelihood of finding a repetition cost, as it has been shown that such costs occur more often when small stimulus sets are used in priming tasks than when large stimulus sets are used (Malley & Strayer, 1995). Second, the distractor brightness was enhanced relative to the probe target to increase the selection difficulty in the probe task; this change was also thought to increase the need for perceptual analysis of the probe target and thereby increase the likelihood of finding a repetition cost on selection trials. In addition to these changes, one other difference between the present experiment and the Neill and Kahan experiments was that the delay between the prime and probe was reduced from 500 ms to 157 ms.

Given these experimental conditions, it was hypothesized that the pattern of qualitatively different priming effects observed previously in Experiment 1a of Neill and Kahan (1999) would also be observed in the current experiment. More specifically, it was predicted that repetition benefits should occur on probe trials that consist of only a single target word and repetition costs should occur on probe trials that include both a target and a distractor.

Method

Participants

Twelve McMaster University undergraduates (9 females) participated in Experiment 1 in exchange for course credit. All participants had normal colour vision and normal or corrected-to-normal visual acuity. Mean age of the participants was 19 years.

Apparatus and Stimuli

All stimuli were presented in graphics mode on a Sony colour monitor (model CPD-15SF1) connected to a 486 microcomputer. The experiment was run using Micro Experimental Laboratory (MEL) software (Schneider, 1988). A microphone was attached to a moveable barrier placed in front of the participants, and they were seated approximately 65 cm from the screen. The barrier did not obstruct the view of the screen. Participants' responses were spoken into the microphone that was plugged into a voice key interfaced to the microcomputer. The accuracy of the participants' responses were coded on the keyboard by the experimenter.

Insert Figure 3 About Here

The sequence of displays comprising a single trial is depicted in Figure 3. In the *fixation* display, a white plus sign measuring 0.7° of visual angle horizontally and 0.7° of visual angle vertically was presented in the center of a black display. The plus sign marked

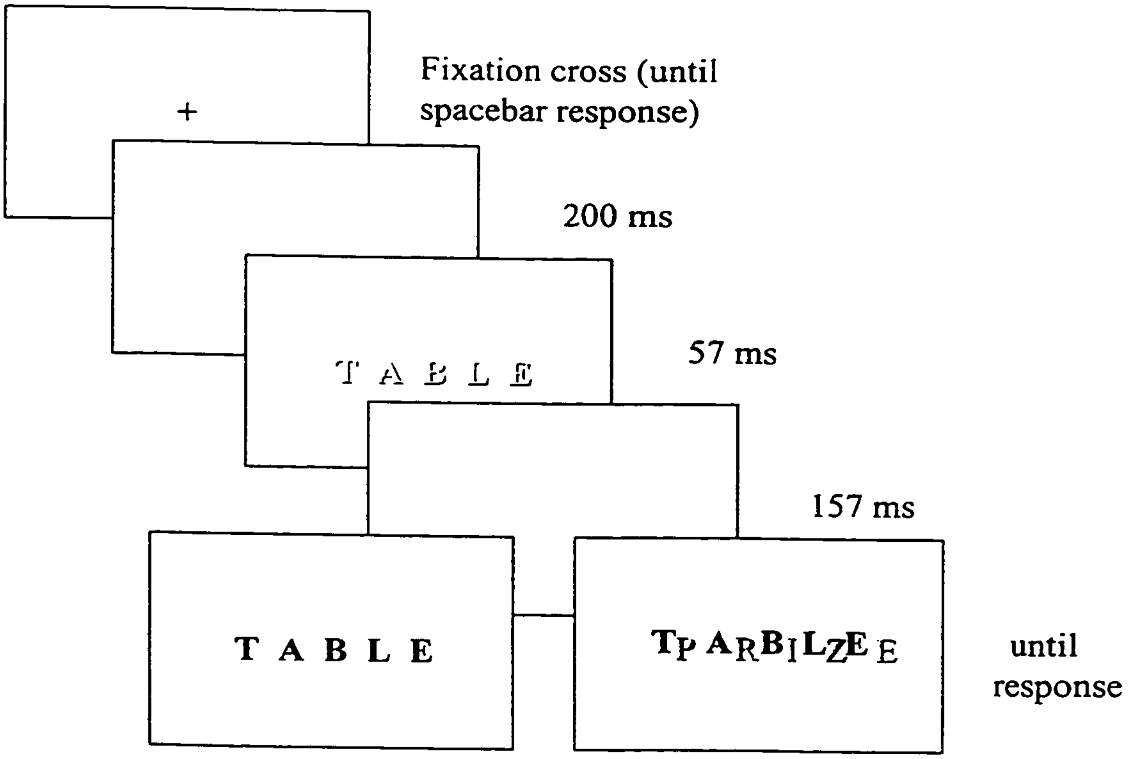

Figure 3. The sequence of events in Experiment 1. A single prime stimulus was always presented in the prime (depicted in white). One of two types of probe displays could be observed on any given trial. Either a single probe target stimulus (depicted in black) or both a probe target (depicted in black) and probe distractor (depicted in gray) were presented. Participants only named the probe target.

the location at which the prime stimulus would appear. The prime display contained a single upper-case word presented in white against a black background. The prime word measured 6.1° horizontally and 0.9° vertically. On any given trial, one of two different types of probe displays could appear. On half of the trials, the probe display contained a single upper-case word that served as the probe target; these were called no-selection trials. The measurements for the single probe target word were identical to those of the prime word. On the other half of the trials, the probe display consisted of two partially interleaved upper-case words, with one word serving as the probe target and the other word as the probe distractor; these were called the selection trials, as the probe target had to be selected from the word pair for response. The interleaved word pair measured 7.0° horizontally and 1.1° vertically. The probe target appeared above the distractor as often as it appeared below the distractor in the word pair. Probe words were displayed in either red or green. Probe target words were presented in the same colour throughout the experiment (e.g., red) and the probe distractor words, when presented, were displayed in the other colour (e.g., green). The brightness of the distractor colour was enhanced relative to the colour of the probe target to increase the selection difficulty of the probe task on selection trials. There were two probe target colour conditions. In the red probe target condition, the probe target word was displayed in red and the distractor word in green. In the green probe target condition, the probe target was displayed in green and the distractor in red. It is also important to note that to ensure there was not a confound in the location of single probe targets and probe targets presented with distractors, on both selection and no selection trials the probe target appeared above and below fixation equally often.

The stimulus set for this experiment consisted of 24 five-letter nouns. This stimulus set was divided into 6 different subsets of 4 words. Each subset of words was used for two of the twelve participants, once in a red probe target condition and once in a green probe target condition of the experiment. The stimulus set is presented in Appendix A.

Design

One between-subject variable and two within-subject variables were manipulated in this experiment. The between-subjects variable, Probe target colour, had two levels: red and green. This variable was used for counterbalancing purposes only and did not factor into any of the subsequent analyses.[2] Half of the participants named a red probe target and half of the participants named a green probe target.

One of the within-subject variables was Repetition, which had two levels: repeated and non-repeated. On repeated trials, the prime word and the probe target were the same, whereas on non-repeated trials the prime word and probe target were different. The probe distractor was unrelated to both the prime word and the probe target on all trials. Half of the trials in the experiment were repeated and half of the trials were non-repeated.

The second within-subject variable was Selection, which also had two levels: selection and no-selection. On selection trials, both a probe target and a probe distractor word were presented. On no-selection trials, only a single probe target word was presented. Half of the trials in the experiment were selection trials and half were no selection trials. The Repetition and Selection variables were crossed factorially, which resulted in four types of probe trials: repeated selection trials, repeated no-selection trials, non-repeated selection trials, and non-repeated no-selection trials.

The experiment consisted of 400 trials - 4 blocks of 96 experimental trials and 16 practice trials. In each block of 96 experimental trials there were 48 no-selection trials and 48 selection trials, which were further divided into equal numbers of repeated and non-repeated trials. Thus, in every block of 96 trials there were 24 repeated selection trials, 24 repeated no-selection trials, 24 non-repeated selection trials and 24 non-repeated no-selection trials.

The 24 repeated selection trials consisted of two examples of every possible combination of prime word and probe display by which a repeated trial could be created from the four stimulus words. For example, the prime word BEARD could be combined with the probe target word BEARD and distractors CLOCK, FLUTE or PRIDE. The same was true for the other 3 words, resulting in 12 possible repeated trials. The 24 repeated no-selection trials were subject to the same constraints. The 24 non-repeated selection trials consisted of one example of every possible combination of prime word and probe display by which a non-repeated trial could be created from the four stimulus words. For example, the prime word BEARD could be combined with the probe target word CLOCK and distractors FLUTE or PRIDE, with the probe target word FLUTE and distractors CLOCK or PRIDE, or with the probe target word PRIDE and the distractors

CLOCK or FLUTE. The same was true for the other 3 words, resulting in 24 non-repeated trials. The 24 non-repeated no-selection trials were subject to the same constraints as the non-repeated selection trials.[3] Equal numbers of the four trial types were also used for the 16 practice trials.

Procedure

Participants were seated in front of the computer and the experimenter explained both the task and the sequence of events that would appear on any given trial. The experimenter instructed participants to name the probe word that appeared in the specified target colour as quickly but as accurately as possible. Upon completion of the instructions, participants began the practice trials.

Figure 3 illustrates the series of displays and temporal parameters used in Experiment 1. On every trial, the fixation display remained on the screen until participants initiated a trial by pressing the space bar on the keyboard. The disappearance of the fixation cross was followed by a 200 ms blank interval. The white prime word was then presented for 57 ms, followed by another 157 ms blank interval. Next, either a single probe target word or an interleaved word pair was presented and remained on the screen until the onset of the participants' vocal response. The experimenter coded the accuracy of the response. Correct responses, errors and spoils were recorded separately. A trial was coded as an error if the participant triggered the voice key by responding with a word that was not the probe target. A trial was coded as a spoil if the voice key was triggered prematurely by background noise or was not triggered when a response was made. Once the response was coded, the fixation cross reappeared to indicate that the next trial could be initiated.

Participants completed 16 practice trials and then 4 blocks of 96 trials. All participants received a 1 minute rest period following the completion of 2 blocks of experimental trials. The experimental session was approximately 20 minutes in duration.

Results

An outlier elimination procedure was performed on the correct response times (RTs) for each cell in the design separately. This modified recursive outlier procedure prevented the inclusion of suspiciously large or small RTs from being included in further analyses (Van Selst & Jolicoeur, 1994). The criterion used for the exclusion of outliers is adjusted on the basis of the number of observations per cell. As a result, this approach avoids the systematic exclusion of different proportions of outliers in cells with different numbers of observations.

The outlier procedure eliminated 1.6% of the RTs. Mean RTs were computed using the remaining observations. A 2x2 repeated-measures analysis of variance (ANOVA) was conducted on the mean correct RTs and error percentages. Mean correct RTs and error percentages, collapsed across participants, are presented in Table 1.

The analysis of the RTs revealed a significant main effect of Selection, $F(1,11) = 73.27$, $MSE = 1093.47$, $p < .0001$, as participants responded more slowly on trials in which selection was required in the probe task (619 ms) than on trials in which selection was not required in the probe task (538 ms). However, the result of particular interest was the significant Repetition x Selection interaction, $F(1,11) = 87.69$, $MSE = 69.70$, $p < .0001$. On selection trials, participants were slower to name the probe target word if it was the same as the preceding prime item (628 ms) than if it differed from the preceding prime item (611 ms). In sharp contrast, on no-selection trials, participants were faster to name the probe target word if it was the same as the preceding prime item (523 ms) than if it differed from the preceding prime item (552 ms). To explore this interaction further, simple effects analyses were conducted. The response cost on selection trials (-17 ms) was significant, $F(1,11) = 5.37$, $MSE = 306.15$, $p < .05$, as was the response benefit on no-selection trials (29 ms), $F(1,11) = 23.20$, $MSE = 211.16$, $p < .001$.[4]

The pattern of error percentages was shown to be consistent with that of the RTs. However, given that no errors were committed for repeated no-selection trials, a sign test was conducted instead of an ANOVA. In accordance with the requirements of the sign test, ties were removed and the remaining pairs in which there was a difference between the trial types were entered into the analysis. The difference in error percentages was not significant for the selection trials. Once all the ties were removed in the no-selection condition, there were insufficient data remaining for analysis.

Discussion

The appearance of a repetition benefit for no-selection probe trials and a repetition cost for selection probe trials in the present experiment shows that qualitatively different priming effects can be observed within the context of the same experiment. Once again, the dependence of priming effects on the nature of the probe task suggests that memory retrieval plays an important role in priming effects; the full pattern of priming effects had to be determined upon the onset of the probe display. The present findings converge with the findings of Experiment 1a of Neill and Kahan (1999) to show that probe events play an important role in priming effects and that priming effects are determined retrospectively (see also Lowe, 1979; Moore, 1994; Neill et al., 1992 for related results).

The finding of qualitatively different priming effects also presents problems for a single-process retrieval account of priming effects. The occurrence of response benefits for repeated stimuli on trials in which a single target word is presented in the probe task is consistent with the proposal that similarity between a current processing event and a prior processing episode increases the likelihood of retrieval, and translates into a response advantage for items that repeat relative to items that do not repeat. This result is in accord with what would be predicted by a single-process episodic retrieval account of priming effects. However, the occurrence of repetition costs on trials in which both a target word and a distractor word were presented in the probe display is not readily explained by the notion that increased similarity between the prime and probe displays leads to repetition benefits in responding. As was the case with the no selection probe trials, the prime and probe displays on repeated probe selection trials were more similar than on non-repeated probe selection trials because the probe target word matched the prime word on repeated trials. Thus, facilitated responding should have also occurred for repeated words relative to non-repeated words on selection trials. Finding slower rather than faster response times on repeated relative to non-repeated probe selection trials demonstrates that similarity between the prime and probe episodes does not always result in facilitated responding. This result provides important empirical support for one of the two hypothesized consequences of a flexible response selection process - under some conditions, responses are faster to novel stimuli than to repeated stimuli. This strongly suggests that a single-process episodic retrieval explanation of priming is not sufficient to explain the full spectrum of priming effects.

Finally, given that the effect of repetition was dependent upon the presence or absence of a selection requirement in the probe task, it follows that attention at the time of the probe plays an important role in modulating priming effects. This finding is therefore consistent with the proposal that attention plays an important role in co-ordinating the two processes that contribute to priming effects.

A Dual-Process Explanation of Priming Effects: Explaining Repetition Benefits and Repetition Costs in Priming Tasks

As discussed in Chapter 1, Kahneman, Treisman and Gibbs (1992) explain priming effects by reference to two different processes. By this account, a current stimulus initiates the retrieval of an episodic memory representation, called an object file, whereupon a correspondence process determines if the current stimulus matches the retrieved object-file. Spatiotemporal information such as location or delay between prime and probe is thought to dictate whether a current stimulus and a retrieved processing episode match. If there is spatiotemporal correspondence between a current stimulus and a retrieved object-file, the current stimulus and the retrieved object-file are integrated. By contrast, if a current stimulus is not a sufficient match to a retrieved object-file on the basis of spatiotemporal constraints, then a new object-file must be created. The new processing episode is based on the stimulus information that is currently available. In effect, these processes are analogous to 'reliance on memory retrieval' and 'reliance on perceptual analysis' discussed previously (see also Jacoby, 1978; Logan, 1988).

Kahneman et al. (1992) posited that the integration of a current stimulus with a retrieved object-file is faster than the creation of a new object-file. This assumption helps to explain the occurrence of faster responses to repeated stimuli than to novel stimuli. Also as mentioned previously, they proposed that the quality of a match affects the speed of this integration process; the better the match the faster the integration. This assumption helps to explain the object-specific preview benefit.

The idea that both the integration of current and past processing episodes and the creation of new processing episodes are involved in response selection may provide a useful framework for explaining priming effects. However, if this dual-process account is to provide a general framework from which to explain priming effects, it must be capable of accounting for both repetition benefits and repetition costs. To account for the appearance of both repetition benefits and repetition costs in priming, I propose that whether memory retrieval or perceptual analysis guides response selection is not simply driven by the spatiotemporal correspondence or physical match between two stimuli, but rather depends on an attentional component that modulates response selection.

In some situations, observers may want their response to be based on current perceptual information, irrespective of whether the current stimulus matches or mismatches with a past stimulus. As a result, response selection should favour perceptual analysis of the current stimulus rather than memory retrieval. Attention to the current stimulus event may be required to establish a new processing episode for that stimulus that is distinct from other prior processing episodes. Therefore, one hypothesized consequence of close attention to the probe task is decreased contribution of integration to response selection. A second hypothesized consequence is that the similarity of a current stimulus to a prior stimulus may be a source of interference when response selection favours reliance on perceptual analysis. More specifically, similarity between the current and past stimuli may interfere with the creation of a new processing episode for the current stimulus. As a result of this interference, a new processing episode may be created faster for a novel stimulus than repeated stimulus; responses to non-repeated stimuli should be faster than to repeated stimuli under these conditions.

Given the logic of the account forwarded above, the findings of Experiment 1 can be explained in the following way. In Experiment 1, the prime stimulus provided predictive information regarding the identity of the following probe item. Therefore, in the no-selection condition, retrieval would predominate in response selection and current and past events would be integrated; this would explain the faster response times for repeated probe target words on no-selection trials. However, on selection trials, the presence of a distracting stimulus in the probe task made it necessary to distinguish the target from the distractor. Therefore, perceptual analysis may have been favoured in response selection. Attention to the probe target may have been required to ensure that the target rather than the distractor was selected for response. Thus, the attentional processing requirements for selection trials may have differed from the no selection trials in an attempt to deal with the task of selection. It is assumed that this analytic processing results in a highly specific episode being created for the probe target which may prevent its integration with prior processing episodes. When perceptual analysis of the current target is favoured in response selection, a prime stimulus that is related to the current probe target may actually interfere with the creation of a new processing episode for the target. As a result, a new processing episode may be established faster for a non-repeated probe target word than a repeated target word. This would account for the slower response times to repeated probe target words observed on selection trials in Experiment 1. This explanation would also account for the Neill and Kahan (1999; Experiment 1a) findings discussed previously.

This modified dual-process account can accommodate findings of faster responses to novel stimuli than repeated stimuli in word-naming tasks. However, to further examine if the dual-process account discussed above is useful for explaining the flexibility of the response selection process, the experiments in the subsequent chapters of this thesis used a procedure similar to that used previously by Kahneman et al. (1992). Given the logic of the dual-process account I forwarded here, changing the attentional demands of the probe task should have two effects in these experiments. First, it should be possible to observe object-specific preview benefits under some conditions but eliminate them under other conditions by changing the attentional requirements of the probe task. Second, as in Experiment 1, it should be possible to observe faster responses to repeated stimuli under some conditions and faster responses to novel stimuli when the attentional requirements are changed.

CHAPTER 3

Manipulating Attentional Requirements Influences the Object-Specific Preview Benefit

Findings of faster responses to non-repeated stimuli than to repeated stimuli in the work of Neill and Kahan (1999; Experiment 1a) and in Experiment 1 of this thesis suggest that repetition does not always lead to facilitation in response selection. Further, as discussed in Chapter 1, if the response selection process is flexible, then object-specific preview benefits may occur in some contexts but not in others. Kahneman, Treisman and Gibbs (1992) proposed that the fast integration of a current stimulus with a retrieved prior processing episode was responsible for the object-specific preview benefit. However, the conditions in which the object-specific preview benefit was observed may have biased response selection in favour of memory retrieval. It is possible that the object-specific preview benefit may not occur under conditions that favour reliance on perceptual analysis of the probe target. If the object-specific preview benefit can be eliminated under conditions thought to bias response selection in favour of reliance on perceptual analysis, this result would provide important converging evidence that the contribution of memory retrieval to response selection is flexible and subject to attentional control.

To examine the variability of the object-specific preview benefit, a procedure similar to that used previously by Kahneman et al. (1992; Experiment 1a) was implemented in all of the experiments in Chapter 3. As discussed previously, they used a stationary-frame procedure in which two letters were presented in the prime display, followed by a single letter in the probe display. Since spatiotemporal constraints are thought to play an important role in determining if the current processing episode can be integrated with a retrieved episode, comparing responses to stimuli that appear in repeated and non-repeated locations is critical to determine if analysis of current perceptual information guides response selection under some circumstances. Note however, that it was not possible to compare responses to stimuli at repeated and novel locations in Kahneman et al.'s procedure because the single probe target letter always appeared at a previously occupied location. Although the identity of the letter could be repeated or novel within the context of a trial, location was always repeated between prime and probe. Therefore, the procedure used in the present experiments was modified such that the probe letter could be presented in either a previously occupied or a previously unoccupied location. This modification made it possible to measure the separate effects that repeating identity and repeating location have on performance.

Two further modifications were made to the Kahneman et al. (1992) procedure. In their procedure, the prime provided predictive information regarding the upcoming probe letter. In all of the experiments conducted in Chapter 3, the task was changed such that the prime did not provide predictive information regarding either the location or the identity of the probe letter. Finally, in each of the experiments discussed in this chapter, priming effects were examined in both an identification task and in a localization task; Kahneman et al. (1992) tested participants only in an identification task. This modification made it possible to determine if the object-specific preview benefit generalizes beyond identification tasks to localization tasks.

The experiments in Chapter 3 examined how changing attentional requirements by adding a distracting stimulus to the probe task influences the object-specific preview benefit, as well as the relative speed of responses to familiar (repeated) and novel (non-repeated) objects. It was hypothesized that the requirement to respond to one of two probe stimuli would promote reliance on perceptual analysis in response selection. As a result, this change in the attentional requirements of the probe task would decrease the contribution of integration to response selection. Therefore, it was predicted that under these conditions an object-specific preview benefit would not be observed. It was also assumed that this manipulation would result in increased interference in the creation of new processing episodes for repeated stimuli relative to novel stimuli. Thus, faster responses to novel probe targets relative to repeated probe targets was also predicted. In Experiment 2, the modified procedure described above was used to demonstrate an object-specific preview benefit. In Experiment 3, a distracting stimulus was added to the probe task. This manipulation, which was thought to change the attentional requirements of the probe task to favour perceptual analysis instead of retrieval, eliminated the object-specific preview benefit and resulted in a negative location repetition effect. Experiments

4 and 5 were conducted to examine other possible explanations for this pattern of priming effects. The results of these experiments supported the proposal that changing the attentional requirements of the probe task change the priming effects observed.

Experiment 2

Experiment 2 was conducted to determine whether an object-specific preview benefit would emerge within the context of the modified procedure described above. In Experiment 2, two gray letters were presented in the prime display followed by a single gray letter in the probe display, a procedure similar to that used previously by Kahneman et al. (1992). However, because letters could appear at repeated and non-repeated locations it was possible to measure the object-specific preview benefit, as well as separate location repetition and identity repetition effects.

The probe target could share attributes with either of the two previously presented prime letters. As a result, the proportion of location repetition trials in the experimental session was .50 and the proportion of identity repetition trials was .50. Thus, the prime offered no predictive advantage regarding either the location or the identity of the probe letter.

It was predicted that under these experimental conditions, an object-specific preview benefit would emerge in the identification task, consistent with the findings of Kahneman et al. (1992; Experiment 1a). Since Kahneman et al. (1992) only investigated object-specific preview benefits within the context of an identification task, specific predictions were not made with respect to the localization task.

Method

Participants

Sixteen McMaster University undergraduates (12 females) participated in both the identification task and the localization task in exchange for introductory psychology course credit. All participants had normal colour vision and normal or corrected-to-normal visual acuity. Mean age of the participants was 21 years.

Apparatus and Stimuli

In Experiment 2, all stimuli were presented in graphics mode on a Sony colour monitor (model CPD-15SF1) connected to a 486 microcomputer. A barrier that allowed chin movement was used to ensure that participants were approximately 57 cm from the computer screen. Participants' responses were recorded using a voice key in the identification task and a joystick in the localization task. The voice key and the joystick were interfaced to the microcomputer.

Insert Figure 4 About Here

The same stimuli were used in both experiments. Figure 4 illustrates the arrangement of stimuli in the prime and probe displays. The entire display measured 5° of visual angle horizontally and 4.3° of visual angle vertically. Each box measured 1.2° x 1.2°

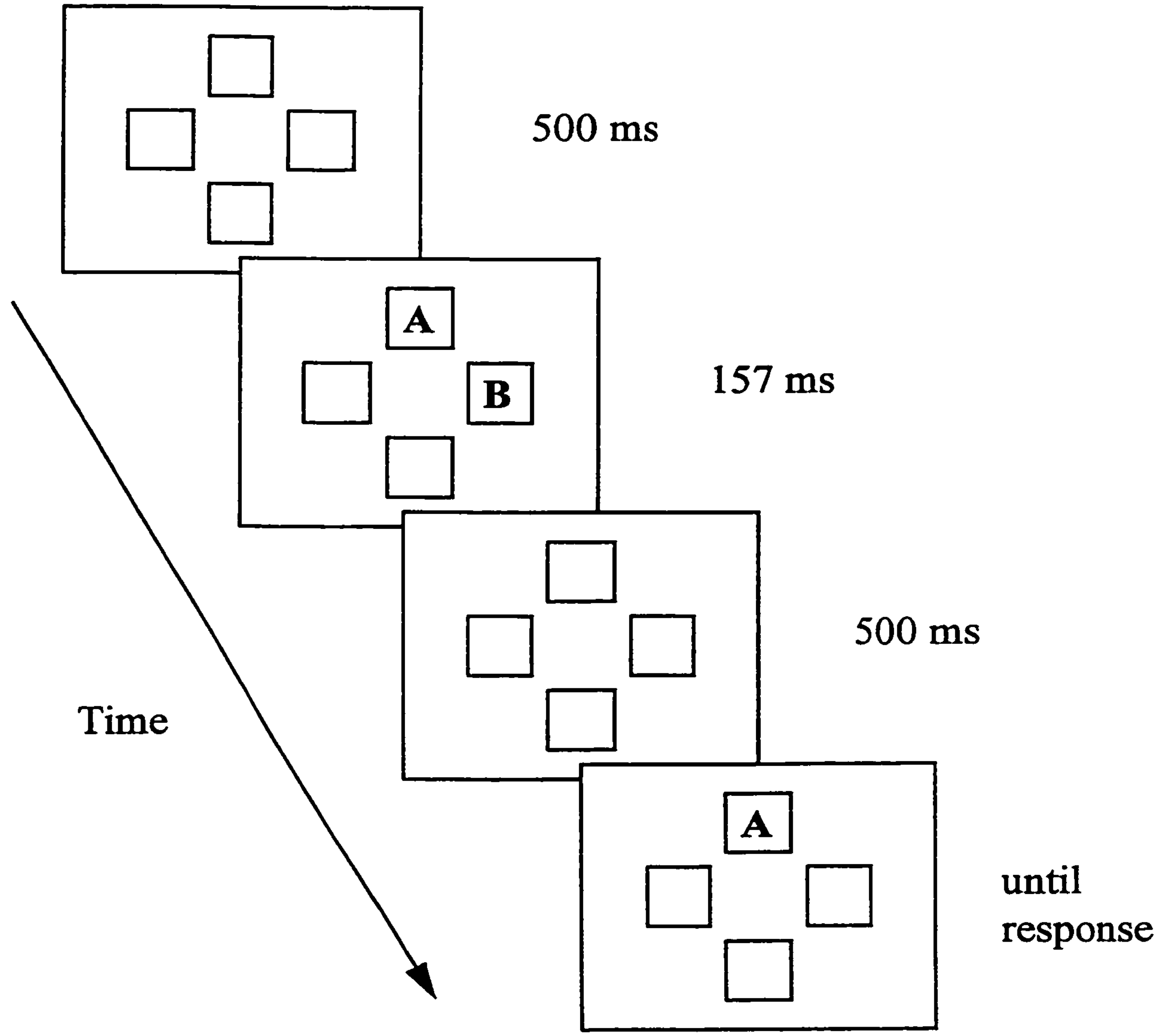

Figure 4. The procedure used in Experiment 2. The four locations were marked on the screen by four boxes. Two letters were presented at two of the four locations in the prime display. A single letter was presented at one of the four locations in the probe display. Participants were required to respond to the single probe letter by making a localization or an identification response.

of visual angle. The upper-case letters A, B, C, and D were used for both prime and probe stimuli. Each letter measured 0.6° of visual angle horizontally and 0.7° of visual angle vertically. All stimuli were displayed in gray against a black background.

Design

In both the identification and localization tasks, a trial consisted of a prime display that contained two of the four letters from the stimulus set presented in two of the four locations on the screen, followed by a probe display that contained a single letter from the stimulus set in one of the four locations. The two letters presented in the prime display could not share the same identity (e.g., two 'A's would not appear together in the prime display). There were no overt selection requirements associated with the items presented in the prime display. Because participants were not required to select one of the two prime stimuli for response, the relationship of the probe letter to the previous prime letters could be determined with respect to the location and the identity of *either* one of the two prime items presented on that trial. As a result of this modification, there were 5 types of trials used in the identification and localization tasks. Figure 5 illustrates the five different trial types used in Experiment 2 and these trials are described below.

Insert Figure 5 About Here

On Control trials, neither identity nor location of either of the prime items was repeated in the probe display. On Location repeated trials, the probe item shared the

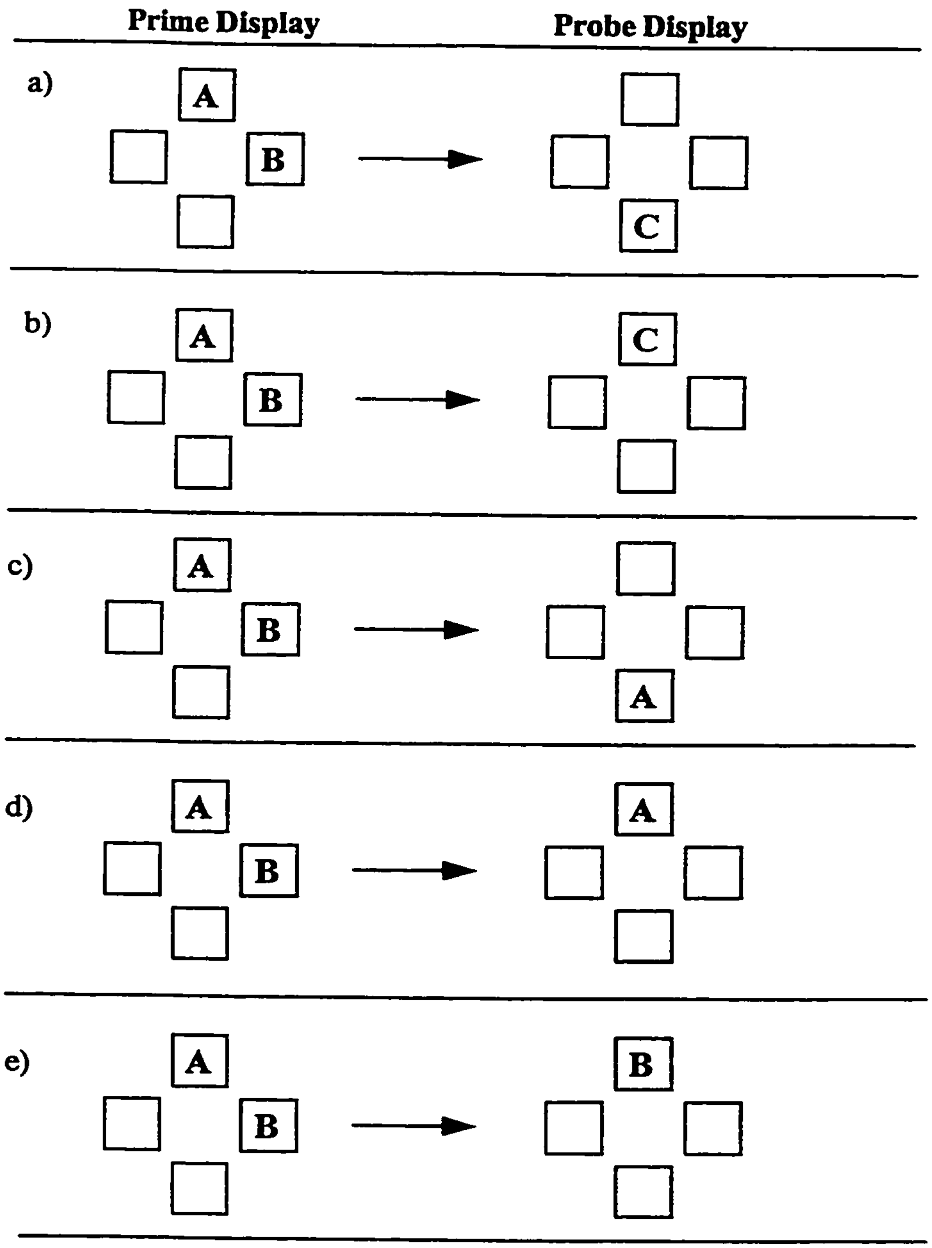

Figure 5. The five trial types used in Experiment 2. Panel (a) is an example of a Control trial. Panel (b) provides an example of a Location-repeated trial. Panel (c) is an example of an Identity-repeated trial. Panel (d) is an example of a Location + Identity repeated trial. Finally, Panel (e) presents an example of a Switched trial.

same location as one of the two previously presented prime items, but the identity of the probe letter differed from that of both prime letters. On Identity repeated trials, the identity of the probe letter was the same as one of the two previously presented prime letters, whereas the location of the probe letter was different from both locations occupied previously by the prime letters on that trial. On Location + Identity repeated trials, both the identity and the location of the probe item was the same as that of one of the two previous prime items. Finally, on Switched trials, the identity of the probe letter matched the identity of one of the prime items while its location matched that of the other prime item.

The identification task and the localization task each consisted of 336 trials. There were 4 blocks of 80 trials and 16 practice trials. Each block of 80 trials was further divided into 5 sub-blocks of 16 trials. Every sub-block of 16 trials consisted of 4 Control trials, 4 Location repeated trials, 4 Identity repeated trials, 2 Location + Identity repeated trials and 2 Switched trials. This composition of trials within a sub-block ensured that the prime display offered no predictive information regarding either the location or identity of the upcoming probe item. The blocks were separated by 30 second rest breaks. An ABBA counterbalance was implemented with half of the participants engaging in the identification task first.

Procedure

Identification task. Participants were tested individually. Once a participant was seated in front of the computer monitor the experimenter explained the task. The instructions emphasized that the participant was to respond only to probe items and that all responses were to be made quickly but accurately. Following the instructions, the participant was positioned in front of the computer and began the practice trials. A trial was initiated by the experimenter pressing the ENTER key on the keyboard.

Figure 4 depicts the series of displays that occurred on each trial. The first display consisted of the words "Press start key to continue", and remained on the screen until the start button was pressed. Four empty boxes were then presented on the screen for 500 ms. This was followed by the prime display in which two of the four letters were presented in two of the four boxes for 157 ms. Following the disappearance of the prime stimuli, the four boxes remained empty for 500 ms. The probe display then occurred. In the probe display, one of the four letters appeared in one of the four boxes and remained on the screen until the participant made a vocal response or until two seconds had elapsed. The experimenter entered the participant's response on the keyboard by pressing the A, B, C or D key. A 'click' was emitted if the participant made an error or if the two second response window had elapsed.

Following the completion of the practice trials, the participants began the experimental trials. The identification task took approximately 20 minutes to complete.

Localization task. The procedure for the localization task was the same as that of identification task with the following exceptions. In the localization task, participants made their response by moving the joystick in a direction that was spatially compatible with the location of the probe target. Since the joystick rested on the table in front of the subject, a response to the top box required that the joystick be moved away from the participant's body, a response to the bottom box required that the joystick be moved toward the participant's body, a response to the left box required that the joystick be moved to the left, and a response to the right box required that the joystick be moved to the right. Participants also initiated their own trials by pressing the start key on the joystick. The localization task took approximately 20 minutes to complete.

Results

Correct RTs were submitted to the same outlier elimination procedure described in Experiment 1. This procedure resulted in the elimination of 1.0% of the RTs in the identification task and 4.2% of the RTs in the localization task. The remaining correct RTs were used to compute mean RTs for each of the trial types in the experiment. These mean RTs and the mean error percentages were subjected to the same set of analyses. Separate analyses were conducted for the identification and localization tasks. First, a one-way repeated measures ANOVA comparing the mean RTs and a one-way repeated measures ANOVA comparing the error percentages for the Switched and Location + Identity repeated trials was conducted to examine the object-specific preview effect. Second, the mean RTs and error percentages were each submitted to a 2x2 repeated measures ANOVA that treated Location (non-repeated/repeated) and Identity (non-repeated/repeated) as within-subject factors. The Switched trials were not included in the 2x2 analyses.

Identification task. Table 2a presents the mean correct RTs and error percentages, collapsed across participants, for the Switched and Location + Identity repeated trials in the identification task. The comparison of the RTs for the Switched and Location + Identity repeated trials revealed that a significant object-specific preview benefit (12 ms) occurred for identical repetitions relative to the non-specific repetitions of the Switched trials, $F(1,15) = 9.14$, $MSE = 139.66$, $p < .01$. The direction of the difference in error percentages was in accordance with that of the RTs, but this difference was not statistically significant ($F = 2.29$).

Table 2b presents the mean RTs and error percentages, collapsed across participants, for the four types of trials included in the 2x2 analysis. The 2x2 ANOVA conducted on the mean RTs showed that neither the main effect of Location nor the main effect of Identity were significant (both Fs <1). However, the Location x Identity interaction was significant, $F(1,15) = 10.89$, $MSE = 26.88$, $p < .005$. To explore this interaction further, simple effects analyses were conducted. The 5 ms cost for repeated locations on the trials in which the identity was not repeated between prime and probe approached significance, $F(1,15) = 4.37$, $MSE = 37.38$, $p < .06$. By contrast, the 3 ms benefit in RTs for repeated locations when identity was repeated between prime and probe was not significant.

The 2x2 ANOVA conducted on the error percentages showed that the pattern of errors was generally consistent with the pattern found for the RTs, but neither of the main effects (both $Fs < 1$) nor the Location x Identity interaction ($F = 1.90$) reached statistical significance.

Localization task. The mean correct RTs and error percentages for the Switched trials and the Location + Identity repeated trials are presented in Table 3a. The comparison of the RTs for the Switched (429 ms) and Location + Identity repeated trials (440 ms) revealed that there was no significant difference between RTs for the two types of trials ($F = 1.48$). The comparable analysis of the error percentages revealed no significant difference between the two types of trials ($F < 1$).

Table 3b shows the mean correct RTs and error percentages of the four trial types included in the 2x2 analysis, collapsed across participants. The results of the 2x2 ANOVA on the RTs in the localization task showed that there was a significant main effect of Location, $F(1,15) = 4.87$, $MSE = 961.79$, $p < .05$. Participants were significantly slower to respond to probe items presented at repeated locations (439 ms) than to probe items presented at non-repeated locations (422 ms). Neither the main effect of Identity nor the Location x Identity interaction were significant. The error analysis revealed no significant differences (all *Fs* < 1).

Discussion

The critical result that emerged from Experiment 2 was the occurrence of a significant object-specific preview benefit in the identification task. This finding is consistent with that reported previously by Kahneman et al. (1992). This result also confirmed that it is possible to observe an object-specific preview benefit using the modified version of Kahneman et al.'s procedure employed in this thesis. Also of note was that there was no significant location repetition effect in the identification task. Repeating location resulted in neither a benefit nor a cost in responding in this task. These two results are of particular interest as they provide the standard against which object-specific effects and location repetition effects in subsequent experiments will be compared.

Of lesser importance in the identification task was the significant Location x Identity interaction. When identity was not repeated, there was a trend for naming latencies to be faster when location was not repeated. By contrast, the trend was in the opposite direction when identity was repeated between prime and probe. Although a null location repetition effect was observed overall, there was a slight trend to suggest that participants did gain a response benefit if both location information and identity information were repeated together.

There was a marked difference in the pattern of results between the identification and localization tasks, however. First, in contrast to the identification task, a significant object-specific preview advantage did not appear in the localization task. This result suggests that the object-specific preview benefit does not necessarily generalize to localization tasks. In fact, the responses are in a direction opposite to what would be predicted for the object-specific preview benefit. A second difference was the appearance of a negative location repetition effect in the localization task. This result stands in contrast to the null location repetition effect in the identification task. These findings suggest that similarity between prime and probe does not necessarily confer the same advantage in identification and localization tasks.

Experiment 3

It was proposed that if the response selection process is flexible, reliance on memory retrieval ought to guide response selection in some circumstances but not in others. It follows then, that the object-specific preview benefit should not occur in all situations. It was demonstrated in both Neill and Kahan (1999; Experiment 1a) and Experiment 1 of this thesis that changing the attentional requirements of the probe task, by including a distractor, eliminated response benefits for repeated stimuli in a word naming task. If the elimination of the response time advantage for repeated stimuli in these experiments reflects a decrease in the contribution that integration of current and past episodes makes to response selection, then the same experimental manipulation could eliminate the object-specific preview benefit.

The procedure used in Experiment 2 was modified to include a second letter in the probe display in Experiment 3. In this experiment, two gray letters were presented in the prime display followed by a red letter that served as the probe target and a green letter that served as the probe distractor. Participants were required to respond only to the red probe target. As in Experiment 2, the prime letters provided no predictive information regarding the location or the identity of the probe target.

According to Kahneman et al. (1992), an object-specific preview benefit should occur under conditions in which current and past processing episodes are integrated. If adding a distractor to the probe task promotes reliance on perceptual analysis, the contribution that integration of current and past processing episodes makes to response selection should be decreased. Consequently, a significant object-specific preview benefit should not be observed in the present experiment.

Also, when there is spatiotemporal correspondence between a prime and probe stimulus, integration should occur; a match in location between prime and probe may be an important cue to integrate two sources of information, whereas a mismatch in location may be an important cue to differentiate the current probe target from past processing events and create a new processing episode for that stimulus. However, if the current task demands require that response be based on current perceptual information, irrespective of whether the probe target matches or mismatches with the preceding prime, differentiation of current and past processing episodes is critical to ensure that response is based on the probe target. It is hypothesized that the creation of a new processing episode may occur faster for a probe target appearing at a non-repeated location than at a repeated location, as a match in location may create interference which impedes the creation of a new episode under such conditions. Therefore, if the inclusion of a distractor biases response selection in favour of perceptual analysis, negative location repetition effects should be observed in both the identification and localization tasks of the present experiment.

Method

Participants

Sixteen McMaster University undergraduates (13 females) participated in both the identification and localization tasks in exchange for introductory psychology course credit. All participants had normal colour vision and normal or corrected-to-normal visual acuity. Mean age of the participants was 20 years.

General Procedure

In Experiment 3, two letters were presented in both the prime and the probe displays (see Figure 6). The two prime letters were presented in gray, whereas the probe target was displayed in red and the probe distractor in green. The prime letters appeared for 157 ms, followed by a 500 ms delay, and then the probe target and distractor appeared and remained on the screen until response.

Insert Figure 6 About Here

Participants were asked to respond as quickly but as accurately as possible to the red letter. The location and identity of the green distractor letter shared no relation with the two prime items or the probe target. This ensured that the probability of a repetition between the probe target and the preceding prime letters was the same as Experiment 2. In all other respects, the present experiment was identical to Experiment 2.

Results

The outlier elimination procedure resulted in the elimination of 1.5% of the RTs in the identification task and 3.6% of the RTs in the localization task. The analyses conducted in the preceding experiment were also conducted on the data of Experiment 3.

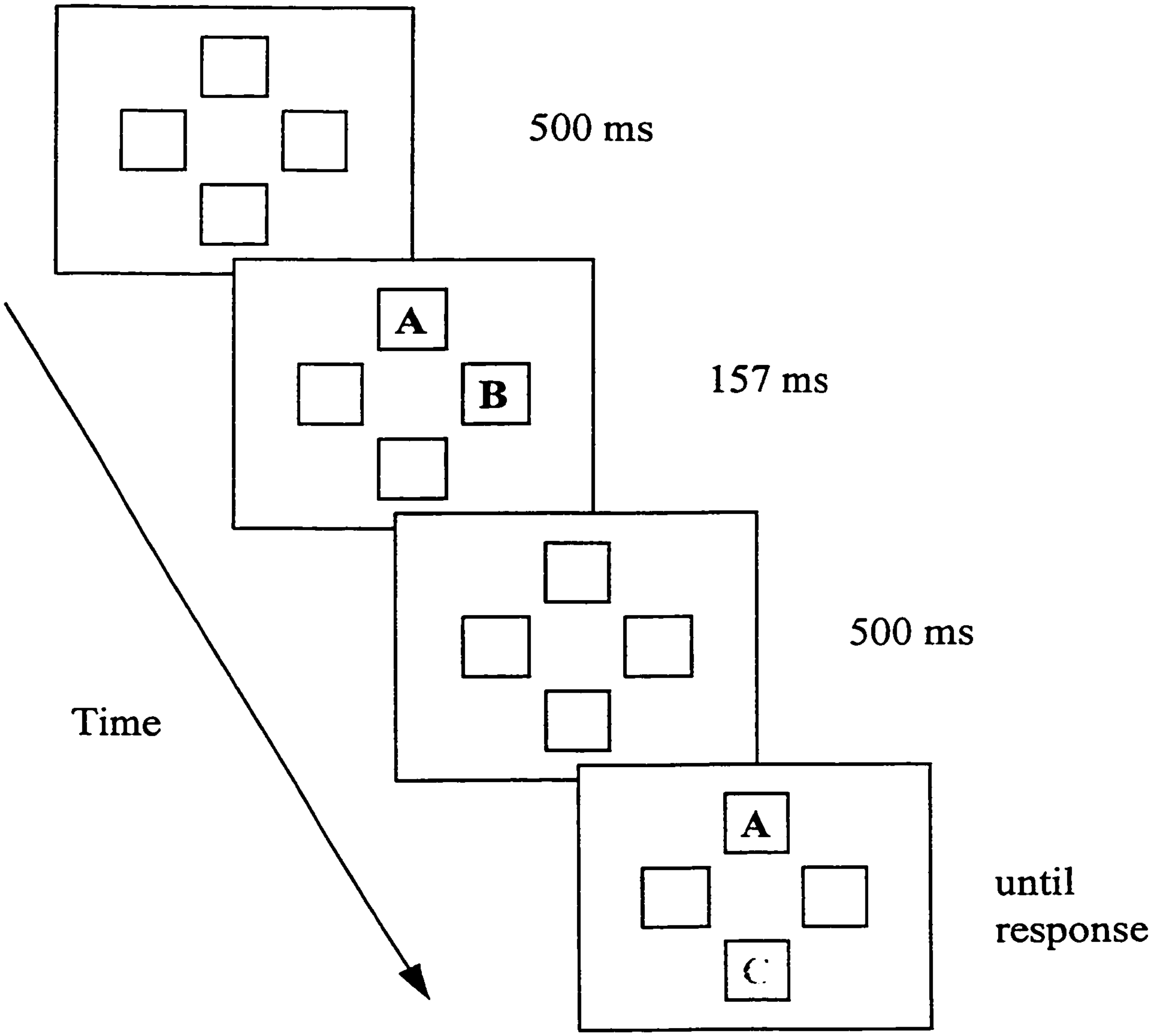

Figure 6. The procedure used in Experiment 3. This procedure was analogous to that of Experiment 2 except that in the probe display both a target (depicted in black) and distractor (depicted in gray) were presented. As in Experiment 2, participants were required to respond to the probe target by making a localization or an identification response.

Identification task. Table 4a shows the mean correct RTs and error percentages for the Switched and Location + Identity repeated trials in the identification task. The comparison of the RTs on Switched and Location + Identity repeated trials indicated that the difference in RTs was not significant ($F < 1$). The results of a power analysis indicated that the power to detect a difference given the number of participants used in this study was high (.87); this suggests that the failure to observe an effect here was not due to insufficient power. Likewise, the difference in error percentages between the two types of trials was not statistically significant ($F < 1$).

The mean correct RTs and error percentages of the four trial types included in the 2x2 repeated-measures analysis of the identification task are shown in Table 4b. The 2x2 analysis revealed that there was a significant main effect of Location, $F(1,15) = 24.44$, $MSE = 485.62$, $p < .0005$, with participants showing slower RTs on trials in which the probe target letter appeared at a repeated location (518 ms) than on trials in which it appeared at a non-repeated location (490 ms). There was also a significant main effect of Identity, $F(1,15) = 20.69$, $MSE = 46.43$, $p < .0005$. Participants were slower to name the probe target letter if its identity matched that of either of the preceding prime letters (508 ms) than if the probe target letter did not match the identity of either of the preceding prime letters (500 ms). The Location x Identity interaction was not significant ($F < 1$).

The 2x2 analysis of the error percentages revealed the presence of a significant Location x Identity interaction, $F(1,15) = 9.73$, $MSE = 1.58$, $p < .005$. On trials in which identity was not repeated between prime and probe, participants made significantly fewer errors if location was also repeated (2.6) than if location was not repeated (0.7) between the prime and probe displays, $F(1,15) = 14.00$, $MSE = 2.09$, $p < .005$. No significant difference in error percentages was observed for repeated and non-repeated location trials when identity was repeated between prime and probe.

Localization task. The mean correct RTs and error percentages for the Switched and Location + Identity repeated trials of the localization task are presented in Table 5a. The comparison of the RTs on Switched and Location + Identity repeated trials revealed no significant differences in RTs between the two types of trials ($F < 1$). No errors were committed on the Switched and Location + Identity repeated trials.

Table 5b shows the mean correct RTs and error percentages of the four trial types included in the 2x2 repeated-measures ANOVA for the localization task. The 2x2 ANOVA showed that there was a significant main effect of Location, $F(1,15) = 28.56$, $MSE = 228.79$, $p < .0001$. Responses were significantly slower on trials in which the probe target letter was presented at a repeated location (459 ms) than on trials in which it was presented at a non-repeated location (439 ms). Neither the main effect of Identity nor the Location x Identity interaction was significant (both $Fs < 1$). Given the small number of errors committed in the localization task, error analyses were not conducted.[5]

Between-Experiment Analyses

Identification task. A between-experiment analysis of the object-specific preview effect was conducted to determine if the object-specific preview effect differed significantly across the identification tasks of Experiments 2 and 3. A 2x2 mixed ANOVA was conducted with Experiment (Experiment 2/Experiment 3) as the between-subject variable and Trial Type (Switched/Location + Identity repeated) as the within-subject variable. Importantly, the Experiment x Trial Type interaction was significant, $F(1,30) = 8.52$, $MSE = 120.38$, $p < .01$. This result indicated that the 12 ms object-specific preview benefit observed in the identification task of Experiment 2 differed significantly from the 3 ms cost for this same effect in the identification task of Experiment 3. There was also a significant main effect of Experiment, $F(1,30) = 28.46$, $MSE = 4035.15$, $p < .0001$, indicating that participants' responses were significantly faster overall in the identification task of Experiment 2 (436 ms) than in the identification task of Experiment 3 (521 ms). This result is consistent with the idea that the inclusion of a distracting item in the probe resulted in slower responding. None of the effects in the error analysis were significant.

To compare the location repetition and identity repetition effects across experiments, a 2x2x2 mixed ANOVA was conducted on the data from the identification tasks, with Experiment (Experiment 2/ Experiment 3) as the between-subject variable, and Location (non-repeated/repeated) and Identity (non-repeated/repeated) as the within-subject variables. The result of particular interest was the finding of an Experiment x Location interaction, $F(1,30) = 20.30$, $MSE = 287.32$, $p < .0001$. This result indicated that the 1 ms cost for repeated locations in Experiment 2 was significantly different than the 27 ms cost for repeated locations in Experiment 3. A number of other effects were significant but of lesser importance and are listed in Appendix B.

Localization task. A corresponding between-experiment 2x2 ANOVA was conducted on the localization data to examine if the object-specific preview effect varied across the localization tasks in Experiments 2 and 3. The Experiment x Trial Type interaction was not significant, indicating that the object-specific preview effect did not differ across experiments. The 2x2x2 mixed ANOVA examining the location and identity variables across experiments revealed no significant differences. Between experiment error analyses were not conducted given the small number of errors committed in the localization task of Experiment 3.

Discussion

It was proposed that changing the attentional requirements of the probe task by adding a distractor would favour reliance on perceptual analysis and thereby decrease the contribution that the integration of current and past processing episodes makes to response selection. The results of the identification and localization tasks were highly consistent with this proposal. First, as predicted, an object-specific preview benefit was not observed when a distractor was included in the probe display of the identification task. The between-experiment analysis of this effect confirmed that the object-specific effect observed in the current identification task was different than the object-specific preview benefit observed in the identification task of Experiment 2. Thus, the object-specific preview benefit does not occur under all conditions. These findings strongly suggest the relative contribution of memory retrieval and perceptual analysis to response selection is subject to attentional control.

The proposal that adding a distractor serves to bias response selection in favour of perceptual analysis rather than memory retrieval is also supported by the finding of a negative location repetition effect. This result stands in contrast to the finding of a null location repetition effect in the previous identification task in which a distractor was not presented in the probe display. Thus, the finding of a response advantage for novel locations is consistent with the idea that response selection favours reliance on perceptual analysis when a distractor is included in the probe task.

In the localization task, an object-specific preview benefit did not emerge. A negative location repetition effect was observed, however. These finding were consistent with those of the previous localization task.

The elimination of the object-specific preview benefit in the identification task, together with the appearance of a negative location repetition effect in this task is consistent with the proposal that reliance on perceptual analysis is favoured in response selection under conditions in which a distractor is included in the probe display. Thus, the present findings strongly suggest that the change in attentional requirements of the probe between Experiments 2 and 3 was responsible for the change in the pattern of effects observed. However, this change in attentional requirements was confounded with a mismatch in colour between the probe target and the preceding primes. In this experiment, the prime letters were both displayed in gray and the probe target letter in red, whereas in Experiment 2, the prime letters and the probe target letter were all displayed in gray. It has been proposed previously in the priming literature that slower responses may occur for a probe stimulus that matches the preceding prime on the dimension upon which the response is based, but mismatches the prime on a different attribute (Allport, Tipper & Chmiel, 1985; Lowe, 1979; Park & Kanwisher, 1994). For example, individuals may be slower to name a repeated probe word if the colour of that word differs from the colour in it appeared in the prime display (see Allport et al., 1985). Similarly, Park and Kanwisher (1994) proposed that slower localization responses to probe stimuli appearing at repeated locations may result from a mismatch in identity between prime and probe. Thus, mismatches in colour (Allport et al., 1985) or identity (Park & Kanwisher, 1994; Tipper et al., 1990) could account for the appearance of repetition costs in priming tasks. Further, it has been shown that when the mismatch on such a dimension is eliminated, a null effect (e.g., Park & Kanwisher, 1994; Tipper et al., 1990) or a repetition benefit (e.g., Neill et al., 1992) often occurs (but see Milliken et al., 1994; Tipper & Cranston, 1985). As a result of such findings, feature mismatching has been considered by many to be a viable explanation for slower response times to repeated stimuli in priming tasks. This account also contrasts with the attentional explanation forwarded in this thesis.

Since the colour of the probe target and preceding prime items differed in Experiment 3, it is possible that the mismatch on the dimension of colour may underlie the elimination of the object-specific preview benefit and occurrence of a negative location repetition effect. Therefore, it was important to address directly the issue of mismatching within the context of the present task.

Experiment 4

Experiment 4 was conducted to determine if patterns of results similar to those of Experiment 3 would also occur under conditions in which the probe target and previous primes matched rather than mismatched in colour. The procedure used in Experiment 4 was the same as that used in Experiment 3, except that the probe target letter was presented in the same colour as the previously presented prime letters on each trial. This change to the procedure made the experimental conditions more similar to those in which an object-specific preview benefit was observed previously. This modification was of particular importance as this change made it possible to assess more definitively if the inclusion of a distractor in the probe task plays a role in determining whether an object-specific preview benefit will occur.

If the mismatch in colour between the probe target and the preceding prime letters was responsible for the different patterns of results that occurred for the identification tasks of Experiments 2 and 3, then a significant object-specific preview benefit should emerge when the colour mismatch is eliminated in the current identification task. However, if it was the change in attentional processing required by the inclusion of a probe distractor that served to eliminate the object-specific preview benefit, then the pattern of results observed in the present experiment should closely resemble the pattern of results observed in Experiment 3. In particular, the object-specific preview benefit should not be observed in this experiment.

Method

Participants

Sixteen McMaster University undergraduates (9 females) participated in both the identification and localization tasks. Thirteen of the participants received introductory psychology course credit in exchange for their participation. Three of the participants were enrolled in a second year psychology course and received $10.00 for their participation. All participants had normal colour vision and normal or corrected-to-normal visual acuity. Mean age of the participants was 21 years.

General Procedure

The design and procedure of Experiment 4 was the same as the previous experiment except that the probe target letter was displayed in gray rather than red.

Results

The outlier elimination procedure resulted in the elimination of 1.2 % of the RTs in the identification task and 5.1% of RTs in the localization task. The analyses conducted on the data were the same as those conducted in Experiment 2.

Identification task. The mean correct RTs and error percentages for the Switched and Location + Identity repeated trials of the identification task are shown in Table 6a. The comparison of the RTs for the Switched (513 ms) and Location + Identity repeated (513 ms) trials revealed no significant difference ($F < 1$). The error percentages for the two types of trials did not differ significantly ($F < 1$).

Table 6b shows the mean correct RTs and error percentages for the four trial types included in the 2x2 repeated-measures ANOVA conducted on the data of the identification task. The 2x2 analysis revealed that there was a significant main effect of Location, $F(1,15) = 33.22$, $MSE = 206.83$, $p < .0001$, with participants showing slower RTs to items appearing at repeated locations (511 ms) than to items appearing at non-repeated locations (491 ms). Neither the main effect of Identity ($F = 1.32$), nor the Location x Identity interaction ($F < 1$) was significant.

The pattern of errors was consistent with that of the RTs. The analysis of the error percentages indicated that there was a significant main effect of Location, $F(1,15) = 9.20$, $MSE = 1.84$, $p < .01$, with more errors occurring on trials in which location was repeated (2.0) than on trials in which location was not repeated (0.9). As was the case with the RTs, neither the main effect of Identity nor the Location x Identity interaction was significant (both $Fs < 1$).

Localization task. Table 7a shows the mean correct RTs and error percentages for the Switched and Location + Identity repeated trials in the localization task. The comparison of the Switched and Location + Identity repeated trials revealed that there was a 17 ms response cost for Location + Identity repeated trials, but this difference only approached significance, $F(1,15) = 3.39$, $MSE = 658.95$, $p < .10$. There was no significant difference between the error percentages of the two trial types ($F < 1$).

Table 7b shows the mean correct RTs and error percentages of the four trial types included in the 2x2 repeated-measures ANOVA conducted on the data of the localization task. The results of the 2x2 ANOVA indicated that there was a significant main effect of

Location, $F(1,15) = 41.55$, $MSE = 209.14$, $p < .0001$. Participants were slower to respond on trials in which the probe target letter was presented at a repeated location (501 ms) than on trials in which it was presented at a non-repeated location (478 ms). Neither the main effect of Identity nor the Location x Identity interaction was significant (both *Fs* < 1). Neither of the main effects (both *Fs* < 1) nor the interaction ($F = 1.26$) in the error analysis were significant.

Discussion

The critical result in this experiment was the elimination of the object-specific preview benefit in the identification task, under conditions in which the probe target and the preceding primes matched in colour. This finding suggests that changing the attentional demands of the probe task rather than feature mismatching underlies the elimination of the object-specific preview benefit. Also of interest was the occurrence of a negative location repetition effect in the identification task. This result was consistent with the identification task of Experiment 3, once again suggesting that repetition costs rather than benefits can occur if response selection favours reliance on perceptual analysis rather than memory retrieval. Finally, although the main effect of Identity was not significant in this experiment, this effect was in the same direction as the identity repetition effect in the identification task of Experiment 3.

The localization data of Experiment 4 were once again consistent with the previous localization task. As in the preceding localization tasks, only a significant response cost on repeated location trials emerged. Thus, the pattern of results for both the identification and localization tasks in Experiment 4 were highly consistent with the patterns observed for the same tasks in Experiment 3.

The observation of similar patterns of results in Experiments 3 and 4 strongly suggests that the inclusion of a distracting stimulus rather than the presence of a feature mismatch was responsible for the elimination of the object-specific preview benefit. It appears that the elimination of the object-specific preview benefit and the finding of negative location repetition effects in Experiments 3 and 4 were the result of a change in the attentional requirements of the probe task which biased response selection in favour of reliance on perceptual analysis rather than memory retrieval.

Experiment 5

The results of Experiment 4 were consistent with the interpretation that the change in the attentional requirements of the probe task brought about by the inclusion of a probe distractor was responsible for the differences observed in the priming effects between Experiment 2 and Experiments 3 and 4. However, the proposed change in attentional demands across experiments was confounded with a second factor - the number of items in the prime and probe displays. Adding a distractor to the probe display changed the number of items in the display. The same number of items appeared in the prime and probe displays of Experiments 3 and 4, whereas a different number of items appeared in the prime and probe displays of Experiment 2. As a result of this difference, an alternative explanation may account for the change in priming effects observed across these experiments.

One explanation forwarded in the priming literature to account for the occurrence of repetition costs in priming tasks proposes that slower responses to repeated stimuli than to novel stimuli may result from the retrieval of an inappropriate prior processing episode (Neill et al., 1992; Neill, 1997). By this account, response selection is determined by the faster of two processes; an automatic retrieval process or an analytic process (see Logan, 1988). Repetition costs are thought to occur when memory retrieval guides response selection. Increased contextual similarity between the prime and probe tasks is thought to promote the retrieval of the most recent related prior processing episode. However, if the current attentional or response requirements for the current probe target (e.g., 'respond to this stimulus') are not consistent with the attentional or response requirements of the retrieved episode (e.g,, 'do not respond to this stimulus'), then a conflict arises between the two episodes. Presumably, the response selection process is slowed, as the conflict in response information must be resolved. As a result, response times to repeated stimuli may be slower than response times to non-repeated stimuli.

One way in which the contextual similarity of the prime and probe may be increased is by presenting the same number of items in the prime and probe displays. It has been demonstrated in a number of studies that slower response times occur for a repeated probe target when a target and distractor item are presented in both the prime and probe displays, whereas faster response times occur for a repeated probe target if a target and distractor are presented in the prime but only a single item is presented in the probe (e.g., Neill, 1997; Tipper & Cranston, 1985). Findings of repetition costs only when the same number of items are presented in the prime and probe tasks are consistent with the claim that contextual similarity promotes the retrieval of inappropriate prior processing episodes, which in turn, results in repetition costs.

Since the inclusion of a distractor in Experiments 3 and 4 created a situation in which the number of items matched between prime and probe, it is possible that the change in the number of items, rather than the change in the attentional requirements of the probe task, was responsible for the elimination of the object-specific preview benefit and the appearance of negative location repetition effects in these experiments. The findings of Experiment 1 argue against such an interpretation, as repetition costs were observed when the inclusion of a distractor caused the number of items in the prime and probe displays to differ. However, since it could be argued that word naming and letter identification may not involve the same processes, it is important to address this issue within the context of the current procedure.

To address this issue, a single item was presented in the prime display followed by a target and a distractor in the probe task. If similarity in the number of items between the prime and probe displays was responsible for the change in the pattern of priming effects between Experiment 2 and Experiments 3 and 4, then the pattern of results in Experiment 5 should differ from those of the previous two experiments. However, if the change in the attentional processing required for the probe task was responsible for the change in priming effects observed, then the pattern of results observed should be similar to those of Experiments 3 and 4. It is important to note that it was not possible to assess the object-specific preview benefit within the context of this experiment, as only a single item was presented in the prime. However, it was possible to examine location repetition effects and identity repetition effects in Experiment 5; these effects could be compared to the same effects in the previous experiments. If the change in attentional processing requirements rather than the match in number of items was responsible for the pattern of results observed in Experiments 3 and 4, then negative location repetition effects should be observed in both the localization and identification tasks of the present experiment.

One other change was made in Experiment 5. In all of the previous experiments that included a distracting stimulus in the probe task, the probe distractor was completely unrelated to the preceding prime on all trials. In both the identification and localization tasks of Experiment 5 however, the distractor item could be unrelated to the preceding prime or it could share location, identity or both with the preceding prime item.[6]

Method

Participants

Sixteen McMaster University undergraduates (14 females) participated in both the identification and localization tasks in exchange for introductory psychology course credit. All participants had normal colour vision and normal or corrected-to-normal visual acuity. Mean age of the participants was 20 years.

Apparatus and Stimuli

The apparatus and stimuli were the same as in the previous experiments.

Design

In Experiment 5, a single item was presented in the prime display followed by both a target and a distractor in the probe display. In Experiment 5, both the probe target and the probe distractor could share location, identity or both with the preceding prime item. All possible combinations of location and identity factors for both the probe target and probe distractor resulted in nine different types of trials. However, because the primary focus of this experiment was to compare the location repetition and identity repetition effects of Experiment 5 to the location repetition effects and identity repetition effects of the previous experiments, only the trial types relevant to these comparisons will be discussed here. These trials were the Control, Location repeated, Identity repeated, and Location + Identity repeated trials. Consistent with the previous experiments, for these four types of trials the probe distractor shared neither location nor identity with the preceding prime letter. On Control trials, the probe target shared neither location nor identity with the preceding prime. On Location repeated trials, the probe target shared location but not identity with the preceding prime letter. On Identity repeated trials, the probe target shared identity but not location with the preceding prime letter. Finally, on Location + Identity repeated trials, the probe target shared both location and identity with the preceding prime. The list of trial types, including the different types of distractor repetition trials, is presented in Appendix C.

The composition of trials within a block ensured that the prime display offered no predictive information regarding either the location or identity of the probe target or the probe distractor. The localization and identification tasks of Experiment 5 each consisted of 352 trials. In each experiment, there were 4 blocks of 80 trials and 32 practice trials.[7] Each block of 80 trials was further divided into 5 sub-blocks of 16 trials. The blocks were separated by 30 second rest breaks. Counterbalancing was conducted in the same manner as in the previous experiments.

Procedure

The procedure used in Experiment 5 was the same as Experiment 3.

Results

The outlier elimination procedure resulted in the elimination of 1.1% of the RTs in the identification task and 4.9% of RTs in the localization task. Mean correct RTs and error percentages for the identification and localization tasks are presented in Tables 8 and 9 respectively. Separate analyses of the distractor repetition trials were conducted for both the identification and localization data and are included in Appendix C.

Identification task. A 2x2 repeated-measures ANOVA was conducted on the same four trial types examined in all of the previous experiments (Control, Location repeated, Identity repeated, Location + Identity repeated). There was a significant main effect of Location, $F(1,15) = 44.46$, $MSE = 226.79$, $p < .0001$. Participants were slower to name a probe target letter appearing at a repeated location (500 ms) than a probe target letter appearing at a non-repeated location (475 ms). This result is consistent with that of the identification tasks in Experiments 3 and 4. Neither the main effect of Identity (F = 2.23) nor the Location x Identity interaction ($F < 1$) was significant.

The corresponding analysis of the error percentages revealed that the main effect of Location approached significance, $F(1,15) = 4.53$, $MSE = 6.62$, $p = .0503$. The pattern of error percentages was consistent with the pattern found for the RTs; more errors were made on trials in which the probe target appeared at a location previously occupied by one of the prime items (3.7) than on trials in which the probe target appeared at a location not previously occupied by one of the prime items (2.3). Thus, it appears that participants were both slower and more error prone on repeated location trials relative to non-repeated location trials. Neither the main effect of Identity nor the Location x Identity interaction was significant (both $Fs < 1$).

Localization task. The 2x2 ANOVA comparing Control, Location repeated, Identity repeated, Location + Identity repeated trials revealed that there was a significant main effect of Location, $F(1,15) = 40.95$, $MSE = 339.44$, $p < .0001$. Responses were slower on trials in which the probe target letter was presented at the same location as one of the preceding primes (490 ms) than on trials in which the probe target letter was presented at a location unoccupied by one of the preceding primes (461ms). Neither the main effect of Identity nor the Location x Identity interaction was significant (both $Fs < 1$). A sign test comparing errors on non-repeated location and repeated location trials was significant at .05 level of significance. More errors were committed on non-repeated location trials than repeated location trials.[8]

Discussion

As predicted, negative location repetition effects were observed in both the localization and identification tasks of this experiment - findings that are consistent with both Experiments 3 and 4. Also, the identity repetition effect in the identification task was in the same direction as the identification tasks of the previous experiments that included a distractor in the probe display. Thus, with respect to the location and identity repetition effects, the pattern of results observed in Experiment 5 were highly consistent with the findings reported in Experiments 3 and 4. These findings support the proposal that the change in attentional requirements of the probe task rather than the match in the number of prime and probe items was responsible for the change in the pattern of results between Experiment 2, and the subsequent experiments that included a distractor in the probe task. If contextual similarity between the prime and probe displays is defined in terms of the number of items in the two displays, then the present results are problematic for Neill et al.'s (1992; Neill, 1997) account of repetition costs. Therefore, the findings of Experiment 5, together with those of Experiments 3 and 4, provide strong empirical support for the contention that including a distracting item in the probe task biases response selection in favour perceptual analysis and reduces the contribution of integration to response selection.

In summary, the experiments described in Chapter 3 provide strong evidence to suggest that the appearance of repetition benefits or repetition costs in priming tasks is influenced by attention at the time of the probe task. It was shown that the object-specific preview benefit observed in Experiment 2 could be eliminated by the inclusion of a distractor in the probe display. It was also demonstrated that the inclusion of a probe distractor led to the appearance of negative location repetition effects in both the identification and localization tasks. It is interesting to note that the findings of repetition costs for repeated stimuli relative to novel stimuli observed in these experiments converge with other results using different procedures in which a distracting stimulus was included in the probe display (e.g., Connelly & Hasher, 1993; Tipper et al., 1990); thus, these results are also converge with findings reported previously in the priming literature. Together, these findings were consistent with what would be anticipated if the inclusion of a probe distractor biased response selection in favour of reliance on perceptual analysis of current target information.

If it is assumed that 'paying attention' to the probe task has two consequences - decreased contribution of integration to response selection and increased interference for repeated items when attempting to establish a new processing episode - then the results of Chapter 3 are highly consistent with this proposal. Finally, because neither the match or mismatch between the colours of the probe target and prime stimuli, nor the number of items in the prime and probe displays affected the pattern of results observed across Experiments 3, 4 and 5, these results strongly suggest that the differing attentional requirements of Experiment 2 and the experiments that included a probe distractor were responsible for the different patterns of priming effects observed across these experiments.

CHAPTER 4

Probability of Repetition and Priming Effects

The experiments discussed in Chapters 2 and 3 provide strong empirical support for the contention that the contribution that reliance on memory retrieval makes to response selection is subject to attentional control. It was shown that the inclusion of a distractor in the probe display, which presumably changes the attentional requirements of the probe task, changes the priming effects observed. The experiments described in this chapter were designed to provide converging support for this view by demonstrating a similar result using a different attentional manipulation.

It has been shown in previous work that varying the proportion of repeated trials can influence priming effects (Merikle & Cheesman, 1987; Neely, 1977; Posner & Snyder, 1975; Posner, 1980). Recent work has demonstrated that manipulating the proportion of repeated trials in tasks that do not include a distractor can produce results similar to those observed in tasks that include a distractor (Milliken, Lupianez, Debner & Abello, in press). Therefore, in the experiments described in this chapter, proportion manipulations rather than a selection requirement were used to change the attentional requirements of the task. More specifically, it was presumed that whether response selection would favour reliance on memory retrieval or perceptual analysis would depend upon the proportion of repeated trials. As in the previous chapter, this theoretical issue was examined by measuring object-specific preview benefits and location repetition effects under two attentional conditions.

Experiments 6 and 7 used a procedure similar to that of Experiment 2, with the exception of the proportion of repeated location trials. In Experiment 2, the proportion of repeated location trials was in accordance with chance, and therefore provided no predictive information regarding the location of the probe target. In Experiment 6, the proportion of repeated location trials was well above chance. The purpose of this change to the procedure was to bias response selection in favour of reliance on memory retrieval, as the prime location information provided useful information for the following probe item. By contrast, in Experiment 7, the proportion of repeated location trials was well below chance. This low proportion of repeated location trials was designed to bias response selection in favour of reliance on perceptual analysis.

Experiment 6

Experiment 6 was one of two experiments conducted to determine if the object-specific preview benefit and the relative rates of responding to repeated and novel stimuli are sensitive to proportion manipulations. Experiment 6 was identical to Experiment 2 with the exception that the proportion of repeated location trials was increased from .50 to .75. The proportion of repeated identity trials remained at .50. Presumably, the relatively large proportion of trials in which the location of a current stimulus matched the location of a preceding prime should have biased responding in favour of reliance on memory retrieval.

As mentioned previously, under conditions in which integration of current and past processing episodes contributes to response selection, faster responses should occur for repeated stimuli relative to non-repeated stimuli. Given that the present conditions were thought to promote the integration of current and past events, two predictions were made; an object-specific benefit was expected in the identification task and positive location repetition effects were predicted for both the identification and localization tasks.

Method

Participants

Twenty-four McMaster University undergraduates (18 females) participated in both the identification and localization tasks in exchange for introductory psychology course credit. The number of participants was increased in accordance with the results of power analyses conducted for this set of two experiments. All participants had normal colour vision and normal or corrected-to-normal visual acuity. Mean age of the participants was 20 years.

General Procedure

The apparatus, stimuli and procedure of Experiment 6 were identical to those of Experiment 2. The only difference between the current experiment and Experiment 2 was that the probe target appeared in a previously occupied location on 75% of the trials instead of 50% of the trials. As a result of this manipulation, in every sub-block of 16 trials there were 2 Control trials, 6 Location repeated trials, 2 Identity repeated trials, 3 Switched trials and 3 Location + Identity repeated trials.

Results

The outlier elimination procedure resulted in the elimination of 0.9% of the RTs in the identification task and 3.7% of the RTs in the localization task. Mean correct RTs and error percentages were then submitted to the same set of analyses as Experiment 2.

Identification task. Mean correct RTs and error percentages for the Switched and Location + Identity repeated trials are presented in Table 10a. The analysis for these two types of trials revealed the presence of a significant 12 ms object-specific preview benefit, $F(1,23) = 32.06$, $MSE = 53.46$, $p < .0001$. The difference in error percentages for Switched trials (2.4) and Location + Identity repeated trials (1.9) was consistent with the RT data but was not statistically significant ($F < 1$).

Table 10b shows the mean correct RTs and error percentages of the four trial types included in the 2x2 repeated-measures ANOVA. This analysis revealed a significant main effect of Location, $F(1,23) = 15.63$, $MSE = 178.23$, $p < .005$. Participants were faster to name the probe target letter on trials in which the probe target appeared at a previously occupied location (435 ms) than on trials in which it appeared at a previously unoccupied location (446 ms). A significant main effect of Identity also emerged, $F(1,23) = 12.10$, $MSE = 75.28$, $p < .01$. Participants responded more rapidly on trials in which the single probe letter shared identity with one of the two prime letters (437 ms), than on trials in which identity was not redundant between the two displays (446 ms). The Location x Identity interaction was not significant ($F < 1$).

The 2x2 analysis of the error percentages showed that the pattern of errors was generally consistent with that of the RTs, although the main effect of Location ($F = 2.43$), the main effect of Identity ($F < 1$) and the interaction ($F < 1$) failed to reach statistical significance.

Localization task. Mean correct RTs and error percentages for the Switched and Location + Identity repeated trials are presented in Table 11a. A comparison between mean RTs for the Switched (385 ms) and Location + Identity repeated trials (390 ms) revealed no significant difference ($F = 2.02$). The difference in error percentages between two types of trials was also not statistically significant ($F = 2.54$).

Table 11b shows the mean correct RTs and error percentages for the four trial types included in the 2x2 analysis. Participants responded faster on trials in which the target letter was presented at a repeated location (390 ms) relative to a non-repeated location (402 ms), although the main effect of Location only approached statistical significance, $F(1,23) = 4.23$, $MSE = 898.99$, $p < .052$. Neither the main effect of Identity nor the Location x Identity interaction was significant (both $Fs < 1$).

The pattern of error percentages was generally consistent with the pattern of RTs. Fewer errors were made on trials in which location was repeated between prime and probe (0.4) than on trials in which location was not repeated between prime and probe (1.0); however, this main effect of Location only approached significance, $F(1,23) = 3.30$, MSE

$= 2.16, p < .09$. Thus, there was a trend for participants to be both faster and more accurate on trials in which the probe target appeared at a repeated location than at a more novel location. The main effect of Identity and the Location x Identity interaction were not significant (both *Fs* < 1).

Discussion

It was hypothesized that increasing the proportion of repeated location trials such that the prime stimulus provided predictive information regarding the location of the subsequent probe target, would induce participants to rely on memory retrieval in response selection. The results of Experiment 6 were consistent this hypothesis. As predicted, a significant object-specific preview benefit emerged in the identification task. Since an object-specific preview benefit it is thought to occur when current and past processing episodes are integrated, this finding is consistent with the proposal that increasing the proportion of repeated trials biased response selection in favour of reliance on memory retrieval. This demonstration also provides an important replication of the object-specific benefit observed in Experiment 2 under conditions in which a lower proportion of repeated location trials (.50) was used.

The second finding of particular interest was the positive location repetition effect in the identification task. This result stands in contrast to the null location repetition effect observed in Experiment 2 under conditions in which a lower proportion of repeated location trials was used. This finding suggests that making the prime stimulus a useful source of response information for the probe enabled participants to capitalize on location redundancy to a greater extent in this experiment than in the preceding experiment. This finding is also consistent with what would be expected if increasing the proportion of repeated trials promoted reliance on memory retrieval in response selection.

Also of note in the identification task was the finding of faster responses for trials in which identity information was repeated between prime and probe. Location was proposed to be the primary source of information used to determine if the probe target should be integrated with a prior processing episode or if a new processing episode should be created. However, in the present experiment, the increased utility of past information for current responding may have induced participants to capitalize on other types of repeated information in response selection as well (see Treisman, 1992). Taken together, the findings of the identification task are consistent with the proposal that repetition benefits in responding should occur under conditions in which the response selection process favours reliance on memory retrieval.

The results of the localization task were also consistent with the notion that there was an increased contribution of integration of current and past processing episodes to response selection in Experiment 6. In the localization task, there was a trend for faster responses to stimuli appearing at repeated locations relative to stimuli appearing at non-repeated locations. This finding stands in sharp contrast to the negative location repetition effects observed in all of the localization experiments reported in Chapter 3. Although this location repetition effect only approached statistical significance, such a reversal in response times was not evident in the any of the previous localization tasks of Chapter 3. Consequently, this result suggests that participants were able to capitalize on the predictive information offered by the prime stimulus to facilitate their responses in the localization task. Finally, the failure to observe a significant object-specific benefit is in contrast to the findings for the present identification experiment but consistent with the previous localization tasks. Thus, it appears that sensitivity to identity information, or at least redundancy in identity information, is not always necessary in localization tasks if identity is not required to make an accurate localization response.

Although the findings of this experiment are consistent with what would be expected if integration of current and past processing episodes was making a greater contribution to response selection, it is possible that these results could be interpreted in a different way. It has been proposed previously that high or low proportions of repeated trials can lead observers to adopt an active expectancy regarding the nature of the subsequent item (Merikle & Cheesman, 1987; Neely, 1977). In particular, the high proportion of repeated location trials may have led participants to develop an expectancy for the probe target to appear at the prime location. Thus, the appearance of positive location repetition effects in the identification and localization tasks may simply reflect a benefit that results from the probe stimulus being consistent with the conscious expectancy regarding the location of the probe stimulus.

Although an expectancy-based explanation can account for the appearance of positive location repetition effects, it does not explain why an object-specific preview benefit occurs in the identification task. Recall that identity and location information were repeated in both the Switched and Location + Identity repeated trials, and that both of these trials occurred equally often in the experiment. A differential expectancy should not have developed for the two types of trials. Therefore, by this account, it is not immediately apparent why having the same letter at the same location would provide a response advantage over a different previewed letter at that location; the only difference between the two types of trials was how the repeated location and repeated identity information are conjoined. Also, if the benefits observed are the result of manipulating expectancy for where the probe item should appear, it is not apparent why a positive identity repetition effect would emerge, given that the proportion of repeated identity trials was not manipulated. Thus, while conscious expectancy may have played a role to some extent in this experiment, it cannot provide a complete explanation of the results observed in Experiment 6. The idea that increasing the proportion of repeated location trials induces participants to adopt a response selection strategy that favours integration of current and past processing episodes appears more capable of explaining the full spectrum of results in this experiment.

Experiment 7

If attentional requirements of the probe task play a critical role in modulating priming effects, then changing the proportion of repeated trials such that relying on past information leads to inefficient integration should produce a different pattern of results than that observed in Experiment 6. The procedure used in Experiment 7 was the same as the preceding experiment except that the proportion of repeated location trials was changed from .75 to .19. Not only was a probe target more likely to appear at a novel location than at a repeated location, but the likelihood of a probe target appearing at a previously occupied location was actually below what would be expected by chance. Given that a stimulus was more likely to appear at a non-repeated location than at a repeated location, response selection should have been biased in favour of reliance on perceptual analysis rather than memory retrieval.

Since reducing the proportion of repeated location trials should decrease the contribution that integration makes to response selection, it was predicted that the object-specific preview benefit would be eliminated in the identification task of Experiment 7. Also, since it is presumed that under conditions favouring perceptual analysis the creation of a new processing episode can occur faster for novel stimuli than repeated stimuli, negative location repetition effects were expected for both the identification and localization tasks of this experiment.

Method

Participants

Twenty-four McMaster University undergraduates (16 females) participated in both the identification and localization tasks in exchange for introductory psychology course credit. All participants had normal colour vision and normal or corrected-to-normal visual acuity. Mean age of the participants was 20 years.

General Procedure

The apparatus, stimuli and procedure of Experiment 7 were identical to that of Experiment 6. The only difference between the two experiments was that the probe target appeared in a repeated location on 19% of the trials rather than 75% of the trials as in Experiment 6. As a result of this manipulation, in each sub-block of 16 trials there were 7 Control trials, 1 Location repeated trial, 6 Identity repeated trials, 1 Switched trial and 1 Location + Identity repeated trial.[9]

Results

The outlier elimination procedure resulted in the elimination of 1.0% of the RTs in the identification task and 5.2% of the RTs in the localization task. Mean correct RTs and error percentages were then each submitted to the same set of analyses as in Experiment 6.

Identification task. Mean correct RTs and error percentages for the Switched trials and the Location + Identity repeated trials are presented in Table 12a. The analysis of the object-specific preview benefit revealed that there was no significant difference in RTs between the Switched (429 ms) and the Location + Identity repeated trials (428 ms; $F < 1$). The pattern of error percentages was consistent with the RT effect but failed to reach statistical significance ($F = 2.12$).

Table 12b shows the mean RTs and error percentages of the four trial types included in the 2x2 repeated-measures ANOVA. This analysis revealed a significant main effect of Location, $F(1,23) = 80.22$, $MSE = 177.18$, $p < .0001$. In sharp contrast to the findings of the previous identification task, participants' naming latencies were slower on trials in which the probe letter appeared in a previously occupied location (425 ms) than on trials in which the probe letter appeared in a previously unoccupied location (400 ms). Participants were also slower to name the probe letter on trials in which the identity of the probe item was the same as one of the previous primes (415 ms) than on trials in which it was unrelated to the previous primes (410 ms). Although this difference was small, it was statistically significant, $F(1,24) = 7.95$, $MSE = 66.56$, $p < .01$. The Location x Identity interaction was not significant ($F < 1$).

The pattern of error percentages was generally consistent with that of the RTs. There was a significant main effect of Identity, $F(1,23) = 10.35$, $MSE = 2.24$, $p < .005$. Participants made more errors on trials in which identity was repeated between prime and probe (1.5) than on trials in which identity was not repeated (0.5) between the two displays. Participants made slightly fewer errors on repeated location trials (0.8) than on non-repeated location trials (1.1) but the main effect of Location was not statistically significant ($F = 1.68$). The Location x Identity interaction was not significant ($F < 1$).

Localization task. Mean correct RTs and error percentages for the Switched trials and the Location + Identity repeated trials are presented in Table 13a. The analysis of RTs for the Switched (451 ms) and Location + Identity repeated (454 ms) trials revealed no significant difference ($F < 1$). There was also no difference between the Switched and Location + Identity repeated trials with respect to error percentage ($F < 1$).

Table 13b shows the mean correct RTs and error percentages for the four trial types included in the 2x2 repeated-measures ANOVA. This analysis revealed a significant main effect of Location, $F(1,23) = 79.06$, $MSE = 890.42$, $p < .0001$. Participants were much slower to respond on trials in which the probe letter appeared in a location previously occupied by one of the two prime items (456 ms) than on trials in which the probe letter appeared at a previously unoccupied location (402 ms). Neither the main effect of Identity ($F < 1$) nor the Location x Identity interaction ($F = 2.82$) reached statistical significance.

With respect to the analysis of the error percentages in the localization task, only the main effect of Identity approached significance $F(1,23) = 3.08$, $MSE = 0.96$, $p < .10$, with participants making more errors when the identity was not repeated between prime and probe (0.7) than when identity was repeated between prime and probe (0.3). Neither the main effect of Location ($F < 1$) nor the Location x Identity interaction ($F = 2.51$) reached statistical significance.

Between Experiments Analyses

The between-experiments analyses comparing Experiments 6 and 7 were the same as the between-experiment analyses comparing Experiments 2 and 3. There were two critical predictions made for these analyses. First, a significant difference between the object-specific preview effects observed in the identification tasks of Experiments 6 and 7 was anticipated. Second, a significant difference in the location repetition effects in both the identification tasks and the localization tasks of Experiments 6 and 7 was expected.

Identification task. The results of the 2x2 mixed ANOVA examining the object-specific preview benefit across the identification tasks of Experiments 6 and 7 revealed a significant Experiment x Trial Type interaction, $F(1,46) = 5.58$, $MSE = 111.65$, $p < .025$. The 12 ms object-specific preview benefit observed in Experiment 6 was significantly different than the 1 ms object-specific preview benefit observed in Experiment 7. The analysis of the error percentages also revealed a significant Experiment x Trial Type interaction, $F(1,46) = 5.81$, $MSE = 5.11$, $p < .05$. The lower number of errors for Location + Identity repeated trials relative to Switched trials in Experiment 6 contrasts with the higher number of errors for Location + Identity repeated trials relative to Switched trials in Experiment 7.

The critical result of the 2x2x2 mixed ANOVA was the significant Experiment x Location interaction, $F(1,46) = 83.23$, $MSE = 177.71$, $p < .0001$, which indicated that the 9 ms benefit for repeated location trials observed in Experiment 6 was significantly different from the 24 ms cost for repeated location trials relative to non-repeated location trials in Experiment 7. There was also a significant Experiment x Identity interaction, $F(1,46) = 19.93$, $MSE = 70.92$, $p < .0001$. The 9 ms response benefit for repeated identity trials relative to non-repeated identity trials in Experiment 6 differed significantly from the 5 ms response cost for the repeated identity trials relative to the non-repeated identity trials in Experiment 7. Other significant effects of lesser importance are presented in Appendix D.

Localization task. The 2x2 mixed ANOVA showed that the Experiment x Trial Type interaction was not significant. This result indicates that the object-specific preview effects did not differ across the two localization tasks. The comparable analysis on the error data was not significant.

The critical result of the 2x2x2 mixed ANOVA was the significant Experiment x Location interaction, $F(1,46) = 59.76$, $MSE = 894.70$, $p < .0001$. This interaction indicates that the 12 ms advantage for repeated location trials in the localization task of Experiment 6 was significantly different than the 54 ms cost for repeated location trials observed in the localization task of Experiment 7. Other significant analyses of lesser importance are presented in Appendix D.

Discussion

It was hypothesized that reducing the proportion of repeated location trials such that a stimulus was more likely to appear at a novel location than a repeated location would bias response selection in favour of reliance on perceptual analysis rather than memory retrieval. Since the object-specific preview benefit is proposed to appear when integration of current and past processing episodes occurs, this effect should not have been apparent under the present conditions. This hypothesis was supported by the appearance of the object-specific preview benefit in the identification task of Experiment 6 and the elimination of this effect in the identification task of Experiment 7.

The second critical finding in the present experiments is that negative location repetition effects emerged in both the identification and localization tasks of Experiment 7. These results stand in sharp contrast to the repetition benefits for repeated locations found in these tasks in Experiment 6, which used the same procedure but a large proportion of location repeated trials. Furthermore, the significant Experiment x Location interactions from the between-experiment analysis of both the identification and localization tasks were also consistent with the proposal that different response selection strategies were adopted in the two experiments. Thus, there is strong evidence to suggest that this attentional manipulation served to bias response selection in favour of reliance on perceptual analysis rather than memory retrieval as in the previous experiment.

A final result of note was the significant response cost that emerged for repeated identity trials in the identification task. This finding contrasts with the significant repetition benefit observed for repeated identity trials in the identification task of Experiment 6. The between experiment comparison of the positive identity repetition effect in the identification task of Experiment 6 and the negative identity repetition effect in the identification task of Experiment 7 was also significant, once again providing converging evidence to suggest that different response selection strategies were adopted across experiments. However since the proportion of identity repetition trials was the same in Experiments 6 and 7, this result suggests that the influence that identity information had on priming effects was influenced by the changes on the location dimension. Although novelty in location may be of particular importance to the creation of a new processing episode, novelty on other dimensions may have also played a role as well under the present experimental conditions.

Once again, it could be argued that the appearance of the negative location repetition effect was the result of an expectancy held by the participant regarding the location of the probe target. However, given the limitations of this account discussed in Experiment 6, it appears that the attentional explanation forwarded in this thesis may be more capable of accommodating the full spectrum of priming effects in Experiments 6 and 7.

In summary, the experiments described in this chapter showed that manipulating the proportion of repeated location trials influenced the nature of the priming effects observed. It was shown that when the proportion of repeated location trials was increased, an object-specific preview benefit and positive location repetition effects were observed. By contrast, when the proportion of location repeated trials was decreased, the object-specific preview benefit was eliminated and negative location repetition effects were observed. The present results converge with the findings of the previous two chapters, in which a selection requirement was used to influence the response selection strategy adopted. Thus, the findings of the experiments in Chapters 2, 3 and 4 provide convincing evidence that attentional manipulations can alter the extent to which response selection is guided by memory retrieval and perceptual analysis.

CHAPTER 5

Inhibition of Return: Converging Evidence for the Importance of Novelty

In this thesis, it has been proposed that the relative contributions perceptual analysis and memory retrieval make to response selection is subject to attentional control. It has been suggested that under conditions in which response selection favours reliance on perceptual analysis of the probe target, the contribution that integration of current and past processing episodes makes to response selection is decreased. It has also been argued that under such conditions, interference from similiar prior processing episodes may delay the creation of a new processing episode for the probe target. As a result of this interference, new processing episodes may be established faster for novel stimuli than repeated stimuli. In particular, a new processing episode should be established faster for stimuli appearing at novel locations than repeated locations. The findings of negative location repetition effects under experimental conditions thought to promote reliance on perceptual analysis in both Chapters 3 and 4 provide critical support for this idea.

The proposal that there is a response advantage for stimuli at novel locations converges with research conducted on an empirical phenomenon called inhibition of return. In the typical inhibition of return task, one of two or more locations is cued by the appearance of a stimulus. Following a delay, a target stimulus appears either at the previously cued location or at a previously uncued location. Importantly, in these tasks, the location of the prime stimulus offers no predictive information regarding the location of the probe target. It has been widely reported in studies using inhibition of return tasks that slower responses occur to stimuli appearing at previously cued locations relative to previously uncued locations (e.g, Maylor, 1985; Maylor & Hockey, 1985; Posner & Cohen, 1984; Tipper, Driver & Weaver, 1991; Tipper, Weaver, Jerreat & Burak, 1994). This response benefit for novel locations has come to be known as the inhibition of return effect (Posner & Cohen, 1984).

It has been proposed that inhibitory processes underlie this effect. More specifically, it has been argued that the inhibition of return effect reflects the operation of inhibitory processes that prevent attention from returning to a previously attended location (Posner & Cohen, 1984). Note however, the inhibition of return findings are similar to the negative location repetition effects reported previously in this thesis. This raises the possibility that the.effects measured by both types of procedures reflect the same general underlying cause - the fast creation of a new processing episode for a stimulus appearing at a novel location. If this is the case, then negative location repetition effects should also occur when the general experimental procedure used in Chapter 3 is changed such that it is similiar to an inhibition of return task. Experiment 8 was conducted to address this issue.

Inhibition of return has been demonstrated in the letter localization tasks similiar to the task described below, but has yet to be demonstrated in analogous letter naming tasks.

Although it is possible to demonstrate inhibition of return in tasks requiring discrimination other than localization (e.g, Pratt, 1995), this effect has not always been observed in these tasks (e.g., Terry, Valdes & Neill, 1994). Therefore, it is of particular interest to determine if it is possible to observe response costs for repeated locations in both localization and identification tasks when the procedure used throughout this thesis is modified to be more like that of an inhibition of return task. If such costs are observed, then it may be possible to explain inhibition of return within the theoretical framework offered here - a framework that can also be used to explain object-specific preview benefits.

Experiment 8

The procedure of Experiment 8 was similiar to that used in the experiments of Chapters 3 and 4, except that one of four letters was presented at one of four locations in both the prime and probe. Presenting a single letter in both the prime and probe displays made the procedure similar to that used in inhibition of return experiments. Also in accordance with inhibition of return studies, the prime letter did not provide predictive information regarding either the identity or the location of the subsequent probe item. Therefore, the proportion of repeated location trials was .25 and the proportion of repeated identity trials was .25. As in the previous experiments described in this thesis, participants engaged in both an identification task and in a localization task. Given that under the present conditions, reliance on memory retrieval would be an inefficient response selection strategy, reliance on perceptual analysis should have been favoured. If the proposal that new processing episodes are created faster for stimuli at novel locations than repeated locations is correct, then negative location repetition effects should appear in both the identification and localization tasks of this experiment.

Method

Participants

Sixteen McMaster University undergraduates (11 females) participated in both the identification and localization tasks in exchange for introductory psychology course credit. All participants had normal colour vision and normal or corrected-to-normal visual acuity. Mean age of the participants was 20 years.

Apparatus and Stimuli

The apparatus and stimuli were the same as the experiments conducted in Chapters 3 and 4 with one exception. In this experiment a chin rest was used.

Design

Only a single item was presented in the prime task. As a result, there were no Switched trials in this experiment. Only Control, Location repeated, Identity repeated, and Location + Identity repeated trials were examined. The relationship between the probe target and preceding prime on these four types of trials was the same as that for the corresponding trial types in Experiment 5.

The identification and localization tasks of Experiment 8 each consisted of 432 trials. There were 5 blocks of 80 trials and 32 practice trials. Each block of 80 trials was further divided into 5 sub-blocks of 16 trials. Every sub-block of 16 trials consisted of 9

Control trials, 3 Location repeated trials, 3 Identity repeated trials and 1 Location + Identity repeated trial; this ensured that the prime display provided no predictive information regarding either the location or the identity of the probe item. Blocks were separated by 30 second rest breaks. Counterbalancing was in accord with the previous experiments.

General Procedure

The procedure used in Experiment 8 was the same as the preceding experiments with two exceptions. First, only a single item was presented in the prime display. Second, the probe target item remained on the screen for 157 ms rather than remaining on until response.

Results

Due to a programming error, 32 trials from each participant's data were eliminated from the analyses. The outlier elimination procedure resulted in the elimination of 1.0% of the RTs in the identification task and 3.4% of the RTs in the localization task. The mean correct RTs and error percentages for the identification and localization tasks are presented in Tables 14 and 15 respectively.

Identification task. The 2x2 repeated-measures ANOVA used previously was conducted on the mean correct RTs and error percentages for the identification task. The analysis of the RTs revealed a significant main effect of Location, $F(1,15) = 25.38$, $MSE = 235.91$, $p < .0005$. RTs for items presented at repeated locations (473 ms) were slower than RTs for probe items presented at non-repeated locations (454 ms). The Location x

Identity interaction was also significant, $F(1,15) = 4.79$, $MSE = 123.43$, $p < .05$. To further explain this interaction, simple effects analyses were conducted. The results of these simple effects analyses revealed that the 25 ms cost in RTs for repeated locations when identity was not repeated between prime and probe was significant, $F(1,15) = 89.70$, $MSE = 57.65$, $p < .0001$. Although smaller in magnitude, the 13 ms cost for repeated locations relative to non-repeated locations when identity was repeated between prime and probe was also shown to be significant, $F(1,15) = 4.67$, $MSE = 301.68$, $p < .05$. The main effect of Identity was not significant ($F < 1$).

Analyses conducted on the error percentages for the identification task showed that neither of the main effects nor the Location x Identity interaction reached statistical significance (all $Fs < 1$).

Localization task. The analysis of the mean correct RTs in the localization task revealed that participants responded more slowly to a probe letter presented at a repeated location (462 ms) than to a letter presented at a non-repeated location (409 ms), $F(1,15) = 50.00$, $MSE = 906.64$, $p < .0001$. Neither the main effect of Identity ($F = 1.30$) nor the Location x Identity interaction ($F < 1$) was significant.

An analysis of the error percentages revealed a significant main effect of Location, $F(1,15) = 9.14$, $MSE = 0.54$, $p < .01$, with more errors being made to items appearing in non-repeated locations (1.0) than to probe items presented at repeated locations (0.4). This pattern of error percentages is consistent with a speed-accuracy trade-off interpretation of the RTs, which does qualify the results of the localization task. The main effect of Identity approached significance, $F(1,15) = 3.13$, $MSE = 0.73$, $p < .10$, with more errors being committed on non-repeated identity trials (0.9) than repeated identity trials (0.5). The Location x Identity interaction was not significant ($F < 1$).

Discussion

As predicted, negative location repetition effects were found in both the identification and localization tasks under conditions similar to those used in inhibition of return studies. These results show that repetition costs like those reported in the inhibition of return literature can also be observed in the type of task used in this thesis. Importantly, the present results demonstrate that under these conditions, it is possible to find negative location repetition effects not only when participants report the location of the probe letter, but when they name the probe letter as well. These results converge with findings reported previously in this thesis and suggest that the theoretical framework used to account for the findings of the previous experiments may also be suitable for explaining findings of inhibition of return. More specifically, the response costs for repeated locations that appear in inhibition of return experiments may also reflect the faster creation of a new processing episode for stimuli appearing at novel locations than for stimuli appearing at repeated locations.

Another result of interest was that in the identification task, the inhibition of return effect was smaller when identity was repeated than when identity was not repeated between prime and probe. This pattern of results is consistent with findings from other inhibition of return experiments in which a smaller inhibition of return effect or no inhibition of return effect occurred when identity also matched between the two displays (Milliken, Tipper et al., 1999; Pratt & Abrams, 1999; Terry et al., 1994). To account for the appearance of such results, it has been suggested that repetition priming on a dimension other than location counteracts or masks the inhibition of return effect (Milliken, Tipper, Houghton & Lupianez, 1999; Pratt & Abrams, 1999; Terry et al, 1994). Thus, it may be the case that participants were attempting to perceptually analyze the current stimuli and create a new processing episode for every probe target, but on a few of the trials integration occurred for a probe stimulus that shared both location and identity with the preceding prime. Given that integration is more likely to occur for an identical repetition, this may account for the reduction in response costs for repeated locations when identity is also repeated (see Milliken, Tipper et al., 1999, and Terry et al., 1994 for a similar discussion). This would explain why inhibition of return is not always observed in tasks requiring discrimination other than localization.

Although the data of the localization task could not be interpreted as a result of a significant speed-accuracy trade-off, the findings of the identification task are highly consistent with the proposal that the creation of a new processing episode is more efficient for stimuli appearing at novel locations than at repeated locations. Also, since the present findings are consistent with findings reported previously in the inhibition of return literature, it suggests that the negative location repetition effects observed in this thesis, and in the inhibition of return literature, may all reflect the fast creation of a new processing episode for novel stimuli.

CHAPTER 6

General Discussion

Many of the objects in our environment have been encountered previously and are familiar to us. As a result, retrieval of a particular prior event often results in efficient responses to a current event. However, memory for a prior event can also serve as a source of interference in responding. In Chapter 1, I suggested that a child who has just recently seen the word 'CAT' may incorrectly respond "cat" to the word 'CAP', presumably because the word 'CAP' triggers the retrieval of similar prior events. This example illustrates that while memory retrieval may lead to efficient response selection in many cases, the influence of memory retrieval on current response selection must be monitored for its appropriateness. Intuitively, one might suggest that it is possible to avoid making such an error by 'paying attention' to the current task. Thus, the role that attention plays in modulating the contribution of memory retrieval to response selection was the central focus of this thesis.

The priming method is a tool used extensively in experimental psychology to investigate how a current response to a stimulus is influenced by prior experience with a related stimulus. There is mounting evidence to suggest that memory retrieval processes contribute to priming effects (e.g., Jacoby, 1983b; Kahneman et al., 1992). The results of Neill and Kahan (1999; Experiment 1a) and Experiment 1 of this thesis are consistent with the idea that retrieval processes play a role in priming, but are inconsistent with a single-process memory retrieval account of priming effects. Rather, the finding of slower responses to repeated stimuli for probe trials that involved selection and faster responses to repeated stimuli for probe trials that did not involve selection implicates dual processes in determining priming effects. Also, because the two types of probe trials differed in their attentional requirements, these results suggest that attentional processes during the second of two processing events play an important role in modulating the relative contributions of these two processes to response selection.

In this thesis, an explanation of priming effects based on a dual-process framework of Kahneman, Treisman and Gibbs (1992) was forwarded. Kahneman et al. proposed that if there is spatiotemporal correspondence between a current and a past stimulus, the two events are integrated, whereas if there is a spatiotemporal mismatch between the two stimuli, a new processing episode is created for the current stimulus. Consistent with this hypothesis is the idea that both memory retrieval and analytic perceptual processing play a role in response selection. However, it is proposed that whether retrieval or perceptual analysis serves as the basis for response selection is not simply contingent on the physical match between the stimuli, but rather depends on an attentional component.

To address this issue, two different attentional manipulations were used in a series of experiments similar to those of Kahneman et al. (1992). More specifically, in an attempt to determine how priming effects were influenced by changes in attentional requirements of a task, either the presence of a probe distractor or the proportion of repeated trials was manipulated across experiments. It was hypothesized that including a distractor in the probe task or reducing the proportion of repeated trials biases response selection in favour of reliance on perceptual analysis, thereby reducing the contribution of memory retrieval to response selection. As a result, these attentional manipulations were proposed to have two empirical consequences. First, since there should be a decreased contribution of memory retrieval to performance, the object-specific preview benefit should be eliminated. Second, it was posited that under these conditions, similar prior processing episodes may actually interfere with the creation of a new processing episode for the current stimulus; this would translate into faster responses for non-repeated stimuli relative to repeated stimuli. The experiments reported in Chapters 3, 4 and 5 were highly consistent with these predictions. Recall that the object-specific preview benefit in Experiment 2 was eliminated when a distractor was added to the probe task in Experiments 3 and 4, and repetition costs for repeated stimuli were observed under these conditions. Similarly, the object-specific preview advantage observed when there was a high proportion of repeated location trials in Experiment 6 was eliminated when the proportion of repeated trials was then reduced below chance levels of responding in Experiment 7. Repetition costs rather than benefits were also observed for repeated stimuli when the proportion of repeated trials was low (Experiments 7 and 8). These results, together with the findings of Experiment 1, provide critical support for the contention that attention modulates the contribution of memory retrieval and perceptual analysis to response selection.

Although the present experiments suggest that attentional manipulations modulate the contribution that memory retrieval makes to response selection, the processes that perform this modulatory function have yet to be discussed in detail. It was suggested that 'paying attention' to the word 'CAP' may somehow prevent the child from mistakenly responding "cat" to the word 'CAP'. Attending to the features of the current word 'CAP' may facilitate the creation of a specific perceptual representation or episode for that stimulus and differentiates it from similar prior experiences. If attending to the current stimulus helps to create a highly specific processing event for the word 'CAP', integration of the current stimulus with a similar prior episode that was retrieved upon the onset of the word may be prevented, as differences between the current stimulus and the prior episode may be readily detected. For example, the child may detect that there is a difference between the 'P' and 'T' and know that the current stimulus is different than the retrieved processing episode. As a consequence, response selection is based on analytic processing rather than a retrieved response. By contrast, if the child is not 'paying attention' to the current task, the specificity of the episode may not be sufficient to indicate that the two processing events are different and response selection may be determined by memory retrieval. In other words, she may fail to notice the differences that exist between 'CAP' and 'CAT', and rely mistakenly on a retrieved response.

Similar logic may be used to explain how priming effects were influenced by the attentional manipulations used in this thesis. When the proportion of repeated location trials was reduced as in Experiment 7, the probe target was much more likely to be a novel stimulus than a repeated stimulus. Since relying on a past response would be an inefficient response selection strategy, observers may have adopted a response selection strategy that favoured perceptual analysis of the current probe target. Attending to the features of the probe target may have helped to establish a highly specific processing episode for the probe target that could be distinguished from similar processing episodes in memory. Consequently, integration of the current stimulus with a prior processing episode may have been prevented. In fact, under these conditions similarity between the current and past stimuli may have served as a source of interference in the creation of a processing episode for the current stimulus that was distinct from prior episodes. This would explain the elimination of the object-specific preview benefit and the appearance of repetition costs for repeated stimuli relative to novel stimuli when the proportion of repeated location trials was below chance. This could also explain the repetition costs observed in Experiment 8 when the proportion of repeated trials was at chance but the likelihood of a repetition was low. Thus, in both the CAT-CAP example and in the case of a low proportion of repeated trials, observers attend to the features of the current stimulus to make sure that their response is determined by the current perceptual stimulus rather than a memory-based inference about how to respond to that stimulus. In this way, attention ensures that their response is based on the appropriate source - the current perceptual stimulus.

It may seem intuitively obvious why observers would want to rely on perceptual analysis rather than memory retrieval in response selection when the proportion of repeated trials is low. However, the inclusion of a probe distractor also appeared to reduce the contribution that reliance on memory retrieval made to response selection, even though the proportion of repeated trials was at (Experiments 3, 4, and 5) or above chance (Experiment 1). When a selection requirement is introduced into the probe task, the probe target must be distinguished from the probe distractor. Thus, I propose that in the experiments involving a selection requirement participants were once again confronted with the problem of source discrimination. To resolve this source problem, observers may have attended to the features of the probe target which would create a highly specific representation of the target and facilitate its differentiation from the distractor. However, the highly specific processing episode created for the probe target may have also distinguished it from other sources of information, including the prior episode. As a result, this approach may also have prevented the integration of the probe target with prior processing episodes. Further, since response selection favours analytic processing of the current target, similarity between the prime and probe would be a source of interference. This would account for the elimination of the object-specific preview benefit and the appearance of response costs for repeated stimuli in the experiments involving a selective attention manipulation.

By this logic, reducing the proportion of repeated trials or adding a selection requirement to the probe task appear to promote reliance on perceptual analysis in response selection. Attending to the features of a current stimulus may establish a highly specific representation for that stimulus which may be distinguished from other prior processing episodes in memory and thus, decrease the likelihood that memory retrieval will serve as a basis for response selection. In particular, it appears that attention to the probe task plays an important part in ensuring that response is based on the appropriate source of information. Thus, attentional processes may serve a discriminative function in the response selection process.

Localization versus Identification: Different Features May Be Important in Different Tasks

In the discussion above, it was suggested that attention to features of the probe target may be critical in establishing a new processing episode for that stimulus. However, there was evidence in this thesis to suggest that the features considered to be important to response may depend upon the nature of the task. For example, in the identification tasks used in Chapters 3, 4 and 5, letters were presented at different locations on the screen and participants were to respond to the identity of the probe target. In this type of task, both location and identity information were important to successful response selection, as the target must be located in space and identified. However, in the comparable localization tasks, participants could respond successfully without knowledge of the letter identity at the location of the probe target. Thus, identity information may not have been critical to the localization task. Differences in the features required for successful responding may underlie the differences observed between localization and identification tasks in this thesis. More specifically, this may explain why object-specific preview benefits and both positive and negative identity repetition effects were observed in identification tasks but not in the comparable localization tasks. Attention to certain features may be more important than others in the response selection process depending upon the task and is therefore an important consideration when attempting to understand priming effects.

Note however, that it should be possible to produce an object-specific preview benefit and find identity repetition effects within the context of a localization task, if that task is changed to make identity information important to a successful localization response. For example, if an observer is required to respond to the location at which a particular letter appears, then identity information is also relevant to the localization task and identity-based effects may emerge. In fact, there is evidence in the priming literature to suggest that when identity information is made relevant to a localization response, a match or mismatch in identity between prime and probe may also influence the speed of responding (e.g., Park & Kanwisher, 1994; Tipper et al., 1992). Thus, object-specific preview benefits may have failed to emerge in the localization tasks used in this thesis because identity information was irrelevant in these tasks, not because it is impossible to demonstrate such an effect in a localization task.

Implications for Accounts of Response Costs in the Priming Literature

It was demonstrated repeatedly in the present experiments that slower responses occurred to repeated stimuli. These repetition costs occurred under conditions in which response selection was thought to favour reliance on perceptual analysis. Further, it was suggested that these response costs occurred under these conditions because of interference in the creation of a new processing episode for a current target stimulus that results from similarity between current and past stimuli. In the priming literature, a number of different phenomena have been reported in which slower responses occur to repeated stimuli. Negative priming (e.g., Neill, 1977; Tipper, 1985) and inhibition of return (e.g., Posner & Cohen, 1984; Tipper et al., 1992) are just two of the phenomena in which slower responses have been shown to occur for repeated stimuli relative to novel stimuli in priming tasks. However, the explanations forwarded to account for these effects have been quite different than that offered in this thesis.

One way in which the appearance of these effects has been explained has been to attribute these costs to the operation of inhibitory processes that occur prior to the onset of the probe display (e.g., Allport et al., 1985; Neill, 1977; Tipper, 1985). Slower responses to repeated probe stimuli are linked to lingering inhibition. Despite the underlying similarity of the outcomes (i.e., slower responses to repeated stimuli), these repetition costs have been attributed to different inhibitory processes. The reason underlying this distinction has been related to presumed processing differences prior to the onset of the probe stimulus - logic that is consistent with the idea that priming effects are determined prior to the onset of the probe display. For example, because the repetition cost observed in studies of inhibition of return occurs for previously attended stimuli, whereas the repetition cost observed in studies of negative priming occurs for previously ignored stimuli, these two phenomena have been widely considered to be determined differently (but see Milliken, Tipper et al., 1999; Neill & Mathis, 1998). Although inhibition is thought to act prior to the onset of the probe stimulus in both cases, given the differences that exist with respect to how the prime stimulus was processed, it is presumed that the locus of inhibition varies for these different effects.

Recall however, that priming effects have been shown to depend on the nature of probe events, both in this thesis (Experiment 1) and in the priming literature (e.g., Lowe, 1979; Moore, 1994; Neill et al., 1992; Neill & Kahan, 1999). Such findings present a challenge to lingering activation accounts of priming effects and suggest that inhibitory processes operating prior to the onset of the probe task are not solely responsible for the occurrence of repetition costs in priming tasks. Rather, it appears that a retrieval-based explanation of priming effects may be better suited for explaining the full spectrum of priming effects.

The idea that retrieval processes play an important role in priming effects is central to the account forwarded in this thesis, as it is attentional control over retrieval that is presumed to be critical to the appearance of repetition costs. However, the present theoretical view differs from other retrieval-based accounts of priming that have been forwarded in the priming literature. As mentioned previously, Neill and colleagues (Neill, 1997; Neill et al., 1992) have proposed a retrieval-based account in which response costs to repeated stimuli occur as a result of the retrieval of an inappropriate prior processing episode. Building on the logic of Logan's (1988) instance theory of automaticity, it is proposed that automatic retrieval processes and more controlled analytic processes race against each other in an attempt to serve as the basis for response. Repetition costs in responding are thought to occur when memory retrieval wins the race to response. They proposed that a mismatch in attentional requirements between current and retrieved processing episodes underlies the appearance of repetition costs.

More recently, Neill and Mathis (1998) have forwarded a modified version of this account in which they suggest that if the processing associated with a retrieved episode conflicts in some way with the processing required for the current stimulus, the time required to resolve the conflict translates into slower times for repeated stimuli relative to non-repeated stimuli. They argue that by focusing on incompatible processing between prime and probe rather than simply incompatible attentional requirements, this retrieval-based account may be used to explain a number of different phenomena in which response costs to repeated stimuli have been reported. Unlike inhibitory accounts of priming effects, it may be possible to attribute findings of repetition costs to the same underlying processes by this account because priming effects are not thought to be solely determined prior to the onset of the probe task.

Neill and Mathis' (1998) proposal that negative priming, inhibition of return and other phenomena in which repetition costs have been reported reflect the same underlying processes is consistent with the approach outlined previously in this thesis. Also, the idea that interference between current and past stimuli leads to repetition costs is consistent with the account forwarded in this thesis. Despite the similarities between the two accounts, however, these two explanations differ in a fundamental way. As discussed above, Neill and colleagues (Neill, 1997; Neill & Mathis, 1998; Neill et al., 1992) propose that repetition costs occur when memory retrieval guides response selection; it wins the race to response. Thus, response costs emerge under conditions in which there is a decreased contribution of controlled processing to response selection. By contrast, the account I have described posits that repetition costs occur under conditions in which controlled processing makes a *greater* contribution to response selection. The elimination of the object-specific preview benefit and the appearance of repetition costs in responding are thought to occur under conditions in which attention serves to decrease the contribution of memory retrieval to response selection. Although the findings of the present experiments fit nicely with the account forwarded in this thesis, further experimentation is needed. In particular, experiments in which the predictions made by the two accounts are placed into opposition will be critical in establishing which of these two retrieval-based explanations offers the more comprehensive account of the priming data.

Populations with Cognitive Deficits

The idea that attentional control over response selection plays an important part in priming effects may also have important implications for the study of populations with cognitive deficits. As discussed above, findings of slower responses to repeated stimuli have been demonstrated both within the context of this thesis, and in the priming literature. However, it has been shown in a variety of priming tasks that groups typically associated with control deficits such as schizophrenics (Beech, Powell, McWilliams & Claridge, 1989), young adults with high scores on the cognitive failures task (Tipper & Baylis, 1987; but see Kane et al., 1994), and developmental populations such as the elderly (Hasher, Stoltzfus, Zacks & Rypma, 1991; Kane, Hasher, Stoltzfus, Zacks & Connelly, 1994) and children (Tipper, Bourque, Anderson & Brehaut, 1989) often fail to show repetition costs or show smaller repetition costs in priming tasks compared to young adult participants without cognitive deficits. Because the cognitive deficits in these populations are commonly associated with deficits in controlled rather than automatic processes (e.g., Jacoby, Jennings & Hay, 1996), such findings provide support for the claim that the appearance of repetition costs in priming tasks are related to control over response selection.

One explanation for the failure to observe repetition costs in groups with cognitive deficits is that these individuals have deficient inhibitory processes. As discussed previously, priming effects may be explained by reference to lingering activation or inhibition of abstract internal representations of stimuli. Recall that by this logic, a response benefit for a repeated probe stimulus occurs as a result of lingering activation of the internal representation of that stimulus that arises from its prior presentation in the prime display. However, in some situations, inhibitory processes may act to suppress the activation of level of the internal representation of a stimulus below baseline. Thus, a response cost for a repeated probe stimulus occurs as a result of lingering inhibition associated with the internal representation of that stimulus that being suppressed below baseline at the time of the prime. It has been suggested that populations with cognitive deficits such as the elderly, fail to adequately suppress irrelevant information during the initial encounter with a stimulus (e.g., Hasher, et al., 1991; Kane, et al., 1994; Tipper & Baylis, 1987; Tipper et al., 1989). Since the abstract representation of the distracting stimulus is not effectively inhibited at the time of the prime, because of deficient inhibitory processes, repetition costs are not observed for these individuals.

However, findings in both the priming literature (e.g., Lowe, 1979; Neill et al., 1992) and in this thesis suggest that inhibition of abstract representations during the initial encounter with a stimulus, alone may not be the most appropriate explanation of the repetition costs observed in priming tasks. One alternative explanation is that deficits in inhibitory control at the time of retrieval may impair individuals' ability to suppress irrelevant memories and prevent them contributing to response selection (e.g., Hasher et al., 1991). Therefore, individuals with cognitive deficits may not inhibit prior experiences from guiding current responding as effectively as those without such deficits. Consequently, memory retrieval may contribute to response selection to a greater extent in these individuals compared to those without such cognitive deficits under the same conditions, and individuals with cognitive deficits may perseverate with a past response. As a result, repetition costs may not occur in priming tasks for groups with cognitive deficits. In this way, inhibitory deficits at the time of retrieval would underlie the failure to observe repetition costs in individuals with cognitive deficits.

Recall however, that an alternative explanation of control over response selection was forwarded in this thesis. It was posited that response selection could be based either on perceptual analysis or on memory retrieval. Further, attention during the second of two processing events was proposed to play an important part in modulating the contribution of these two processes to response selection. Under conditions in which reliance on memory retrieval is favoured, current and past processing episodes are integrated. However, in some situations individuals may have to ensure that their response is based on perceptual information associated with the current stimulus, irrespective of whether it matches or mismatches with a past stimulus. Under these conditions, it is imperative that they base their response on the appropriate source - the current perceptual stimulus. In contrast to situations in which memory retrieval serves as the basis for response selection, when reliance on perceptual analysis is favoured in response selection, discriminating between different sources of response information is critical. As discussed previously, repetition costs occur under conditions favouring reliance on perceptual analysis - conditions in which source discrimination is important.

There is evidence in the memory literature to suggest that populations such as elderly adults do not monitor source as effectively as young adults without cognitive deficits, and that they make more errors in ascribing source (e.g., Dywan & Jacoby, 1990; Henkle, Johnson & De Leonardis, 1998). Thus, individuals with cognitive deficits may fail to distinguish between sources as effectively as those without such deficits. As a result, individuals with cognitive deficits may integrate current and past processing episodes under the same conditions in which those without such deficits would differentiate current and past processing episodes. Since memory retrieval may serve as the basis for response selection to a greater extent in these individuals as a result of their inability to monitor source effectively, they may fail to show repetition costs under the same conditions in which those without cognitive deficits do show repetition costs. Thus, ineffective monitoring of source rather than deficient inhibitory processes could explain the failure to observe repetition costs in groups with cognitive deficits.

It is apparent from the discussion above that investigating response selection in populations with cognitive deficits may provide important insights into how control over response selection is achieved. Thus, an important next step in this research may be to extend this work to populations with cognitive deficits.

Conclusions

Retrieval of a particular prior event from memory often serves as an efficient way in which to determine a response to a current event. However, because a past response may not always be appropriate for a current situation, it must also be possible to modulate the contribution that memory retrieval makes to response selection. In this thesis, it was proposed that attention may serve to modulate the contribution that memory retrieval and analytic perceptual processes make to performance.

Attention was manipulated within the same priming experiment and across priming experiments in this thesis to determine if changing the nature of attentional processing also changed the nature of the priming effects observed. Object-specific preview benefits and response benefits for repeated stimuli relative to novel stimuli were observed under some circumstances, whereas object-specific preview benefits were eliminated and response costs for repeated stimuli relative to novel stimuli were observed when the attentional requirements of the task were changed to presumably promote reliance on perceptual analysis. These findings offer important empirical support for the contention that attention during the second of two processing events plays a critical role in modulating the contributions of memory retrieval and perceptual analysis to response selection.

It was proposed in this thesis that when response must be determined on the basis of current perceptual information, attention to the features of a current stimulus may be vital in creating a distinct processing episode that can be distinguished from similar processing episodes in memory. This idea that attention during the probe task prevents the integration of current and past events not only accounts for the results reported in this thesis, but also accommodates findings reported previously in the priming literature. Thus, the work in this thesis provides important initial evidence to suggest that attentional control at the time of retrieval may play a critical role in modulating behaviour.

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Appendix A

The 24 words used in Experiment 1. Six sets of four words each were presented and the words are presented in their respective sets.

Set 1

BEARD

CLOCK

FLUTE

PRIDE

Set 2

STAMP

GLASS

FLAME

PAINT

Set 3

PRIZE

CROWN

DREAM

TABLE

Set 4

PLANT

GRAPH

BAKER

CHARM

Set 5

TRUNK

CLERK

GHOST

BRACE

Set 6

GIANT

FLOUR

STOVE

PILOT

Appendix B

The additional significant results of the between-experiment analysis for the identification tasks of Experiments 2 and 3, were as follows. First, there was a significant Experiment x Identity x Location interaction, $F(1,30) = 6.57$, $MSE = 40.95$, $p < .05$. There was also an Experiment x Identity interaction, $F(1,30) = 12.21$, $MSE = 60.97$, $p < .005$. This indicated that the 1 ms benefit for repeated identity in Experiment 2 was different than the 8 ms cost on repeated identity trials in Experiment 3.

There was a main effect of Experiment, $F(1,30) = 21.88$, $MSE = 7479.73$, $p < .0001$, with the overall response times being faster in Experiment 2 (432 ms) than in Experiment 3 (504 ms). There was also a significant main effect of Identity, $F(1,30) = 4.49$, $MSE = 60.97$, $p < .05$, with response times being slower on repeated identity trials (470 ms) than on non-repeated identity trials (467 ms). Finally, there was a main effect of Location, $F(1,30) = 20.30$, $MSE = 287.32$, $p < .0001$. Response times were slower overall on repeated location trials (475 ms) than on non-repeated location trials (461 ms).

There was only one significant effect in the error analysis. There was a significant Identity x Location interaction, $F(1,30) = 9.83$, $MSE = 1.70$, $p < .005$. The greater number of errors committed on repeated location trials relative to non-repeated location trials when identity was not repeated between prime and probe was different from the fewer number of errors committed on repeated location trials relative to non-repeated location trials when identity was repeated.

Appendix C

Every sub-block of 16 trials in Experiment 5 consisted of 4 Control trials, 2 Location- repeated trials, 2 Identity-repeated trials, 1 Location + Identity repeated trial, 2 Control/Location repeated Distractor trials, 2 Control/Identity repeated Distractor trials, 1 Control/ Location + Identity repeated Distractor trial, 1 Location repeated/Identity repeated Distractor trial and 1 Identity repeated/Location repeated Distractor trial. A description of each trial type is presented below. The RTs and error percentages are presented in the second table of Appendix C.

Trial Type	Relation of Probe Target to Prime	Relation of Probe Distractor to Prime
1) Control	no relation	no relation
2) Location-repeated	location repeated	no relation
3) Identity-repeated	identity repeated	no relation
4) Location + Identity-repeated	location + identity repeated	no relation
5) Ctrl/ Location-rep. Distractor	no relation	location repeated
6) Ctrl/ Identity-rep. Distractor	no relation	identity repeated
7) Ctrl/ Location + Identity- rep. Distractor	no relation	location + identity repeated
8) Location-rep./ Identity- rep. Distractor	location repeated	identity repeated
9) Identity rep./ Location-rep. Distractor	identity repeated	location repeated

Appendix C

Trial Type	Identification Task RT (%error)	Localization Task RT (%error)
1) Control	473 (2.1)	461 (0.2)
2) Location repeated	495 (3.3)	491 (0.0)
3) Identity repeated	477 (2.5)	461 (0.6)
4) Location + Identity repeated	505 (4.1)	490 (0.0)
5) Ctrl/ Location rep. Distractor	458 (1.1)	463 (0.0)
6) Ctrl/ Identity rep. Distractor	465 (1.7)	462 (0.5)
7) Ctrl/ Location + Identity rep. Distractor	453 (0.3)	456 (0.0)
8) Location-rep./ Identity rep. Distractor	487 (1.6)	495 (0.0)
9) Identity rep./ Location rep. Distractor	470 (1.9)	465 (0.0)

Appendix C

Analyses of Repeated Distractor Trials

Identification task. To assess the effects of redundancy in distractor information, a one-way ANOVA examining non-repeated distractor and repeated distractor trials was conducted. The non-repeated distractor condition collapsed across Control, Location repeated and Identity repeated trials. The repeated distractor condition collapsed across the Control-Location repeated Distractor, Control-Identity repeated Distractor, Control-Location + Identity repeated Distractor, Location repeated-Identity repeated Distractor and Identity repeated-Location repeated Distractor trials. The Location + Identity repeated condition was not included in the analysis as it did not have a comparable repeated distractor condition. The one-way ANOVA comparing the RTs of the non-repeated distractor and repeated distractor trials was significant, $F(1,15) = 17.09$, $MSE = 100.364$, $p < .005$. RTs were significantly faster on repeated distractor trials (467 ms) than on non-repeated distractor trials (482 ms). The comparable error analysis was also significant, $F(1,15) = 9.17$, $MSE = 1.585$, $p < .01$. Fewer errors were committed on repeated distractor trials (1.3%) than on non-repeated distractor trials (2.6%).

It is interesting to note that findings of faster response times to probe targets if an attribute or attributes of the distractor were shared with the preceding prime stimulus has been demonstrated in a number of studies reported previously in the priming literature (Allport et al., 1985; Tipper, 1985, Terry et al., 1994). Therefore, such results are consistent with findings reported previously in the priming literature.

Localization task. The same one-way analysis was conducted on the RTs of the localization task but the analysis was not significant. Given the fact that no errors were committed on many of the different types of trials, a sign test was conducted on the data. There was no significant difference between non-repeated distractor trials and repeated distractor trials with respect to errors.

Appendix D

The additional significant results of the between experiments analysis are listed below.

Identification Task. There was a significant main effect of Trial Type in the analysis of the object-specific preview effect, $F(1,46) = 10.11$, $MSE = 111.65$, $p < .005$, indicating that responses were faster overall for Location + Identity repeated trials (430ms) relative to Switched trials (436ms). In the 2x2 repeated measures ANOVA there was a significant main effect of Experiment, $F(1,46) = 4.90$, $MSE = 7589.42$, $p < .05$, as participants RTs were faster overall in Experiment 7 (413ms) than in Experiment 6 (440 ms). There was also a significant main effect of Location, $F(1,46) = 12.42$, $MSE = 177.71$, $p < .001$, as participants were faster to non-repeated location trials (423ms) than repeated location trials (429ms). In the error analysis there was a main effect of Experiment, $F(1,46) = 8.61$, $MSE = 7.29$, $p < .01$, with participants making a greater percentage of errors in Experiment 6 than in Experiment 7. There was also a main effect of Identity, $F(1,46) = 6.17$, $MSE = 3.12$, $p < .05$, with more errors being made in on repeated identity trials than non-repeated identity trials. Finally, the main effect of Location also approached significance in the error analysis, $F(1,46) = 3.91$, $MSE = 3.32$, $p < .06$, with more errors being made on non-repeated location trials relative to repeated location trials.

Localization Task. There was a significant main effect of Experiment, $F(1,46) = 4.19$, $MSE = 12372.08$, $p < .05$, with participants showing faster overall RTs in

Experiment 6 (396ms) than Experiment 7 (429 ms). There was also a main effect of Location, $F(1,46) = 23.17$, $MSE = 894.70$, $p < .0001$. RTs were slower on repeated location trials (423ms) than on non-repeated location trials (402ms). Also, the three-way interaction approached significance, $F(1,46) = 3.13$, $MSE = 317.07$, $p < .09$.

Footnotes

Note 1. The procedure used by Kahneman et al. (1992) used 8 locations instead of 4 as portrayed in Figure 1. However, because subsequent experiments in this thesis used a procedure similar to that of Kahneman et al. but only 4 locations, the three trial types were represented using a 4 location array.

Note 2. There was no effect of Probe Target Colour when it was entered into the statistical analysis so the results were collapsed across this factor.

Note 3. Due to a programming error, one of the combinations was not included in the non-repeated no-selection trials for the red probe target condition. However, the results of Experiment 1 have been replicated recently by different experimenters using the same program but with all of the combinations included.

Note 4. A t-test is often used to examine a pair of means. However, since $F = t^2$, the values obtained using either analysis are equivalent. Thus, a one-way ANOVA was selected as it was consistent with the other analyses conducted.

Note 5. Two participants each committed a single error in the localization task. The other 14 participants did not commit any errors in this task.

Note 6. It is possible that changing the task such that the distractor could share identity, location or both with the preceding prime may have induced participants to adopt a different, perhaps more conservative, strategy than in the preceding experiments. However, the pattern of results of this experiment are strikingly similar to those of the previous experiments in which the distractor did not share any relation to the preceding prime.

Note 7. The number of practice trials was increased from 16 to 32 because of the changed composition of trials in this experiment. In the previous experiments, participants saw a minimum of 2 examples of each trial type in the practice session. However, in Experiment 5 many of the trial types only occurred once every 16 trials. Thus, to ensure that participants had sufficient exposure to the different trial types, the number of experimental trials was increased in Experiment 5. As a result of the simplicity of the task, participants were performing quickly and accurately after only a few trials; thus, the extra trials were not thought to provide an additional performance advantage relative to other experiments.

Note 8. The direction of the error percentages was consistent with that of a speed-accuracy trade-off. However, given the findings of Experiment 4 in which a similiar pattern of results occurred without a significant speed-accuracy trade-off being present in the data, this result was not considered to be a serious compromise to the results of Experiment 5.

Note 9. Thirty-two practice trials were used in Experiment 7 for the same reason as Experiment 5.

Table 1. Mean correct RTs in milliseconds and error percentages for the four trial types used in Experiment 1. Standard errors of the priming effects (N-R) are presented in parentheses.

		Probe Selection Requirement	
Identity		No-selection	Selection
Non-repeated	RT	552	611
	% Error	0.6	1.3
Repeated	RT	523	628
	% Error	0.0	3.1
Priming Effect (N - R)	RT	**29** (5.9)	**- 17** (7.1)
	% Error	**0.6** (0.2)	**-1.8** (0.8)

Table 2a. Mean correct RTs in milliseconds and error percentages for the Switched and Location + Identity Repeated trials of the identification task of Experiment 2. Standard error of the Object-specific preview effect are presented in parentheses.

	Trial Type		
	Switched	Location + Identity Repeated	**Object-Specific Preview Effect**
RT	442	430	**12** (4.2)
% Error	2.2	0.9	**1.3** (0.8)

Table 2b. Mean correct RTs in milliseconds and error percentages for the four trial types included in the 2x2 ANOVA for the identification task of Experiment 2. Standard errors of the priming effects (N-R) are presented in parentheses.

		Identity		
Location		Non-repeated	Repeated	**N - R**
Non-repeated	RT	431	433	**-2** (2.1)
	% Error	0.7	1.4	**-0.7** (0.5)
Repeated	RT	436	430	**6** (2.9)
	% Error	1.2	0.9	**0.3** (0.4)
N - R	RT	**-5** (2.2)	**3** (3.1)	
	% Error	**-0.5** (0.3)	**0.5** (0.5)	

Table 3a. Mean correct RTs in milliseconds and error percentages for the Switched and Location + Identity Repeated trials of the localization task of Experiment 2. Standard error of the Object-specific preview effect are presented in parentheses.

	Trial Type		
	Switched	Location + Identity Repeated	**Object-Specific Preview Effect**
RT	429	440	**-11** (8.7)
% Error	0.3	0.2	**0.1** (0.3)

Table 3b. Mean correct RTs in milliseconds and error percentages for the four trial types included in the 2x2 ANOVA for the localization task of Experiment 2. Standard errors of the priming effects (N-R) are presented in parentheses.

		Identity		
Location		Non-repeated	Repeated	**N - R**
Non-repeated	RT	421	423	**-2** (1.8)
	% Error	0.2	0.2	**-0.0** (0.2)
Repeated	RT	438	440	**-2** (6.3)
	% Error	0.2	0.2	**0.0** (0.1)
N - R	RT	**-17** (6.8)	**-17** (9.6)	
	% Error	**0.0** (0.1)	**0.0** (0.2)	

Table 4a. Mean correct RTs in milliseconds and error percentages for the Switched and Location + Identity Repeated trials of the identification task of Experiment 3. Standard error of the Object-specific preview effect are presented in parentheses.

	Trial Type		
	Switched	Location + Identity Repeated	**Object-Specific Preview Effect**
RT	519	522	**-3** (3.6)
% Error	1.1	1.1	**0.0** (0.6)

Table 4b. Mean correct RTs in milliseconds and error percentages for the four trial types included in the 2x2 ANOVA for the identification task of Experiment 3. Standard errors of the priming effects (N-R) are presented in parentheses.

		Identity		
Location		Non-repeated	Repeated	**N - R**
Non-repeated	RT	487	493	**-6** (2.1)
	% Error	0.7	1.2	**-0.5** (0.4)
Repeated	RT	513	522	**-9** (2.9)
	% Error	2.6	1.1	**1.5** (0.4)
N - R	RT	**-26** (5.2)	**-29** (6.3)	
	% Error	**-1.9** (0.5)	**0.1** (0.6)	

Table 5a. Mean correct RTs in milliseconds and error percentages for the Switched and Location + Identity Repeated trials of the localization task of Experiment 3. Standard error of the Object-specific preview effect are presented in parentheses.

	Trial Type		
	Switched	Location + Identity Repeated	**Object-Specific Preview Effect**
RT	461	459	**2** (4.9)
% Error	0.0	0.0	**0.0** (0.0)

Table 5b. Mean correct RTs in milliseconds and error percentages for the four trial types included in the 2x2 ANOVA for the localization task of Experiment 3. Standard errors of the priming effects (N-R) are presented in parentheses.

		Identity		
Location		Non-repeated	Repeated	**N - R**
Non-repeated	RT	440	438	**2** (2.8)
	% Error	0.1	0.0	**0.1** (0.8)
Repeated	RT	460	459	**1** (3.6)
	% Error	0.1	0.0	**0.1** (0.8)
N - R	RT	**-20** (4.9)	**-21** (4.0)	
	% Error	**0.0** (0.1)	**0.0** (0.0)	

Table 6a. Mean correct RTs in milliseconds and error percentages for the Switched and Location + Identity Repeated trials of the identification task of Experiment 4. Standard error of the Object-specific preview effect are presented in parentheses.

	Trial Type		
	Switched	Location + Identity Repeated	**Object-Specific Preview Effect**
RT	513	513	**0** (4.4)
% Error	1.3	2.0	**- 0.7** (0.8)

Table 6b. Mean correct RTs in milliseconds and error percentages for the four trial types included in the 2x2 ANOVA for the identification task of Experiment 4. Standard errors of the priming effects (N-R) are presented in parentheses.

		Identity		
Location		Non-repeated	Repeated	**N - R**
Non-repeated	RT	489	492	**-3** (3.6)
	% Error	0.9	1.0	**-0.1** (0.3)
Repeated	RT	510	513	**-3** (3.3)
	% Error	1.9	2.0	**-0.1** (0.6)
N - R	RT	**-21** (3.9)	**-21** (4.3)	
	% Error	**-1.0** (0.4)	**-1.0** (0.5)	

Table 7a. Mean correct RTs in milliseconds and error percentages for the Switched and Location + Identity Repeated trials of the localization task of Experiment 4. Standard error of the Object-specific preview effect are presented in parentheses.

	Trial Type		
	Switched	Location + Identity Repeated	**Object-Specific Preview Effect**
RT	485	502	**-17** (9.1)
% Error	1.4	1.3	**0.1** (0.7)

Table 7b. Mean correct RTs in milliseconds and error percentages for the four trial types included in the 2x2 ANOVA for the localization task of Experiment 4. Standard errors of the priming effects (N-R) are presented in parentheses.

		Identity		
Location		Non-repeated	Repeated	**N - R**
Non-repeated	RT	476	480	**-4** (5.4)
	% Error	1.6	2.0	**-0.4** (0.4)
Repeated	RT	500	502	**-2** (10.7)
	% Error	1.8	1.3	**0.5** (0.6)
N - R	RT	**-24** (7.8)	**-22** (6.1)	
	% Error	**-0.2** (0.5)	**0.7** (0.6)	

Table 8. Mean correct RTs in milliseconds and error percentages for the four trial types included in the 2x2 ANOVA for the identification task of Experiment 5. Standard errors of the priming effects (N-R) are presented in parentheses.

		Identity		
Location		Non-repeated	Repeated	**N - R**
Non-repeated	RT	473	477	**-4** (3.5)
	% Error	2.1	2.5	**-0.4** (0.8)
Repeated	RT	495	505	**-10** (8.1)
	% Error	3.3	4.1	**-0.8** (1.6)
N - R	RT	**-22** (3.9)	**-28** (7.1)	
	% Error	**-1.2** (0.8)	**-1.6** (1.4)	

Table 9. Mean correct RTs in milliseconds and error percentages for the four trial types included in the 2x2 ANOVA for the localization task of Experiment 5. Standard errors of the priming effects (N-R) are presented in parentheses.

		Identity		
Location		Non-repeated	Repeated	**N - R**
Non-repeated	RT	461	461	**0** (5.4)
	% Error	0.2	0.6	**-0.4** (0.3)
Repeated	RT	491	490	**1** (7.6)
	% Error	0.0	0.0	**0.0** (0.0)
N - R	RT	**-30** (5.3)	**-29** (7.7)	
	% Error	**0.2** (0.1)	**0.6** (0.3)	

Table 10a. Mean correct RTs in milliseconds and error percentages for the Switched and Location + Identity Repeated trials of the identification task of Experiment 6. Standard error of the Object-specific preview effect are presented in parentheses.

	Trial Type		
	Switched	Location + Identity Repeated	**Object-Specific Preview Effect**
RT	443	431	**12** (2.1)
% Error	2.4	1.9	**0.5** (0.6)

Table 10b. Mean correct RTs in milliseconds and error percentages for the four trial types included in the 2x2 ANOVA for the identification task of Experiment 6. Standard errors of the priming effects (N-R) are presented in parentheses.

		Identity		
Location		Non-repeated	Repeated	N - R
Non-repeated	RT	448	443	**5** (2.2)
	% Error	2.4	2.7	**-0.3** (0.8)
Repeated	RT	439	431	**8** (1.9)
	% Error	1.6	1.9	**-0.3** (0.4)
N - R	RT	**9** (2.8)	**12** (3.0)	
	% Error	**0.8** (0.7)	**0.8** (0.7)	

Table 11a. Mean correct RTs in milliseconds and error percentages for the Switched and Location + Identity Repeated trials of the localization task of Experiment 6. Standard error of the Object-specific preview effect are presented in parentheses.

	Trial Type		
	Switched	Location + Identity Repeated	**Object-Specific Preview Effect**
RT	385	390	**-5** (3.6)
% Error	0.8	0.3	**0.5** (0.3)

Table 11b. Mean correct RTs in milliseconds and error percentages for the four trial types included in the 2x2 ANOVA for the localization task of Experiment 6. Standard errors of the priming effects (N-R) are presented in parentheses.

		Identity		
Location		Non-repeated	Repeated	**N - R**
Non-repeated	RT	403	401	**2** (2.9)
	% Error	0.9	1.0	**-0.1** (0.4)
Repeated	RT	389	390	**-1** (4.2)
	% Error	0.6	0.3	**0.3** (0.3)
N - R	RT	**-14** (6.2)	**11** (7.0)	
	% Error	**0.3** (0.4)	**0.7** (0.5)	

Table 12a. Mean correct RTs in milliseconds and error percentages for the Switched and Location + Identity Repeated trials of the identification task of Experiment 7. Standard error of the Object-specific preview effect are presented in parentheses.

	Trial Type		
	Switched	Location + Identity Repeated	**Object-Specific Preview Effect**
RT	429	428	**1** (3.8)
% Error	0.6	1.5	**- 0.9** (0.6)

Table 12b. Mean correct RTs in milliseconds and error percentages for the four trial types included in the 2x2 ANOVA for the identification task of Experiment 7. Standard errors of the priming effects (N-R) are presented in parentheses.

		Identity		
Location		Non-repeated	Repeated	**N - R**
Non-repeated	RT	399	402	**-3** (1.3)
	% Error	0.8	1.5	**-0.7** (0.4)
Repeated	RT	422	428	**-6** (3.0)
	% Error	0.2	1.5	**-1.3** (0.6)
N - R	RT	**-23** (3.1)	**-26** (3.2)	
	% Error	**0.6** (0.3)	**0.0** (0.5)	

Table 13a. Mean correct RTs in milliseconds and error percentages for the Switched and Location + Identity Repeated trials of the localization task of Experiment 7. Standard error of the Object-specific preview effect are presented in parentheses.

	Trial Type		
	Switched	Location + Identity Repeated	**Object-Specific Preview Effect**
RT	454	451	**3** (8.1)
% Error	0.2	0.2	**0.0** (0.3)

Table 13b. Mean correct RTs in milliseconds and error percentages for the four trial types included in the 2x2 ANOVA for the localization task of Experiment 7. Standard errors of the priming effects (N-R) are presented in parentheses.

		Identity		
Location		Non-repeated	Repeated	**N - R**
Non-repeated	RT	399	404	**-5** (3.8)
	% Error	0.6	0.5	**0.1** (0.1)
Repeated	RT	461	451	**10** (8.0)
	% Error	0.8	0.2	**0.6** (0.3)
N - R	RT	**-62** (9.1)	**-47** (5.7)	
	% Error	**-0.2** (0.4)	**0.3** (0.1)	

Table 14. Mean correct RTs in milliseconds and error percentages for the four trial types included in the 2x2 ANOVA for the identification task of Experiment 8. Standard errors of the priming effects (N-R) are presented in parentheses.

		Identity		
Location		Non-repeated	Repeated	**N - R**
Non-repeated	RT	450	458	**-8** (3.5)
	% Error	1.0	0.9	**0.1** (0.3)
Repeated	RT	475	471	**4** (4.7)
	% Error	0.9	0.5	**0.4** (0.7)
N - R	RT	**-25** (2.7)	**-13** (6.1)	
	% Error	**0.1** (0.4)	**0.4** (0.4)	

Table 15. Mean correct RTs in milliseconds and error percentages for the four trial types included in the 2x2 ANOVA for the localization task of Experiment 8. Standard errors of the priming effects (N-R) are presented in parentheses.

		Identity		
Location		Non-repeated	Repeated	N - R
Non-repeated	RT	412	405	**-7** (3.5)
	% Error	1.2	0.8	**0.4** (0.3)
Repeated	RT	462	462	**0** (5.5)
	% Error	0.6	0.3	**0.3** (0.2)
N - R	RT	**-50** (7.4)	**-57** (9.2)	
	% Error	**0.6** (0.2)	**0.5** (0.2)	