The Effects of Context and Number of Presentations on Repetition Priming

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THE EFFECTS OF
CONTEXT AND NUMBER OF PRESENTATIONS
ON
REPETITION PRIMING

by

Terry A. Simpson

Supervisor: Dr. Craig Speelman

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THE EFFECTS OF CONTEXT AND NUMBER OF PRESENTATIONS ON REPETITION PRIMING

Abstract

When a stimulus such as a word is presented twice, the identification of the word on the second presentation is usually facilitated, reflecting repetition priming. This facilitation can occur without a person’s awareness and is often referred to as reflecting implicit memory. The present study investigated the effects of number of presentations of words and the context in which words were presented on repetition priming. The study measured reaction times on a lexical decision task in which the participants decided whether a string of letters constituted a word or a non-word. Repetition priming on this task was determined by comparing the reaction times of words presented previously (‘old’ words) to words not previously encountered (‘new’ words). 60 participants completed the experiment which involved five phases, each comprising a ‘study’ block and a ‘test’ block. In each ‘study’ block a passage containing target words (presented once or four times) was presented. Lexical decisions were then made on isolated words presented during the ‘test’ block and comprised: (1) ‘old’ words (words previously presented in the passage once; words previously presented in the passage four times; words presented in isolation once and words presented in isolation four times); (2) ‘new’ words presented once only in each phase; and (3) non words. Results showed the repetition priming of words was sensitive to the context of presentation - words previously presented in the passage resulted in significantly less repetition priming than words which were presented in isolation. A greater amount of priming was observed when words were presented four times in both the passage and isolation conditions, compared to one presentation. Accuracy priming on the lexical decision task was significantly higher in words presented in the passage than in isolation. Different amounts of priming observed in the text-word and word-word transitions from study to test are discussed in terms of the information processing view of repetition priming. An explanation based on Kirsner and Speelman’s (1996) model of lexical processing is presented to accommodate the findings. The study also addresses the issue of whether the results of priming studies using isolated words are generalisable to reading contexts.

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Submitted: 30.10.1998
Declaration

I certify that this thesis does not incorporate, without acknowledgment, any material previously submitted for a degree or diploma in any institution of higher education and that, to the best of my knowledge and belief, it does not contain any material previously published or written by another person except where due reference is made in the text.

Signature: ____________________________
Date: 30-10-1998
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Introduction

Information retrieved from memory without conscious control or awareness is referred to as *implicit memory*. In contrast, *explicit memory* is memory that is recalled with particular reference to the conscious recollection of a prior learning experience. In implicit memory studies on word identification, subjects are asked to perceive, identify or make a decision about a word without any explicit reference to the prior learning experience.

One common example of implicit memory is *repetition priming*. Repetition priming occurs when the prior presentation of a stimulus improves performance on a subsequent presentation of the same stimulus (Graf and Schacter, 1985). Repetition priming occurs in the presentation of isolated words, paragraphs of text, inverted text, pictures and auditory information. Repetition priming is also sensitive to experimental manipulations such as the number of times a word has been initially encountered, whether or not a word has been presented with other words, and the types of tasks used in retrieval of the word during the second presentation. However, results of many repetition priming studies have produced inconsistencies and researchers differ in their explanations of the priming effect.

Recent research into repetition priming is concerned with the processes underlying word identification tasks rather than describing memory structures as implicit or explicit. Priming from this perspective is seen as the temporary modification of learning processes that benefit the later processing of the same information (Ratcliff and McKoon, 1996). Furthermore, performance on word identification tasks improves with practice on the task. These findings have led to the
Repetition Priming

investigation of priming in the framework of skill acquisition models. Logan’s (1988; 1990) ‘Instance’ theory suggests that repetition priming increases cumulatively with the number of times a word is presented. However, Kirsner and Speelman (1996) suggest that when task practice effects are controlled for, repetition priming does not necessarily increase with an increase in presentations.

The present study examines the effects of multiple repetitions of words on repetition priming. In particular, whether a word presented once or four times results in an increase in priming, taking into account task practice effects. Secondly, the effects of context on repetition priming will be explored by presenting words initially in isolation or in the context of a written passage. As many priming studies use isolated word strings, the generalisability of such repetition priming studies to reading contexts will be discussed.

**Priming and Lexical Decision**

One major area of research in word priming studies involves the nature of access to and representation of words in a person’s ‘mental lexicon’ (the repository of word knowledge). Most priming studies that examine the mental lexicon use tasks that do not make explicit reference to a prior study episode (Schacter, 1987). Examples of these indirect measures have included tasks such as the completion of partially presented words (Schwartz and Hashtroudi, 1991); word generation (Jacoby, 1983) and the lexical decision task (Kirsner and Smith, 1974; Scarborough, Cortese and Scarborough, 1977).

The ‘lexical decision task’ involves subjects making decisions about whether strings of letters constitute actual words or non words. When the lexical decision task
is used in repetition priming, the reaction time in making a lexical decision on a second presentation of the same letter string is usually faster than on the first presentation. The benefit observed by a reduction in reaction time is an instance of repetition priming.

**Implicit Memory Models**

Research into implicit memory has produced various explanations of repetition priming (for a review, see Schacter, 1987). Most repetition priming studies can be classified as being examples of one of three different views of implicit memory: 1) the 'multiple memory' view; 2) the 'activation view'; and 3) the 'information processing' view.

**Multiple Memory Systems**

A large amount of priming theory is based on dissociations between explicit and implicit memory systems. Tulving and Schacter (1990) describe implicit memory revealed by priming effects as the reflection of a memory system that is separate from a memory system used for conscious recollection. Squire (1994) classifies memory into two broad categories: declarative (explicit) and nondeclarative (implicit) with each having subcategories. Squire (1994) argues that the view suggesting multiple memory systems is supported by evidence that there are different brain systems that operate in different ways.

Experimental approaches testing this concept are based on the assumption that different memory tasks used to measure memory result in different performances and
Repetition Priming

reflect different memory systems (Bowers and Schacter, 1990). Explicit memory tasks typically require participants to consciously recollect previously encoded information such as cued recall (Tulving and Thompson, 1973) and the free recall of previously presented items (Graf and Schacter, 1987). In contrast, implicit memory is revealed when performance on a task improves without the deliberate recollection from a particular learning episode. Bowers and Schacter (1990) studied single word priming and test awareness. Using a questionnaire following a test block, participants were classified into 'test-aware' and 'test-unaware' groups. Results showed single word priming effects in both aware and unaware test groups. In contrast, another form of priming that required elaboration and conscious effort (associative priming) was found in the 'test aware' group but not in the 'test unaware' group. Bowers and Schacter (1990) concluded that the absence of priming on associative priming tasks in unaware subjects reflected a system that was operating independently of implicit memory.

The dissociation between explicit and implicit memory is also found in clinical studies where amnesics have shown improvement in performances on tasks due to simple repetition or practice, without awareness of practice episodes (Dunn, 1998). Graf and Schacter (1985) supported these clinical findings in studies using both amnesic and non amnesic subjects. Repetition priming effects were observed in both normal and amnesic subjects on word stem completion tasks, whereas on a task requiring elaboration of studied words, less priming was observed.

Tulving, Schacter and Stark (1982) studied the lag effects of repetition priming. Results of this study showed that on the same sets of words a decrease in recognition accuracy was observed after a 7 day interval, but accuracy performance
on priming tasks remained virtually unchanged after this interval. Tulving, et al. (1982) suggested that these results provide further support to implicit and explicit dissociations in memory that operate independently of each other.

A major criticism of multiple memory models is that they describe structures of memory and do not explain how the performance on implicit tasks may be affected by prior experiences (Ratcliffe and McKoon, 1996). Ratcliffe and McKoon (1996) propose that rather than dissociating between memory systems, explaining the underlying mechanisms governing priming effects provides a more integrated approach.

**Spreading Activation**

One model used to explain the mechanisms involved in priming is that it occurs by 'spreading activation' (Anderson, 1983; Graf and Mandler, 1984; Morton, 1979). A basic assumption of this model is that memory comprises many interconnected nodes. Each of these nodes has an activation level that determines the availability of information. Priming occurs when the features of a stimulus such as a word are detected by a perceptual system that 'activates' a memory node, with a high level of activation causing the information to be more readily available in memory. On a subsequent presentation of the same stimulus, the link to the memory trace becomes stronger and more easily accessed. Hence, the rate of access to the activated memory node is faster and the more times this representation is accessed, the faster the rate of retrieval (Forbach, Stanners and Hochaus, 1974; Schneider and Shiffrin, 1977).

According to the spreading activation model, implicit memory occurs automatically and relies on pre-existing memory traces. In repetition priming, these memory traces do not contain any contextual information and therefore they do not contribute to the
explicit or conscious remembering of the prior episode. Information is predominantly "data driven", with emphasis on the perceptual features of the stimulus material only.

The activation model has also been described by Morton (1969) in terms of a 'logogen' system present in memory. Logogens are described as representations of word units in memory. Morton (1969) described the processes of word identification as an accumulation of perceptual information over time. Incoming information on a particular word that is repeated is 'counted' by the logogen system, irrespective of the source. Priming is the product of activation of these representations in the logogen system and occurs when the accumulation of incoming stimulus information additively reaches a threshold level of activation. When sufficient activation of the logogen is reached, responses can be made on this information. This model explains priming as the result of the modification of existing memory traces in the earlier stages of processing.

The activation view has been used to account for findings where priming has occurred independently of elaborative processes used in retrieval (Jacoby and Dallas, 1981) and studies with amnesic patients where repetition priming has been observed without the patients demonstrating any awareness of repetitions of the stimulus material (Graf and Schacter, 1985). These outcomes provide evidence for the models that emphasise the perceptual and 'data driven' elements of word identification.

Activation models focus on how much information is received and transferred over time to allow stimuli to be identified and decisions to be made on this information. However, one major criticism of the activation model is that it fails to explain the role of new associations with the memory trace (Schacter, 1987). The activation model is adequate only in explaining memory traces that are pre-existing
and does not account for newly acquired information. It is further argued that if a single lexical ‘system’ is present in the memory system (such as Morton’s logogen system) a word should become available or ‘activated’, and priming should occur regardless of the way in which words are presented when visual changes are made to the stimulus presentation (Kirsner, Milech and Standen, 1983).

The Processing View

Another account of how priming occurs is the ‘processing view’ (Roediger and Blaxton, 1987). Implicit and explicit memory in this model rely on newly established episodic representations that are context dependent. This view differs from other approaches by comparing encoding processes during study and the retrieval processes employed during the test phases of experiments (Roediger and Blaxton, 1987).

A particular version of the processing view of priming is that of ‘transfer appropriate processing’ (Roediger, 1990). According to this view, priming relies on the extent of similarities between study and retrieval processes. Jacoby (1983) suggests that the priming effect is only observed when conditions are matched between encoding and retrieval. Consequently, differences in performance on tasks such as word identification are found when conditions are changed between the study of stimulus material and the demands of tasks imposed in test phases of experiments. For example, tests that draw on meaning or semantic information of a word (e.g., free recall) or use elaborative encoding are insensitive to changes in surface features. In contrast, tasks that rely on a perceptual form of memory (e.g. lexical decision tasks) are enhanced by implicit tests and changes to the visual features of words such as
changing the typescript of letters and blurred print results in a reduction of priming (Roediger and Blaxton, 1987).

Evidence in support of this model is found in studies reporting a reduction in priming due to changes between the presentation of stimuli during the initial study phase and the way the stimuli are again presented in the test phase of an experiment. In a study by Kirsner, Milech and Stumpfel (1986), stimuli were presented as words and pictures and later tested as words only, using a word identification task. A smaller amount of priming was observed between picture-word presentations than for word-word presentations.

The processing view incorporates 'data driven' processes that rely on features of the test data as well as 'conceptually driven' processes initiated by the subject to elaborate, organise and reconstruct the original presentation of material. Similarly, Tulving and Thompson's (1973) 'encoding specificity' model suggests that the recognition of words is not purely the result of the activation of pre-existing memory traces. Their model proposed that word recognition involves complex interactions between stored information and the retrieval environment. For example, the use of a cue such pairing the word 'table' with 'chair' facilitates the later recall of the word 'chair' when this cue is again presented during test, rather than if the word 'chair' is presented on its own. Tulving and Thompson (1973) conclude that the storage of information in memory is determined by the way in which information is encoded during study and the effectiveness of the retrieval cues during test. Priming, by this account, should be observed when information is encoded and retrieved in the same environment.
The processing view differs from the multiple systems view in that it does not dissociate between memory systems but explains performance differences as part of a single memory system (Schacter, 1987). However, the assumption of a single memory system poses problems in studies that use amnesic patients who are still able to process language and possess cognitive skills when explicit memory is impaired (Dunn, 1998).

**Factors Affecting Repetition Priming**

Studies of repetition priming have shown that priming is sensitive to a number of experimental manipulations.

**Differences Between Study and Test Conditions**

Surface features such as modality, type font and texture of words are assumed to be processed at a perceptual level. As a result, when these features are changed between the study and test phases of an experiment, priming should be reduced compared to when these features are the same in both phases. These priming effects associated with changes in the surface features of words are considered to support the suggestion that repetition priming reflects data driven processing (Roediger and Blaxton, 1987). Research supporting this prediction has found a decrease in priming effects in changes to typescript (Masson, 1986); changes between typed words and hand printed words (Roediger and Blaxton, 1987) and changes from words to pictures (Kirsner et al., 1986).

Kirsner et al. (1983) found that priming effects in word identification were reduced when words were presented and tested in a different modality. For example,
large priming effects were observed with auditory presentation of words during study and test, and also with visually presented words during study and test. However, some small but significant priming effects were also observed when modality was changed from study to test (i.e., auditory to visual and visual to auditory), presenting a problem for activation models. Consequently, Kirsner et al. (1983) suggested that the processing view provided a better account of their data, where priming is explained by mechanisms that are both modality specific (e.g. visual or auditory) and modality free (independent of modality). Additionally, Kirsner et al. (1986) proposed priming involves the 'primary and secondary' processing of memory tasks. Primary processing initially makes use of the stimulus quality (e.g. word form) to identify the stimulus. Secondary processing is separate from stimulus identification and involves tasks such as judgements used in classifying stimulus and task instructions that may affect the voluntary control of word identification. Priming studies using strategies such as the lexical decision involve other processes that are extraneous to perception and these strategies are more susceptible to the experimental manipulations of tasks (Kirsner, et al., 1986).

**Presentation Context**

The context in which words are presented can influence the subsequent priming of words. Jacoby (1983) proposed that the data driven processes underlying the perceptual identification of a word depend upon the context in which the word was initially presented. Jacoby's (1983) study demonstrated that words read with no context during study, (e.g. 'XXX-COLD') facilitated the later identification of the word 'COLD' whereas the generation of the word from a conceptual cue (e.g. paired
with the antonym 'HOT-COLD') resulted in less perceptual identification. Jacoby (1983) concluded that perceptual priming is at its most effective when the initial encoding of words occurs with no contextual restraints or semantic identification.

Context and repetition priming has been studied in experiments using homographic words, i.e. words that are structurally the same but have many meanings (Bainbridge, Lewandowsky and Kirsner, 1993; Masson and Freedman, 1990). Priming in these studies is reduced or eliminated when the context in which words are presented changes the meaning of the word. Bainbridge et. al. (1993) suggested that priming does not rely only on the repeated presentation of a word, but also on the activation in memory of its perceived context selected 'sense'.

MacLeod (1989) measured the effects of context presentation on priming by presenting words in a word list, in disconnected discourse and in the context of a passage. Using a fragment completion task, results from this study found greater priming effects in words from the word list, moderate priming for words presented in disconnected discourse and the least amount of priming of words presented in a passage. MacLeod concluded that priming was not an 'all or none' effect and the more words are contextually bound, the smaller the extent of priming.

A study by Oliphant (1983) manipulated three context presentations. Target words were presented in a study phase of (1) a lexical decision task, (2) as part of instructions, and (3) as part of a questionnaire. The test phase used the lexical decision task to measure priming effects. Priming effects were found for the repeated words in the lexical decision task. However, no repetition priming effects were observed in the two text conditions (as part of instructions or in the questionnaire).
Oliphant’s explanation was that priming was the result of the similarity of the method of presentation of words between study and test.

A study by Levy and Kirsner (1989) investigated word identification processes underlying skilled reading. They found that words presented in word lists produced perceptual priming on subsequent presentations. No priming occurred when words had been previously presented in the context of a written passage, suggesting that presenting words at different linguistic levels affects priming.

The fact that reading words in text results in reduced priming suggests that the processing of words in text may require less data driven processing than when words are presented in isolation. It may be this feature that leads to reduced priming in later perceptual identification tasks. The question still remains, though, whether word meaning and contextual constraints influence the data driven, or perceptual elements in word identification (Levy and Kirsner, 1989).

**Word Frequency**

A consistent finding in priming studies is the effect of word frequency. Databases listing the frequency of occurrence of words in normal language use (e.g., books and newspapers) are employed to reflect the amount of exposure participants have had to words outside the laboratory. It has been observed in memory studies that high frequency words elicit faster reaction times in word identification than low frequency words (Kirsner and Speelman, 1996; Scarborough et al., 1977; Schwartz and Hashtroudi, 1991). In contrast, priming is observed to be far greater with low frequency words than with high frequency words (the ‘frequency attenuation effect’) (Duchek and Neely, 1989).
**Number of Presentations and Practice**

The effects of number of presentations and word frequency have often been
described in terms of practice in recent priming studies (Kirsner and Speelman, 1996;Logan, 1988; 1990). Consequently, priming effects have been explained in recent
literature within the framework of skill acquisition models.

There are conflicting reports on the effect of multiple presentations of words
during the initial stimulus presentation, or study episode. Logan (1988; 1990)
proposed that learning was a direct function of the number of times a word was
presented. In contrast, a recent study by Kirsner and Speelman (1996) found that
priming occurred only after a single presentation of a word and did not increase with
further repetitions.

Logan's (1988; 1990) account of the relationship between repetition priming
and practice effects is that they are both the product of a single cognitive process. In
his Instance theory, Logan proposed that repetition priming is influenced by the
storage and retrieval of specific 'instances' that are stored as separate episodic
memory traces. When a subsequent stimulus word is presented, a general problem
solving algorithm is applied to assist the retrieval of this memory trace. The more
instances (memory traces) are stored in memory, the more likely the instance will be
retrieved, resulting in faster reaction time on tasks such as word identification. With
sufficient practice on a retrieval task (such as lexical decision), the retrieval from
memory becomes automatic. Therefore, an increase in the number of entries in
episodic memory increases the likelihood of retrieval, with quicker access, thus
accounting for the repetition priming effect.
Logan (1990) found that repetition priming conformed to the power law of learning, where the initial gains observed in priming decrease with subsequent presentations in a negatively accelerated way. This 'power law of learning' has been applied to other cognitive domains such as problem solving (Neves and Anderson, 1981) and syllogistic reasoning (Speelman, 1991). However, Logan's studies combined the repetition of words across massed practice trials (i.e. 16 repetitions in 3 minutes) and did not allow for task practice effects in his account of repetition priming. In short, no explanation was provided for the relationship between practice on the lexical decision task (skill acquisition) and repetition priming.

Schwartz and Hashtroudi (1991) dissociated priming and skill learning in a series of studies. They defined priming as 'the facilitation in processing a specific item' and skill learning as the 'general improvement in task performance as a function of practice'. Schwartz and Hashtroudi (1991) observed increases in skill learning in partial word identification tasks but the amount of priming did not differ. They concluded that priming and skill learning involve two types of memory processes: those that involve specific occurrences (priming) and those that involve operations and procedures (skill acquisition).

The distinction between skill acquisition and repetition priming has been reflected in clinical findings where skill acquisition has been impaired by subcortical dementia (e.g., Huntingdon's disease) whereas repetition priming is impaired by cortical dementia (Schwartz and Hashtroudi, 1991).

Another account of skill acquisition is provided by Anderson's ACT* Theory (1982). This model is similar to Logan's in that the speed up observed on a task such as lexical decision is reflected by a power function that governs principles of learning.
However, it differs in its explanation of the mechanisms involved in the way information is processed and retrieved. Logan's account suggests that repetition priming is not the result of an improvement in the retrieval mechanisms with practice, but that priming is the result of the amount of instances stored in memory. In contrast, Anderson's ACT* theory (1982) proposes that improvement on word retrieval relies on improvements gained from practice on retrieval tasks. That is, tasks such as lexical decision improve with practice and can be transferred to other stimuli. Hence, the transfer of information reflected by repetition priming is a function of the number of shared components of processing between tasks, rather than the specific task episodes experienced.

This multicomponent view is also advocated by Ostergaard (1998) who states that priming effects are not due entirely to the strengthening of a memory trace but the combined effects of memory activation and the information processing of the retrieval task.

This view has been extended by Kirsner and Speelman (1996) who proposed that although repetition priming and skill development follow the same principle of learning, they are independent processes that benefit from different amounts of practice. Contrary to Logan, Kirsner and Speelman's (1996) approach is that learning functions reflect improvement on component tasks that have been practiced to different extents. In the example of the lexical decision task, the initial processing of words may be a well practiced component for adult readers but the lexical decision component (i.e., word/non word decision) is usually not a well practiced task.
Kirsner and Speelman's (1996) study manipulated the frequency values of words and the amount of experimental practice. The reaction time on lexical decision performance was compared between 'old' and 'new' words. Results showed that performance with high, medium and low frequency words improved with practice, with low frequency words obtaining the most benefit, reflecting the frequency attenuation effect. Kirsner and Speelman (1996) suggest that this is the result of extralaboratory practice. In other words, low frequency words have been processed (i.e., practiced) less by most people and are therefore more sensitive to priming effects observed under experimental manipulations.

Kirsner and Speelman's (1996) model claims that performance on a task such as lexical decision can be considered as reflecting improvements on several components. The model assumes that each component improves at the same rate but that components may differ in the amount of prior practice they have had. To account for task practice effects, an equation representing the components as several power functions is proposed:

\[ T = N_{old}P_{old}^r + N_{new}P_{new}^r \]

In this equation, \( T \) represents improvement on a task as a result of two sets of skills: old and new. \( N_{old} \) represents the initial time involved in executing the old components of a task and \( P_{old} \) represents amount of practice on old components. \( N_{new} \) is the initial time involved in executing the new components of the task, \( P_{new} \) represents the amount of practice on new components and \( r \) is the learning rate.

Kirsner and Speelman (1996) accounted for performance in the lexical decision task in their study with an extended version of this equation. For example, performance on a lexical decision task can be composed of different stages such as:
perceptual processing \((i)\); a premotor planning stage \((o)\); a decision stage \((d)\) and a motor stage \((m)\) of response execution. A detailed example of this model reflecting the component tasks is shown in the equation below:

\[
T = N_{i1}P_{i1} + N_{o1}P_{o1} + \ldots + N_{o2}P_{o2} + \ldots + N_{d1}P_{d1} + N_{d2}P_{d2} + \ldots + N_{m1}P_{m1} + N_{m2}P_{m2}.
\]

Performance on a task comprises both item practice and task practice components. The more components common between study and test, the more benefits (as embodied by increments in each learning function) are accrued, leading to greater improvements in performance speed. It follows, then, that more repetition priming would be observed if the task used in study was the same as that used in test than if tasks changed between study and test. For example, if a lexical decision task on isolated words during study involved three stages of 1) a perceptual stage \((i)\); 2) a decision stage \((d)\) and 3) a motor response stage \((m)\), that each improve at the same rate of, say \(r = 1\), the presentation of the same word and task at study would transfer all the stages (perception, lexical decision and motor response), with a maximum amount of priming occurring. However, hypothetically, if reading a word in text involved three qualitatively different stages of 1) the perceptual identification of the word \((i)\), 2) a comprehension decision and 3) an inferential processes, when the word was presented again and retested using a lexical decision task, only the perceptual identification component \((i)\) would show transfer benefits. If all these components also improved at the rate of \(r = 1\), the fact that only one of the three sets of components is shared between study and test would mean that the overall facilitation observed in the lexical decision task would certainly be less to that observed when the word had been presented in isolation both times.
As components may be shared between processing episodes, Kirsner and Speelman's model can account for perceptual priming effects and the partial transfer reported in priming studies such as the modality effects mentioned previously. This model offers a more detailed account to the transfer appropriate processing view by describing component tasks that account for priming and task practice effects. This implies that studies that test priming by changing the tasks employed between study and test blocks should take into account the different component processes used.

**Generalisability of Priming Studies to Reading Processes**

The research discussed previously demonstrates some of factors that affect repetition priming and highlights the diversity of the mechanisms involved. There is evidence that the processing of words at the visual and perceptual level affects subsequent word recognition. Factors such as word frequency, number of repetitions and practice at lexical decision mediate priming effects. It is important to note, though that the effects of these variables have been observed mainly in studies using isolated words. This raises the question of whether any of these variables are important with respect to comprehending language in normal circumstances (i.e., reading text and listening to speech). Certainly, 'it is very rarely the case in natural reading that subjects can devote their entire processing resources to the task of identifying a single word' (Spoehr and Schuberth, 1981, p.104). Although words must be identified at a perceptual level before meaning can be assigned to them, other higher cognitive functions such as conceptual processing play an important role in word identification (Seidenberg, 1985).
La Berge and Samuels (1974) suggest that the processing of words during reading involves the encoding of hierarchical levels of word perception, phonetic decoding and semantic processing information progressively.

Some priming benefits have been observed in studies that examine the reading of text (Kolers, 1975). In Kolers' (1975) study, the speed of reading rotated text was facilitated by a later presentation of a rotated text rather than when the text was presented normally. Kolers attributed this result to the development of pattern recognition skills, indicating evidence for data driven processes. However, a study by Levy, Newell, Snyder and Timmins (1986) found the speed of rereading texts improved across four trials, regardless of changes in typefont, suggesting the operation of conceptually driven processes.

As reading involves the interaction of many processes, Kirsner and Speelman (1996) suggest that repetition priming effects found in laboratory studies do not always occur to the same extent in normal reading contexts, as rarely are words repeated to the extent of experimental practice conditions.

**The Present Study**

The present study was designed to examine whether repetition priming is affected by whether words are presented in context or in isolation. Words were presented within the context of a passage or in isolation and re-presented again in isolation. Priming was measured as facilitation in performing lexical decision. The aim was to compare priming benefits of a 'word to word' level of transfer and 'text to word' level of transfer. If the reading of target items embedded in text results in less priming, then priming studies that used single word stimulus material may not
sufficiently explain priming of words in context. This would indicate that conceptual processes interact with the perceptual identification of word strings. Based on Kirsner and Speelman’s (1996) model, it is hypothesised that a smaller amount of priming will occur when words are initially presented in text and tested in isolation, than when words are presented and tested in isolation.

Given the conflicting research findings on the effect of multiple presentations on repetition priming, this experiment was also designed to examine this issue directly by comparing the effects of one and four presentations of a target word in both isolated and reading contexts. Logan’s studies used reaction time to measure priming over practice trials, however, the present study predicts that once practice is controlled for, repetition priming effects will differ to those presented by Logan. That is, a smaller amount of priming will be observed when taking into account the speed up of reaction time with practice on the lexical decision task.

The present study addresses Kirsner and Speelmans’ (1996) concern over whether priming effects found in single word lexical decision studies can be generalised to normal reading contexts. As many priming studies involve the use of isolated word strings in lexical decision, the processes underlying normal reading of words in text may yield different outcomes to those generated in the controlled situation of the laboratory.
Method

Participants

A convenience sample of 60 people voluntarily participated in an experimental session lasting approximately 30 minutes. The participants comprised 45 students from Edith Cowan University and 15 from the general public. The ages ranged from 19 to 49 years old, with 18 males (mean age = 36.78) and 42 females (mean age = 29.40). All of the participants were native English speakers and had normal or corrected to normal vision, with these requirements determined during the recruitment process.

Ethical considerations of voluntary participation, data management and confidentiality were addressed in the introductory letter and consent form (see Appendix A).

Design

Two independent variables were manipulated in this experiment, each comprising two levels. The experiment was designed to ensure all participants were tested under all four conditions.

The first independent variable was the presentation format (Context), comprising two levels: (1) words presented in the context of a written passage (Passage); and (2) words presented in isolation for the first time in the lexical decision task (Isolated).

The second independent variable was the number of item presentations prior to the test presentation (Presentations). There were two levels to this variable: (1) words presented once only; and (2) words presented four times.

Two dependent variables were used in this experiment: 1) reaction times (in milliseconds) on the correct ‘word’ response and 2) accuracy (%) of the lexical
decision task in the ‘test blocks’ of the experiment. Priming values were calculated by subtracting reaction times of previously presented words from reaction times of the new words presented in each block.

There were five phases in the experimental session, each consisting of a ‘study block’ and a ‘test block’. Each ‘study block’ comprised 20 target words presented in the context of a written passage and a comprehension question. Each ‘test block’ consisted of the lexical decision task containing 60 word/non word trials. The 60 trials were divided into (1) 20 words previously presented in the written passage (10 presented once and 10 presented four times) (these words were not presented again in the experiment); (2) 20 non words and (3) 20 additional new words presented for the first time in the first lexical decision block. These 20 additional words were subsequently divided into 10 new words and 10 words to be repeated across the five blocks. The 10 words in each ‘new’ set were presented just once in the experiment. The word/non word lexical decision trials were presented in a random order during each test block and participants were not made aware of these word groupings. A visual representation outlining the stimulus arrangement is appended (Appendix B).

For counterbalancing purposes, half of the subjects received passages numbered 1 - 5 and the other half received passages numbered 6 - 10. Target words comprising the ‘old’ words (i.e. repeated throughout the lexical decision task) in the test block were taken from the alternative group of passages. This ensured all participants were exposed to all target words.

**Apparatus**

A program was developed using the Superlab Pro computer software package and was run on an IBM compatible Pentium 166 computer with a 15” Monitor screen. Responses were made on a standard IBM keyboard. The program was
designed to present all stimulus material and to record responses (keys pressed and reaction times).

**Materials**

Two hundred target words were selected on the basis of the following constraints: (a) frequency value of 1 per million words ($M=1.0$) (Kucera and Francis, 1967); (b) between 4 and 7 letters (inclusively) ($M=5.68$); (c) all words were nouns; and (d) no words were compound words (e.g., 'parkland') (see Appendix C).

One hundred 'non words' were constructed from English words and rearranged to an unrecognisable form. The non words conformed to the above constraints and complied to English phonetic rules (e.g., 'libit') (see Appendix D).

Ten unrelated passages were constructed with each containing a word length ranging from 197 - 201 words. Each passage contained 20 of the target words with 10 words presented once and 10 words presented four times. The passages were constructed to be as comprehensible as possible given these constraints (see Appendix E).

A brief but general comprehension question was constructed for each passage. Each comprehension question required a simple Yes/No answer and did not contain any target words (see also Appendix E).

All words presented in the passage and lexical decision task were of matching type (Times New Roman) and font size.

**Procedure**

Testing was conducted in a computer laboratory with subjects working individually at terminals. Participants were given written instructions on a sheet of paper (See Appendix F). This was followed by a question time and a practice trial on the terminal screens before undertaking the experimental task. The practice trial
consisted of a 62 word passage and 4 lexical decision trials. Participants were instructed to respond as quickly and accurately as possible.

Each phase consisted of two parts. Firstly, in the ‘study block’ a passage was presented on the computer screen for a maximum of 3 minutes. However, participants could continue when they had completed reading by pressing the ‘space bar’ on their keyboard. To ensure participants attended to the passage, a brief, single line comprehension question appeared on the screen. This required participants to respond by pressing the ‘Y’ key for a ‘yes’ answer or the ‘N’ key for a ‘no’ answer.

The second ‘test block’ followed, involving the lexical decision task, where participants decided whether a letter string constituted a word or a non word. Both designated response keys were located on the lower row of the keyboard. The ‘Z’ key was marked ‘NONWORD’ and the ‘M’ key was marked ‘WORD’.

Each trial within the lexical decision block consisted of the presentation of a letter string that remained on screen until the participant made a response. Each block consisted of 60 trials with a 30 second break before the commencement of the next phase. However, participants had the option to proceed sooner by pressing the ‘space bar’ on the keyboard. This process was repeated over five phases, resulting in a total of 300 word/non word lexical decision trials.

Each phase lasted for approximately 6 minutes with all five phases presented in one experimental session lasting approximately 30 minutes.

At the completion of the experimental session, each participant was given an opportunity to discuss the nature and purpose of the experiment with the researcher.
Results

Data Screening and ANOVA Assumptions

Screening of Reaction Times and Priming Values

The mean scores of each participant’s reaction times (RT) in milliseconds (ms) on the lexical decision task were coded into SPSS for Windows Version 7.5 for Context and Number of Presentations conditions into the following groups: ‘Passage/Presentations 1’, ‘Passage/Presentations 4’, ‘Isolated/Presentations 1’ and ‘Isolated/Presentations 4’ in each of the five phases.

The mean scores for the Context condition represented an average of performance on words in each of the five passages. That is, performance in the ‘Passage/Presentation 1’ condition represented mean performance on 10 words (presented once) in 5 phases (a total mean of 50 words). Performance in the ‘Passage/Presentation 4’ condition represented mean performance on 10 words (presented four times) in 5 phases (a total of 50 words).

Means in the Isolated conditions represented the average performance on only two sets of words. That is, performance in the ‘Isolated/Presentation 1’ condition represented mean performance on 10 words in Phase 2 (a total of 10 words). Performance in the ‘Isolated/Presentation 4’ condition represented mean performance on 10 words in Phase 5 (a total of 10 words). Performance in all four conditions represented performance on ‘old’ words (those previously presented).

The mean RTs of ‘new’ words were also calculated on 10 words in each of the five phases separately (i.e. the 10 new words in each phase).

Incorrect responses on each trial were excluded as were reaction times on non words.

Preliminary screening was carried out on the mean RT’s of ‘old’ words (i.e. ‘Passage/Presentations 1’, ‘Passage/Presentations 4’, ‘Isolated/Presentations 1’ and ‘Isolated/Presentations 4’). The data was screened for coding errors, range of scores
and missing values (none were found). No outliers were detected. As an additional screening measure, responses smaller than 200 ms and greater than 6,000 ms were deleted. No participants recorded measures below 200 ms, however, four cases of individual trials exceeding 6000 ms were identified. New means were calculated for these blocks and a separate data file of trimmed scores was used as additional screening measure in the main analysis. As the removal of these scores did not change the overall main effects, all subsequent analyses were performed on the original data base, with the inclusion of these trials.

Descriptive data revealed all cells were positively skewed in distribution with normality assumptions violated. However, the data was considered robust to violations of the assumptions of ANOVA as the number of cases in each cell were equal (n=60), and consisted of a sample size larger than 20 (Tabachnik and Fidell, 1996, p.71.) The Fmax value to determine the homogeneity of variance of the four conditions was assessed by dividing the largest variance by the smallest variance. The ratio obtained was < 3, therefore this assumption was not violated (Coakes and Steed, 1997).

Reaction time repetition priming values (PV) were produced by subtracting the mean RT's for each of the four groups of 'old words' ('Passage/Presentations 1', 'Passage/Presentations 4', 'Isolated/Presentations 1', and 'Isolated/Presentations 4') from the mean RT's of the 'new' words within each of the five phases \(\text{RT}_{\text{new}} - \text{RT}_{\text{old}}\) as used by Kirsner and Speelman (1996). Data screening on priming values produced a similar pattern as the reaction time data, with descriptive data considered robust to violations of ANOVA assumptions.

Separate data screening was carried out on the means of 'new' words presented in each phase, and produced similar results to the screening of old words.
Screening of Accuracy

The mean accuracy (%) rate was determined for all ‘words’ in each block. That is, correct responses from: 10 trials for ‘Passage/Presentations 1’ words; 10 trials for ‘Passage/Presentations 4’ words; 10 trials for ‘Isolated/to be repeated words; 10 trials for ‘Isolated/Presentations 4’ words and 10 trials for ‘New’ words in each phase. These trials represented 40 out of the 60 trials, with the remaining 20 trials on non words excluded. The minimum requirement for a subject’s data to be included into the analysis was that participants perform with a minimum of 75% to allow for participants guessing of responses. The mean accuracy % was calculated on the total accuracy for each test ‘phase’. No participants scored below this limit, therefore no cases were excluded.

Accuracy priming was calculated by subtracting accuracy (%) of old words from accuracy (%) on new words for each block. Data screening was carried out on accuracy (%) and accuracy priming on the five cells and was deemed satisfactory.

Main Analysis - Reaction Time Priming

A 2 x 2 repeated measures analysis of variance (ANOVA) was performed on priming values (PV) where the within subject factors were Context and Number of Presentations (Appendix G). A significant main effect was found for Number of Presentations (1 or 4), $F(1,59) = 10.164, p<0.05$. A significant main effect was also found for Context (Passage or Isolated) $F(1,59) = 5.336, p<0.05$. No interaction was found between conditions (Context and Number of Presentations). Post hoc comparisons using Tukey’s HSD test were performed on all possible pairwise comparisons for the Context and Number of Presentations conditions. A significant difference was found for between Number of Presentations 1 and Number of Presentations 4 and also between Context/Passage and Context/Isolation. This indicates that, overall, priming was significantly increased when words were presented four times compared to one time during the study phase of the experiment and that
priming was significantly reduced when words were presented in the context of a written passage.

Means and standard deviations are reported in Table 1 and means shown in Figure 1.

Table 1. Means and Standard Deviations of Priming Values (ms) as a Function of Context and Number of Presentations.

<table>
<thead>
<tr>
<th>Number of Presentations</th>
<th>Context</th>
<th>Priming Value (ms)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>M</td>
</tr>
<tr>
<td>One</td>
<td>Isolated</td>
<td>89.24</td>
</tr>
<tr>
<td>Four</td>
<td>Passage</td>
<td>135.20</td>
</tr>
</tbody>
</table>

Figure 1. Repetition Priming (ms) as a Function of Context and Number of Presentations.
The additional 2 x 2 repeated measures analysis of variance (ANOVA) of priming values (PV) on Context and Number of Presentations was carried out using the trimmed means (Appendix G). The results from this analysis produced similar effects to the main analysis, with significant main effects observed for Number of Presentations, $F(1,59)=9.455, p<.05$, and Context, $F(1,59)=6.211, p<.05$, and no interaction between the Number of Presentations and Context conditions. Post hoc comparisons using Tukey's HSD test were performed on all possible pairwise comparisons for the Context and Number of Presentations conditions and produced similar significant effects as the main analysis (ie. a significant difference was found for between Number of Presentations 1 and Number of Presentations 4, and also between Context/Passage and Context/Isolation).

**New Words RT**

A one way repeated measures analysis of variance (ANOVA) was performed on ‘new’ word RT in each phase to determine if the speed of lexical decision improved with practice across phases (Appendix H). A significant effect was found $F(4,236) = 3.265, p<0.05$. Means and standard deviations are presented in Table 2 and graph in Figure 2.

Table 2. *Means and Standard Deviations of Reaction Times (ms) as a function of New Words Presented in Phases 1, 2, 3, 4 and 5.*

<table>
<thead>
<tr>
<th>Phases</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>New</td>
<td>Words</td>
<td>917.36</td>
<td>316.42</td>
<td>853.00</td>
<td>212.60</td>
</tr>
</tbody>
</table>
Post hoc comparisons using Tukey's HSD test were performed on all possible pairwise comparisons within the New Words effect (Phases 1, 2, 3, 4 and 5). The only significant difference was between Phase 1 \((M = 917.36\text{ms})\) and Phase 5 \((M = 805.49\text{ms})\). This indicates that participants improved with practice on the lexical decision task for 'new' words presented in Phase 1 compared to Phase 5, although this improvement was not uniform from one phase to the next.

**Priming Values of Number of Presentations of Isolated Words**

Although it has already been established that priming on isolated words was greater after 4 repetitions compared to one, the design of the experiment enabled an examination of priming values as a function of 1, 2, 3 and 4 repetitions. A repeated measures analysis of variance (ANOVA) was performed on Priming Values of isolated words repeated across Phases 2, 3, 4 and 5 (Appendix 1). Although the mean priming values increased with the number of presentations, this effect was not
significant $F(3, 177) = .818, p>.05$. Post hoc comparisons using Tukey’s HSD test were performed on all possible pairwise comparisons within the Isolated Repeated Words condition (Presentations, 1, 2, 3 and 4), and revealed no significant differences. Although this result appears contradictory to the main findings where priming increased significantly from one to four presentations, investigation of the means and standard deviations revealed that in the second and third presentation of isolated word conditions a high error variance was observed. Therefore, the study may not have had enough power in detecting the significance of this increase. It can be seen from the means and standard deviations presented in Table 3 and means in Figure 3 that priming of isolated words increased across phases.

Table 3.  
*Means and Standard Deviations of Priming Values (ms) as a Function of Repeated Presentations of Isolated Words in Phases 2, 3, 4 and 5.*

<table>
<thead>
<tr>
<th>Phases</th>
<th>2 (Pres = 1)</th>
<th>3 (Pres = 2)</th>
<th>4 (Pres = 3)</th>
<th>5 (Pres = 4)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$M$</td>
<td>$SD$</td>
<td>$M$</td>
<td>$SD$</td>
</tr>
<tr>
<td>Repeated Isolated Words</td>
<td>89.24</td>
<td>181.98</td>
<td>103.82</td>
<td>260.26</td>
</tr>
</tbody>
</table>
As a comparative measure, the method reported by Logan (1988; 1990) was used to investigate priming values by subtracting the RT of each of the presentations 1, 2, 3 and 4 (i.e. Phases 2, 3, 4 and 5) from the initial presentation RT (Phase 1), rather than comparing RT_{old} to RT_{new} words within each Phase. A repeated measures analysis of variance (ANOVA) was performed on Priming Values (using Logan’s method) of isolated words repeated across Phases 2, 3, 4 and 5 (Appendix I). A significant effect was found for the priming of isolated words across presentations $F(3,177) = 8.768, p = .000$). Post hoc comparisons using Tukey’s HSD test were performed on all possible pairwise comparisons and significant effects were found between Presentations 1 and 4, Presentations 2 and 4 and Presentations 3 and 4. Means and Standard Deviations for these groups are shown in Table 4 and the pattern of priming is shown in Figure 4.
Table 4.  
*Means and Standard Deviations of Priming Values (ms) as a Function of Repeated Presentations in Phases 2, 3, 4 and 5 (Using Logan’s method).*

<table>
<thead>
<tr>
<th>Phases</th>
<th>2 (Pres = 1)</th>
<th>3 (Pres = 2)</th>
<th>4 (Pres = 3)</th>
<th>5 (Pres = 4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>242.29</td>
<td>247.84</td>
<td>277.43</td>
<td>335.75</td>
</tr>
<tr>
<td>SD</td>
<td>226.35</td>
<td>274.97</td>
<td>230.81</td>
<td>238.17</td>
</tr>
</tbody>
</table>

Figure 4.  
*Priming Values of Isolated Words (ms) as a Function of Repeated Presentations in Phases 2, 3, 4 and 5 (Using Logan’s method).*

This result indicates that by employing a different measure of priming that excludes practice on the lexical decision task (i.e. not using improvement on ‘new’ words), greater priming values (ms) are observed.
Accuracy of Old Words and New Words (%)

The mean percentage of correct responses for each phase and word status group was observed from descriptive data to determine whether any groups performed below the minimum requirement of 75%. The accuracy % Means for each phase and word status group are shown in Table 5.

Table 5. Accuracy (in %) on Lexical Decision Task as a Function of Word Status and Phases.

<table>
<thead>
<tr>
<th>Phase</th>
<th>New</th>
<th>Old</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pres. 1</td>
<td>Pres. 4</td>
</tr>
<tr>
<td>1</td>
<td>95.67</td>
<td>96.83</td>
</tr>
<tr>
<td>2</td>
<td>94.67</td>
<td>98.33</td>
</tr>
<tr>
<td>3</td>
<td>87.00</td>
<td>98.33</td>
</tr>
<tr>
<td>4</td>
<td>93.50</td>
<td>98.50</td>
</tr>
<tr>
<td>5</td>
<td>95.00</td>
<td>98.17</td>
</tr>
</tbody>
</table>

Accuracy Priming Values

Accuracy Priming Values were calculated for each participant by subtracting accuracy (%) for each of the four conditions 'Passage/Presentations 1', 'Passage/Presentations 4', 'Isolated/Presentations 1', and 'Isolated/Presentations 4' from accuracy (%) new words in each phase. A repeated measures ANOVA was carried out on Priming Values of Accuracy for the four conditions 'Passage/Presentations 1', 'Passage/Presentations 4', 'Isolated/Presentations 1', and
A significant main effect was observed for the Context (Passage/Isolated) only, $F(1, 59) = 8.859, p<.05$. (See Appendix J), with words presented in passages resulting in more accuracy priming than words presented in isolation. Means and standard deviations are presented in Table 6.

Table 6. *Means and Standard Deviations of Accuracy Priming as a function of Context and Number of Presentations.*

<table>
<thead>
<tr>
<th>Context</th>
<th>Isolated</th>
<th>Passage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Presentations</td>
<td>$M$</td>
<td>$SD$</td>
</tr>
<tr>
<td>One</td>
<td>1.33</td>
<td>9.99</td>
</tr>
<tr>
<td>Four</td>
<td>2.33</td>
<td>6.73</td>
</tr>
</tbody>
</table>

**Accuracy - New Words (%)**

A one way repeated measures analysis of variance (ANOVA) was performed on Accuracy (%) of new words presented in each phase to determine whether accuracy improved with practice (Appendix J). A significant effect was found $F(4, 236) = 10.149, p=.000$. Means and standard deviations are presented in Table 7 and means are presented in Figure 5.
Table 7. *Means and Standard Deviations of Accuracy (%) as a function of New Words Presented in Phases 1, 2, 3, 4 and 5.*

<table>
<thead>
<tr>
<th>New Words</th>
<th>Phases</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$M$</td>
<td>$SD$</td>
<td>$M$</td>
<td>$SD$</td>
<td>$M$</td>
<td>$SD$</td>
<td>$M$</td>
</tr>
<tr>
<td>New Words</td>
<td>95.67</td>
<td>5.93</td>
<td>94.67</td>
<td>8.33</td>
<td>87.00</td>
<td>15.22</td>
<td>93.50</td>
</tr>
<tr>
<td></td>
<td>8.40</td>
<td>95.00</td>
<td>7.01</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 5. *Graph of Means Accuracy (%) as a Function of New Words in Phases 1, 2, 3, 4 and 5.*

Inspection of this data reveals that new words presented in the lexical decision block of Phase 3 resulted in an increase of errors in the lexical decision task. Further inspection of the original data file revealed that five participants made inaccurate responses on five of the ten ‘new’ words presented for the first time in Phase 3. Although no distinctive patterns were identified in the presentation of new words,
errors were made on the same five words. Demographic data revealed that these participants were aged between 19 and 25 years old. This result may therefore have been due to an unfortunate grouping of low frequency new words that a particular group of subjects apparently did not recognise as actual words. However, it does not appear from Figure 5 that there is an overall systematic effect of practice on accuracy in lexical decision. Accuracy was maintained at a high level throughout the phases with Phase 3 obtaining the lowest accuracy at 87%. 
Discussion

The main findings of the present study revealed the following: (1) repeating words four times led to greater repetition priming than when words were repeated only once; (2) when words were presented in the context of a written passage, repetition priming was significantly reduced; and (3) the amount of accuracy priming was significantly higher for words presented in the context of the written passage. Each of these results will be discussed separately, concluding with a summary that integrates the results and their implications to the generalisability of priming studies.

Number of Presentations

The first finding that multiple presentations resulted in an increase in priming provides support for activation models (Anderson, 1983; Morton, 1979) that are based on the assumption of additive effects of the repeated word presentations on priming. According to these models, if the presentation of words results in strengthening of a memory trace, then the ease of retrieval on subsequent presentations results in an increase in repetition priming. The results are also consistent with results reported by Logan (1988; 1990) and Forbach et al, (1974) who found priming increased with increased presentations. According to Logan, the increase in the number of memory traces with each presentation results in faster access to these traces.

Kirsner and Speelman’s (1996) suggestion that task practice effects may have contributed to the priming reported by Logan (1990) is also supported by the present study. Analyses of reaction times of new words showed that performance on the lexical decision task improved significantly from Phase 1 to Phase 5, indicating that
improvements of time taken on lexical decision improved (i.e. was faster) with practice. Furthermore, comparisons made between the method employed by Logan (1988; 1990) and Kirsner and Speelman (1996) demonstrated that priming patterns differed and that once task practice was controlled for, repetition priming values were much smaller. This result provides a challenge for repetition priming studies that use reaction times on repeated word identification tasks and exclude skill learning to definitively account for priming effects (Logan, 1988; 1990). In view of this, the measure of priming used in this study (i.e. reaction times of old words are subtracted from reaction times of new words) is a more valid measure of repetition priming than that employed by Logan (i.e. the overall benefit accrued by words with each repetition).

**Context of Presentation**

The finding that presenting words within a passage resulted in significantly less repetition priming than presenting words in isolation supports previous findings of context effects in memory (Jacoby, 1983; Oliphant, 1983). This finding also provides further support to the concept that priming is reduced when words are presented on a different linguistic level (Levy and Kirsner, 1989).

The finding that increasing the number of repetitions from one to four presentations resulted in a significant increase in priming in the context condition, can be explained by MacLeod’s (1989) suggestion that priming is not necessarily an ‘all or none’ effect. As the repetition of words in the passage condition increased priming, some activation at the perceptual level was still present when words were presented in text and then tested in isolation.
The finding that priming occurred from words presented in text and tested in isolation poses a problem for Logan's (1988; 1990) account of repetition priming. According to Logan's Instance theory, repetition priming relies on specific encoding instances that are stored separately in memory. This model predicts that because different encoding processes are occurring for words in the four conditions, different instances would be shared between study and test. Hence, the text based instances of word storage could not be retrieved during lexical decision and no priming would occur; a prediction not supported by the results of the present study.

The results of the present study can be accommodated by Kirsner and Speelman's (1996) model that incorporates several stages of components of a task. That is, some benefits of past experiences on a word are transferred to new experiences of the word. Therefore, when processing a task that may have various processing components, each time a component is engaged, it moves down the curve of its learning function and improves at a different rate. When processing another episode engages those same components, performance is influenced by the benefits of the past experience (i.e. the learning increments) that are passed on to the second episode, resulting in different extents of priming.

If words presented in isolation elicited sets of components such as the perception of a word, a lexical decision and the execution of a response, then all the components of this process would have contributed to the rate of improvement on performance when the same tasks were required at test. However, reading the word in the context of a passage would not normally involve lexical decision and may have
involved perceptual processes and some other components. These other components include reading processes such as phonetic decoding and semantic processing of higher conceptual processes outside of the lexical system (LaBerge and Samuels, 1974), or, as demonstrated by the results of Bainbridge et al. (1993), deciding on the context selected meaning in relation to other words in the sentence. This analysis suggest that the passage-to-lexical decision conditions would only have had perceptual processes in common in the study and test phases, whereas the lexical decision-to-lexical decision conditions would have had all processes in common (including perceptual processes). Hence, having fewer components in common in the passage-to-lexical decision conditions (compared to lexical-to-lexical decision conditions) leads to less priming.

Although Kirsner and Speelman’s (1996) model explains the present results, one result is inconsistent with this model. There was an absence of an interaction between the effects of context and number of presentations. As can be seen from Figure 1, the increase in priming that occurred with the increase of repetitions from one to four words was the same in both the isolated word and word in context conditions. The Kirsner and Speelman (1996) model predicts that the amount of increase in priming for words presented in text would be less than for words presented in isolation because the former condition shares fewer processing components to the test phase. Furthermore, as the lexical decision task is not a well practiced task for most people, according to the power law of learning, the model would have assumed the repetition of isolated words would result in a faster rate of improvement compared to repetition in text. However, the Kirsner and Speelman (1996) model predicts only a
small difference in this rate of improvement, and so the fact that no differences were detected may reflect a lack of power in this comparison rather than a falsification of the model.

**Accuracy**

Results from accuracy priming analyses revealed that correct response rates were significantly higher for words presented in context than when presented in isolation. Accuracy was not affected by the number of word presentations, nor by practice on new words. One suggestion for the increased accuracy for words in context is that when words are read in the context of a sentence or passage, the surrounding words provide a context which facilitates the selection of a 'meaning' for the word and it becomes more easily recognised as a 'word'. This is demonstrated by an increased priming accuracy in the lexical decision phase of the experiment for words previously presented in the passage, when compared to words presented in isolation. As target words were of a low frequency value, (i.e., they occurred once in a million times in normal language use) they were more sensitive to experimental manipulations, such as the context presentation. This finding provides further evidence for the influence of context on word identification.

**Generalisability of Repetition Priming Studies to Reading Contexts**

The many variables that contribute to the priming effect (e.g., word meaning and task practice) are evidence that repetition priming observed in experimental situations may not generalise well to normal reading contexts. The use of word frequency tables often used to reflect the extralaboratory practice of a word, exclude a person’s exposure to the morphological clusters of words (e.g., 'run', 'runner' and
Repetition Priming 43

‘running’). This further complicates measures of word exposure in relation to practice and priming in reading contexts.

The present study also demonstrated that repetition priming occurs in quantitatively different amounts when words presented in isolation are compared to words in the context of a written passage. With regard to single word studies, Kirsner and Speelman (1996) have demonstrated that item practice (word repetition) and task practice (lexical decision practice) can result in different performance outcomes. Priming studies that interpret practice on a task as indicative of priming (such as Logan’s studies) must take the many components into account to provide ecological validity to their results.

The present study showed that increased repetitions improved priming generally at the same rate between text bound words and isolated words. The main results, to some degree, suggest that experimental results with isolated words can be generalised to more normal reading contexts. However, reading and language comprehension processes in normal circumstances are difficult to identify when tasks, such as the lexical decision task, are employed that selectively measure data driven components. Reading involves more than just identifying a single word, with interactions occurring between data driven and conceptual processes (Spoehr and Schuberth, 1981). Studies on priming and reading have provided evidence for the data driven processes such as pattern recognition (Kolers, 1975), however, there is also evidence for the role of conceptual processes such as comprehension (Levy et al., 1986). Therefore, in order to understand the reading of text at a word level, some insights can be obtained from priming studies. However, they cover only a portion of the reading process.
Discussion of Methodology and Suggestions For Future Research

The primary purpose of the present experiment was to directly measure the effect of two variables (context and number of presentations) on repetition priming.

The present study, to some extent, ignored any changes in meaning of target words. The text passages may have changed the nuances of the target words in such a way as to influence the priming effect. Given the evidence that repetition priming effects are changed when meaning changes (Bainbridge, et al., 1993, Masson and Freedman, 1990), the present study could be extended to include this variable. The passages constructed were brief and somewhat difficult to follow and, as participants were aware of a comprehension question, they may have been reading for meaning, relying heavily on the context selected sense of the word.

The present study enabled comparisons to be made on the differing methods used to measure priming on performance (Logan, 1988; 1990; Kirsner & Speelman, 1996). Differences in the patterns of priming varied according to how they are measured, however, as these differences were small, a larger sample size would improve the power of detecting differences.

The experiment was not designed to test text-to-text levels of transfer and rates of improvement, and further research could explore this further by the inclusion of some text-based test at the test phase. Although the target words were presented in two contexts, this study, as with others, explained repetition priming using single words only in the test phase. This demonstrates that priming is not a simple phenomenon and many variables need to be taken into account to justify the generalisability of experimental studies.
Summary and Conclusions

The present study explored the effects of multiple word presentations and context on repetition priming. When task practice effects were controlled for, repetition priming was greater for words repeated four times, compared to words repeated once only. More priming was also observed when target words were presented in isolation compared to when embedded in text. The results of this study demonstrated that factors such as word meaning, number of presentations and practice on a word identification task can mediate the effects of repetition priming.

As Kirsner and Speelman (1996) suggested, reading involves the interaction of many processes, each with possibly differing rates of improvement of skill. Further studies could benefit from exploring priming in terms of rates of improvements of reading words in text, and in isolation, manipulating meaning, reprocessing text to text and perhaps testing with other measures that are both indirect (implicit) and direct (explicit).
References


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Appendix C. List of Target Words.

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Appendix E. Trial Passage, 10 Passages and Comprehension Questions.

Appendix F. Experiment Instruction Sheet.

Appendix G. 2 x 2 Repeated Measures Analysis of Variance (ANOVA) on PV on original data base.

2 x 2 Repeated Measures ANOVA on PV using Trimmed Scores.

Appendix H. One Way Repeated measures ANOVA on New Words (RT) For Each Phase.

Appendix I. Repeated Measures ANOVA on Isolated Words (PV) in Phases 2, 3, 4 and 5.

Repeated Measures ANOVA on Isolated Words (PV) in Phases 2, 3, 4 and 5 (using Logan's Measure of Priming).

Appendix J. Accuracy Analyses (%):

2 x 2 Repeated Measures ANOVA on Accuracy (PV).

One Way Repeated Measures ANOVA on Accuracy (%) of New Words in Each Phase.
Appendix A

Introductory Letter and Consent Form

Dear student,

My name is Terry Simpson and I am a 4th year Psychology student at Edith Cowan University. I am currently conducting research into the area of memory for my Honours thesis. The aim of my research is to investigate the underlying processes of word identification. The experiment complies with the guidelines provided by the Edith Cowan University Committee for the Conduct of Ethical Research.

It is proposed the experiment will be conducted at the Joondalup Campus in room 2.130 during the first weeks of Semester 2 (5 - 15 August, 1998).

In this experiment participants will be asked to complete two types of tasks on a computer. In the first part, participants will be shown a paragraph and will be asked a comprehension question about the paragraph. In the second task, participants will be shown a series of strings of letters and will be asked to decide whether each string of letters is a word or not. The experiment involves completing each of these tasks five times and will take approximately 30 minutes to complete. Tea and coffee will be provided for all participants.

Please do not be concerned if you are not very computer literate as only a basic knowledge of computers is required. The only requirement for this experiment is that participants first language is English and that they have normal (or corrected to normal) vision.

Participation is entirely voluntary and participants are free to withdraw at any time they please, in which case that data will be removed from the study. Names will not be reported with responses at any stage and at the conclusion of this study, a report of the results will be made available to participants at their request.

Any questions concerning my project can be directed to myself on (08) 9242 4667 or my principal supervisor, Dr Craig Speelman, of the Psychology Department, Edith Cowan University, Joondalup Campus, on (08) 9400 5724.

If you would like to participate, please complete the attached form indicating your name (first name will suffice), and preferred days and times. You will then be contacted for confirmation attendance details.

Your participation is greatly appreciated, thank you.

Student Researcher (Terry Simpson)  
Supervisor, Dr Craig Speelman

(This page is to be kept by participants)
CONSENT FORM

I, ............................................., have read the information above and any questions I have asked have been answered to my satisfaction. I agree to participate in this project and I understand that I am free to withdraw at any stage of the experiment and information gathered will be treated with confidentiality.

I agree that the research data gathered for this study may be published provided I am not identifiable.

________________________________________
Signature

________________________________________
Participant Name (First name will suffice) Date

Contact Telephone No: _______________________

Testing Dates:

Please tick one of the following preferred times:  
(Whole session should take approximately 30 minutes)

**Tue 11 August:**

☐ 3.00pm - 3.30pm  
☐ 3.30pm - 4.00pm  
☐ 4.00pm - 4.30pm  
☐ 4.30pm - 5.00pm

**Wed 12 August:**

☐ 12.00pm - 12.30pm  
☐ 12.30pm - 1.00pm  
☐ 3.00pm - 3.30pm  
☐ 3.30pm - 4.00pm

**Thu 13 August:**

☐ 3.00pm - 3.30pm  
☐ 3.30pm - 4.00pm  
☐ 4.00pm - 4.30pm  
☐ 4.30pm - 5.00pm

☐ Other: Day: _____ Time: _____

(Please specify if other time is suitable to you as an appointment can be arranged)
### Appendix B

**Experimental Design and Stimulus Arrangement**

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Total Trials = 300
### Appendix C

**Target Words**

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# Appendix D

## Nonwords

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<td>veahy</td>
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<td>vememe</td>
<td>vement</td>
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</tbody>
</table>

(Total non words: 200)
Appendix E

Trial Passage, Passages
and Comprehension Questions

(Note: Target words are underlined)

Trial Passage:

It was the secretary’s first day on the job. She sat at her new desk and systematically unloaded the contents from her cardboard box - a clock, some books, ornaments and framed photographs. Her boss could not believe his eyes when he saw all the objects cluttered over her desk. She had appeared to be a very tidy person at the interview!

(Word count: 62)
(No target words)

Comprehension Question:

Do you think her boss was surprised?  Y/N
Passage 1:

It was dusk when the dingo emerged from the cavern. He crept over the dune and quietly snuck toward the ravine. Amongst the lush green flora a gazelle kept a vigil over a fawn. In a nearby shrub a cheetah and coyote also watched the prey - the young fawn and a small hare. The dingo noticed a vulture circling above the dune and, under duress, crept into the ravine, careful not to make a sound. The cheetah, crouched behind the shrub of fern, drooled at the fodder. As he moved out of the shrub, the cheetah became distracted by the swooping vulture and snagged his claw on a perch. The gazelle heard a jostle in the distance and quickly stood up. She spotted the coyote in the shrub and the vulture over the dune, but not the dingo in the ravine. The gazelle, fawn and hare scampered from the ravine towards the dune and away from the coyote. The gazelle and fawn fled the coyote and vulture, who were then chased by the cheetah. The hare became confused from all the commotion and was not so lucky. The hare had not survived the guile of the dingo.

(Word count: 198)

Comprehension Question:

Were there any survivors from the chase?  Y/N
Passage 2:

The khaki clad fisherman left his shack, boarded his dinghy with one paddle and set out to catch lobster, leaving his pets (a walrus and a gull) behind. The fisherman in khaki enjoyed his shack, with the walrus and gull, eating a nibble of lobster with pickle. That day he couldn't get a nibble out of the devious fish. He only spotted a frog, which wouldn't taste pleasant with pickle. A looming typhoon made his dinghy bounce through the froth. He pondered returning to his shack to pickle with bread. Suddenly a cascade of froth splashed into his dinghy, creating a huge puddle. He heard a squawk coming from the gullet of a dolphin. With a squirt of froth from his snout, the dolphin swam out in front of the rudder, showing the fisherman the way to the lobster. His khaki wet with froth, he waited in his dinghy when suddenly he felt a nibble on his line. That evening he returned to his shack to the walrus and gull waiting for a nibble, and removed his khaki clothes. Thanks to the dolphin, he ate lobster with pickle, sharing his catch with the walrus, gull and his new pet, the dolphin.

(Word Count: 201)

Comprehension Question:

Did the fisherman have a new pet? Y/N
Passage 3:

The octet played an anthem with exuberant pomp. I heard a squeak as the diva approached the podium. The diva wore a white blouse, under a mauve tunic. On her cuff was a trinket that created a shimmer in the light. The diva was a consort who had arrived with a cortège that could fill the entire parquet of the orchestra. The flute player in the octet began with a ditty that sounded like a polka. The flute ditty was an anthem but without the pomp. What sounded like a squeak came from the octet on the parquet, but the crowd still gave a loud clap after the polka ditty with the flute. When the flute player finished the polka at the end of the ditty, the crowd waited for liqueur. Liqueur was served in ornate liqueur glasses to all, including the octet. The anthem with pomp from the parquet amused the crowd, who liked the polka but not the squeak. The guests revelled in the pomp, music and liqueur. During the harp solo, another squeak was heard as a baby stirred in the crowd. As the diva began, her anthem bellowed across the parquet and all listened silently.

(Word count: 199)

Comprehension Question:

Did the crowd enjoy the concert?  Y/N
Passage 4:

The whiff of food filled the room as he stood beside the faucet. Tonight he’d ask her to be his fiancé. The cuisine was exquisite - venison cooked in saffron, soufflé with raisin, currant and melon. By the parcel lay the corsage the florist had prepared. A whiff of the lily and fuchsia wafted from the corsage. The clock dial showed she was late, so he opened the chablis and admired the parcel. The constant drip from the faucet made him uneasy. Sprinkling the parsley onto some giblet, he again glanced at the parcel and the lily and fuchsia corsage. Taking a whiff of the venison and a gulp of chablis, ‘my fiancé will soon be here’ he thought. An hour passed with the constant drip of the faucet. The venison was becoming dry; the lily and fuchsia corsage was wilting and the floral whiff fading. Groggily, he realised that chablis without venison wasn’t a good idea. The drip from the faucet began to annoy him. The parcel glared at him, with no fiancé to claim it. The lily and fuchsia had died. After finishing the chablis and another drip, he wondered if he’d see his fiancé at all.

(Word count: 199)

Comprehension Question:

Was the girlfriend early?  Y/N
Passage 5:

The hobo with the strange mumble and giggle was considered a slouch to the people at the hospice. They thought him a rascal and a vagrant rogue with a horrid stench. The hobo lived with this stigma and thought himself a buffoon with a funny giggle. He thought his stunt with the syringe would raise a giggle with the staff at the hospice. However, the cocaine addict only managed to create a mumble amongst the staff. He ended up wrapped in gauze and drinking a nasty tasting tonic to counter the cocaine. The rascal would let out a disapproving mumble at the tonic, preferring cocaine instead. The hospice tried teaching yoga to the hobo as no tonic or vaccine worked on the slouch. The addict continued to be a rascal and often let out his strange mumble during the yoga. One night, tired of being a slouch, the addict escaped from the horrid tasting tonic and the boring yoga at the hospice, to resume his life as a tramp and addict. The rascal continued his life as a hobo with cocaine for many years and would often let out a strange giggle at the thought of a slouch trying yoga.

(Word count: 200)

Comprehension Question:

Did the staff like the main character?  Y/N
Passage 6:

The orphan in plaid was no tycoon. He lived in a duplex laden with mould and mildew. On the dole, he would eat from the silo he shared with a ferret avoiding both the mould and the mildew in his home. The orphan always wore plaid, often using his dole to purchase a lottery coupon from the vendor at the kiosk. He dreamed of the day he’d become a tycoon or a magnate from a coupon, not having to worry about the leaking gutter or the ghoul who lived in the other duplex with mould and mildew. One day, a particularly chilly draught swept through the duplex. The orphan decided to sell his plaid suit and purchase another coupon from the vendor at the kiosk. To his surprise, the coupon from the vendor at the kiosk won a large amount of money - more than his dole. A broker instantly made him a tycoon! He collected his thermos, left the mould and mildew of the duplex, and ventured past the vendor and kiosk to a department store. He bought himself a kite, a new plaid suit and a racquet. He was indeed the happiest tycoon orphan on the dole.

(Word count: 199)

Comprehension Question:

Did the main character often purchase lottery tickets? Y/N
Passage 7:

The burglar, covered in soot, crept like a panther past the chassis carrying the hearse. If he could beat the congregation to the crypt in the sphinx, he could steal the jewel behind the mural. It was said a genie lived in the duct of the crypt. The burglar slithered into the tunnel, landing quietly on a trestle. His soot covered mask made it difficult to breathe through one nostril, but he moved as quick as a panther over the rubble. He had little time to locate the jewel behind the mural in the crypt. Finding the duct through the tunnel, he found no genie. Like a panther, the burglar glided over the rubble and found the mural. The soot marks on the tunnel did not concern him, and he continued through a gorge. Past the rubble he found the crypt with the mural. Carefully unscrewing the hinge, he hoped to find the jewel or the genie. A thunder came from the duct but no genie appeared. A spectre of a zombie floated angrily towards the burglar. Like a hunted panther, he swept through the tunnel, beyond the rubble and soot, knowing he’d never escape the duct with the jewel.

(Word count: 200)

Comprehension Question:

Do you think the prowler escaped?  Y/N
Passage 8:

The muffled waltz echoed around the walls of the dressing room. The nymph found herself amidst the scuffle of fabric - tulle, crepe and nylon. Each vamp busily prepared her tint and varnish, chewing carrot sticks. The mentor, with a thimble on her thumb, fixed the crepe and nylon and advised the nymph not to touch the cookie or toffee served on a platter. Only carrot was allowed or she would not fit into the chemise. She felt she looked a weed, not a vamp. The girth of her pelvis was tightly wrapped in tulle and nylon to her sternum. She hesitantly refused the carrot. Her mentor painted her nails with varnish the tint of a zebra. The mentor then scuttled to another vamp. The waltz began and the nymph was nudged onto the catwalk. She nervously strode to the waltz, like a chamois in tulle and crepe. Her mentor admired the nylon and tulle with matching varnish and tint. The nymph, glad she refused the carrot, could barely breathe through the crepe. Stepping to the waltz, she glimpsed her admiring audience. With her immaculate varnish and tint, she felt, for a moment, she was indeed a vamp.

(Word count: 198)

Comprehension Question:

Was the fashion parade a success?  Y/N
Passage 9:

Each morning the damsel dons her helmet and rides her tandem to the grocer, baby in a sling. The baby, the youngest of the sibling, lets out a yodel to her mother in the helmet. Like a robot, the damsel stops by the grocer, removes her helmet, and with a hobble, purchases prune and egg yolk for the gnome in the sling. The tiny gnome on the tandem loves prune and yolk. The damsel gives out a moan to herself, wishing she could visit the salon, without the tandem and the yodel. She stops to fix her thong, giving the baby a guzzle of prune juice to stop the yodel. A creche would be nice, then she wouldn't need the sling, or even a pram to visit the grocer. The damsel, feeling like a robot, reminisces about the time she wasn't a robot cycling to the grocer, making prune juice and whipping egg yolk after yolk. The time she didn't need a tandem or helmet, or hear a yodel - when the gnome was an embryo in her womb. Her face smiles as she watches the baby doze in the sling, feeling happy to be a robot to the gnome.

(Word count: 200)

Comprehension Question:

Was the baby small and noisy?  Y/N
Passage 10:

The glacier looked as if it were made with a gouge. Mammal after mammal passed the pebble road, beside the poplar trees. Across the paddock a donkey slept beneath a citrus tree that looked like a skewer. The molar of one mammal in the paddock stood out fiercely. A steed galloped from the glacier. One wearing a stirrup was a courier to the others through the sleet. The steed passed an old house, sheltering beneath an eave, drinking water from an old cask. A meal of mince and almond was always left for the steed. As they journeyed home to the roost, the steed stopped by poplar and plum trees to shelter from the sleet. The glacier made an impressive backdrop as each mammal, some with a stirrup, some without a stirrup, headed across the pebble road to the roost in the paddock. One by one, each donkey ambled past the poplar in the sleet, toward the roost. The pebble road was long, and the glacier looked cold. A lone donkey with a stirrup sheltered by a poplar tree, as sleet covered the paddock. Across the pebble road, the final donkey made its way to the roost.

(Word count: 197)

Comprehension Question:

Were the animals keen to get to their home?  Y/N
Appendix F

Experiment Instruction Sheet

Please read the passages presented on your screen carefully once through. On completion of this task, press ‘space bar’ and you will then be presented with a question regarding the passage you have just read. This will involve a very short answer for you to type on the screen (‘Y’ for ‘yes’ answer or ‘N’ for ‘no’ answer).

On completion of this task, you will be presented with a string of letters. It is your task to decide, as quickly and accurately as possible, whether the letter string is a ‘word’ (press key marked “WORD”) or a ‘non word’ (press the key marked “NONWORD”) situated on the bottom row of the keyboard.

When the presentation of letter strings is completed, you will again be presented with another passage and the process will be repeated a further four times.

You will receive one initial practice session prior to commencement of the experiment whereby you will have a short practice trial of the entire process before continuing to the experimental task. Please feel free to ask questions during the trial session. You may have a short break between sections (i.e. after ‘word/nonword’ task). To continue to the next passage press ‘space bar’.

Below is a summarised version of the procedures:

• 1. Read passage............................SPACE BAR
• 2. Answer short question briefly............’Y’ or ‘N’ key
• 3. Decision on words presented on screen:

    for WORD .........................“WORD” key
    Or
    for NON Word......................“NONWORD” key

• 4. Have a few seconds break, or,
    to continue to the next passage............SPACE BAR

You will be advised on the computer screen when the experiment is completed. Please signal the experimenter and do not turn off the computer.
## Appendix G

### 2 x 2 Repeated Measures Analyses of Variance on Priming Values
For Context and Number of Presentations Conditions
(On Original Data Base and on Trimmed Scores)

#### 2 x 2 Repeated Measures Analyses of Variance on Priming Values For Context and Number of Presentations Conditions for All Scores

Tests of Within-Subjects Effects

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<th>Measure: MEASURE_1</th>
<th>Sphericity Assumed</th>
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<td>PRES</td>
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^a. Computed using alpha = .05

### 2 x 2 Repeated Measures Analyses of Variance on Priming Values For Context and Number of Presentations Conditions on Trimmed Scores.

Tests of Within-Subjects Effects

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^a. Computed using alpha = .05
Appendix H

One Way Repeated Measures Analysis of Variance (ANOVA)
on New Words (RT) For Each Phase.

One way Repeated Measures Analysis of Variance (ANOVA) on New Words (RT) For Phases 1, 2, 3, 4 and 5.

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<th>Sig.</th>
<th>Noncent. Parameter</th>
<th>Observed Power^a</th>
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^a. Computed using alpha = .05
Appendix I

Repeated Measures Analysis of Variance (ANOVA) of Priming Values Of Words Presented in Isolation in Blocks 2, 3, 4 and 5.

1. Repeated Measures Analysis of Variance (ANOVA) of Priming Values Of Words Presented in Isolation in Blocks 2, 3, 4 and 5 using Kirsner & Speelman’s measure of Repetition Priming (Rtold - RTnew).

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<th>Sig.</th>
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<th>Observed Power^a</th>
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^a. Computed using alpha = .05

2. Repeated Measures Analysis of Variance (ANOVA) of Priming Values Of Words Presented in Isolation in Blocks 2, 3, 4 and 5 using Logan’s (1988; 1990) measure of Repetition Priming.

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^a. Computed using alpha = .05
Appendix J

Output of Accuracy (%) Analyses

2 x 2 Repeated Measures Analysis of Variance (ANOVA) on Priming Values for Accuracy in Conditions Passage/1 Presentation, Passage/4 Presentations, Isolated/1 Presentation, and Isolated/4 Presentations.

### Tests of Within-Subjects Effects

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^a. Computed using alpha = .05

Repeated Measures Analysis of Variance (ANOVA) on Accuracy (%) of New Words from Phases 1 to 5.

### Tests of Within-Subjects Effects

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Sphericity Assumed

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^a. Computed using alpha = .05