Modulation of Identity Priming with Lag Employing Non-Recycled Words

---

A dissertation submitted in partial fulfilment of the requirements for the degree

of

Doctor of Philosophy in Psychology

at the

University of Canterbury

New Zealand

By

Sandila Tanveer

2019

Acknowledgements

I would like to thank the University of Canterbury for providing me UC Doctoral Scholarship to assist my doctoral study. My sincere gratitude to Dr. Ewald Neumann (Senior Supervisor) for his patience and continual assistance. I would also like to appreciate Dr. Zhe Chen (Associate Supervisor) and Jon Wilshire (Programmer) for their support in need. My special thanks to my husband Muti Ul Bari for his ongoing encouragement and my daughters for their love and support during my doctorate. Lastly, my heartfelt gratitude to my mum Mrs. Gulnaz Tanveer for her prayers and her endless kindness.

Table of Contents

List of Figures

ABSTRACT

There has been ongoing research at an accelerated pace on negative priming since Dalrymple-Alford and Budayr (1966) examined this phenomenon. Negative priming is of interest to cognitive psychologists because it can help answer questions about the mechanisms of selective attention that allow us to prioritize some perceptual inputs while ignoring others. In a typical negative priming task, the stimuli are believed to leave a processing trace that can either facilitate or impair the processing of later identical or related stimuli over time. These priming effects are successfully obtained when the stimuli immediately follow the initial display. But can we obtain any priming effects when the stimuli are repeated with a protracted multi-minute interval? If yes, then are there any differences in the priming effects obtained at lagged interval compared to the ones obtained in the immediate condition? To answer these questions, the dissertation presents three pairs of experiments that examined identity priming with and without lag using a large pool of non-recycled words as stimuli. The results are argued to increase our understanding of the underlying mechanisms of selective attention which govern target and distractor processing. These experiments can also test some of the key predictions of the distractor inhibition hypothesis and episodic retrieval account concerning long-lag priming effects.

The task involved a pair of consecutive displays in which target and distractor words were presented. Participants were required to name the lowercase target word and later make a word/non-word judgment to the lowercase target item while ignoring the uppercase distractor words in both displays. The priming conditions were created by repeating the distractor word as a target in the ‘ignored repetition’ condition. Further priming conditions were created by repeating the target word as a target in the ‘attended repetition’ condition; by repeating the

distractor word as a distractor in the ‘distractor repetition’ condition; and by repeating both target and distractor words as is in the ‘target and distractor repetition’ condition. The unrepeated items in the control condition provide a baseline against which to examine the possibility of obtaining any priming effects. In each experiment, the ignored repetition and control conditions were examined along with either one of the attended repetition, distractor repetition, or target and distractor repetition conditions; giving a total of three conditions per experiment. Those conditions were examined in one short-lag and one corresponding long-lag experiment. The stimuli were repeated successively without intervening stimuli in the short-lag experiments and 151 trials (about 10 minutes) later in the long-lag experiments.

Across the experiments, the most consistent finding was that negative priming was reliably observed in the ignored repetition condition evidenced by response delays at both short and long lags; indeed, without any diminishment over time. By contrast, response facilitation was observed in both short-lag and long-lag target repeat (e.g., attended repetition, target and distractor repetition) conditions. However, these response facilitatory effects diminished over time with lag compared to without lag condition. Taken together, these findings shed light on how we use attention to focus our processing resources on some information while minimizing others. During selective attention, the target was processed at the explicit level and the distractor was processed at the implicit level. When the ignored distractor appeared 151 trials (about 10 minutes) later, the effect of prime distractor implicit processing remained intact to obtain response time delays like the short-lag ignored repetition condition. However, when the explicitly attended target appeared 151 trials (about 10 minutes) later, a reduction in response facilitation was observed in both target repeat (e.g., attended repetition, target and distractor repetition) conditions with lag due to possible cluttering owing to intervening stimuli. Lastly, the response facilitation observed in the short-lag distractor repetition condition eliminated over time as no priming effects were obtained in the long-lag distractor repetition condition. It seems likely that the processing mechanisms applied to the distractor in the distractor repetition condition are less durable than the processing mechanisms applied to the distractor in the ignored repetition condition; as no facilitation emerged with lag. In short, current experiments systematically addressed the various ways our previous interactions with information influence our subsequent processing. The set results can be more easily accommodated by distractor inhibitory hypothesis than episodic retrieval account.

Chapter 1

Introduction

Our brains are remarkably equipped for processing enormous amounts of sensory information. This is efficiently done when the brain identifies and categorizes information as relevant or irrelevant through selective attention. One of the convenient tools to examine the mechanisms underlying selective attention is by using negative priming (NP) paradigm. In this paradigm, the stimuli are believed to leave a processing trace that can either facilitate or impair the processing of later identical or related stimuli over time (Tipper, 1985, 2001). In a typical NP manipulation, there is always a pair of successive tasks called 'prime' (initial presentation) and 'probe' (repeated presentation) in which the target and distractor stimuli are presented. NP researchers commonly use visual stimuli (e.g., letters, words, numbers, nonsense shapes, pictures, coloured dots, etc.) in variety of tasks (e.g., naming, Stroop, lexical decision, spatial localization, etc.) following conceptual, semantic, or perceptual stimuli repetition. The priming conditions are generally based on the repetition of the attended target or ignored distractor; while the variations are created by manipulating the number of stimuli repetitions and the interval between prime and probe.

As far as the variety of priming conditions are concerned, the no repetition control (CO) condition provides a baseline against which to examine the possibility of obtaining any priming effects. For instance, when the prime distractor is repeated as a probe target in the 'ignored repetition' (IR) condition; NP can be observed. This NP effect can be evidenced by response delays, error increase, or both in the IR condition compared to the CO condition. On the contrary, when the prime target is repeated as a probe target in the 'attended repetition' (AR) condition, positive priming (PP) can be observed. This PP effect can be evidenced by faster responses, fewer errors, or both in the AR condition compared to the CO condition. Researchers assert that response facilitation can also be observed when the prime distractor is repeated as a probe distractor in the ‘distractor repetition’ (DR) condition or when both prime target and distractor are repeated as probe in the ‘target and distractor repetition’ (ARDR) condition (Neumann & DeSchepper, 1991; Stadler & Hogan, 1996). In a nutshell, the NP paradigm provides a convenient tool to examine the mechanisms of selective attention particularly in relation to recurring sensory information.

Several NP theories emerged overtime to explain the priming effects discussed above. Among those, the two prominent NP theories are the distractor inhibition hypothesis and episodic retrieval account. The distractor inhibition hypothesis is an inhibition-based theory of NP which assumes inhibition to be active and transient (Tipper & Cranston, 1985). One of the founding advocates of the distractor inhibition hypothesis, Steven P. Tipper (1985), asserts that the target excitation is coupled with the inhibition of competing for distractor stimuli. These excitatory and inhibitory effects are even deemed to be equally potent mechanisms by some researchers (Neumann & DeSchepper, 1991). The proponents further assert that the distractor inhibition persists for some time until it falls below the baseline activation level. This lingering inhibition can affect probe processing in case of recurring stimuli (e.g., Fox & de Fockert, 1998). For instance, when the prime distractor is repeated as a probe target in the IR condition, the activation of the probe target representation can be delayed due to transient residual inhibition of the prime distractor. Hence, more activation may be required to boost the probe target for response generation, which slows down probe processing in the IR condition. By contrast, when the prime target is repeated as a probe target in the AR condition, the probe processing accelerates due to pre-activation of the prime target representation.

Tipper, Weaver, Cameron, Brehaut, and Bastedo (1991) argued that the act of preventing a response to the distractor alters the internal representations of the ignored stimulus. They added that long-lag NP effects obtained with non-recycled stimuli can provide evidence of such altered distractor representation. Notably, such long-lag NP effects don't rule out the existence of residual inhibition as some data may be better explained by such decaying residual inhibition (Tipper et al., 1991). Interestingly, DeSchepper and Treisman (1991, as cited in Tipper & Milliken, 1996, pg. 341) provided evidence for long-lag NP with non-recycled novel shapes over minutes protracted lag and observed no effect of lag on NP. This evidence apparently confirms Tipper et al.'s (1991) assumptions concerning the long-term consequences of the altered distractor representation. However, Tipper and colleagues proposed Houghton-Tipper model (1994) instead; in which they accommodated both memory and attention to explain the priming effects. Later, Tipper published a paper with Milliken in 1996 and pointed out a possible limitation in the classical distractor inhibition hypothesis. They asserted that the residual inhibition cannot last through minutes protracted lag and consequently fails to accommodate long-lag priming effects (Tipper & Milliken, 1996). At that point, it seems fairly reasonable as DeSchepper and Treisman's (1991)[1] reported long-lag NP effect was not replicated and Treisman and DeSchepper (1996) also reported a failure to obtain long-lag NP with non-recycled words. Tipper (2001) acknowledged the strengths of the distractor inhibition model by stating that "*there is no firm evidence to discount inhibition models*". However, Tipper continued to appreciate both memory and inhibition as underlying mechanisms of priming and one can argue that the last paper that explained NP using distractor inhibition alone (to our knowledge) was of

[1] Notably, DeSchepper and Treisman (1991, 1996) refer to the same set of data. Brett Treisman was contacted via LinkedIn and he confirmed that it was presented in 32nd Annual Meeting of the Psychonomic Society in 1991 and then later published as a paper in 1996 with additional findings.

Tipper et al. (1991). Recently, McLennan, Neumann, and Russell (2019) observed long-lag NP with non-recycled words and argued that the consequence of inhibiting a prime distractor might have raised the activation threshold of the distractor in a way that it could possibly obtain NP even after minutes protracted lag and numerous intervening trials. These assumptions of McLennan et al. are fairly in line with Tipper et al. (1991), collectively favouring inhibition as a proximal cause of NP (see also Li, Neumann, & Chen, 2017).

Other than distractor inhibition, NP researchers widely used episodic retrieval account to explain the obtained priming effects. By contrast, episodic retrieval account is a memory-based theory of NP that assumes that each information processing episode is stored individually containing a detailed account of stimuli and their responses (Neill, Valdes, Terry, & Gorfein, 1992). When the stimuli reoccur, an incidental retrieval of the prime episode is triggered which in turn affects probe processing depending on the compatibility between the retrieved (prime) and current (probe) responses (Neill, 1997). For instance, in the IR condition, the retrieved prime distractor response ("do-not response") conflicts with the current probe target response ("respond"). Resolving this conflict takes time and delays probe processing in the IR condition. By contrast, in the AR condition, PP can be observed due to pre-activation of the target representation and congruent current and retrieved target responses ("respond"). The episodic retrieval account proposed the mechanisms of retrieval in a way that the task-relevant target repetition (e.g., in the AR condition) can obtain facilitation at the lagged interval. By contrast, task-irrelevant distractor repetition (e.g., in the IR condition) can obtain a decay in NP with lag (Neill & Valdes, 1992; Neill et al., 1992). These predicted mechanisms are somehow speculative as some NP researchers observed decay in NP with lag while others observed no decay in NP with a protracted multi-minute lag (see Table 1.1.). Interestingly, the only research that examined the longevity of PP effects with a protracted multi-minute lag; reported a failure to obtain long-lag PP (McLennan et al., 2019). The episodic retrieval account has also undergone theoretical evolution and its major off-shoots is the response retrieval account (Frings, Rothermund, & Wentura, 2007; Rothermund, Wentura, & De Houwer, 2005).

Despite involving different mechanisms, both classical NP theories (distractor inhibition, episodic retrieval) predict NP in the IR condition, PP in the AR condition, and response facilitation in the DR and ARDR conditions. Some researchers assert that a clear difference between both NP theories is that the distractor inhibition hypothesis works in a “forward” direction and episodic retrieval account in a “backward” direction (May, Kane, & Hasher, 1995; Neumann, Nkrumah, & Chen, 2018). For instance, the distractor inhibition hypothesis assumes the prime residual inhibition to carry forward and affect probe processing. By contrast, the episodic retrieval account assumes the probe to act as a memory cue which triggers retrieval in a backward direction, which in turn affects probe processing. It is added that another salient difference between both classical NP theories (distractor inhibition, episodic retrieval) is in terms of their assumptions concerning the long-lag priming effects. Episodic retrieval account clearly predicts facilitation at lagged intervals and decay in NP with lag. By contrast, the distractor inhibition hypothesis is not clear on long-lag priming effects, most critically whether long-lag NP can be accommodated by residual inhibition or not. Interestingly, there hasn’t been a lot of research interest in the realm of long-lag priming effects and the theoretical assumptions concerning the long-lag priming effects still strive for empirical evidence. As mentioned, the researchers that examined the effect of lag on NP reported inconsistent findings (see Table 1.1.). Some studies that obtained no effect of lag on NP favours the assumptions of distractor inhibition hypothesis proposed by Tipper et al. (1991, e.g., DeSchepper & Treisman, 1996; McLennan et al., 2019).

Table 1.1.

Summary of Published Research that Examined the Effect of Lag on Negative Priming

NP Studies	Design	Stimuli	Task	% of IR trials	Lag	Results
Neill & Westbury (1987)	Within-subjects	Stroop conflict	Identification	57	20, 520, 1,020, or 2,020 ms	Decay in NP
Hasher et al. (1991)	Between-subjects	Letter pairs	Naming	50	500 or 1200 ms	No decay in NP
Tipper et al. (1991)	Between-subjects	Picture	Identification & localization	33	1,350, 3,100, or 6,600 ms	No decay in NP
Neill & Valdes (1992)	Within-subjects	Flanker letters	Identification	33	500, 1,000, 2,000, 4,000, or 8,000 ms	Decay in NP
Neill et al. (1992)	Within-subjects	Alphabets (*XO*)	Localization	33	500 or 4000 ms	Decay in NP
DeSchepper & Treisman (1996)	Within-subjects	Novel shapes	Shape matching task	50	1 (1000 ms), 10, 100, or 200 intervening trials	No decay in NP
Erickson & Reder (1998)	Within-subjects	Two-digit number	Identification	10	0, up to 90 intervening trials	No decay in NP
Erickson et al. (2005)	Within-subjects	Three-digit number	Number identification	75*	2 (500 ms), 4, 8, 16, 200, 400, and 800 intervening trials	Decay in NP
McLennan et al. (2019)	Within-subjects	Words	Naming & lexical decision	8	0 (1000 ms), 151 intervening trials	No decay in NP

*Experiment 2

Note: See also Treisman & DeSchepper (1996) who reported a failure to obtain long-lag NP with non-recycled words.

By contrast, the studies that obtained a decay in NP with lag corroborate the assumptions of episodic retrieval account regarding the long-lag NP effects (Neill & Valdes, 1992). Most importantly, the only reported attempt to examine PP with a protracted multi-minute lag reported a failure to obtain long-lag PP (McLennan et al., 2019), hence challenging the traditional NP view that predicts facilitation at lagged intervals. It is critical to examine the time course of priming across lag and to examine the replicability of obtained long-lag priming effects in an effort to settle some of the theoretical disagreements concerning the long-lag priming effects.

Devising a viable NP experimental set-up to examine the long-lag priming effects is quite challenging. The priming effects seem to be sensitive towards the variations in experimental features and procedural context which can modulate or even reduce the possibility of obtaining NP effects (Cesario, 2014). For instance, Treisman and DeSchepper (1996) used colour as a selection cue to discriminate between the target (green) and distractor (red) words and reported a failure to obtain long-lag NP with 100 or 200 intervening trials employing non-recycled words. They argued that there are too many interfering tokens attached with the familiar stimuli which reduce the likelihood of obtaining long-lag NP with familiar stimuli. This assumption of Treisman and DeSchepper regarding the stimuli familiarity was challenged by Grison, Tipper, and Hewitt (2005), who found significant long-lag NP with non-recycled face and object pictures. But it remained unclear for decades whether long-lag NP can be reliably obtained using non-recycled words. Until recently when McLennan et al. (2019) provided evidence of long-lag NP with non-recycled words by using Neumann, McCloskey, and Felio's (1999) experimental set-up (see also Neumann & Russell, 2000 as cited in Grison et al., 2005[2]). Participants were

[2] Grison et al. (2005) cited that Neumann and Russell (2000, unpublished) obtained long-lag NP over 100 displays and with one-week lag using word stimuli. Upon inquiry, E. Neumann replied that they observed long-lag NP with a lag of 15-20 minutes (and not with a lag of one week).

required to name the lowercase prime target word and later make a word/non-word judgement (lexical decision) to the lowercase probe target item while ignoring the uppercase distractor words in both displays. The prime distractor word was repeated as a subsequent probe target in the short-lag IR condition. The prime distractor word was repeated 151 trials later as a probe target in the long-lag IR condition. They successfully obtained long-lag NP which was no different than NP obtained in the short-lag IR condition (McLennan et al., 2019). In a follow-up experiment, McLennan et al. reported a failure to observe long-lag PP. They argued that the explicit target processing is subject to larger interference than the implicit distractor processing consequently leading to differences in the durability of long-lag priming effects.

It is argued that an important factor in the above contradictory findings was related to the employment of selection cue (e.g., letter case, colour) to discriminate between the target and distractor words; which possibly modulated the task difficulty and consequently affected the possibility of obtaining long-lag NP with non-recycled words. Most importantly, Treisman and DeSchepper's failure to obtain long-lag NP can be possibly due to the employment of colour as a selection cue to discriminate between the target and distractor words (instead of using familiar word stimuli). A colour singleton (e.g., a green target word amongst a red distractor word) is a typical pop-out scenario which makes the selection against a distractor easy (see Treisman & Gormican, 1988). If a target pops-out in an attentional display, there is very little conflict between the target and distractor words, and thus reduced the likelihood of obtaining NP employing non-recycled words (see also Moore, 1994; Pritchard & Neumann, 2009). This account of Treisman and DeSchepper's failure to obtain long-lag NP with non-recycled words is different from their assumptions but most certainly provides a plausible account of their findings.

Interestingly, the above account of Treisman and DeSchepper's findings can also accommodate Malley and Strayer's (1995) failure to obtain with-in trial NP with non-recycled words. Participants in their experiments named the red target word while ignoring the white distractor word in both prime and probe displays. Malley and Strayer failed to obtain NP with non-recycled words and obtained NP only when the prime distractor word was repeated randomly either as a target or distractor before appearing as a probe target in the IR condition. They argued that the repetition of prime distractor enhanced its activation level. This enhanced distractor activation made the prime distractor more competitive with the probe target consequently delaying probe processing in the repeated prime-probe couplets of the IR condition. As NP was not obtained with non-recycled words, Malley and Strayer argued that the stimuli repetition is a necessary pre-requisite for NP to emerge (Grison & Strayer, 2001; Kramer & Strayer, 2001; Lowe, 1998; Malley & Strayer, 1995; Strayer & Grison, 1999; see also Erickson & Reder, 1998; Erickson, Shang, Buchanan, & Reder, 2005).

These assumptions of Strayer and colleagues regarding the necessity of stimuli repetition were challenged by Neumann et al. (1999) who successfully obtained with-in trial NP with non-recycled words by employing letter case as a selection cue to discriminate between the target and distractor words (see also Neumann et al., 2018). It seems likely that Neumann et al.'s and McLennan et al.'s employment of letter case as a selection cue was a key to their obtained NP effects. According to Treisman and Gormican's (1988) theory of attentional pop-out effects, colour is a quintessential pop-out scenario. By contrast, the tick marks encompassing the upper and lowercase words is definitely not a pop-out scenario. Henceforth, letter case makes selection difficult and consequently increase interference and make NP more likely with non-recycled words (e.g., McLennan et al., 2019; Neumann et al., 1999). The argument made is that the noted failures to achieve NP with non-recycled words (e.g., Malley & Strayer, 1995; Treisman & DeSchepper, 1996) more generally relate to the differences in selection cue. It is important to note that the above observations are not intended to identify the right or wrong selection cues. As NP effects are successfully obtained across a range of stimuli and task employing a range of selection cues (including colour). For instance, several researchers used colour as a selection cue to discriminate between the target and distractor stimuli and find perfectly robust NP effects (e.g., Neumann & DeSchepper, 1991; Tipper, 1985). The important thing in those experiments is that the stimuli were a bit interleaved which makes the red and green stimuli more competitive with one another. In contrast to Treisman and DeSchepper's experiments in which red and green words were not interleaved and were further apart (see also Malley & Strayer, 1995). That is, the activation state of the distractor (Tipper, 2001) or the degree of competitiveness between the target and distractor words (Neumann et al., 2018) is what determines whether NP will be observed and not what type of selection cue is used (see also Pritchard & Neumann, 2009). For instance, a distractor that is bold font and twice as big as the target would be unlikely to produce any NP, because it would be so easy to discriminate the target from the distractor. The salience of the distractor is not a key ingredient. It's really how competitive the distractor is with the target that determines if, or how much, NP will be produced.

Notably, both Malley and Strayer (1995) and Neumann et al. (1999) argued that NP can be obtained by employing a higher or stronger distractor activation level. Malley and Strayer obtained a higher distractor activation level by employing the stimuli repetition, while Neumann et al. obtained a stronger distractor activation by manipulating the task difficulty. Taken together, these NP researchers highlight the necessity of increased distractor activation to obtain NP and their findings reflect the significance of procedural contexts that can modulate the manifestation of NP (see also Lowe, 1998). Such contradictions in the NP literature not necessarily pose a challenge to the empirical research. These apparently conflicting pieces of evidence provide a wider understanding of NP instead by asserting that long-lag NP can be obtained using non-recycled words (e.g., McLennan et al., 2019; Neumann et al., 1999). However, the obtained NP effect can be significantly reduced due to decreased task difficulty owing to the employment of colour as the selection cue (e.g., Malley & Strayer, 1995; Treisman & DeSchepper, 1996). Strayer and colleagues' assumption that a higher level of distractor activation is required to obtain NP seems reasonable. But rather than employing stimulus repetition, a higher level of distractor activation can be obtained by modulating task difficulty or by increasing the amount of conflict between the target and distractor stimuli. Such an explanation was long needed to resolve an ongoing debate in the NP literature regarding the number of occurrences of similar or related stimuli needed to obtain short-lag and long-lag NP.

Because of the ostensible replication crisis in NP literature, it is becoming more and more important for researchers to ensure not only the extension of findings but even the replicability of findings when seemingly minor methodological modifications are made in the design. Henceforth, in current experiments, Neumann et al.'s (1999) experimental set-up was employed (like McLennan et al., 2019) in a series of six experiments. The participants named the lowercase prime target word and later make a lexical decision (LD) to the lowercase probe target item while ignoring the uppercase distractor words in both displays. Other than employing a different set of stimuli and participants, current experiments differs slightly with Neumann et al.'s and McLennan et al.'s experiments in terms of display (e.g., prime duration, blank duration), apparatus, and design. The prime was repeated as a subsequent probe without intervening stimuli in the short-lag experiments (Experiment 1a, 2a, and 3a). The prime was repeated 151 trials (302 attentional displays) later as a probe in the long-lag experiments (Experiment 1b, 2b, and 3b). To make meaningful comparisons across experiments, the stimuli were used in their precise role as 'prime or probe' 'target or distractor' while maintaining the sequential order of words and trials (see Figure 1.1.).

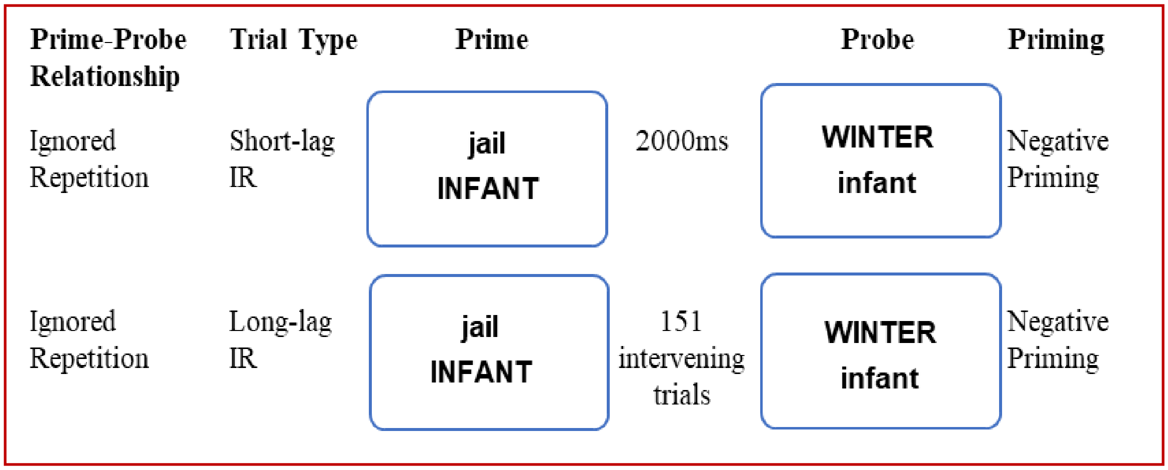


Figure 1.1. The lowercase target and uppercase distractor stimuli appear pseudo-randomly in the top or bottom positions in both prime and probe displays with a minimal vertical space of 1 pixel between them. When the prime distractor word is repeated as a probe target in both short-lag and long-lag ignored repetition conditions, negative priming can be observed evidenced by response delays and/or error increase compared to the control condition.

All six experiments included the IR and CO conditions; while the AR, DR, and ARDR conditions were tested in one short-lag experiment and one corresponding long-lag experiment, giving a total of three conditions per experiment. Current experiments systematically addressed the various ways our previous interactions with information (in this case words) influence our subsequent processing. It is argued that the reoccurrence of prime stimuli in the probe can modulate its processing compared to the items in the CO condition. Hence, the priming effects were measured through the activity modulation in probe LD response time and LD errors. Moreover, the findings of the short-lag experiment provided a baseline against which to examine the possibility of obtaining long-lag priming effects. Such manipulations provided an empirical opportunity to observe the changes in immediate versus lagged stimuli processing. There is a nice symmetry and progression to the series of experiments, and the repetition of the IR conditions across experiments allows for replication. Most importantly, this can be credited as first-ever empirical evidence to examine the time course of identity priming in the DR and ARDR conditions with a protracted multi-minute interval and intervening trials.

If McLennan et al.'s findings are replicable, then response facilitation should not be observed in the current long-lag target repeat (e.g., AR and ARDR) conditions and no decay in NP can be observed with lag. Such permanence of NP effect would suggest that the act of preventing a response alters the internal representation of distractor to an extent that NP could be observed 151 trials later, as in the short-lag IR condition (see also Tipper, et al., 1991). Taken together, these long-lag NP effects would suggest that NP can be reliably obtained by using non-recycled words. Hence, challenging the assumptions of Malley and Strayer (1995) regarding the stimuli repetition and Treisman and DeSchepper (1996) regarding the stimuli familiarity. In addition, if the distractor processing in the DR condition is less durable then the distractor processing in the IR condition, then no facilitation should emerge with lag. Collectively, these findings would challenge the traditional NP views which assumes that inhibition is unlikely to last through the interference of many intervening trials (Grison et al., 2005; Treisman & DeSchepper,1996) and facilitation is likely to be obtained at lagged intervals (Neill & Valdes, 1992; Neill et al., 1992). Notably, current experiments were not designed to discriminate between the distractor inhibition hypothesis and episodic retrieval account (see also Mayr & Buchner, 2007, pg. 40; Tipper, 2001). However, such set results can be more easily accommodated by distractor inhibitory hypothesis than episodic retrieval account.

Most importantly, current findings would test the assumptions of May et al. (1995) regarding the contexts that induce episodic retrieval. May et al. argued that the AR, DR, and ARDR conditions encourage episodic retrieval. They added that when the IR condition is examined along with either one of the AR, DR, and ARDR conditions, NP can be obtained owing to episodic retrieval without an inhibitory mechanism (May et al., 1995; pg. 48). They asserted that decay in NP can be observed with lag in contexts that induce episodic retrieval. Notably, most researches that examined the effect of lag on NP with a protracted multi-minute lag observed the IR condition along with the CO condition in their experiments (e.g., DeSchepper & Treisman, 1996; Erickson et al., 2005; McLennan et al., 2019). Current research can be credited as a first-ever empirical test of May et al.'s assumptions (to our knowledge) regarding the contexts that induce episodic retrieval as the IR condition was examined with the AR, DR, and ARDR conditions across lag. Henceforth, in current experiments, May et al. would credit episodic retrieval as the underlying mechanism of the obtained NP effect and would predict a decay in NP with lag. If no decay in NP is observed, then our findings will refute May et al.'s assumptions. In short, there are many strengths in this programme of research and henceforth it is believed that the findings can have a clear contribution to the NP literature. In the following section, a brief synopsis of chapters containing these current experiment pairs is provided.

In Chapter 2, Experiment 1a and 1b examined the effect of lag on the manifestation of positive and negative priming employing a large pool of non-recycled words. Experiment 1a examined the short-lag identity priming in the AR and IR conditions by repeating the prime as a subsequent probe target word within the same prime-probe couplet without intervening stimuli. Experiment 1b examined the longevity of priming effects obtained in Experiment 1a by repeating the probe 151 prime-probe couplets (302 attentional displays) later than its yoked prime display using the same stimuli as in Experiment 1a. The long-lag NP was significant and no different than NP obtained in the short-lag IR condition (like McLennan et al., 2019). The obtained long-lag NP effects provided a stronger test of the idea that stimuli repetition is not necessary to obtain NP particularly when words are used as stimuli. Notably, a significant reduction in PP was observed in the AR condition with lag compared to without lag condition. These findings can have implications on the predictive mechanisms of retrieval proposed by episodic retrieval account (Neill & Valdes, 1992; Neill et al., 1992; see also May et al., 1995).

In Chapter 3, Experiment 2a and 2b examined the role of distractor processing in identity priming across lag in the DR and IR conditions using a large pool of non-recycled words. Experiment 2a examined short-lag identity priming by repeating the prime distractor word as a subsequent probe in the DR and IR conditions. Experiment 2b examined the longevity of priming effects obtained in Experiment 2a by repeating the probe 151 prime-probe couplets (302 attentional displays) later than its yoked prime display. As expected, the long-lag NP was significant and no different than NP obtained in the short-lag IR condition. Unlike short-lag DR response facilitation, no priming effects were obtained in the long-lag DR condition. It seems likely that the processing mechanisms applied to the distractor in the DR condition are less durable than the processing mechanisms applied to the distractor in the IR condition as no facilitation emerged with lag.

In Chapter 4, Experiment 3a and 3b examined short-lag and long-lag identity priming in the ARDR and IR conditions employing a large pool of non-recycled words. Experiment 3a examined short-lag identity priming by repeating the prime as a subsequent probe in the ARDR and IR conditions. Experiment 3b examined the longevity of priming effects obtained in

Experiment 3a by repeating the probe 151 prime-probe couplets (302 attentional displays) later than its yoked prime display. The long-lag NP was reliably intact and consistently no different than the NP obtained in the short-lag IR condition. However, a reduction in response facilitation was observed in the ARDR condition with lag compared to without lag condition, as in the AR condition.

In line with the distractor inhibition hypothesis and episodic retrieval account, our findings from the short-lag experiments (Experiment 1a, 2a, and 3a) provided a conceptual replication of obtaining NP in the IR condition, PP in the AR condition, and response facilitation in the DR and ARDR conditions (Neumann & DeSchepper, 1991; Stadler & Hogan, 1996) by employing a large pool of non-recycled words. Taking together the long-lag experiments (Experiment 1b, 2b, and 3b), long-lag NP was consistently observed across experiments, PP was observed in the long-lag AR condition, response facilitation was observed in the long-lag ARDR condition, and no priming effects were obtained in the long-lag DR condition. The long-lag NP was consistently no different than NP obtained in the short-lag IR condition across experiments. However, a reduction in response facilitation was observed in both AR and ARDR conditions with lag compared to without lag condition. These long-lag priming effects can be more easily accommodated by the distractor inhibitory hypothesis than episodic retrieval account. For instance, the long-lag NP effects suggest that the act of ignoring and preventing a response to a distractor alters its internal representations (Tipper et al., 1991). Essentially, its status as an attended target (explicit) or ignored distractor (implicit) becomes a component of its representation. For instance, a component of this implicit distractor representation could be that the response to that stimulus is inappropriate. Therefore, NP is observed even with a protracted multi-minute (about 10 minutes) interval and 151 intervening trials. By contrast, the effect of explicit target processing seems to clutter away in the AR and ARDR conditions owing to the intervening stimuli. Lastly, the processing mechanisms applied to the prime distractor in the DR condition seem less durable than the processing mechanisms in the IR condition, as no DR facilitation emerged with lag. Our findings are somehow challenging for the episodic retrieval account which predicts the mechanisms of retrieval in a way that facilitation can emerge at lagged intervals and decay in NP can be observed with lag. It is argued that the episodic retrieval account must re-evaluate their predictions concerning the long-lag priming effects.

Chapter 2

Effect of lag on the manifestation of positive and negative priming employing non-recycled words.

It is acknowledged that few studies have examined the longevity of NP (DeSchepper & Treisman, 1996; Erickson & Reder, 1998; Erickson et al. 2005; Grison et al., 2005; McLennan et al., 2019; Treisman & DeSchepper, 1995) and PP (McLennan et al., 2019) with a protracted multi-minute lag. Among those studies, most researchers employed a large pool of non-recycled stimuli (except Erickson and colleagues) and provided evidence of long-lag NP (except Treisman & DeSchepper). Interestingly, only McLennan et al. successfully obtained long-lag NP with recycled words and also reported a failure to obtain long-lag PP in a follow-up experiment. It is of utmost importance to examine the replicability of McLennan et al.'s (2019) findings as such set result can be challenging for episodic retrieval account which predicts the mechanisms of retrieval in a way that facilitation can emerge at lagged intervals while a decay in NP can be observed with lag (Neil et al., 1992). Perhaps most critically, if McLennan et al. obtained long-lag NP effect is replicable, then it would assert that long-lag NP can be reliably obtained using familiar word stimuli (see Treisman & DeSchepper, 1996).

Henceforth, Neumann et al.'s (1999) experimental set-up was employed (like McLennan et al.) to examine the conceptual replicability of McLennan et al.'s findings. The effect of lag on identity priming was examined across the ignored repetition (IR), attended repetition (AR), and control (CO) conditions using a large pool of non-recycled words. Other than having a different set of stimuli and participants, there were minor changes in display, apparatus, and design with that of Neumann et al. and McLennan et al. Most importantly, current experiments employed a between-subjects design by using lag (short-lag versus long-lag) as a between-subjects variable (unlike McLennan et al. who employed a with-in subjects design). If McLennan et al.'s findings are replicable in the IR condition, such long-lag NP effect will corroborate DeSchepper and Treisman's (1996) findings with novel shapes and can be explained using their view that a single unattended exposure is required to obtain NP. These findings would also provide a stronger test of the idea that stimuli repetition is not necessary to activate distractor representations to an extent that long-lag NP can be observed (Erickson & Reder, 1998; Lowe, 1998; see also Malley & Strayer, 1995) and verify Neumann et al.'s (1999) findings of short-lag NP for non-recycled familiar word stimuli. By implication, such evidence is indispensable to settling an ongoing controversy in the NP literature concerning the necessity of stimuli repetition to obtain NP particularly when words are used as stimuli.

Such findings would be challenging for Treisman and DeSchepper's (1996) view which asserts that the interference from previously stored instances reduces the likelihood of long-lag NP for familiar word stimuli. Perhaps most critically, if no effect of lag on NP is observed (like McLennan et al.), then the findings would challenge the ideas that the probability of the prime distractor being retrieved reduces over time. Lastly, current research would add to the line of inquiry by providing a first empirical test of May et al.'s (1995) assumptions regarding the contexts that induce episodic retrieval (e.g., the AR condition) and would observe a decay in NP with lag. Thus, the novel contributions advocated here is intended as an attempt to expand the NP literature, to reconcile the discrepant findings regarding NP for non-recycled word stimuli, and to pit the predictions of classical NP theories (distractor inhibition hypothesis, episodic retrieval account) concerning the long-lag priming effects.

2.1. Experiment 1a

In line with the distractor inhibition hypothesis and episodic retrieval account, findings can provide a conceptual replication of obtaining PP in the AR condition and NP in the IR condition using non-recycled words (Neumann et al., 1999; Neumann et al., 2018). Such findings will reflect that the magnitude of NP is influenced by the level of task difficulty and the level of competition between the target and distractor stimuli which can obtain NP without the need for stimuli repetition. The argument made (in Chapter 1) is that the noted failures to achieve NP with non-recycled words (e.g., Malley & Strayer, 1995) generally relate to differences in selection cue use of word stimuli. For instance, letter case is argued to make the selection more difficult (compared to colour) and thus likely to increase interference and make NP more likely (e.g., Neumann et al., 1999; see also Neumann et al., 2018). While difficulty might indeed be a factor here, it is also important to be clear that difficulty wasn't manipulated in current experiments and the assumptions regarding the modulation of NP with task difficulty are the impetus for further research. The findings of Experiment 1a also served as a baseline with which to assess the possibility of obtaining the long-lag PP and NP in Experiment 1b, since the same stimuli were used for the long-lag AR and IR conditions except that 151 trials intervene between the prime and its yoked probe display.

2.1.1. Method

2.1.1.1. Participants

Data were collected from 54 students (26 female) from the University of Canterbury New Zealand either for course credit or monetary incentive. Participants were right-handed English monolinguals aged between 18 to 30 years (*M* = 20.23 years, *SD* = 2.57). Furthermore, they had a normal or corrected-to-normal vision and no reported sensory perceptual disability. Participants were excluded if they took part in research employing a similar design. This study received formal approval from the Human Ethics Committee, University of Canterbury.

2.1.1.2. Stimuli and apparatus

Two hundred eighty-eight words were taken from Francis and Kucera (1982) word pool. The word list was created using the Paivio, Yuille, and Madigan's (1968) wordlist online generator (Friendly, 1996) using the following constraints; 1) 5.5 or above rating on imagery and 5.5 or above rating on concreteness[3]; 2) letter count (3 to 11); and 3) neighbourhood size (1 to 3)[4]. Seventy-two words were chosen randomly as probe targets and the remaining 216 words were used as fillers for the word trials (see Appendix A). Another list of 216 words was generated (using the same online wordlist generator) to act as filler words for the non-word (NW) trials. Seventy-two orthographically legal non-words were generated using the WinWord Gen 1.0 program (Duyck, Desmet, Verbeke, & Brysbaert, 2004). WinWord Gen 1.0 program used heuristic NW generation, which meant changing a random letter from the words alternating the location between the early, middle, and late positions. Both word and non-word stimuli were matched on word-length and neighbourhood size.

In both prime and probe, the lowercase target and uppercase distractor were presented one above another pseudo-randomly with a vertical space of 1 pixel separating the top and bottom stimulus. A dual prime-probe display was used to maintain a constant state of selection within a trial and throughout the experiment. By using a dual prime-probe display, inhibition remains active and this also prevents a faster probe response. Fifty percent of the time the target was on the top in prime and probe throughout the experiment. Furthermore, 50% of the time the prime

[3] Imagery and concreteness ratings are based on Paivio et al.'s (1968), seven-point scale.
[4] Neighbourhood size refers to the count of orthographic or phonological neighbours of a word. These ratings are taken from the English Lexicon Project database (Balota et al., 2007).

display was in the centre and 25% of the time either slightly left or right of centre (with a visual angle of 1.5° from the centre); and this held true for each condition. These measures regarding the target position and prime location were taken to enhance the selection difficulty and to increase the possibility of obtaining NP without the need for stimuli repetition. The probe was always displayed centrally on the display. Displays were created using E-Prime 2.0 Professional SP2 program. Stimuli were presented in black colour 20-point Arial font against a white background on a 22-inch Philips Brilliance 220SW widescreen TFT monitor. A Chronos device was used to audio record prime naming responses and probe LD response time featuring 1 ms accuracy.

2.1.1.3. Design

This experiment employed a within-subjects design to examine within-trial identity priming. The three prime-probe conditions were: (1) Attended repetition or AR condition (prime target word was repeated as a subsequent probe target); (2) Control or CO condition (prime target or distractor words were not repeated or related to the probe target and distractor words); (3) Ignored repetition or IR condition (prime distractor word was repeated as a subsequent probe target). There was an equally distributed trial-type percentage each with the stimuli set the size of 24 trials. Along with those 72 word trials, there were 72 NW trials to control the expectancy effects by having an equal proportion of word/NW trials.

Participants were assigned randomly to one of the three versions of the 144 prime-probe couplets. These versions were created by counterbalancing the conditions (AR, CO, IR) using a Latin square design while maintaining the stimuli (prime or probe; target or distractor) and the sequential order of the stimuli and trials. For instance, if a probe target (‘*infant’*) appeared on a trial in the IR condition, the same word would appear as a probe target in the same trial sequence, but in the CO condition in version 2 and in the AR condition in version 3, etc. (see Figure 2.1.). In this way, the probe for each condition was perfectly counterbalanced in the three versions of the experiment.

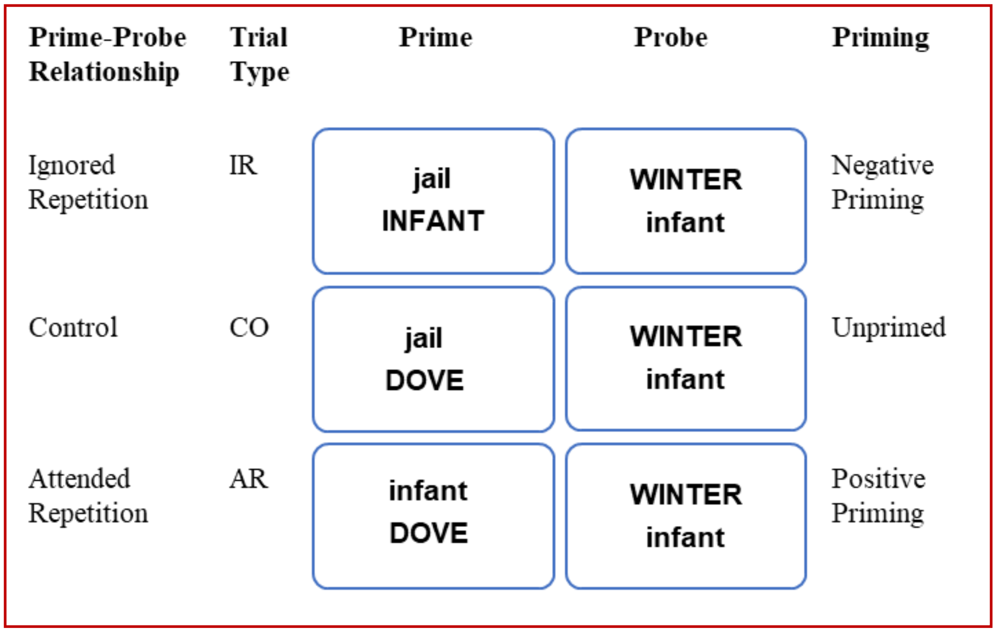


Figure 2.1. Schematic sample trial for the prime probe conditions. When the prime distractor word is repeated as a subsequent probe target in the ignored repetition condition, negative priming can be observed compared to the control condition. Whereas, when the prime target word is repeated as a subsequent probe target in the attended repetition condition, positive priming can be observed compared to the control condition.

A catch trial (145th trial) was presented at the end to test whether the participants had effectively ignored the prime distractor word or not. After the presentation of the prime display in the catch trial (like other trials), an instruction turned up which asked the participant to ‘recall’ the uppercase word (LITERAL) in the preceding display. The recall display lasted for 5000 ms followed by another display in which the participants had to ‘recognize’ the uppercase word of the preceding display out of the three given choices (LIBERAL, LITERAL, LYRICAL).

2.1.1.4. Procedure

Each participant was tested individually on the same desktop in the Cognitive Research Lab I, University of Canterbury. Participants were seated at the viewing distance of 45 cm (approximately) from the display. At the beginning of each session, participants signed an informed consent form. Instructions were shown on the display and were also summarized by the experimenter. Participants were required to name the lowercase word in the first display. Following that the participants were required to click the leftmost key on the Chronos device (*with the right index finger*) if the lowercase item was a word or adjacent key (*with the right middle finger*) if the lowercase item was not a word. Notably, the Chronos device had 5 keys in a row, but the two left-most keys were only used to collect the response time data.

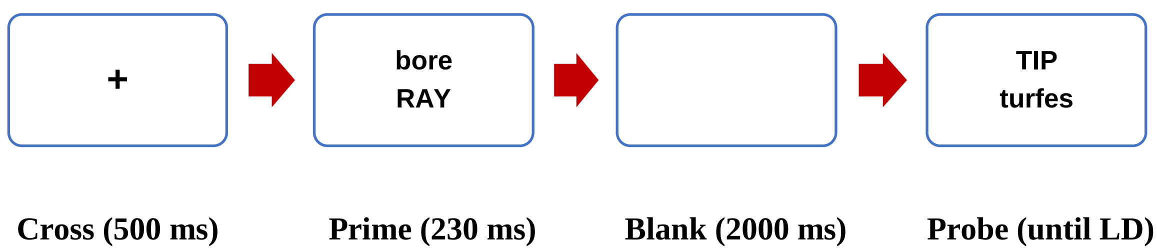


Figure 2.2. Sample non-word trial. In a non-word trial, the probe target is replaced with a pronounceable non-word stimulus. The figure also presents the sequence of events within a prime-probe couplet and the relative duration of each display.

Each participant completed a set of 24 practise trials before the main experiment. During practice, participants received performance feedback on the incorrect LD. The main experiment started with an additional 24 practice trials, 144 testing trials, and a catch trial. The within-trial sequence of events was: (1) fixation cross in the centre for 500 ms; (2) the prime display for 230 ms; (3) blank display for 2000 ms; and (4) the probe display until LD is made followed by the automatic initiation of the next trial (see Figure 2.2.). The experimenter recorded the naming errors on a ‘Naming Response Sheet’ every time the prime target was missed or named incorrectly during the session (see Appendix B for sample naming response sheet). Participants received a self-report ‘Post-Experiment Questionnaire’ at the end of the testing session (see Appendix C). It took almost twenty-five minutes to complete each experimental session.

2.1.2. Results and discussion

The LD response time on a word trial was included in the analysis only when the prime target was appropriately named, and a correct LD was made on the subsequent probe target within 200 ms to 3000 ms. Furthermore, data of participant were excluded from the LD response time analysis, if the overall percentage of trials removed due to having either naming errors, LD errors or LD response time outliers exceed above the pre-set 20%. In this respect, the data of one participant were removed due to having naming errors above the pre-set 20%. Data of one additional participant was excluded due to having LD errors above the pre-set 20%. No data were removed because of having LD response time outliers above the pre-set 20%.

The mean of the median LD response time was recorded for the AR, CO, and IR conditions. A repeated measures ANOVA on the LD response time indicated overall priming effects across conditions (AR, CO, IR), F (2, 102) = 26.343, p =.001, η_p^2 = .34. To further examine the origin of these priming effects, paired sample t-tests were carried out. The NP response time cost (M = 39 ms, SD = 117.63) was observed in the IR condition compared to the CO condition, t (51) = 2.372, p = .022, d = 0.33, demonstrating a NP effect. The PP response time benefit of (M = 102 ms, SD = 142.92) was obtained in the AR condition compared to the CO condition, t (51) = 5.155, p = .001, d = 0.71, demonstrating a PP effect.

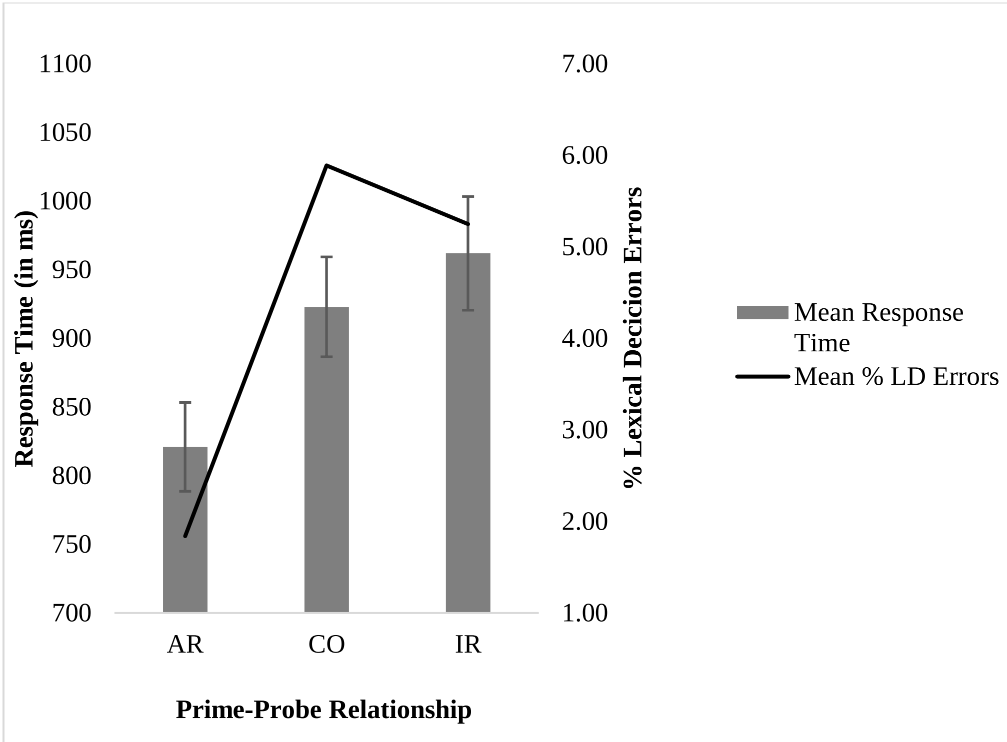


Figure 2.3. Lexical decision (LD) response time (in milliseconds) and percentage of lexical decision errors in the attended repetition (AR), control (CO), and ignored repetition (IR) conditions. Error bars depict standard errors.

The LD errors were analysed in a similar manner. A repeated measures ANOVA on the LD errors showed overall priming effect across conditions (AR, CO, IR), *F* (2, 102) = 8.8381, *p* =.001, η_p^2 = .15. There were no differences (*M* = 0.64 %, *SD* = 8.10) in the LD errors between the IR and CO conditions, *t* (51) = .574, *p* = .569, *d* = 0.08. However, the AR condition produced fewer LD errors compared to the CO condition, *t* (51) = 4.015, *p* = .001, *d* = 0.56, hence demonstrating PP in LD errors (*M* = 4.05 %, *SD* = 7.27). The results were not compromised by speed-accuracy trade-off as there were fewer LD errors in the faster condition (AR) and the difference between the LD errors in the IR and CO conditions was not significant. Eight of 52 participants recognized the uppercase distractor word (LITERAL) from the three given options in the catch trial. A binomial test indicated that the probability of catch correct response (0.15) was no different than would be expected by chance (0.33), p = .499 (two-tailed).

The findings provided a conceptual replication of obtaining PP in the AR condition and NP in the IR condition employing a large pool of non-recycled words (Neumann & DeSchepper, 1991; Stadler & Hogan, 1996). These findings can be easily accommodated using both distractor inhibition hypothesis and episodic retrieval account. By implication, these findings challenge Strayer and colleagues' assumption regarding the necessity of stimuli repetition to obtain NP (Grison & Strayer, 2001; Kramer & Strayer, 2001; Malley & Strayer, 1995; Strayer & Grison, 1999; see also Lowe, 1998). In the current experimental set-up, both target and distractor were displayed in black colour with a minimal vertical space (1 pixel) separating the target and distractor stimulus. Furthermore, a heightened state of selective attention was created by briefly presenting the prime, varying the prime location, varying the target position, and varying prime-probe response requirements (naming, LD). The presence of NP using non-recycled words may entail stronger distractor activation because of a stronger conflict from the prime distractor, requiring enhanced inhibition to counteract it. Hence, it can be argued that the magnitude of NP is influenced by the level of difficulty of the task or the amount of conflict between the target and distractor stimuli. Our results demonstrate that by enhancing those factors, NP can be obtained without the need for stimuli repetition (see also Neumann et al., 1999; Neumann et al., 2018).

2.2. Experiment 1b

The purpose of Experiment 1b was to determine the possibility of obtaining long-lag PP and NP employing non-recycled word by repeating the probe 151 trials later than its yoked prime display in the conditions of interest. There has been some disagreement in the NP literature regarding the necessity of word repetition to obtain long-lag NP. For instance, some researchers found long-lag NP with non-recycled words (McLennan et al., 2019) while others found long-lag NP when the words were repeated multiple time before appearing as a probe (Erickson & Reder, 1998; see also Lowe, 1998; Treisman & DeSchepper, 1996). If McLennan et al.'s long-lag NP effects are replicable, then collectively it will extend Neumann and colleagues (1999, 2018) view that challenge the necessity of word repetition to obtain NP. As mentioned, McLennan et al. a failure to obtain long-lag PP with a protracted multi-minute lag. If McLennan et al. findings in the long-lag AR condition are replicable, then no PP should emerge with lag compared to without lag condition. Such set results can be more easily accommodated by the distractor inhibitory hypothesis than the episodic retrieval account.

2.2.1. Method

2.2.1.1. Participants

Data were collected from 54 (34 female) students (*M* = 20.31 years, *SD* = 3.05) from the University of Canterbury either for course credit or monetary incentive. The inclusion and exclusion criteria to recruit participants were identical across experiments (see Section 2.1.1.1.).

2.2.1.2. Stimuli, apparatus, and design

The present long-lag experiment was identical with its corresponding short-lag experiment (in Experiment 1a) in terms of stimuli, apparatus, and design. The only exception was that there was no within-trial stimulus repetition as the probe target was moved 151 trials later than its yoked prime display. To make meaningful comparisons across experiments, Experiment 1a stimuli were used in their precise role as 'prime or probe' 'target or distractor' in the conditions of interest. For instance, if the stimuli appear as prime and probe on trial 7 in the AR and IR conditions of Experiment 1a; the same prime appeared on trial 7 but its yoked probe was moved to trial 158 to create the long-lag manipulations in Experiment 1b (see Figure 2.4.). To create these long-lag manipulations, an additional list of 504 filler words and 72 filler non-words were generated using the same programs. These lag filler stimuli were matched with the stimuli used in the Experiment 1a on word length and neighbourhood size.

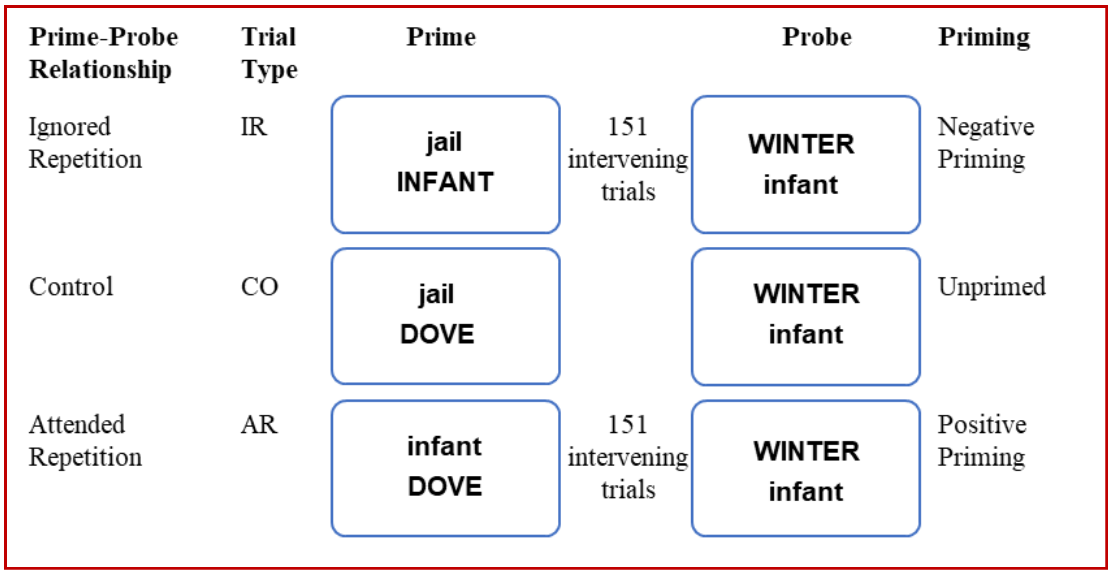


Figure 2.4. Schematic sample trial for the prime-probe conditions. When the prime distractor word is repeated 151 trials later as a probe target in the ignored repetition condition, negative priming can be observed compared to the control condition. Whereas, when the prime target word is repeated 151 trials later as a probe target in the attended repetition condition, positive priming can be observed compared to the control condition.

2.2.1.3. Procedure

There was uniformity in the data collection among experiments (see Section 2.1.1.3.). The only exception was that the main experiment started with 24 practise trials, followed by 144 filler trials, a break, 6 warmup trials, 144 experiment proper testing trials, and a catch trial. It required about fifty minutes to complete the experiment.

2.2.2. Results and discussion

The response time on a word trial was included in the analysis only when the prime target was appropriately named, and a correct LD was made on the pertinent probe within 200 ms to 3000 ms. Data of two participants were removed due to having naming errors above the pre-set 20%. No data were removed because of having LD errors or having LD response time outliers above the pre-set 20%. The mean of the median LD response time was recorded for the AR, CO, and IR conditions. A repeated measures ANOVA on the LD response time indicated long-lag priming effects across conditions (AR, CO, IR), F (2, 102) = 4.0492, p = .02, η_p^2 = .07. To isolate these long-lag priming effects, follow-up paired sample *t*-tests were carried out. The long-lag IR condition was slower than the CO condition, t (51) = 2.022, p = .048, d = 0.28, demonstrating a NP effect (M = 29 ms, SD = 104.18). There were no differences (M = 12 ms, SD = 92.14) in the LD response time between the AR and CO conditions, t (51) = .907, p = .369, d = 0.13.

Similar analyses were carried out on the LD errors. A repeated measures ANOVA on the LD errors indicated no long-lag priming effects across conditions (AR, CO, IR), F (2, 102) = 2.0202, p =.138, η_p^2 = .04. To rule out the possibility of obtaining any priming effects (in particular PP) in the LD error data further analyses were carried out. There were no differences in the LD errors (M = .92, SD = 4.49) between the long-lag IR and CO conditions, t (51) = 1.339, p = .187, d = 0.19. However, the long-lag AR condition produced fewer LD errors relative to the CO condition, t (51) = 2.014, p = .049, d = 0.28, demonstrating a PP effect (M = 1.25, SD = 4.49). The results were not compromised by speed-accuracy trade-off; as there were significantly fewer LD errors in the AR and the difference between the LD errors of IR and CO condition was not significant. A binomial test of the catch trial revealed that the proportion of participants who correctly recognized the uppercase distractor word (0.36) were no different than what would be expected by chance (0.33), $p = .171$ (two-tailed).

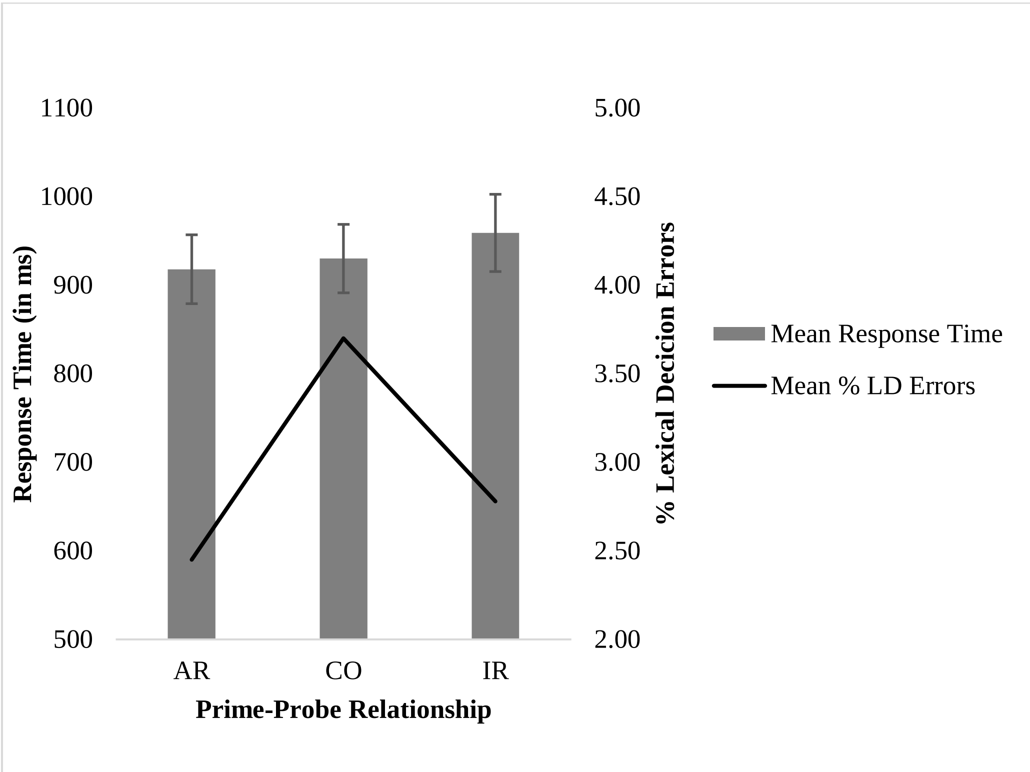


Figure 2.5. Lexical decision (LD) response time (in milliseconds) and percentage of lexical decision errors in the long-lag attended repetition (AR), control (CO), and ignored repetition (IR) conditions. Error bars depict standard errors.

Both long-lag PP and NP effects were successfully obtained with 151 intervening trials and a protracted multi-minute lag (about 10 minutes). Such set results can be more easily accommodated by the distractor inhibitory hypothesis than the episodic retrieval account. For instance, such long-lag NP effects reflect that the cognitive representation of ignored distractor must be altered in some way as to cause the impairment when it reappears as a probe target, even after minutes protracted lag and intervening trials, the stimuli must be undergoing inhibition (Tipper et al., 1991, pg. 57). Some NP researchers added that the reactivation thresholds of suppressed words may have long term consequences, possibly leading to long-lag NP (McLennan et al., 2019). Current evidence corroborates with both arguments that collectively favour inhibition as a proximal cause of NP (see also Li et al., 2017). Our findings together with McLennan et al. are somehow challenging for the episodic retrieval account which predicts the mechanisms underlying the probability of retrieval in a way that facilitation can emerge at lagged interval but a decay in NP can be observed with lag (Neill & Valdes, 1992; Neill et al., 1992), particularly in contexts that induce episodic retrieval (e.g., in the AR condition) the probability of obtaining long-lag NP decreases further still (May et al., 1995). To examine the effect of lag on obtained PP and NP, further analyses were carried out in the next section by using lag (short-lag versus long-lag) as a between-subjects variable.

2.3. Identity Priming and Lag Interaction

Adding a between-subjects variable involving different groups can be compromised by the possibility of response time differences between groups. For example, the participants of the long-lag experiment can be either slower (due to fatigue) or faster (due to the practice effect) compared to that of the short-lag experiment. These possibilities were ruled out as the overall LD response time for the short-lag Experiment 1a (823 ms) was not different than that of the long-lag Experiment 1b (889 ms), t (102) = .630, p = .265, d = 0.12. A 3 (AR, CO, IR) x 2 (short-lag, long-lag) mixed ANOVA on the LD response time indicated priming by lag interaction, F (2, 204) = 9.837, p =.001, η_p^2 = .09. To further examine the origin of this priming by lag interaction mixed ANOVAs were carried out. A 2 (IR, CO) x 2 (short-lag, long-lag) mixed ANOVA indicated no differences in the obtained NP effects, F (1, 102) = .189, p = .664, η_p^2 = .00. A 2

(AR, CO) x 2 (short-lag, long-lag) mixed ANOVA indicated differences with lag compared to without lag condition, F (1, 102) = 14.757, p = .001, η_p^2 = .13 (see Figure 2.6.).

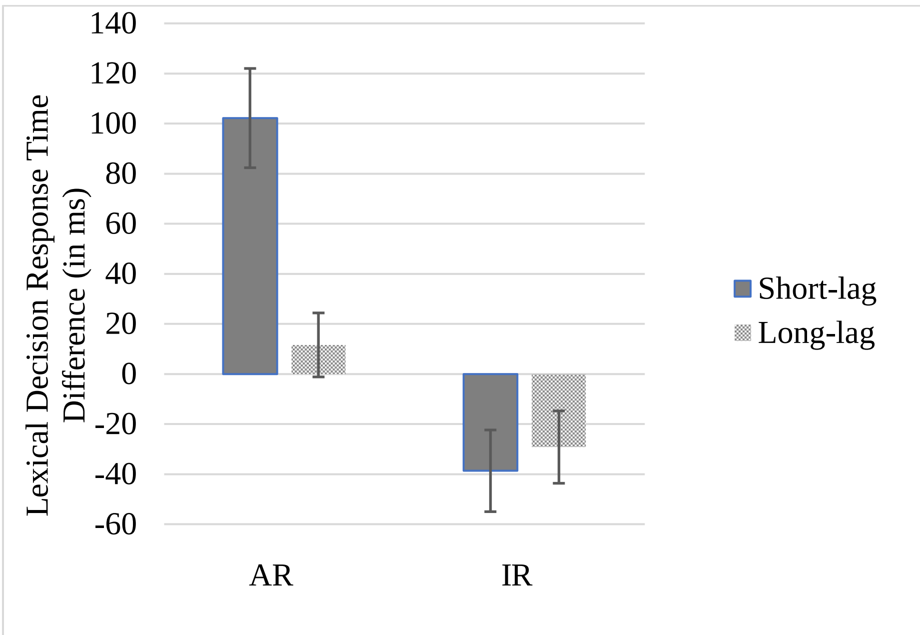


Figure 2.6. Comparison between the lexical decision response time difference scores of the short-lag and long-lag attended repetition (AR) and ignored repetition (IR) conditions. Error bars depict standard errors.

Similar between-subjects analyses were carried out on the LD errors. A 3 (AR, CO, IR) x 2 (short-lag, long-lag) mixed ANOVA on the LD errors indicated priming by lag interaction, F (2, 204) = 3.882, p = .02, η_p^2 = .04. A 2 (IR, CO) x 2 (short-lag, long-lag) mixed ANOVA indicated no differences with lag compared to without lag condition, F (1, 102) = .045, p = .833, η_p^2 = .00. A 2 (AR, CO) x 2 (short-lag, long-lag) mixed ANOVA indicated differences in the obtained PP effects, F (1, 102) = 5.564, p = .020, η_p^2 = .05.

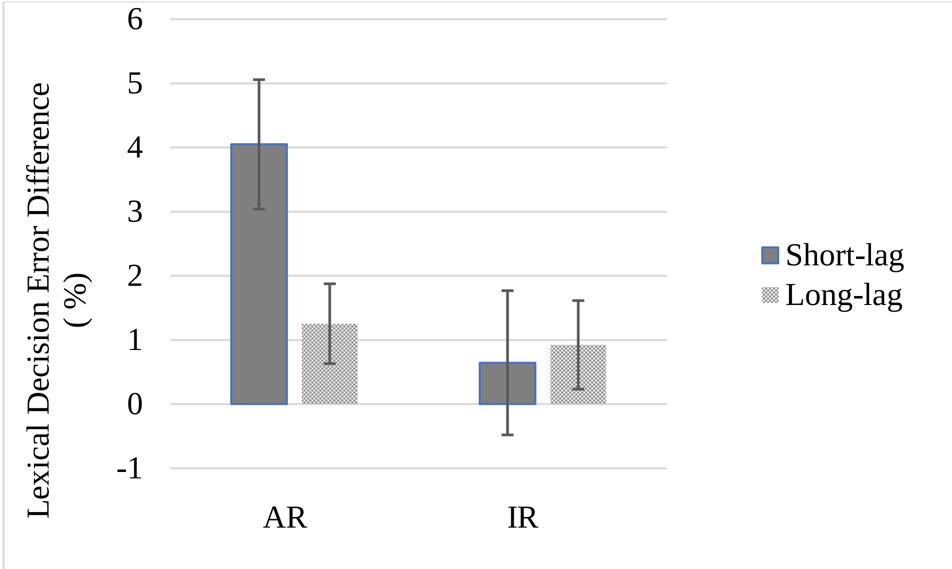


Figure 2.7. Comparison between the lexical decision error difference scores of the short-lag and long-lag attended repetition (AR) and ignored repetition (IR) conditions. Error bars depict standard errors.

To examine the effect of lag on the AR condition, further analyses were carried out on the LD response time difference scores (AR - CO) and LD error difference scores (AR - CO) using independent sample *t*-tests (two-tailed). A reduction was observed in the LD response time of the AR condition with lag compared to without lag condition, t (102) = 3.841, p = .0002, d = 0.75. Similarly, a reduction was observed in the LD errors of the AR condition with lag compared to without lag condition, t (102) = 2.359, p = .021, d = 0.46. Hence, demonstrating a reduction in LD response time and LD errors in the AR condition with lag compared to without lag condition.

The NP obtained in the long-lag IR condition was no different than the NP obtained in the short-lag IR condition (like McLennan et al., 2019). Compared to relative stability in NP over lags, a reduction in LD response time and LD errors was observed in the AR condition with lag compared to without lag condition. Collectively, these findings are in complete contrast with the predicted mechanisms of retrieval proposed by the episodic retrieval account (Neill et al., 1992; Neill & Valdes, 1992). Perhaps most critically, current findings challenge May et al.'s (1995, pg. 48) assumptions as the IR condition was examined with the AR condition, and no decay in NP was observed with lag. Our findings suggest a relative persistence of NP across lag which is apparently independent of experimental context (e.g., the AR condition) suggested by May et al. To pit May et al.'s predictions regarding the effect of context on NP, the distractor repetition (DR) condition will be examined with the IR condition in the follow-up experiment (Experiment 2a and 2b) using the same stimuli and experimental set-up as in current experiments. Such manipulations would provide a systematic analysis of the contexts that induce episodic retrieval (suggested by May et al.) along with with with the replication of the short-lag and long-lag IR conditions. It is expected that long-lag NP can be reliably obtained (in Experiment 2b) and would be consistently no different that NP obtained in the short-lag IR condition (in Experiment 2a), hence challenging the assumptions of May et al.

2.4. Discussion

The results of Experiment 1a showed short-lag PP and NP effects for non-recycled words. The findings obtained for Experiment 1b showed robust long-lag NP (like McLennan et al., 2019) and PP effects (unlike McLennan et al.). The lag comparisons in the AR condition, however, showed long-lag PP to be reduced in comparison to short-lag PP effect. By contrast, the long-lag NP effect was similar across lags (like McLennan et al). Ultimately, these NP results challenge the ideas that a) the stimulus repetition is necessary to activate distractor representations to an extent that NP can be observed (see also Erickson & Reder, 1998; Lowe, 1998), b) interference from previously-stored instances reduces the likelihood of long-lag NP for familiar word stimuli (Treisman & DeSchepper, 1996), c) the probability of the prime processing episode being retrieved reduces over time to obtain NP (Neill & Valdes, 1992; Neill et al., 1992), and d) in contexts that induce episodic retrieval (e.g., the AR condition) the probability of obtaining long-lag NP decreases further still (May et al., 1995).

Interestingly, unlike McLennan et al. (who reported a failure to obtain long-lag PP), long-lag PP was observed in the LD error. To reconcile the discrepant findings, the differences in the experimental set-up were considered. For instance, a salient difference between both studies was in terms of experimental designs. McLennan et al. examined the effect of lag on PP by employing a with-in subjects design. In their experiment, 8% of the trails were of the short-lag AR condition and 8% of the trials were of the long-lag AR condition. Notably, the trials that had with-in trial word repetition (e.g., in the short-lag AR condition) were employed in the first half of their experiment. They obtained PP in the short-lag AR condition (180 ms) and reported a failure to obtain PP in the long-lag AR condition. It is argued that the participants might have developed an expectancy bias of no-word repetition in their experiments over time due to a smaller proportion of trials (8%) that have within-trial word repetition. When the target word is repeated in the short-lag AR condition, an exaggerated response time benefit was observed (compared to ours). By contrast, due to the absence of with-in trial word repetition in the latter half of their experiment, an expectancy bias of no-word repetition inflated over time (compared to the first half of the experiment) which consequently reduced the possibility of obtaining long-lag PP effects in McLennan et al.'s experiment. To test the accuracy of the above contentions, the LD response time and LD errors in the first half of the McLennan et al.'s long-lag AR condition can be compared with that of the latter half. Such analysis can confirm whether McLennan et al. failed to obtain long-lag PP altogether or the expectancy bias of no-word repetition reduced long-lag PP over time to an extent that it was eliminated. However, in current experiments, a between-subjects design was employed and the underlying mechanisms of with-in trial word repetition were held constant within an experiment as a possible control to obtain process-pure priming. For example, there was no within-trial word repetition in the Experiment 1b (long-lag experiment) and obtained long-lag PP effects reflects the existence of long-lag response facilitation. Further research could be done to examine the replicability of current or McLennan et al.’s findings in the long-lag AR condition. In particular, the research could be done to examine the effect of experimental design (with-in subjects versus between subjects) in obtaining long-lag PP by employing non-recycled stimuli.

Another methodological difference that may account for the discrepant findings was in terms of duration of the prime display. The prime display lasted for 230ms in current experiments and for 200ms in McLennan et al.’s experiment. One could assume that attending to the prime target for a relatively longer duration might have altered the internal representation in a way that when it reappears 151 trials later, it can obtain (albeit reduced) long-lag PP effects. Notably, such assumptions remain somewhat speculative and perhaps the impetus for further study. Lastly, to argue that the long-lag PP effects are observed (albeit reduced) when the IR condition is included in the experimental context versus not (e.g., McLennan et al., 2019) also requires further investigation. To examine the effect of context (e.g., the IR condition) on PP, then together with our Experiment 1a and 1b, the AR and IR conditions can be examined separately in one short-lag and one corresponding long-lag experiment in a series of four experiments. If no differences are observed in NP across lag, then together with McLennan et al. (2019) it will strengthen our assumption that NP is relatively independent of the contextual effects (see also May et al., 1995; Neill & Valdes, 1992). By contrast, if the AR condition is contextually independent (like the IR condition), then a reduction in PP can be observed with lag as in Experiment 1b. Perhaps most critically, if long-lag PP is observed (albeit reduced) it would further confirm our assumption that McLennan et al. reported failure to obtain long-lag PP can be possibly due to expectancy bias of no-word repetition in later part of their experiments. These findings are indispensable to unravel whether the long-lag PP was observed or eliminated by chance.

2.4.1. Theoretical implications of long-lag PP and NP

Together with McLennan et al.'s findings, the set results can be more easily accommodated by the distractor inhibitory hypothesis than the episodic retrieval account. The reason the inhibition theory comes out better is that exactly matching stimuli (e.g., in the AR condition) should be more likely to elicit a prior episode and cause a PP effect at lagged intervals. Whereas, a mismatching stimulus that goes from the uppercase distractor to the lowercase target (e.g., in the IR condition) should be much less likely to cause an NP effect with a protracted multi-minute lag and intervening trials. Yet no effect of lag is observed on NP and a reduction in PP (or absence of PP in McLennan et al.'s findings) was observed with lag compared to without lag condition. Ignoring something once implicitly seems to affect its threshold for responding, later on, it doesn't seem to be interfered with; otherwise, no long-lag NP would be produced. On the other hand, attending to something explicitly makes it highly susceptible to subsequent interference from all the naming and lexical decisions participants make before the 151st trial appears (about 10 minutes later). This is why long-lag PP is reduced in our case or eliminated in McLennan et al.'s findings. By contrast, the IR trials are preserved and not susceptible to either further implicit or explicit memories from all the stimuli attended and ignored before the 151st trial appears. Because the long-lag PP effect was reduced relative to the long-lag NP effect, the assumption is that different mechanisms may underlie long-lag facilitation versus long-lag inhibition.

Most importantly, the long-lag NP was no different than NP obtained in the short-lag IR condition (like McLennan et al.). These findings are challenging for the episodic retrieval account which predicts a decay in NP with lag (Neill & Valdes, 1992; Neill et al., 1992). For instance, Neill and Valdes (1992) examined the time course of NP by employing a letter matching the task. Participants in their experiments were shown a string of five uppercase flanker letters centrally on the display and were required to judge whether the second and fourth letters were the same or different by pressing corresponding keys. The stimuli remained on the display until the letter identification (same, different) was made followed by an automatic initiation of the next trial with a randomly selected lag of 500, 1000, 2000, 4000, or 8000 ms. Neill and Valdes observed NP across lags but the obtained NP effect was largest at the shortest lag (500 ms). They argued that long-lag NP effects reflect a relative permanence of episodes, however, the probability of retrieval declines with lag, consequently leading to having decay in NP with lag (see also Neill et al., 1992, pg. 994). Interestingly, when Neill and Valdes eliminated 500 ms lag from their analysis, their findings replicated Tipper et al.'s (1991) findings of having no effect of lag on NP (see Neill & Valdes, 1992, pg. 569). They agreed that the greatest change in NP occurred between 500 and 1000 ms and admitted that it is difficult to explain no change in NP at lags beyond 500 ms (Neill & Valdes, 1992, pg. 570).

However, to cater the conflicting evidence, Neill et al. (1992, pg. 994) added that the studies that employed a between-subjects design would observe no decay in NP with lag as participants adapt to a constant retention interval and a stable probability of retrieval (e.g., Hasher, Stoltzfus, Zacks, & Rypma, 1991; Tipper et al., 1991). They added that decay in NP can be observed in studies that employ a within-subjects design as the lags are randomized within an experiment. May et al. (1995, pg. 46) rejected Neill et al.'s above assumptions and commented that experimental design is not a critical factor in determining the persistence versus decay of NP with lag. Rather than rejecting Neill et al.'s above assumptions altogether, it is argued that the assumptions concerning the stable probability of retrieval seem reasonable for the NP experiments that employed a between-subjects design and manipulated lag without intervening stimuli (e.g., Hasher et al., 1991). However, when the long-lag NP is examined with numerous intervening trails, participants are not vulnerable to develop a constant retention interval and a stable probability of retrieval as the trials are pseudo-randomized in the experiment. For instance, McLennan et al. (2019) examined the longevity of NP effects by employing a with-in subjects design. Contrary to Neill et al.'s predictions, they obtained robust NP effects and also observed no decay in NP with protracted multi-minute lag and 151 intervening trials. Our findings corroborate McLennan et al.'s findings, hence collectively asserting that experimental design is not a critical factor in determining the persistence versus decay of NP, particularly when the long-lag NP manipulation involves intervening trials (see also DeSchepper & Treisman, 1996; Tipper et al., 1991).

However, to understand why Neill and colleagues reported decay in NP trend; an alternate account has been proposed. Neill and colleagues employed a with-in subjects design and manipulated lags without intervening stimuli in their experiments (e.g., Neill & Valdes, 1992; Neill & Westbury, 1987; Neill et al., 1992). Although the presence of long-lag NP in Neill and colleagues' experiments reflect a relative permanence of the stored episodes. However, to assume that the probability of retrieval declines with lag seems farfetched; as the decay in NP trend observed by Neill and colleagues was not steady across lags but was rather obtained due to asymmetrically large NP at the shortest lag (500 ms). It is argued that such decay in NP trend seems to reflect dissipating distractor inhibition instead; particularly in contexts when the lags were randomised and manipulated without intervening stimuli (see also Tipper et al., 1991). Such an explanation can effortlessly accommodate the asymmetrically large and inflated NP Neill and colleagues obtained at the shortest lag (500 ms) as the residual inhibition is strongest immediately. This account of Neill and colleagues obtained decay in NP trend is different from their account but provides a plausible account of their findings. In a nutshell, it is argued that the episodic retrieval account must re-evaluate their assumptions concerning the predicted mechanisms of retrieval (Neill & Valdes, 1992) and the contexts that induce episodic retrieval (May et al., 1995). Contrary to their predictions, the persistence of NP with a protracted multi-minute lag seems to be more robust findings. Such findings suggest that the act of preventing a response alters the internal representation of distractor to an extent that NP can be observed even with minutes protracted lag and intervening trials. Thus, when long-lag NP effects are observed, there may be no active inhibition processes present, but only the results of that prior inhibitory processing. Lastly, this chapter also highlights the effect of experimental features and procedural contexts (e.g., selection cue, number of repetitions, intervening trails, etc.) that can modulate the manifestation of NP. Henceforth, careful consideration must be given before interpreting the obtained NP effects (see also Cesario, 2014).

2.5. Conclusion

Findings of Experiment 1a provided a conceptual replication of obtaining within-trial PP and NP employing non-recycled words. Priming effects obtained in Experiment 1a were successfully obtained when the probe appeared 151 trials later than its yoked prime display in Experiment 1b. These findings assert that long-lag NP can be reliably obtained using non-recycled familiar words. Unlike the traditional view, the inhibition of irrelevant distractor information seems pervasive and robust even if the prime distractor word is repeated only once 151 trials later as a probe target (see also Li et al., 2017; Wu & Thierry, 2017). The set results can be more easily accommodated by the distractor inhibitory hypothesis than the episodic retrieval account. Contrary to the predictions of episodic retrieval account, our findings suggest that the task irrelevant distractor processing seems pervasive to obtain NP at lagged intervals, while the effect task relevant target processing seems to diminish with lag. Because the long-lag PP effect was reduced relative to the long-lag NP effect, the assumption is that different mechanisms may underlie long-lag facilitation versus long-lag inhibition.

Chapter 3

Role of distractor processing in short-lag and long-lag identity priming.

Current experiments were designed to further investigate the role of implicit distractor processing by repeating the prime distractor word as a probe target in the IR condition and as a probe distractor in the DR condition, with and without lag as previously. In line with the distractor inhibition hypothesis and episodic retrieval account, the results can provide a conceptual replication of obtaining with-in trial NP in the IR condition and response facilitation in the DR condition (Neumann & DeSchepper, 1991; Stadler & Hogan, 1996). There are two ongoing debates in the NP literature concerning identity priming in the DR condition. Firstly, some researchers assert that the temporal discrimination model predicts response cost in the DR condition (Frings & Wuhr, 2007; see also Mayr & Buchner, 2007; McLennan et al., 2019; Pritchard & Neumann, 2011). Secondly, Frings and colleagues (2007; see also Frings 2011) observed response cost in the DR condition faces mounting counterevidence (e.g., Frings & Wühr, 2007; Ihrke, Behrendt, Schrobsdorff, Herrmann, & Hasselhorn, 2011; Neumann & DeSchepper, 1991; Stadler & Hogan, 1996; see also Nett, Bröder, & Frings, 2016; Pramme, Dierolf, Naumann, & Frings, 2015; Rothermund et al., 2005; Schrobsdorff, Ihrke, Behrendt, Herrmann, & Hasselhorn, 2012). In the following section, both of these ongoing debates will be discussed in detail.

Frings and Wuhr (2007) argued that the temporal discrimination model predicts response cost in the DR condition. Despite noting that the proponents of the model observed response facilitation in the distractor-repeat trials (e.g., Milliken, Joordens, Merikle, & Seiffert, 1998, Experiment 5), they criticised the temporal discrimination model for offering no clear explanation for their finding[5]. Interestingly, Milliken and colleagues neither examined nor discussed the DR condition as they sought to provide a method of explaining NP in a context in which selection against a prime distractor was not required (unlike the distractor inhibition hypothesis and episodic retrieval account). To demonstrate this, Milliken and colleagues (1998) repeated a singularly presented white prime[6] (unattended, unmasked) as a red probe target or as a green probe distractor in their experiments. They observed response facilitation in the distractor-repeat trials and response impairment in the target-repeat trials. They argued that priming is an "*emergent consequence of a discrimination process*" which has an attentional basis. They added that a probe response categorized 'old' is retrieved from the memory and the probe response categorized 'new' relies on perceptual analysis. Where ambiguity in this temporal discrimination process can delay performance (Milliken et al., 1998; see also Healy & Burt, 2003). Milliken and colleagues earlier work didn't sketch out the two-process idea well which resulted in some criticism particularly concerning the DR condition (e.g., Frings & Wuhr, 2007; see also Mayr & Buchner, 2007; McLennan et al., 2019; Pritchard & Neumann, 2011).

It seems likely that Frings and Wuhr were misled by the title of Milliken and colleagues Experiment 5 "Repeated distractors". However, to understand why Frings and Wuhr assumed that the model predicts response cost in the DR condition, it can be reasoned that the temporal discrimination model wasn't sufficiently clear on one issue. That is whether the two key processes (attentional set, automatic retrieval) are dependent or independent. For instance, based

5 Frings and Wuhr added that the model considers the compatibility of prime-probe targets alone to predict response facilitation (e.g., in the AR condition) and won't consider the compatibility of prime-probe distractor to predict response facilitation in the DR condition (Frings & Wuhr, 2007, pg. 168-169, 176; see also Frings, Schneider, & Fox, 2015, pg. 1580).

6 Some NP researchers commented that the participants in Milliken and colleagues' experiments responded to probe target alone which can implicate that the prime might be suppressed (as per inhibition theorists) or a 'do-not response' (as per retrieval theorists) tag might be attached to it (Mayr & Buchner, 2007, pg. 39; see also Tipper, 2001, pg. 333).

on Milliken et al.'s Figure 6 it can be assumed that attention and retrieval are dependent and might affect both target-repeat and distractor-repeat trials in a similar fashion (i.e., slowing response for both). To accommodate both attention and retrieval, the temporal discrimination model seems to points in the right direction. However, the key is to think of the two processes; attention and retrieval; as separate from one another. For instance, the automatic retrieval facilitates responses to the AR condition, and attention set favouring novelty slows responses to the IR conditions (while also speeding performance for DR conditions). Perhaps most critically, the part of Milliken and colleagues' paper that comes closest to capturing the DR effects is the idea that there is a fundamental old/new discrimination that occurs upon the stimulus onset, and attention favours new over old (see Milliken et al., 1998, pg. 219). By the view, when the unattended prime appears as a probe distractor (in the DR condition), attention tends to orient toward the 'new' probe target rather than the 'old' probe distractor, which helps performance overall. The temporal discrimination model recent work did point out that the two-processes can operate separately (D'Angelo, Thomson, Tipper, & Milliken, 2016); however, the model stretched way beyond the context of NP (e.g., Spadaro, He, & Milliken, 2012). If pushed on this issue, it is argued that the temporal discrimination model probably doesn't account for all the relevant results (e.g., Neumann & DeSchepper, 1991; Stadler & Hogan, 1996), and the DR effect is an important one to sort out.

Interestingly, the researchers that obtained response cost in the DR condition didn't employ the temporal discrimination model to accommodate their findings (Frings, 2011; Frings et al., 2007). They used the response retrieval variant of the episodic retrieval account instead. For instance, Frings et al. (2007) employed a letter flanker task using a small pool of recycled stimuli (D, F, J, K) and examined identity priming across the AR, DR, ARDR, and CO conditions. They reported response facilitation in the target repeat (AR, ARDR) conditions and response cost in the DR condition (see also Frings, 2011). Frings et al. argued that the target and distractor are stored with a response bound to all stimuli in the form of a stimuli-response association. They added that when the stimuli are repeated, the stored stimuli-response association is retrieved which can either facilitate or delay probe processing depending on the compatibility between the retrieved (prime) and current (probe) responses. For example, the retrieved stimuli-response association delays probe processing in the DR condition due to the response change owing to the employment of different prime-probe targets (Frings et al., 2007; see also Frings & Wuhr, 2007).

To cater mounting counter-evidence, Frings et al. argued that when the target is selected against a distractor, it can help in the selection of the next target with the same distractor (e.g., in the DR condition) due to sequence effect. Interestingly, Frings et al.'s findings in the DR condition is also incompatible with other proponents of the response retrieval account (e.g., Ihrke et al., 2011; Rothermund et al., 2005). To settle this controversy, Ihrke et al. (2011) argued that Frings et al.'s employment of letter flanker task might have reduced the discrimination between the target and distractors stimuli, which consequently lead to obtaining response cost in the DR condition. Notably, Ihrke et al.'s assumption to elucidate Frings et al.'s response cost in the DR condition is also problematic as it fails to accommodate the DR facilitation obtained in a relatively similar experimental context (e.g., Stadler & Hogan, 1996). It is argued that NP researchers examined identity priming in the DR condition by employing a small pool of recycled stimuli. Using a small pool of recycled stimuli together with identical prime-probe response requirements can be a source of the problem in some of these experiments (Henson, Eckstein, Waszak, Frings, & Horner, 2014; Neumann & Levin, 2018). In this respect, current experiments would provide an empirical opportunity to circumvent this potential confound as the DR condition was examined across lag using a large pool of non-recycled words and different prime-probe (naming, LD) response requirements, as in our previous experiments (see also Nett et al., 2016). Most importantly, the longevity of identity priming in the DR condition was examined for the very first time with a protracted multi-minute lag and 151 intervening trials. Current manipulations would also allow a direct replication for the NP effect obtained in Chapter 2 and would further pit the predictions of May et al. (1995) concerning the contexts (e.g., the DR condition) that induce episodic retrieval and would obtain a decay in NP with lag.

3.1. Experiment 2a

In the current experiment, short-lag identity priming was examined in the DR and IR conditions using the same stimuli and design as in the previous experiments. The prime distractor word was repeated as a subsequent probe within the same prime-probe couplet without intervening stimuli in the DR and IR conditions. In line with the distractor inhibition hypothesis and episodic retrieval account, it is expected that the findings will provide a conceptual replication of obtaining response facilitation in the DR condition and NP in the IR condition (Neumann & DeSchepper, 1991; Schrobsdorff et al., 2012; Stadler & Hogan, 1996) employing word stimuli (Frings & Wühr, 2007) and varying prime-probe task response requirements (Nett et al., 2016). Such findings can have implications on the temporal discrimination model and would suggest attentional set and automatic retrieval be independent of one another. The findings of Experiment 2a also served as a baseline with which to assess the possibility of obtaining long-lag identity priming in Experiment 2b, since the same stimuli were used for the long-lag DR and IR conditions except that 151 trials intervene between prime distractor and its yoked probe display, as previously.

3.1.1. Method

3.1.1.1. Participants

Forty-two (25 female) students (*M* = 20.84 years, *SD* = 3.04) from the University of Canterbury participated either for course credit or monetary incentive. The inclusion and exclusion criteria to recruit the participants were identical across experiments (see Section 2.1.1.1.).

3.1.1.2. Stimuli, apparatus, and design

Identity priming was examined employing a large pool of non-recycled words with repetition only once to fulfil the constraints of the DR and IR conditions (see Figure 3.1.). Experiments were identical in stimuli, apparatus, and design (see Section 2.1.1.2.).

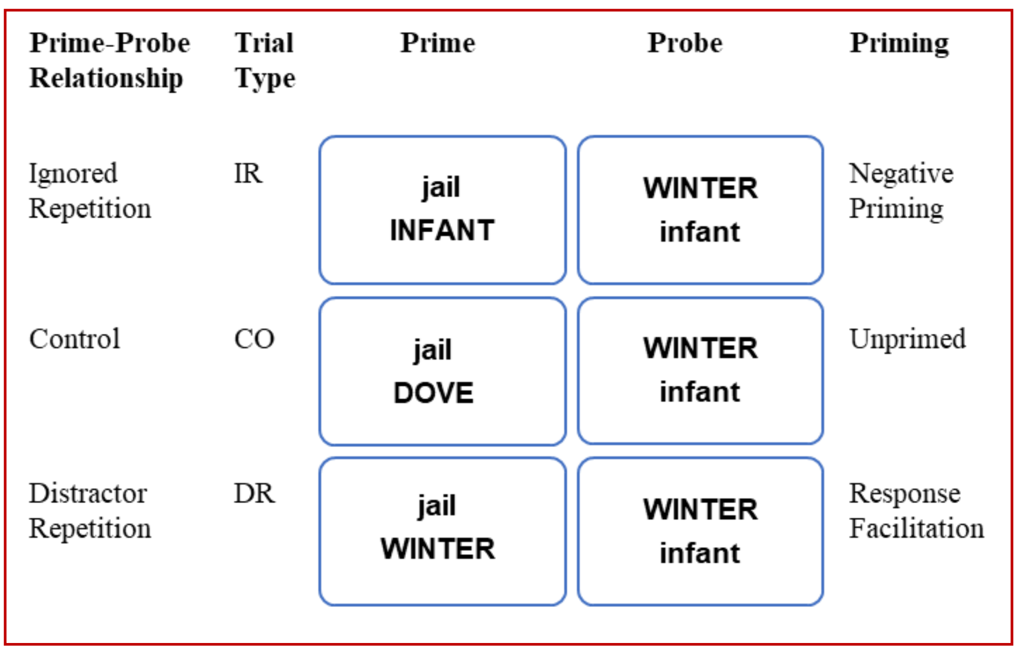


Figure 3.1. Schematic sample trial for the prime probe conditions. When the prime distractor word is repeated as a subsequent probe target in the ignored repetition condition, negative priming can be observed. Whereas, when the prime distractor word is repeated as a subsequent probe distractor in the distractor repetition condition; response facilitation can be observed.

3.1.1.3. Procedure

There was uniformity in the procedures among experiments (see Section 2.1.1.3.). The main experiment started with 24 practise trials, followed by 144 experiment proper testing trials, and a catch trial. It required about twenty-five minutes to complete the experiment.

3.1.2. Results and Discussion

The LD response time on word trials was included in the analyses only when the prime target was correctly named, and a correct LD was made on the subsequent probe target within 200 to 3000 ms. Data of one participant were removed due to having naming errors above the pre-set 20%. No data were removed because of having LD errors above the pre-set 20%. Furthermore, data of 3 additional participants were removed due to having LD response time outliers above the pre-set 20%. The mean of the median LD response time was recorded for each of the conditions of interest. A repeated measures ANOVA on the LD response time indicated overall priming across conditions (DR, CO, IR), F (2, 74) = 7.6384, p = .001, η_p^2 = .17. To isolate these priming effects further analyses were carried out using paired sample t-tests. The NP response time cost (M = 43 ms, SD = 130.87) was observed in the IR condition compared to the CO condition, t (37) = 2.027, p = .05, d = 0.33, demonstrating a NP effect. The LD response time on the DR condition was faster than the CO condition, t (37) = 2.172, p = .036, d = 0.35, demonstrating response facilitation (M = 31 ms, SD = 87.50) in the DR condition.

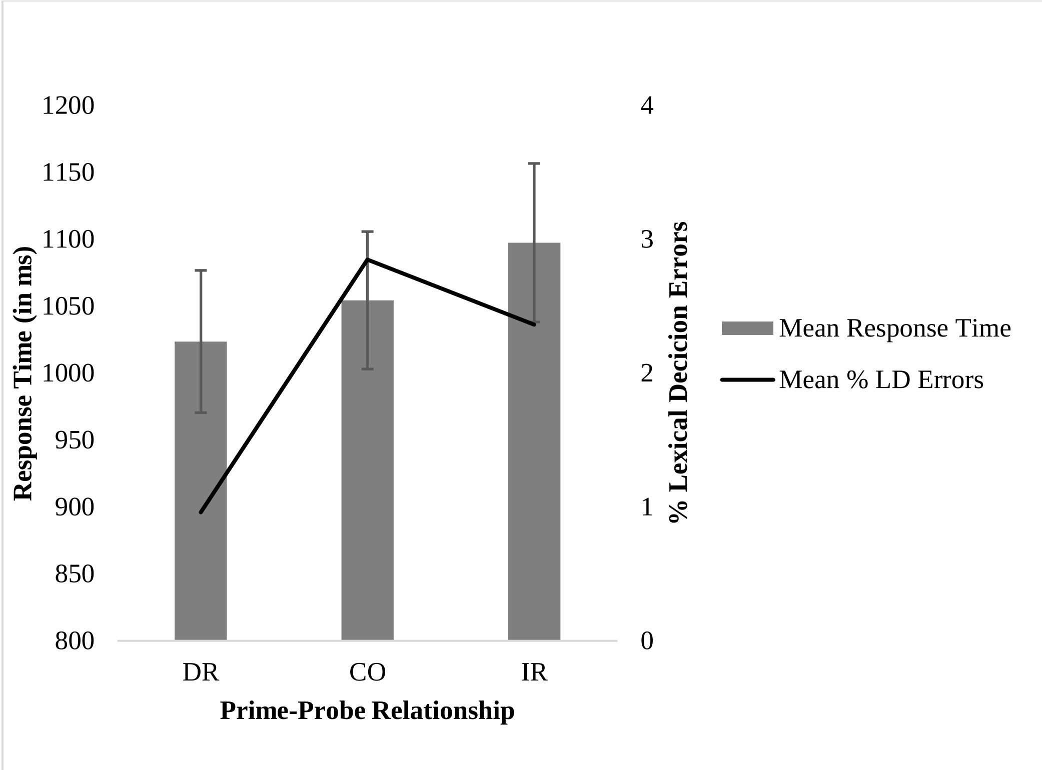


Figure 3.2. Lexical decision (LD) response time and percentage of lexical decision errors in distractor repetition (DR), control (CO), and ignored repetition (IR) conditions. Error bars depict standard errors.

The LD errors were analysed in a similar manner. A repeated measures ANOVA on the LD errors indicated overall priming across conditions (DR, CO, IR), F (2, 74) = 4.6647, p =.012, η_p^2 = .11. Further analysis indicated no differences (M = 0.49 %, SD = 3.75) in the LD errors between the IR and CO conditions, t (37) = .801, p = .428, d = 0.13. However, the DR condition produced fewer LD errors relative to the CO condition, t (37) = 2.688, p = .011, d = 0.44, demonstrating DR response facilitation in LD errors (M = 1.89 %, SD = 4.33). The results were not compromised by speed accuracy trade-off as there were significantly fewer LD errors in the faster condition (DR) and the difference between the LD errors of the IR and CO condition was not significant. The binomial test of the catch trial revealed that the proportion of participants who correctly recognized the uppercase distractor (0.26) was no different than what would be expected by chance (0.33), p = .427 (two-tailed).

In line with the distractor inhibition hypothesis and episodic retrieval account, the findings provided a conceptual replication of obtaining within-trial NP in the IR condition and response facilitation in the DR condition (Frings & Wühr, 2007; Ihrke et al., 2011; Neumann & DeSchepper, 1991; Schrobsdorff et al., 2012; Stadler & Hogan, 1996). These findings add to the theoretical continuum by observing the DR response facilitation in an experiment in which a large pool of non-recycled words was employed along with varying prime-probe response requirements. Notably, such findings cannot be accommodated employing the response retrieval account as the response requirements were not repeated between prime (naming) and probe (LD) to modulate priming (see also Henson et al., 2014). Similar findings were reported by Nett et al. (2016) who required participants to use different hands to perform the prime and probe task. Given that motor programs could not be transferred between the prime and probe, the results showed DR facilitation compared to the CO condition. Taken together, these findings not only provided counter-evidence against the response cost reported by Frings and colleagues in the DR condition (2007, 2011) but also demonstrate the priming effects that cannot be explained using the response retrieval account.

3.2. Experiment 2b

The purpose of Experiment 2b was to determine the possibility of obtaining long-lag priming effects since the same stimuli were used for the long-lag DR and IR conditions except 151 trials intervene between the prime distractor word and its yoked probe display. It is expected that NP can be successfully observed in the long-lag IR condition, as previously. Furthermore, if the DR condition is similar to the IR condition in terms of durability, then it should produce DR facilitation with lag. On the other hand, if the processing mechanisms applied to the prime distractor in the DR condition are less durable than the processing mechanisms of the IR condition, then no DR facilitation should emerge with lag. Notably, it is the first independent corroboration of examining identity priming in the DR condition with a protracted multi-minute lag and intervening trials.

3.2.1. Method

3.2.1.1. Participants

Fifty-seven (41 female) students (*M* = 19.67 years, *SD* = 3.01) were recruited from the University of Canterbury as participants either for course credit or monetary incentive. The inclusion and exclusion criteria to recruit participants were identical across experiments (see Section 2.1.1.1.).

3.2.1.2. Stimuli, apparatus, and design

The present long-lag manipulation was identical with its corresponding short-lag manipulation (in Experiment 2a) in terms of stimuli, apparatus, and design. The only exception was that there was no within-trial stimulus repetition as the probe was moved 151 trials later than its yoked prime display in the conditions of interest. For instance, if the stimuli appear as prime and probe on trial 7 in the DR and IR conditions of Experiment 2a; the same prime display appeared on trial 7 but its yoked probe was moved to trial 158 to create the long-lag DR and IR manipulations in Experiment 2b (see Figure 3.3.). To create these long-lag manipulations, additional stimuli from Experiment 1b were used as lag fillers to create current long-lag manipulations (see Section 2.2.1.2.). To make meaningful comparisons, the stimuli were used in their precise role while maintaining the sequential order of stimuli and trials across experiments.

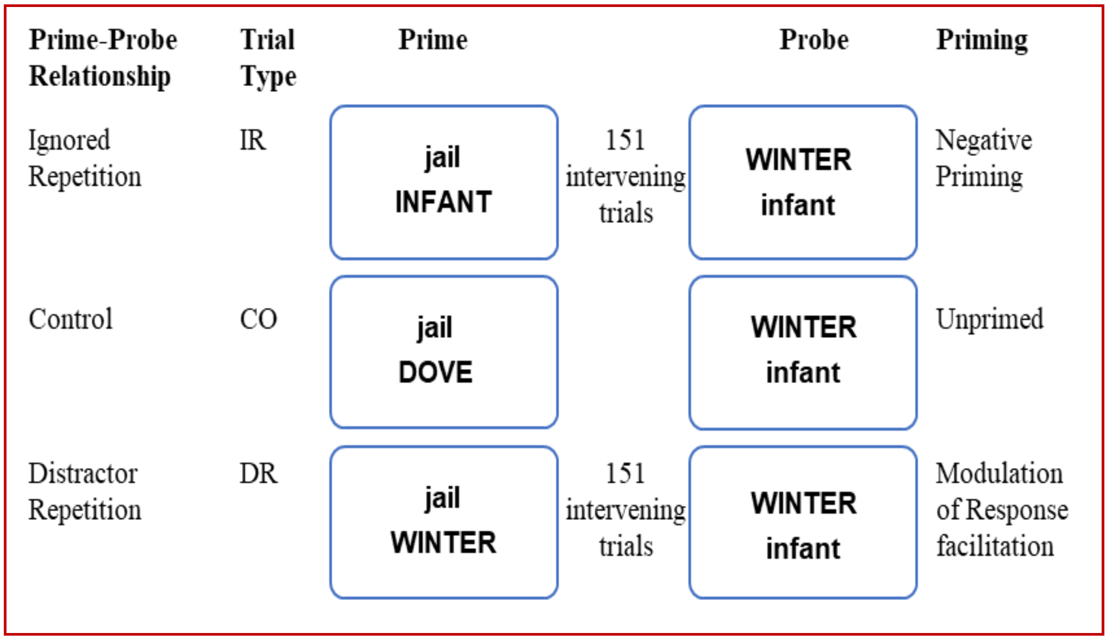


Figure 3.3. Schematic sample trial for the prime probe conditions. When the prime distractor word is repeated 151 trials later as a probe target word in the ignored repetition condition, negative priming should be observed. However, modulation of response facilitation can be observed when the prime distractor word is repeated 151 trials later as the probe distractor in the distractor repetition condition.

3.2.1.3. Procedure

There was uniformity in the data collection among experiments (see Section 2.1.1.3.). The main experiment started with 24 practise trials, followed by 144 filler trials, a break, 6 warm-up trials, 144 experiment proper testing trials, and a catch trial. It required about fifty minutes to complete the experiment.

3.2.2. Results and Discussion

The LD response time on word trials was included in the analyses only when the prime target was appropriately named, and a correct LD was made on the pertinent probe within 200 to 3000 ms. The data of one participant were taken out due to having naming errors above the pre-set 20%. Furthermore, the data of one additional participant were taken out due to having LD errors above the pre-set 20%. No participant was excluded because of having LD response time outliers above the pre-set 20%. The mean of the median LD response time was recorded for each of the DR, CO, and IR conditions. A repeated measures ANOVA on the LD response time indicated overall long-lag priming effects across conditions (DR, CO, IR), F (2, 108) = 3.1877, p = .045, η_p^2 = .05. Additional follow-up paired sample t-tests were carried out to isolate these long-lag priming effects. The NP response time cost (M = 50 ms, SD = 160.49) was observed in the long-lag IR condition compared to the CO condition, t (54) = 2.292, p = .026, d = 0.31. However, no differences (M = 27 ms, SD = 139.07) were observed in the LD response time between the long-lag DR condition and CO condition, t (54) = 1.414, p = .163, d = 0.19.

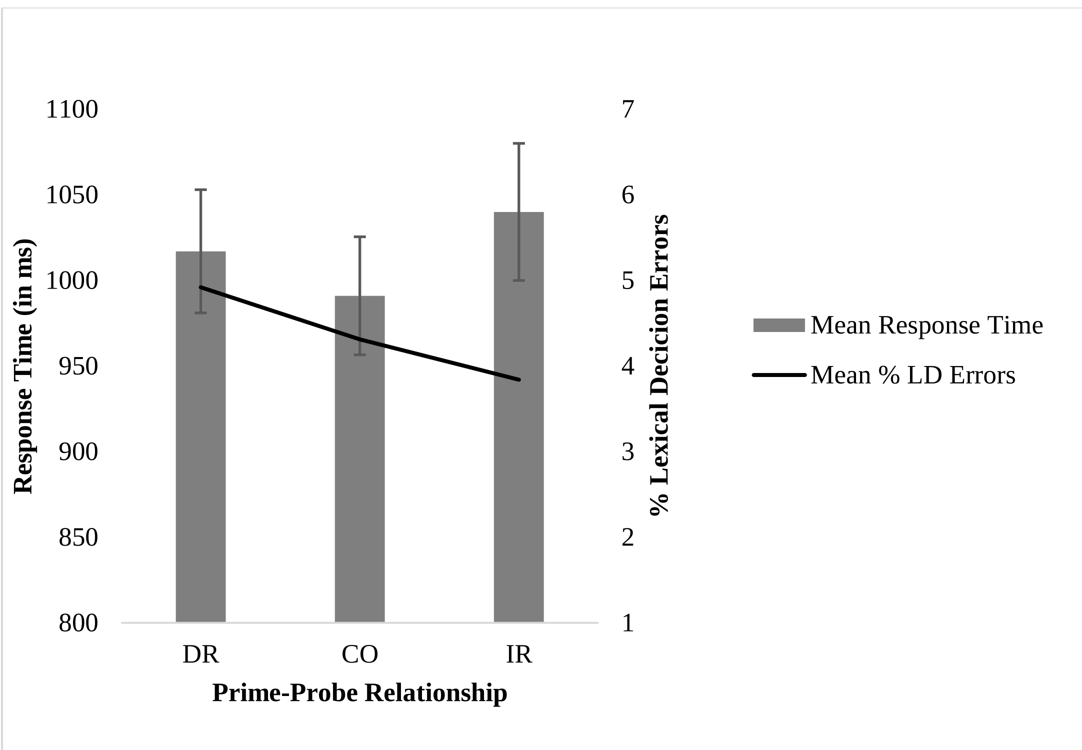


Figure 3.4. Lexical decision (LD) response time and percentage of lexical decision errors in long-lag distractor repetition (DR), control (CO), and ignored repetition (IR) conditions. Error bars depict standard errors.

The LD errors were analysed in a similar manner. A repeated measures ANOVA on the LD errors indicated no long-lag priming effects across conditions (DR, CO, IR), F (2, 108) = 1.2778, p =.282, η_p^2 = .02. These findings also indicate that the LD response time was not compromised by speed accuracy trade-offs. The binomial test of the catch trial revealed that the proportion of participants who correctly recognized the uppercase distractor (0.40) was not different than would be expected by chance (0.33), p = .084 (two-tailed).

As expected, NP was successfully obtained when the prime distractor word was repeated 151 trials (about 10 minutes) later as a probe target in the long-lag IR condition. Unlike response facilitation obtained in the short-lag DR, no priming effects were observed in the long-lag DR condition. It seems likely that the processing mechanisms applied to the prime distractor in the DR condition are less durable than the processing mechanisms applied to the IR condition, as no long-lag DR facilitation emerged with lag. These findings are challenging for the episodic retrieval account which predicts the mechanisms underlying the probability of retrieval in a way that facilitation can emerge at lagged interval but a decay in NP can be observed with lag (Neill & Valdes, 1992; Neill et al., 1992), particularly in contexts that induce episodic retrieval (e.g., the DR condition) the probability of obtaining long-lag NP decreases further still (May et al., 1995). To test the accuracy of these assumptions and rule out the possibility of obtaining decay in NP with lag, further analyses were carried out in the next section by using lag as a between-subjects variable. Based on our previous findings (see Section 2.3.), it is expected that no decay in NP will be observed with lag compared to without lag condition.

3.3. Distractor Processing and Lag Interaction

To rule out the possibility of LD response time differences between groups, independent sample *t*-test (two-tailed) was carried out. The overall LD response time for the short-lag experiment (*M* = 1058 ms) was not different than that of long-lag experiment (*M* = 1016 ms), *t* (91) = .688, *p* = .493, *d* = 0.14. A 3 (DR, CO, IR) x 2 (short-lag, long-lag) mixed ANOVA on the LD response time indicated no priming by lag interaction, *F* (2, 182) = 2.435, *p* =.090, η_p^2 = .03. To isolate any potential differences in priming with lag (particularly in the IR condition) follow-up mixed ANOVAs were carried out. A 2 (IR, CO) x 2 (short-lag, long-lag) mixed ANOVA indicated no differences in the NP effects obtained in the IR condition with lag compared to without lag condition, *F* (1, 91) = .044, *p* = .835, η_p^2 = .00, as would be expected. A 2 (DR vs. CO) x 2 (short-lag vs. long-lag) mixed ANOVA indicated differences with lag compared to without lag condition, *F* (1, 91) = 5.066, *p* = . 027, η_p^2 = .05.

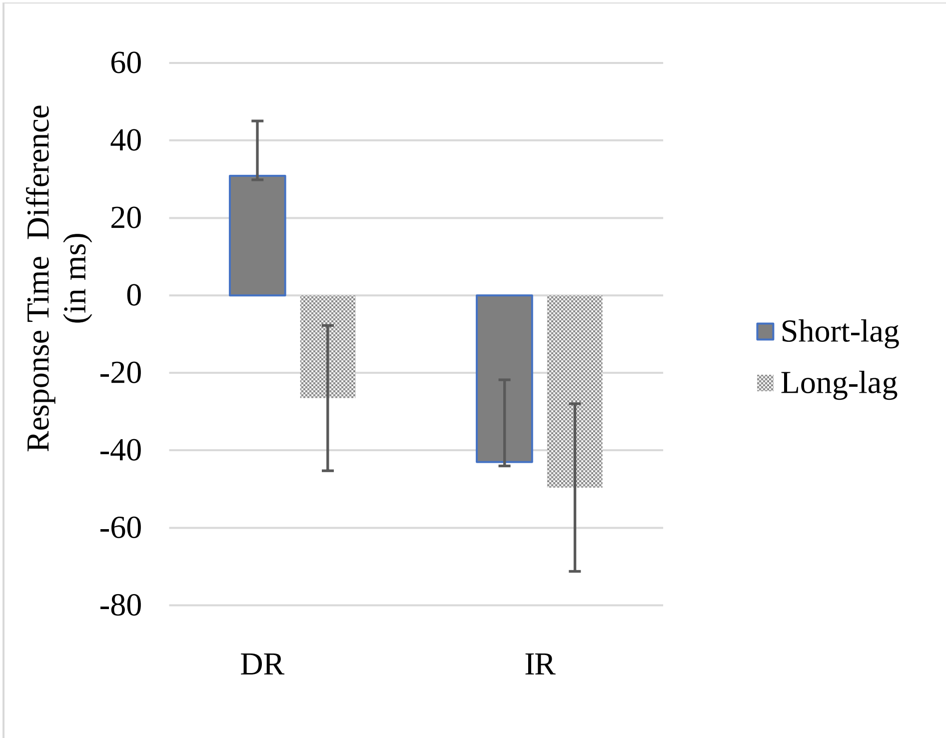


Figure 3.5. Comparison between the lexical decision response time difference scores of the short-lag and long-lag distractor repetition (DR) and ignored repetition (IR) conditions. Error bars depict standard errors.

Similar between-subject analyses were carried out on the LD errors. A 3 (DR, CO, IR) x 2 (short-lag, long-lag) mixed ANOVA on the LD errors indicated priming by lag interaction, F (2, 182) = 4.358, p = .014, η_p^2 = .04. Further analysis using a 2 (IR vs. CO) x 2 (short-lag vs. long-lag) mixed ANOVA indicated no differences with lag compared to without lag condition, F (1, 91) = .000, p = .987, η_p^2 = .00. A 2 (DR vs. CO) x 2 (short-lag vs. long-lag) mixed ANOVA indicated differences with lag compared to without lag condition, F (1, 91) = 5.902, p = .017, η_p^2 = .06.

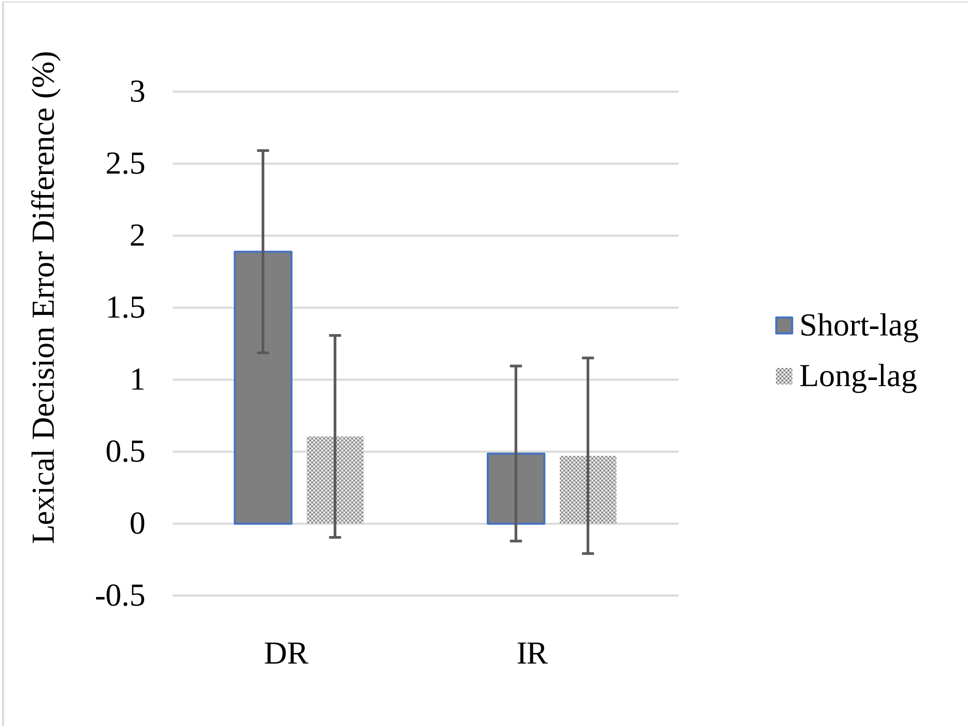


Figure 3.6. Comparison between the lexical decision error difference scores of the short-lag and long-lag distractor repetition (DR) and ignored repetition (IR) conditions. Error bars depict standard errors.

The long-lag NP was no different than NP obtained in the short-lag IR conditions, as in our previous findings (see also DeSchepper & Treisman, 1996; McLennan et al., 2019). Taken together, these findings question a commonly held notion in the NP literature that predicts a decay in NP with lag (Neill & Valdes, 1992; Neill et al., 1992), particularly in contexts that induce episodic retrieval (e.g., the AR and DR conditions) the probability of obtaining long-lag NP decreases further still (May et al., 1995). To further pit the prediction of May et al., the ARDR condition would be examined along with the IR condition across lag in follow-up experiments (Experiment 3a and 3b) using the same stimuli and design as previously. Based on our previous findings, it is expected that no decay in NP would be observed with lag when the IR condition will be examined with the ARDR condition. Taken together, these findings will systematically refute May et al.'s (1995) assumptions and reflect the relative durability of distractor representation in the IR condition. Although priming by lag interaction was significant in both LD response time and LD error of the DR condition, it was not subject to further analysis as no priming effects were obtained in the long-lag DR condition in the first place. Yet, it remains clear that distractor repetition plays no role in obtaining long-lag facilitation, at least for the lag employed. However, further research could be done to examine the replicability of current findings and to examine identity priming in the DR condition varying lags by employing a large pool of non-recycled stimuli. Such findings could add to the theoretical continuum by observing the time course of identity priming in the DR condition.

3.4. Discussion

Experiment 2a showed short-lag NP and response facilitation in the DR condition using a large pool of non-recycled words. Experiment 2b replicated the long-lag NP achieved in Experiment 1b (again, with no decay evident when lag was treated as a between-subjects variable) but found no evidence for long-lag DR facilitation effects. These set results corroborate better with the distractor inhibition hypothesis (McLennan et al., 2019; Tipper et al., 1991) and would implicate that the processing mechanisms applied to the prime distractors in the DR condition may be less durable than those applied in the IR condition. These findings are challenging for the episodic retrieval account that predict the mechanisms of retrieval in a way that facilitation can emerge at lagged intervals while a decay in NP can be observed in lag (Neill & Valdes, 1992; Neill et al., 1992), particularly in contexts (e.g., the DR condition) that induce episodic retrieval, the probability of obtaining long-lag NP decreases further still (May et al., 1995). These findings also have implications on the temporal discrimination model and would implicate that both attentional set and automatic retrieval operate independently (see also

D'Angelo et al., 2016) otherwise response cost would be observed in the short-lag DR condition. Notably, the set result cannot be accommodated using the response retrieval account as the response requirements were not repeated between prime (naming) and probe (LD) to modulate priming (see also Nett et al., 2016).

As mentioned, the prime-probe response requirements were varied to circumvent a possible confound that occurs when a small pool of stimuli is used together with identical prime-probe response requirements (see also Henson et al., 2014; Neumann & Levin, 2018). Controlling this potential confound is of utmost importance as it is believed to contaminate the obtained priming effects, particularly in the DR condition to an extent that response cost can be observed instead of DR facilitation. For instance, Frings et al. (2007) employed a letter flanker task using a small pool of recycled letters (D, F, J, K). The three priming conditions (AR, DR, ARDR) and a baseline control condition were equally distributed, each with the stimuli set size of 40 trials. They reported response facilitation in the target repeat (AR, ARDR) conditions and response cost in the DR condition. They argued that the retrieved stimuli-response association delays probe processing in the DR condition, due to the response change because of employment of different prime-probe targets (Frings et al., 2007; see also Frings, 2011). Interestingly, the obtained response cost in the DR condition by Frings and colleagues don’t corroborate with the NP literature (Frings & Wühr, 2007; Nett et al., 2016; Neumann & DeSchepper, 1991; Pramme et al., 2015; Schrobsdorff et al., 2012; Stadler & Hogan, 1996) and is also inconsistent with other proponents of the response retrieval account (Ihrke et al., 2011; Rothermund et al., 2005). Perhaps most critically, Stadler and Hogan (1996) employed a relatively similar flanker task with a small pool of recycled Arabic numerals (1, 2, 3, 4) and reported response facilitation in the DR condition[7]. In the following section, Frings et al.'s findings will be compared with that of the Stadler and Hogan.

It is argued that there are two noticeable differences between Frings et al.'s (2007) and Stadler and Hogan's findings. Firstly, in Frings et al.'s experiment, the AR condition (183 ms) shows more than twice the speedups of that reported by Stadler and Hogan in the AR condition (67 ms). Secondly, Frings et al. reported 20 ms response cost in the DR condition, while Stadler and Hogan reported 12 ms response facilitation in the DR condition. It is argued that because 50% of Frings et al.'s task required target repetitions, participants anticipate stimuli and response repetition and developed expectancy bias over time due to making the same response repeatedly on almost every second trial. When the target is repeated almost on every second trial in Frings et al.'s experiment, the enhanced response facilitation is developed over time in the AR condition, consequently resulting in double speed-ups compared to Stadler and Hogan in the AR condition. By contrast, when the distractor stimuli are repeated in the DR condition in Frings et al.'s experiment, an eventual inclination is to repeat the prime response due to the expectancy bias of stimuli and response repetition. Overcoming this misleading inducement may have caused the delay in the DR condition in Frings et al.'s experiments.

An asymmetric transfer account of Frings et al.'s (2007) findings is completely different from their explanation but most certainly provides a plausible account of their speedups in the AR condition and response cost in the DR condition. To test the accuracy of the above contentions, the response time in the first half of the Frings et al.'s experiment can be compared with that of the latter half (see also Neumann & Levin, 2018). Such analysis can help identify the

[7] Stadler and Hogan (1996) examined the seven possible combinations of target and distractor repetitions.

possible speedups in the latter half of Frings et al.'s experiment in the AR condition due to the expectancy bias. Secondly, it can potentially help establish that the DR condition was actually faster than the CO condition very early on and only later reversed to end up becoming significantly slower in Frings et al.'s experiment. In short, it is argued that the Frings and colleagues' failures to find expected DR response facilitation was due to an asymmetric transfer of expectancy bias, whereby the inclination to retrieve and repeat the prime response in the DR condition confounds the probe response. This was hypothesized to have resulted from a context in including a small pool of repeated stimuli and 50% AR conditions (e.g., Frings et al., 2007). The effect of percentage of target repeat conditions on response facilitation was also observed by Neumann and DeSchepper (1991) when they obtained a steady decline in the response facilitation by reducing the percentage of target repeat trials in a series of three experiments. They argued that the response facilitation was enhanced due to expectancy bias that developed due to the employment of a higher percentage of target repeat trials. Our asymmetrical transfer account of Frings et al.'s (2007) findings, henceforth, provides an extension to Neumann and DeSchepper's expectancy bias assumptions by demonstrating the asymmetrical transfer of expectancy bias from the target repeat trials (AR and ARDR) to the DR trials. Collectively, the asymmetric transfer account of Frings and colleagues' data due to employing a small pool of recycled stimuli and a higher percentage of target repeat conditions is thus more likely to account for their response cost in the DR condition. In a nutshell, this chapter highlighted the effect of experimental features and procedural contexts (e.g., size of stimuli set, prime-probe response requirements, percentage of target repeat trials, etc.) that can modulate the obtained priming effect. Henceforth, it is emphasised that careful consideration must be given before interpreting the obtained priming effects (see also Cesario, 2014).

3.5. Conclusion

The findings of Experiment 2a provided a conceptual replication of obtaining within-trial response facilitation in the DR condition and NP in the IR condition employing a large pool of non-recycled words. Perhaps most critically, response facilitation obtained in the short-lag DR condition corroborated the predictions of distractor inhibition hypothesis and episodic retrieval account and can have implications on the temporal discrimination model and response retrieval account. In Experiment 2b, the long-lag NP was not only intact but no different than NP obtained in the short-lag IR condition, as expected. These findings can be easily accommodated using the distractor inhibition hypothesis. These findings are somewhat challenging for the episodic retrieval account that predicts a decay in NP with lag in contexts (e.g., the DR condition) that induce episodic retrieval. Unlike response facilitation in both LD response time and LD errors of the short-lag DR condition, the long-lag DR condition did not obtain any priming effects. It can be argued that the processing mechanisms applied to the prime distractor in the long-lag DR condition were less durable than the processing mechanisms in the long-lag IR condition, as no long-lag DR facilitation emerged with lag.

Chapter 4

The manifestation of target and distractor activation with lag.

Taking together the long-lag manipulations in previous chapters, NP was consistently observed across experiments in the long-lag IR condition by employing a large pool of non-recycled words (see also DeSchepper & Treisman, 1996; McLennan et al., 2019). By contrast, PP was obtained in the long-lag AR condition (Experiment 1b) and no priming effects were observed in the long-lag DR condition (Experiment 2b). Based on these findings, it seems likely that the distractor repetition plays no role in obtaining long-lag response facilitation and the long-lag facilitation can be credited to target repetition alone. To test these assumptions, identity priming was examined by repeating both prime target and distractor words as the probe in the 'target and distractor repetition' (ARDR) condition across lag by using a between-subjects design (as previously). This can be taken as first-ever empirical evidence (to our knowledge) to examine the longevity of identity priming in the ARDR condition with a protracted multi-minute lag and intervening trials. It is expected that when both prime target and distractor words are repeated 151 trials later as a probe (e.g., in the long-lag ARDR condition), response facilitation would be observed as in the long-lag AR condition (Experiment 1b).

Some NP researchers assert that the repetition of the distractor in the ARDR condition added advantage to mere target repetitions in the AR condition (Frings et al., 2007; Neumann & DeSchepper, 1991; Stadler & Hogan, 1996). For instance, Frings et al. (2007) argued that both target and distractor act as a retrieval cue in the ARDR condition, which enhances the already strong target repetition effect. They added that the combined effect of target and distractor repetition in the ARDR condition can be due to the retrieval of distractors. It is argued that the assumptions of added advantage in the ARDR condition were made considering the short-lag

ARDR condition in which the probe follows prime without intervening stimuli. Furthermore, the assumptions of added advantage in the ARDR condition won't employ in the long-lag ARDR condition as our findings from the long-lag DR condition (Experiment 2b) suggest that there is no long-lag distractor repetition effect (at least for the lag employed). In this respect, PP obtained in the AR condition (in Chapter 2) can be compared with the response facilitation obtained in the ARDR condition (in the current chapter). Such analysis can help establish that the added advantage of distractor repetition was only present in the short-lag ARDR condition and not in the long-lag ARDR condition. Based on these findings, one would expect a relative reduction in the ARDR response facilitation with lag compared to without lag condition. Interestingly, a similar reduction in PP was observed in the AR condition with lag (see Section 2.3.) which was assumed to be obtained due to cluttering owing to intervening stimuli. It is argued that if a similar reduction in the ARDR response facilitation is observed with lag, it could be credited to lack of distractor repetition effect in the long-lag ARDR condition, and explicit target processing which makes it highly susceptible to subsequent interference from all the naming and lexical decisions participants make before the 151th trial appears (about 10 minutes later).

Researchers also assert that the response facilitation obtained in the ARDR condition can be inherently strategic due to visual identity (D'Angelo, Thomson, Tipper, & Miliken, 2016; Ecker, Zimmer, & GrohBordin, 2007; Frings et al., 2007; Kessler & Moscovitch, 2013; Zimmer Mecklinger, & Lindenberger, 2006). It is argued that the effect of explicit visual identity cannot be completely abolished in the short-lag ARDR condition. However, the long-lag ARDR condition can provide an opportunity to examine identity priming due to underlying processes alone as the effect of explicit visual identity might not last through minutes protracted lag and 151 intervening trials. In addition to the ARDR condition, identity priming was examined in the

IR condition in both experiments. Together with our previous experiments, these manipulations were specifically designed to test the assumptions of May et al. (1995) regarding the experimental contexts (e.g., the AR, DR, and ARDR conditions) that induce episodic retrieval and would observe a decay in NP with lag. Notably, the assumptions of May et al. were refuted previously when no decay in NP was observed when the IR condition was examined along with the AR condition (see Section 2.3.) and also when the IR condition was examined along with the DR condition (see Section 3.3.). Considering our previous findings, it is expected that long-lag NP will be reliably obtained and no decay in NP will be observed with lag. Collectively, these findings would systematically refute May et al.'s assumption regarding the contexts that induce episodic retrieval, the probability of obtaining long-lag NP decreases further still. The implications of findings on both the distractor inhibitory hypothesis and episodic retrieval account will be discussed.

4.1. Experiment 3a

In the current experiment, within-trial identity priming was examined across the ARDR and IR conditions using a large pool of non-recycled words with repetition only once to fulfil the requirements of the conditions of interest. The prime distractor word was repeated as a subsequent probe target without intervening stimuli in the IR condition, as previously. Both prime target and distractor words were repeated as a subsequent probe without intervening stimuli in the ARDR condition. In line with the distractor inhibition hypothesis and episodic retrieval account, these findings can provide a conceptual replication of obtaining within-trial response facilitation in the ARDR condition and NP in the IR condition (Neumann & DeSchepper, 1991; Stadler & Hogan, 1996; see also Frings et al., 2007; Giesen, Weissmann, & Rothermund, 2018) employing a large pool of non-recycled words. This experiment also served as a baseline for Experiment 3b in which the identity priming was examined in the ARDR and IR conditions using the same stimuli except that 151 trials intervene between the prime and its yoked probe display.

4.1.1. Method

4.1.1.1. Participants

Forty-two (24 female) students (*M* = 19.54, *SD* = 1.67) from the University of Canterbury participated either for course credit or monetary incentive. The inclusion and exclusion criteria to recruit the participants were identical across experiments (see Section 2.1.1.1.).

4.1.1.2. Stimuli, apparatus, and design

The current experiment employed a within-subjects design to examine short-lag identity priming across the ARDR, CO, and IR conditions using a large pool of non-recycled words. The words were repeated only once to fulfil the constraints of the ARDR and IR conditions. The present experiment was identical to Experiment 1a and 2a in terms of stimuli, design, and apparatus (see Section 2.1.1.2.).

4.1.1.3. Procedure

There was uniformity in procedures among experiments (see Section 2.1.1.3.). The main experiment started with 24 practise trials, followed by 144 experiment proper testing trials, and a catch trial. It took about twenty-five minutes to complete each experimental session.

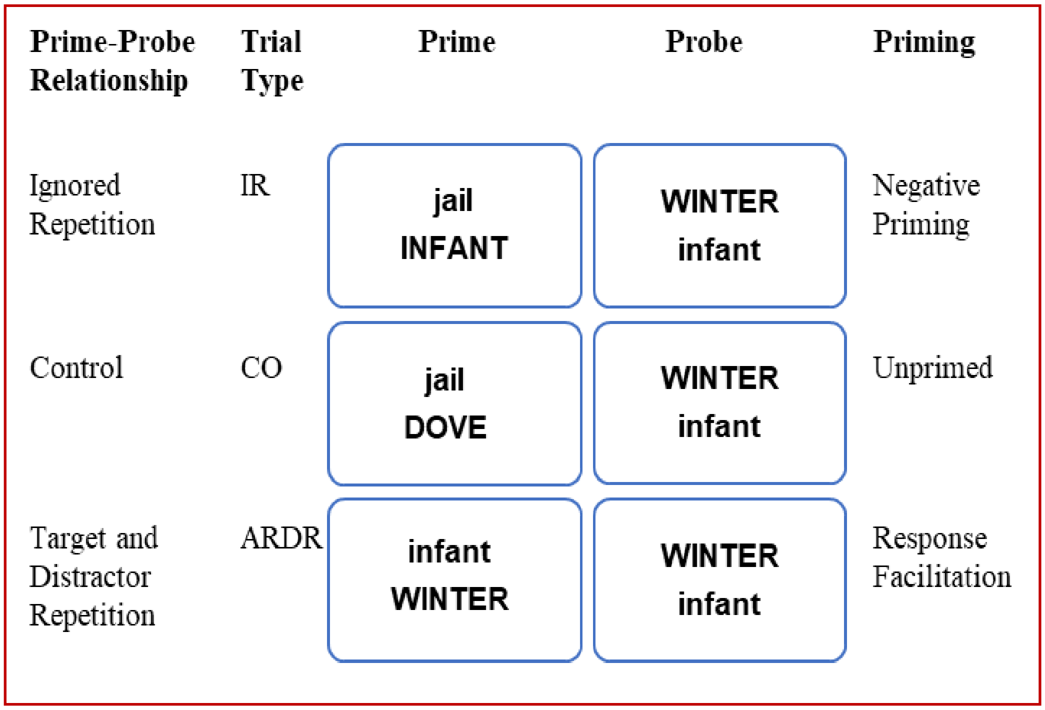


Figure 4.1. Schematic sample trial for the prime-probe conditions. Negative priming can be observed when the prime distractor word repeats as a subsequent probe target in the ignored repetition condition. Whereas, response facilitation can be observed when the prime target and distractor words are repeated as a subsequent probe in the target and distractor repetition condition.

4.1.2. Results and Discussion

The LD response time on word trials was included in the analysis only when the prime target was correctly named, and a correct LD was made in the subsequent probe within 200 to 3000 ms. Data of one participant were removed due to having naming errors above the pre-set 20%. Data of one additional participant were taken out due to having LD response time outliers above the pre-set 20%. No data were excluded due to having LD errors above the pre-set 20%. The mean of the median LD response time was recorded for each of the ARDR, CO, and IR conditions.

A repeated measures ANOVA on the LD response time indicated overall priming effects across conditions (ARDR, CO, IR), *F* (2, 78) = 53.880, *p* = .001, η_p^2 = .58. To further examine the origin of these priming effects paired sample *t*-tests were carried out. The NP response time cost of was obtained in the IR condition compared to the CO condition, *t* (39) = 2.322, *p* = .026, *d* = 0.37, demonstrating a NP effect (*M* = 37 ms, *SD* = 101.04). The LD response time on the ARDR condition was faster than the CO condition, *t* (39) = 7.251, *p* = .000, *d* = 1.15, demonstrating response facilitation (*M* = 180 ms, *SD* = 156.83) in the ARDR condition.

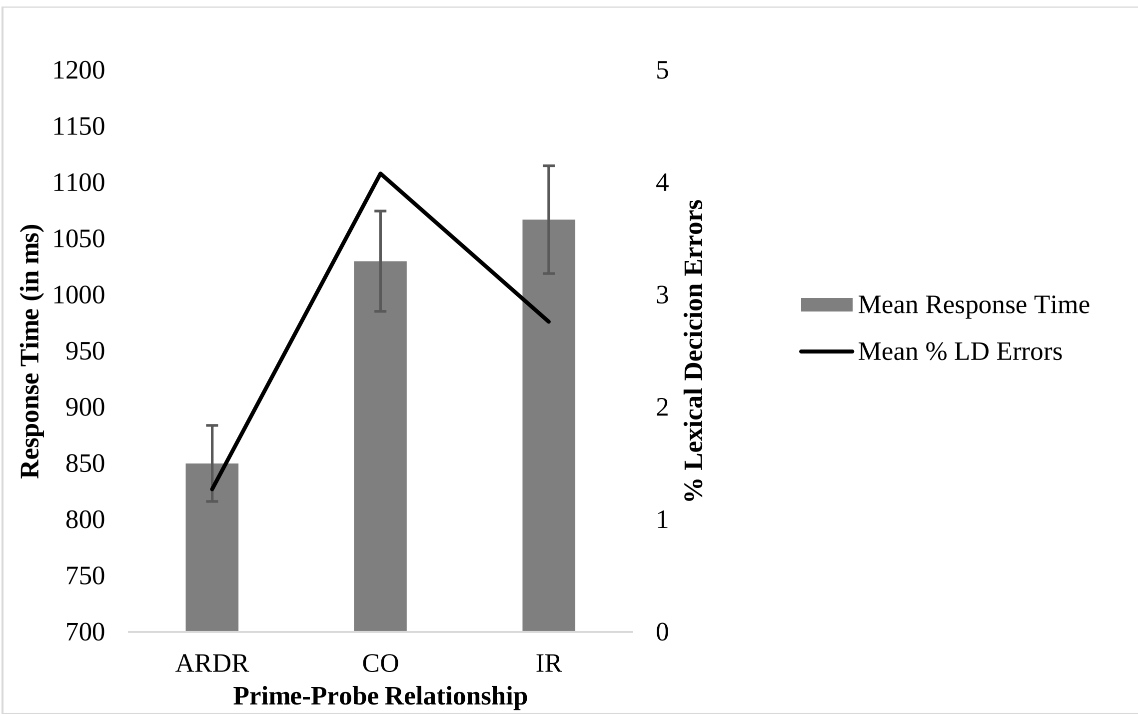


Figure 4.2. Lexical decision (LD) response time (in milliseconds) and the percentage of lexical decision errors in the target and distractor repetition (ARDR), control (CO), and ignored repetition (IR) conditions. Error bars depict standard errors.

The LD error data were analysed in a similar manner. A repeated measures ANOVA on the LD errors indicated overall priming effects across conditions (ARDR, CO, IR), *F* (2, 78) =

4.4912, *p* =.01425, η_p^2 = .01. There were no differences (*M* = 0.65 %, *SD* = 0.85) in the LD errors between the IR and CO conditions, *t* (39) = 1.490, *p* = .144, *d* = 0.24. However, the ARDR condition produced fewer LD errors relative to the CO condition, *t* (39) = 2.603, *p* = .013, *d* = 0.41, demonstrating response facilitation (*M* = 1.32 %, *SD* = 5.59) in the LD errors of the ARDR condition. The results were not compromised by speed accuracy trade-off as there were significantly fewer LD errors in the faster condition (ARDR) and the difference between the LD errors of the IR and CO condition was not significant. The analysis of the catch trial using the binomial test indicated that the probability of catch correct response (.28) was no different than what would be expected by chance (.33), *p* =.409 (two-tailed).

In line with the distractor inhibition hypothesis and episodic retrieval account, within-trial response facilitation was obtained in the ARDR condition and NP in the IR condition (Neumann & DeSchepper, 1991; Stadler & Hogan, 1996). As mentioned, some NP researchers assert that an added advantage can be observed in the ARDR condition due to the repetition of distractors, which enhances the already strong target repetition effect (Frings et al., 2007; Neumann & DeSchepper, 1991; Stadler & Hogan, 1996). To examine this, independent sample *t*-tests (two-tailed) were carried out to compare the priming effects obtained in the short-lag ARDR condition and short-lag AR condition (in Experiment 1a). Our findings support the assumptions of added advantage in the short-lag ARDR condition, as the priming effects obtained in the LD response time (*p* = .01) and LD errors (*p* = .00) of the AR and ARDR condition were different. These findings also provide a baseline against which to examine the possibility of obtaining an added advantage of distractor repetition in the long-lag ARDR condition (i.e., Frings et al., 2007).

4.2. Experiment 3b

The purpose of Experiment 3b was to examine the longevity of priming effects obtained in Experiment 3a by repeating the probe 151 trials later than their yoked prime display in the ARDR and IR conditions. Considering our previous findings, it is expected that NP will be reliably obtained in the current long-lag IR condition. Nevertheless, response facilitation should be obtained in the current long-lag ARDR condition, if the long-lag AR facilitation obtained in Experiment 1b is replicable (see also McLennan et al., 2019). However, it would be unlikely that this long-lag ARDR facilitation would be obtained due to visual identity as the effect of the explicit visual identity is not likely to last over minutes protracted lag and 151 intervening trials (see also D'Angelo et al., 2016; Ecker et al., 2007; Frings et al., 2007; Kessler & Moscovitch, 2013; Zimmer et al., 2006). Researchers also assume an added advantage in the ARDR condition due to the repetition of distractors (e.g., Frings et al., 2007; Neumann & DeSchepper, 1991; Stadler & Hogan, 1996). It is argued that the assumptions of added advantage in the ARDR condition were made considering the short-lag ARDR condition and those assumptions won't employ at lagged intervals, as the findings from Experiment 2b showed that there is no long-lag distractor repetition effect (e.g., in the DR condition).

4.2.1. Method

4.2.1.1. Participants

Fifty-one (36 female) students (*M* = 18.92, *SD* = 1.58) were recruited as participants from the University of Canterbury either for course credit or monetary incentive. The inclusion and exclusion criteria were identical across experiments (see Section 2.1.1.1.).

4.2.1.2. Stimuli, apparatus, and design

Experiment 3a and 3b were identical in stimuli, apparatus, and design. The only exception was that the trials in Experiment 3b had no within-trial couplet word repetition, as the probe was moved 151 trials later than its yoked prime display in the conditions of interest (see Figure 4.3.). For instance, if the stimuli were used as prime and probe on trial 7 in Experiment 3a, the prime stimuli appeared on trial 7 and its probe display was moved to trial 158 in Experiment 3b to create the long-lag ARDR and IR conditions. Additional stimuli were employed to act as lag fillers to create long-lag ARDR and IR conditions as in Experiment 1b and 2b (see Section 2.2.1.2.).

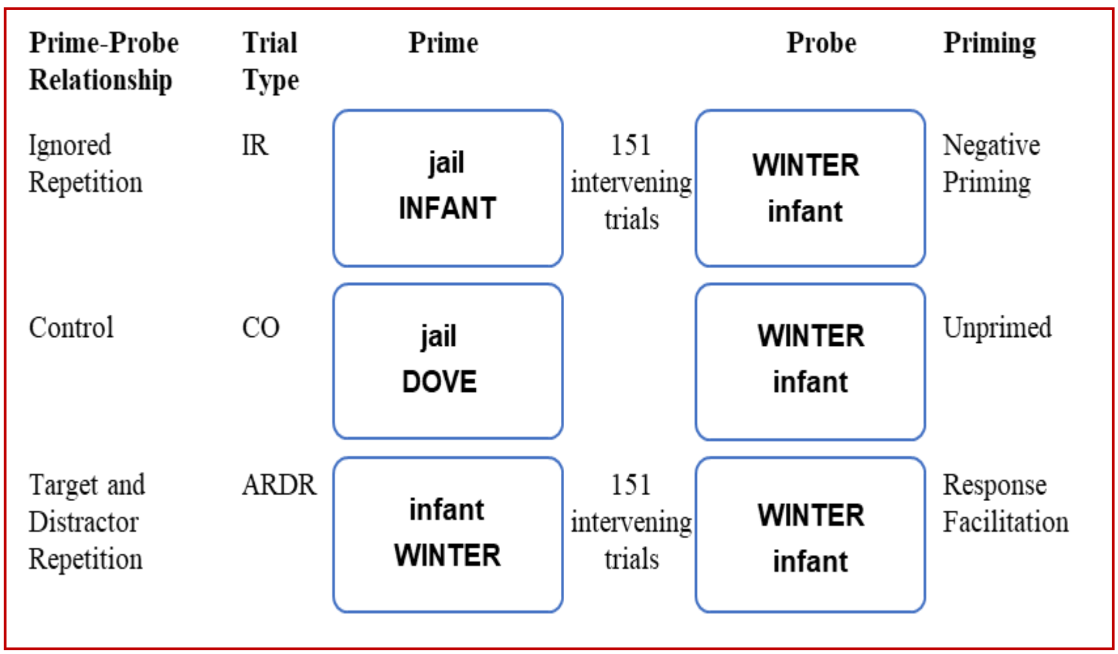


Figure 4.3. Schematic sample trial for the prime-probe conditions. Negative priming can be observed when the prime distractor word is repeated 151 trials later as a probe target in the ignored repetition condition. Whereas, response facilitation can be observed when the prime target and distractor words are repeated 151 trials later as a probe in the target and distractor repetition condition.

4.2.1.3. Procedure

There was uniformity in the procedures among experiments (see Section 2.1.1.3.). The main experiment started with 24 practise trials, followed by 144 filler trials, a break, 6 warm-up trials, 144 experiment proper testing trials, and a catch trial. It required about fifty minutes to complete the experiment.

4.2.2. Results and Discussion

The LD response time on word trials was included in the analysis only when the prime target was appropriately named, and a correct LD was made on the pertinent probe within 200 ms to 3000 ms. Data of two participants were taken out due to having naming errors above the pre-set 20%. No data were excluded due to having LD errors or having LD response time outliers above the pre-set 20%. The mean of the median LD response time was recorded for each of the ARDR, CO, and IR conditions. A repeated measures ANOVA on the LD response time indicated long-lag priming effects across conditions (ARDR, CO, IR), F (2, 96) = 10.490, p = .001, η_p^2 = .18. Additional follow-up paired sample *t*-tests were carried out to isolate these priming effects. The NP response time cost of 35 ms (on average) was obtained in the long-lag IR condition compared to the CO condition, t (48) = 2.021, p = .049, d = 0.29, demonstrating the NP effect. The long-lag ARDR condition was 33 ms (on average) faster than the CO condition, t (48) = 2.288, p = .027, d = 0.33, demonstrating response facilitation in the ARDR condition.

The LD errors were analysed in a similar manner. A repeated measures ANOVA on the LD errors in the priming conditions indicated no priming effect, F (2, 96) = 1.5347, p =.22075, η_p^2 = .03, hence asserting that the LD response time was not compromised by speed accuracy trade-offs. The analysis of the catch trial using a binomial test indicated that the probability of catch correct response (.12) was no different than would be expected by chance (.33), *p* = .500 (two-tailed).

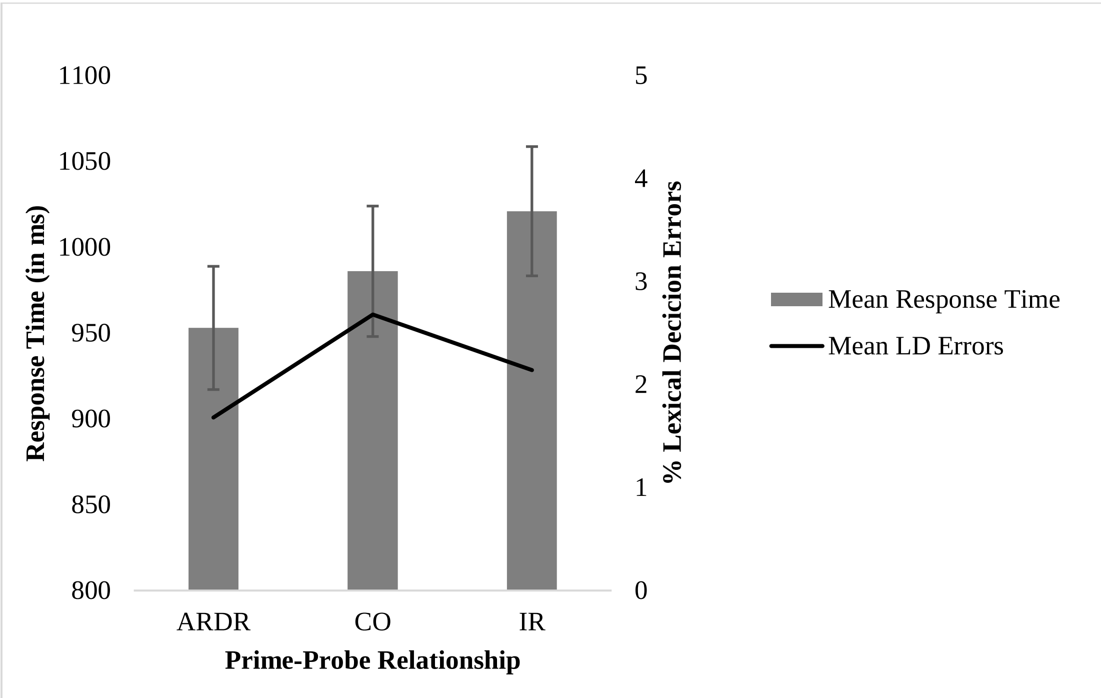


Figure 4.4. Lexical decision (LD) response time (in milliseconds) and the percentage of lexical decision errors in the long-lag target and distractor repetition (ARDR), control (CO), and ignored repetition (IR) conditions. Error bars depict standard errors.

Priming effects obtained in the short-lag ARDR and IR condition were successfully obtained when the probe appeared 151 trials later than its yoked prime display in the long-lag ARDR and IR conditions. This can be considered as the first reported evidence of obtaining ARDR response facilitation with a protracted multi-minute lag (about 10 minutes) and 151 intervening trials. To examine the possibility of obtaining the added advantage of distractor repetition in the long-lag ARDR condition than mere target repetition in the long-lag AR condition, supplementary analyses were carried out using independent sample *t*-tests (two-tailed). Results indicate that there were no differences in the priming effects obtained in the LD response time (p = .27) and LD errors (p = .19) of the long-lag ARDR condition with that of the long-lag AR condition. These findings strengthen our argument that 1) long-lag response facilitation was obtained due to target repetition alone (in both AR and ARDR conditions); 2) distractor repetition plays no role in obtaining long-lag response facilitation in the ARDR condition (as in the long-lag DR condition); and 3) the added advantage of distractor repetition can only be observed in the short-lag ARDR condition and not in the long-lag ARDR condition. To examine the effect of lag on the ARDR condition and IR condition with lag, further analyses were carried out in the next section by using lag (short-lag vs. long-lag) as a between-subjects variable, as previously. If a reduction in ARDR response facilitation is observed (as in the AR condition), then these findings will strengthen our argument that the explicit prime target is vulnerable to interference. By contrast, if no decay in NP is observed with lag (as previously), then the findings will reject the assumptions made by May et al. (1995) regarding the contexts (e.g., the AR, DR, and ARDR conditions) that induce episodic retrieval and probability of obtaining long-lag NP decreases further still.

4.3. Stimuli Activation and Lag Interaction

The overall LD response time for the short-lag Experiment 3a (982 ms) was not different than that of the long-lag Experiment 3b (987 ms), t (87) = .082, p = .935, d = 0.02, hence ruling out the possibility of response time differences between groups. A 3 (ARDR, CO, IR) x 2 (short-lag, long-lag) mixed ANOVA on the LD response time indicated priming by lag interaction, F (2, 174) = 21.801, p =.001, η_p^2 = .20. Further analysis using a 2 (IR vs. CO) x 2 (short-lag vs. long-lag) mixed ANOVA indicated no differences in the NP effects obtained in the IR condition with lag compared to without lag condition, F (1, 87) = .009, p = .925, η_p^2 = .00. A 2 (ARDR vs. CO) x 2 (short-lag vs. long-lag) mixed ANOVA indicated differences in the response facilitation observed in the ARDR condition with lag compared to without lag condition, *F* (1, 87) = 28.901, *p* = .001, η_p^2 = .25.

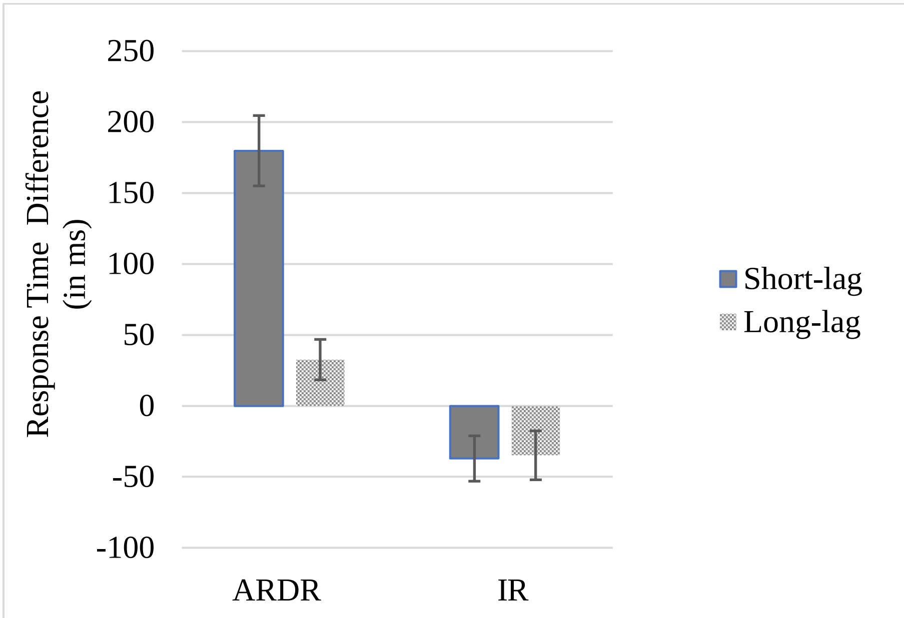


Figure 4.5. Comparison between the lexical decision response time difference scores of the short-lag and long-lag target and distractor repetition (ARDR) and ignored repetition (IR) conditions. Error bars depict standard errors.

To examine the reduction in ARDR response facilitation with lag, further analyses were carried out on the LD response time difference scores (ARDR - CO) using independent sample *t*-test (two-tailed). A reduction in the LD response time facilitation was observed in the ARDR condition with a lag compared to without lag condition, *t* (87) = -5.377, *p* = .00001, *d* = 1.12. A similar between-subject analysis was carried out on LD errors. A 3 (ARDR, CO, IR) x 2 (short-lag, long-lag) mixed ANOVA on the LD errors indicated no priming by lag interaction, *F* (2, 174) = 1.474, *p* =.232, η_p^2 = .02.

Current findings indicate a salient reduction in the ARDR response facilitation with lag compared to without lag condition. These findings support our assumption that the distractor repetition plays no role in obtaining long-lag response facilitation in the ARDR as the findings from Experiment 2b also shows that there is no long-lag distractor repetition effect. Thus, all that remains is the target repetition effect in the long-lag ARDR condition, and that is why the response facilitation effect in the long-lag ARDR condition is overall smaller than the short-lag ARDR condition. Notably, a similar reduction in response facilitation was observed in the AR condition with lag compared to without lag condition (see Section 2.3.) due to possible cluttering owing to the intervening stimuli. Taken together, the reduction in the ARDR response facilitation with lag can be credited to both lack of added advantage owing to the repetition of distractors and explicit target processing which makes it highly susceptible to subsequent interference from all the naming and lexical decisions participants make before the 151st trial appears (about 10 minutes later). By contrast, the long-lag NP effects were no different than NP obtained in the short-lag IR condition, as expected. Taken together, these findings systematically refute May et al.'s (1995) predicted to decay in NP in contexts (e.g., the AR, DR, and ARDR conditions) that induce episodic retrieval, the probability of obtaining long-lag NP decreases further still.

4.4. General Discussion

Experiments 3a and 3b aimed to further examine the role of target processing in obtaining long-lag response facilitation given that the previous set of experiments have demonstrated that distractor repetition plays no part in obtaining long-lag response facilitation (Experiment 2b) but target repetition does (Experiment 1b). Consequently, short-lag and long-lag priming effects were examined for the ARDR condition whereby the repetition of both distractor and target stimuli should add advantage according to some NP theorists (Frings et al., 2007; Neumann & DeSchepper, 1991; Stadler & Hogan, 1996). However, because no long-lag response facilitation was obtained with the DR condition in Experiment 2b it was argued that target repetition underlies response facilitation at lagged intervals. Accordingly, if true, a reduction in response facilitation should be observed with the ARDR condition at long-lag intervals relative to short-lag but that some facilitation should be observed if the long-lag AR PP in Experiment 1b is replicable (see also McLennan et al., 2019). The current design was also pitted as a further test of May et al.'s conjecture that long-lag NP decays in contexts that encourage episodic retrieval. Again, a large pool of non-recycled words and the same LD task were used to test these hypotheses. The results supported above predictions as NP effects were found for the IR condition and response facilitation was observed for the ARDR condition across lags. When the priming effects were compared across lag, NP was similar but a significant reduction in response facilitation was observed with lag compared to without lag condition. These findings suggest that the added advantage due to the repetition of distractors in the ARDR condition was absent in the long-lag ARDR condition, as evidenced by the lack of priming effects in the long-lag DR condition (in Experiment 2b). Hence, the obtained response facilitation in the long-lag ARDR condition can be credited to target repetition alone, as evidenced by response facilitation in the long-lag AR condition (Experiment 1b).

The set results can be more easily accommodated by the distractor inhibitory hypothesis than the episodic retrieval account. The reason the inhibition theory comes out better is that ignoring something once implicitly seems to affect its threshold for responding later on (McLennan et al., 2019; see also Tipper et al., 1991, pg. 57). It doesn't seem to be interfered with; otherwise, no long-lag NP would be produced. On the other hand, attending to something explicitly makes it highly susceptible to subsequent interference from all the naming and lexical decisions participants make before the 151st trial appears (about 10 minutes later). This is why long-lag response facilitation in the ARDR condition is reduced. In contrast, the IR trials were preserved and were not susceptible to either further implicit or explicit memories from all the stimuli attended and ignored before the 151st trial appears (about 10 minutes later). Some NP researchers argue that the response facilitation obtained in the ARDR condition can be inherently strategic due to explicit visual identity (D'Angelo et al., 2016; Ecker et al., 2007; Frings et al., 2007). It is argued that the possible effect of explicit visual identity cannot be completely abolished in the short-lag ARDR (or the short-lag AR) condition due to explicit target processing. However, our long-lag manipulations provide an empirical opportunity to examine identity priming due to underlying processes alone as the effect of explicit visual identity might not last over minutes protracted lag and 151 intervening trials. This assumption is supported as the participants of Experiment 3b (like Experiment 1b) didn't report noticing target repetitions in the post-experiment questionnaire unlike some of the participants who reported target repetition in short-lag Experiment 1a and 3a. It is suggested that NP researchers can rule out the possibility of obtaining priming effects due to visual identity by using "recognition of target repetition" as a between-subjects variable. Such analysis can help rule out the possibility of identifying any differences in priming effects due to visual identity.

Our findings are challenging for the episodic retrieval account which predicts the mechanism of retrieval in a way that task relevant target information is likely to facilitate at lagged intervals while a decay in NP can be observed with lag (Neill & Valdes 1992; Neill et al., 1992). For instance, the exactly matching stimuli in the ARDR condition should be more likely to elicit a prior episode and cause response facilitation at lagged intervals. Whereas, a mismatching stimulus in the IR condition that goes from uppercase distractor to lowercase target should be much less likely to cause an NP effect with lag. Yet no effect of lag is observed on NP and a reduction in response facilitation was observed in the ARDR condition with lag compared to without lag condition. Collectively, challenging the predicted mechanisms of retrieval by the episodic retrieval account. Perhaps most critically, our findings challenge May et al.'s (1995) assumptions concerning the contexts that induce episodic retrieval (e.g., IR condition examined with AR, DR, and ARDR conditions), the probability of obtaining long-lag NP decreases further still.

The current findings also have implications on the response retrieval account assumptions concerning the ARDR condition. For instance, Frings et al. (2007) assert that both target and distractor act as a retrieval cue in the ARDR condition to enhance the already strong target repetition effect. They asserted that the combined effect of target and distractor repetition in the ARDR condition can be due to the retrieval of distractors. Our findings question these assumptions of Frings et al. as the long-lag ARDR and long-lag DR conditions suggest that the distractor repetition plays no salient role in obtaining response facilitation at lagged intervals (at least for the lag employed). Furthermore, Rothermund et al. (2005) argued that the response facilitation observed in the ARDR condition is credited to response repetition. In the current experimental set-up, participants named the lowercase prime target word and later made an LD to the lowercase probe target item while ignoring the uppercase distractor words in both displays. Considering the response requirements were not repeated between prime (naming) and probe (LD) to modulate priming, present findings in the ARDR condition demonstrate priming effects that cannot be explained using the response retrieval account.

4.5. Conclusion

The experiments in the current chapter extend the previous work to examine identity priming in the IR condition along with the ARDR condition in which response facilitation can be observed. NP was again observed over the lag, while facilitation in the ARDR condition diminished (but was still significant) with lag. This ARDR facilitation is attributed to the repetition of the target alone, similar to that observed in the AR condition (in Chapter 2). Perhaps most critically, no decay in NP was observed with lag compared to without lag condition, as expected. These findings can have implications for May et al.'s (1995) assumption regarding the contexts that induce episodic retrieval and the probability of obtaining long-lag NP decreases further still.

Chapter 5

Modulation of identity priming with lag employing non-recycled words; Methodological and theoretical implications.

This research examined short-lag and long-lag identity priming across the IR, AR, DR, and ARDR conditions by using a large pool of non-recycled words in a series of six experiments. Neumann et al.'s experimental set-up (1999) was employed in an effort to obtain NP without the necessity of stimuli repetition. The IR and CO conditions were examined with either one of the AR, DR, and ARDR conditions in one short-lag and one corresponding long-lag experiment. The prime appeared as a subsequent probe in the three short-lag experiments (Experiment 1a, 2a, and 3a) and the prime appeared 151 intervening trials (about 10 minutes) later as a probe in the three long-lag experiments (Experiment 1b, 2b, and 3b). NP was reliably observed and was also consistently no different across lag, hence providing a direct replication of own effect (see Appendix D for supplementary analyses). By contrast, a salient reduction in the response facilitation was observed in both AR and ARDR conditions with lag, compared to without lag conditions (see also Malley & Stayer, 1995, Experiment 1). Lastly, response facilitation observed in the short-lag DR condition eliminated in the long-lag DR condition (at least for the lag employed). These manipulations provided an empirical opportunity to observe the changes in identity priming by dissociating the processing mechanisms involved in immediate versus lagged stimuli processing. The research reported here is clearly a contribution to the NP literature. In the following section, the theoretical and methodological implications of findings would be discussed in detail.

5.1. Theoretical implications

It was maintained that the set results can be more easily accommodated by the distractor inhibitory hypothesis than the episodic retrieval account. The reason the inhibition theory comes out better is that ignoring something once implicitly seems to affect its threshold for responding later on (McLennan et al., 2019). Essentially, its status as an attended target (explicit) or ignored distractor (implicit) becomes a component of its representation. For instance, a component of this implicit distractor representation could be that the response to that stimulus is inappropriate (see also Tipper et al., 1991). Therefore, when the prime distractor is repeated 151 trials later, the implicit distractor representation evokes to obtain long-lag NP effects (even in the absence of residual inhibition). It doesn't seem to be interfered with; otherwise, no long-lag NP would be produced. Such an explanation not only suggests inhibition as a proximal cause of NP (see also Li et al., 2017) but also accommodate the long-lag NP effects (even in the absence of residual inhibition) conveniently using the distractor inhibition hypothesis.

This variant of the distractor inhibition hypothesis is somewhat different from the classical distractor inhibition hypothesis which overemphasizes the role of residual inhibition to obtain NP (e.g., Neill & Westberry, 1987; Tipper, 1985). It is argued that if NP is based on residual inhibition alone, then a gradual decline in the NP can be observed as the effect of residual inhibition can be strongest immediately which dissipates with lag (see also Grison et al., 2005; Erickson et al., 2005; Schrobsdorff et al., 2012; Tipper & Milliken, 1996). Our findings suggest a relative permanence of implicit distractor processing to obtain NP at lagged intervals (see also DeSchepper & Treisman, 1996; McLennan et al., 2019). However, the processing mechanisms applied to the implicit prime distractor in the DR condition seems less durable than the processing mechanisms of the IR condition, as no DR facilitation emerged with lag compared to without lag condition. Further research could be done to examine the replicability of these findings. It could be argued that the residual inhibition which merely plays any role in obtaining NP can possibly have a salient role in obtaining DR response facilitation. If this assumption is true, then the DR facilitation can show a gradual decline with lag due to diminishing residual inhibition. It is noteworthy that these assumptions concerning the role of residual inhibition in the DR condition are preliminary and are the impetus to further research preferably using a large pool of non-recycled stimuli. Such findings could add to the theoretical continuum by providing a more extensive account of distractor processing.

The findings can also have implications on episodic retrieval account which predicts the mechanisms of retrieval in a way that facilitation should emerge at lagged intervals, while a decay in NP can be observed with lag. For instance, the exactly matching stimuli (target) in the AR and ARDR conditions should be more likely to elicit a prior episode and obtain response facilitation at lagged intervals. Whereas, a mismatching stimulus that goes from uppercase distractor to lowercase target should be much less likely to cause an NP effect on lag. Yet no effect of lag is observed on NP and a reduction in long-lag PP (or absence of long-lag PP in McLennan et al.'s findings) and long-lag response facilitation in the ARDR condition was observed compared to without lag condition. It is argued that attending to something explicitly (across the visual, articulatory, and auditory modalities) makes it highly susceptible to subsequent interference from all the naming and lexical decisions participants make before the 151st trial appears (about 10 minutes later). This is why long-lag PP and ARDR response facilitation was reduced in our case and long-lag PP was eliminated in McLennan et al.'s findings. In contrast, the IR trials are preserved and not susceptible to either further implicit or explicit memories from all the stimuli attended and ignored before the 151st trial appears (about

10 minutes later). Because the long-lag facilitation was reduced relative to the long-lag inhibitory effect, the assumption is that different mechanisms may underlie long-lag facilitation (e.g., in the AR and ARDR conditions) versus long-lag inhibition (e.g., in the IR condition). Henceforth, it is argued that the episodic retrieval account must re-evaluate their assumptions concerning the predictive mechanisms of retrieval (Neill & Valdes 1992; Neill et al., 1992) and the contexts that induce episodic retrieval (May et al., 1995).

As mentioned, our findings (particularly in the AR and ARDR conditions) cannot be explained using the response retrieval variant of the episodic retrieval account as the response requirements were not repeated between prime (naming) and probe (LD) to modulate priming, (Nett et al., 2016; see also Henson et al., 2014). It is argued that the experimental features and procedural context must be taken account, but the theoretical explanations must consider the obtained priming at the central or abstract level (see also May et al., 1995). For instance, the priming effects are demonstrated in a variety of settings and modalities; while the response retrieval account limits it to response compatibility and incompatibility alone. Furthermore, the response retrieval account suggests an added advantage in the ARDR condition due to the repetition of distractors (Frings et al., 2007; see also Neumann & DeSchepper, 1991; Stadler & Hogan, 1996). Our findings question these assumptions as the long-lag DR condition suggests that there is no distractor repetition effect at lagged intervals. This lack of distractor repetition effect was also observed in the long-lag ARDR condition evidenced by the reduction in the ARDR response facilitation with lag compared to without lag condition.

Lastly, current findings can also have implications on an ongoing controversy in the NP literature that asserts that the temporal discrimination model predicts response cost in the DR condition (Frings & Wuhr, 2007; see also Mayr & Buchner, 2007; McLennan et al., 2019;

Pritchard & Neumann, 2011). As mentioned, the temporal discrimination model credits both attentional set and automatic retrieval as underlying mechanisms of priming effect and devises a mechanism of demonstrating NP in which selection against a prime distractor was not required (Milliken et al., 1998). It is argued that the key is to think of the two processes; attention and retrieval; as separate from each other rather than dependent on each other. For instance, if one assumes both processes to be dependent, then one might predict a slowing response in both IR and DR trials by the temporal discrimination model. However, if one assumes both processes to be independent, then one can assume attention set favouring novelty slows responses to the IR conditions while also speeding performance for DR conditions (see also D'Angelo et al., 2016). Our findings support the latter argument and would suggest both cognitive processes (attention and retrieval) to be independent of one another. In short, it is argued that the temporal discrimination model didn’t account for a variety of priming effects and the model’s ambiguity on whether the two processes (attention and retrieval) were dependent or independent resulted in criticism particular concerning the DR condition (e.g., Frings & Wuhr, 2007; see also Mayr & Buchner, 2007; McLennan et al., 2019; Pritchard & Neumann, 2011).

5.2. Methodological implications

The research also highlights the importance of experimental features and procedural contexts (e.g., selection cue, number of repetitions, intervening trails, size of stimuli set, prime-probe response requirements, percentage of target repeat trials, etc.) that can modulate the manifestation on priming. For instance, there is a mention of attentional ‘pop-out’ effects in relation to colour as the selection cue which reduced the likelihood of obtaining NP with non-recycled words (e.g., Malley & Strayer, 1995; Treisman & DeSchepper, 1996). Our consistency observed long-lag NP effects with non-recycled words suggest that letter case as a selection cue can enhance the task difficulty and can consequently obtain both short-lag and long-lag NP without the need for stimuli repetition (see also McLennan et al., 2019). Notably, the above argument is not intended to determine ‘right’ or ‘wrong’ selection cue, as NP effects can be reliably obtained when colour is used to discriminate between the target and distractor stimuli (e.g., Neumann & DeSchepper, 1991; Tipper, 1985). The inconsistencies to obtain NP with non-recycled stimuli can be taken as an empirical opportunity to understand the underlying mechanisms of information processing that can modulate the manifestation of NP. These apparently conflicting pieces of evidence provide a wider understanding of NP as a phenomenon by asserting that NP can be obtained using non-recycled words (as in Neumann and colleagues’ findings). However, the obtained NP effect can be significantly reduced (as in Strayer and colleagues’ findings) due to decreased task difficulty owing to the employment of colour as the selection cue to discriminate between the target and distractor words. Notably, the issue of stimuli competitiveness or task difficulty is brought up as a possible explanation for previous discrepant findings regarding the necessity of stimulus repetition for NP. While difficulty might indeed be a factor here, it is also important to be clear that difficulty wasn’t manipulated in current experiments. Hence, the assumptions regarding task difficulty can be considered preliminary and impetus for further research. Further research could be done to have a direct test of the influence of selection cue type on the outcome (e.g., case versus colour, uppercase versus lowercase, red versus green, leaved versus interleaved, or letter case versus colour, etc.) on NP to comprehensively examine the effects of selection cue on NP (see also Manso de Zuniga, Humphreys, & Evett, 1991) by using a large pool of non-recycled stimuli.

NP researchers generally employ a small pool of recycled stimuli combined with identical prime-probe response requirements to examine the priming effects. Such manipulations are vulnerable to develop arbitrary associations which can contaminate priming due to non-priming factors (Henson et al., 2014; Neumann & Levin, 2018). In this respect, Neumann and Levin (2018) re-evaluated the findings of two classical NP researches (Neumann & DeSchepper, 1991; Stadler & Hogan, 1996) using predictive pattern testing. They argued that the findings of both studies corroborate one another except that the priming effects were more symmetrical in Neumann and DeSchepper's study and asymmetrical with inflated response facilitation in Stadler and Hogan's study. Based on their analysis, they showed that the magnitude of Stadler and Hogan's response facilitation was exaggerated due to asymmetric transfer produced by the expectancy bias of target and response repetition that developed over time in their experiments due to the repetition of the same target three times in every 12 displays. They further argued that Neumann and DeSchepper avoided the asymmetrical transfer confound that affected Stadler and Hogan's findings due to the employment of a relatively large pool of stimuli. To avoid such confounding artefacts and to obtain process pure priming, Neumann and Levin suggested the use of a large pool of non-recycled stimuli (see also Henson et al., 2014).

Interestingly, the asymmetrical transfer effect can also be observed in Frings et al.'s (2007; see also Frings, 2011) findings. Frings et al. (2007) examined the AR, DR, and ARDR conditions by using a small pool of recycled letters (D, F, J, K). The observed response facilitation in the AR and ARDR conditions and response cost in the DR condition. Perhaps most critically, Frings et al.'s reported DR response cost is inconsistent with NP literature in general (Frings & Wühr, 2007; Ihrke et al., 2011; Neumann & DeSchepper, 1991; Stadler & Hogan, 1996; see also Nett et al., 2016; Pramme et al., 2015; Rothermund et al., 2005; Schrobsdorff et al., 2012). In Chapter 3, an alternate account of Frings et al.'s (2007) findings were established considering their experimental context. It was argued that due to employment of a small pool of recycled stimuli combined with a higher percentage (50%) of target repeat trials, Frings et al.'s findings were contaminated to an extent that response cost emerged in the DR condition instead of response facilitation (see also Neumann & DeSchepper, 1991). These examples demonstrate the sensitivity of priming towards the variations in the experimental features and procedural context which can modulate (e.g., Stadler & Hogan, 1996), cancel (e.g., Malley & Strayer, 1995, Experiment 1), or even reverse (e.g., Frings et al., 2007) the obtained priming effects. Notably, the theories that can specify the precise contingencies that lead to such variations in priming do not exist. Hence, the specificity of the experimental paradigm must be considered while interpreting the findings. Furthermore, researchers should provide a direct replication of their findings (like our NP findings), or use meta-analysis and publish review articles to resolve some of the ongoing controversies in the NP literature.

5.3. Other empirical implications

There are many strengths in the current program of research. The experiments themselves are well-designed, and show great attention to detail and experimental control; for example, through careful selection of stimuli and counterbalancing. Most importantly, the experiments are systematic in addressing the various ways our previous interactions with information influence our subsequent processing. There are a nice symmetry and progression to the series of experiments, and the repetition of the IR condition across experiments allows for replication. An obvious future direction would be to investigate all of the conditions advocated by Christie and Klein (2008; see also Neumann & DeSchepper, 1991; Stadler & Hogan, 1996) but to extend them to both short and long-lag priming effects to develop a more comprehensive understanding of this dynamic phenomenon. Secondly, a relative persistence of current long-lag NP effects suggests that distractor inhibition is a more pervasive form of cognitive control than once thought (see also Li et al., 2017). It further indicates that the task-irrelevant distractor leaves a memory trace that can affect performance over time. Such finding is of immense theoretical importance to understand psychological problems with inhibitory control issues (e.g., OCD, PTSD and schizophrenia) and to devise better treatments plans for them (see also Catarino, Küpper, Werner-Seidler, Dalgleish, & Anderson, 2015; Schooler, Neumann, Caplan, & Roberts, 1997a, b). Lastly, there are several additional potentially important implications as the selection and interference are central cognitive phenomena when it comes to human behaviours, interaction, and ergonomics. For instance, imagine you are reading something while ringing or vibrating phone disturbs you. Are the distractors presented to the unattended sense (e.g., auditory) ignored the same way than distractors in the attended sense (e.g., vision)? Is distractor processing comparable across sensory modalities (e.g., touch and vision)? And what about distractors of affective nature?

5.4. Conclusion

Using a large pool of non-recycled familiar words, the research investigated the underlying mechanism governing target and distractor processing in selective attention through a series of six experiments and considers the outcomes for a current opinion on the cognitive processes behind the priming effects. Across the experiments, the most consistent finding is that NP is observed at both short and long lag; indeed, without any diminishment over time. The other types of priming, in contrast, either diminished (e.g., in the AR and ARDR condition) or eliminated (e.g., in the DR condition) with a protracted multi-minute lag (about 10 minutes) and 151 intervening trials. The results are argued to increase our understanding of the nature of distractor inhibition at the implicit level and to challenge some of the key predictions of the episodic retrieval and response retrieval account of identity-based priming.

References

Balota, A. D., Yap, J. M., Cortese, J. M., Hutchison, A. K., Kessler, B., Loftis, B., Neely, H. J., Nelson, L. D., Simpson, B. G., & Treiman, R. (2007). The English lexicon project. *Behaviour Research Methods, 39*(3), 445–459. Retrieved from http://elexicon.wustl.edu/userguide.pdf

Catarino, A., Küpper, C. S., Werner-Seidler, A., Dalgleish, T., & Anderson, M. C. (2015). Failing to Forget: Inhibitory-Control Deficits Compromise Memory Suppression in Posttraumatic Stress Disorder. *Psychological Science, 26*(5), 604–616. https://doi.org/10.1177/0956797615569889

Cesario, J. (2014). Priming, replication, and the hardest science. *Perspectives on Psychological Science. 9*(1), 40–48. doi: 10.1177/1745691613513470

Christie, J. J., & Klein, R. M. (2008). On finding negative priming from distractors. *Psychonomic Bulletin & Review*, *15*(4), 866–873. PMID: 18792518

Dalrymple-Alford, E. C., & Budayr, B. (1966). Examination of some aspects of the Stroop color-word test. *Perceptual and Motor Skills, 23*(3_suppl), 1211-1214. https://doi.org/10.2466/pms.1966.23.3f.1211

D'Angelo, M. C., Thomson, D. R., Tipper, S. P., & Milliken, B. (2016). Negative priming 1985 to 2015: A measure of inhibition, the emergence of alternative accounts, and the multiple process challenge. *Quarterly Journal of Experimental Psychology, 69*(10), 1890–909. doi: 10.1080/17470218.2016.1173077

DeSchepper, B., & Treisman, A. (1991, November). Novel visual shapes in negative priming. Paper presented at the 32nd Annual Meeting of the Psychonomic Society, San Francisco.

S. P. Tipper, & B. Milliken (1996). In Distinguishing between inhibition and episodic retrieval based accounts of negative priming. In A. F. Kramer, M. Coles, & G. Logan (Eds.), Converging operations in the study of visual attention (pp. 337-364). Washington, DC: American Psychological Association.

DeSchepper, B., & Treisman, A. (1996). Visual memory for novel shapes: Implicit coding without attention. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 22*, 27–47. PMID: 8648288

Duyck, W., Desmet, T., Verbeke, L. P., & Brysbaert, M. (2004). WordGen: A tool for word selection and nonword generation in Dutch, English, German, and French. *Behavior Research Methods, Instruments, & Computers, 36*(3), 488–499. PMID: 15641437

Ecker, U., Zimmer, H., & GrohBordin, C. (2007). Color and context: An ERP study on intrinsic and extrinsic feature binding in episodic memory. *Memory & Cognition, 35*, 1483–1501. PMID: 18035643

Erickson, A., M., & Reder, M. L. (1998). The influence of repeated presentations and intervening trials on negative priming. In M. A. Gernsbacher & S. J. Derry (Eds.), *Proceedings of the Twentieth Annual Conference of the Cognitive Sciences Society*, (pg. 327-332). Mahwah, NJ; Erlbaum.

Erickson, A. M., Shang, J., Buchanan, E. E., & Reder, M. L. (2005). Long and short-term negative and positive priming. Retrieved from https://goo.gl/kwtvij

Fox, E., & de Fockert, J. W. (1998). Negative priming depends on prime probe similarity: Evidence for episodic retrieval. *Psychonomic Bulletin & Review, 5*(1), 107–113. http://dx.doi.org/10.3758/BF03209464

Francis, W. N., & Kucera, H. (1982). *Frequency analysis of English usage: Lexicon and grammar*. Boston, MA: Houghton Mifflin.

Friendly, M. (1996). Paivio et al. Word List Generator. Retrieved from http://www.datavis.ca/online/paivio/, Accessed 01/05/2015.

Frings, C. (2011). On the decay of distractor-response episodes. *Experimental Psychology, 58*, 125–131. doi: 10.1027/1618-3169/a000077

Frings, C., & Wu¨hr, P. (2007). On distractor repetition benefits in the negative-priming paradigm. *Visual Cognition, 15*, 166–178.

Frings, C., Rothermund, K., & Wentura, D. (2007). Distractor repetitions retrieve previous responses to targets. *Quarterly Journal of Experimental Psychology, 60*(10), 1367–77. doi:10.1080/17470210600955645

Giesen, C., Weissmann, F., & Rothermund, K. (2018). Dissociating distractor inhibition and episodic retrieval processes in children: No evidence for developmental deficits. *Journal of Experimental Child Psychology*, *166*, 212–231. https://doi.org/10.1016/j.jecp.2017.08.011

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

Grison, S., Tipper, S. P., & Hewitt, O. (2005). Long-term negative priming: Support for retrieval of prior attentional processes. *The Quarterly Journal of Experimental Psychology, 58A*(7), 1199–1224. doi: 10.1080/02724980443000557

Hasher, L., Stoltzfus, E. R., Zacks, R. T., & Rypma, B. (1991). Age and inhibition. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 17*, 163–169. Retrieved from https://goo.gl/7M6S3q

Healy, D., & Burt, J. S. (2003). Attending to the distractor and old/new discriminations in negative priming. *The Quarterly Journal of Experimental Psychology A: Human Experimental Psychology, 56A* (3), 421-443. http://dx.doi.org/10.1080/02724980244000477

Henson, R. N., Eckstein, D., Waszak, F., Frings, C., & Horner, A. J. (2014). Stimulus-response bindings in priming. *Trends in Cognitive Sciences, 18*(7), 376–84. doi:10.1016/j.tics.2014.03.004

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

Ihrke, M., Behrendt, M., Schrobsdorff, H., Herrmann, M., & Hasselhorn, M. (2011). Response-Retrieval and Negative Priming Encoding- and Retrieval-Specific Effects. *Experimental Psychology, 58*(2), 154–161. DOI: 10.1027/1618-3169/a000081

Kessler, Y., & Moscovitch, M. (2013). Strategic processing in long-term repetition priming in the lexical decision task. *Memory, 21*(3), 366–376. https://doi.org/10.1080/09658211.2012.728611

Kramer, A. F., & Strayer, D. L. (2001). Influence of stimulus repetition on negative priming. *Psychology and Aging, 16*, 580–587

Li, L., Neumann, E., & Chen, Z. (2017). Identity and semantic negative priming in rapid serial visual presentation streams. *Attention, Perception & Psychophysics, 79*, 1755–1776.

Lowe, D. (1998). Long-term positive and negative identity priming: Evidence for episodic retrieval. *Memory and Cognition, 26*, 435–443. PMID: 9610115

Malley, G. B., & Strayer, D. L. (1995). Effect of stimulus repetition on positive and negative identity priming. *Perception & Psychophysics, 57*(5), 657–667. PMID: 7644326

Manso De Zuniga, C., Humphreys, G. W., & Evett, L. J. (1991). Additive and interactive effects of repetition, degradation, and word frequency in the reading of handwriting. In D. Besner and G. W. Humphreys (Eds.), *Basic processes in reading: Visual word recognition* (pp. 10-33). Hillsdale, NJ: Erlbaum.

May, C. P., Kane, M. J., & Hasher, L. (1995). Determinants of negative priming. *Psychological Bulletin, 118*, 35–54. PMID: 7644605

Mayr, S., & Buchner, A. (2007). Negative priming as a memory phenomenon: A review of 20 years of negative priming research. *Zeitschrift für Psychologie, 215*, 35–51. doi: 10.1027/0044-3409.215.1.35

McLennan, K. S., Neumann, E., & Russell, P. N. (2019). Positive and negative priming differences between short-term and long-term identity coding of word-specific attentional priorities. *Attention, Perception, and Psychophysics.* http://dx.doi.org/10.3758/s13414-018-01661-9.

Milliken, B., Joordens, S., Merikle, P. M., & Seiffert, A. E. (1998). Selective attention: A reevaluation of the implications of negative priming. *Psychological Review, 105*, 203–229. doi: 10.1037//0033-295X.105.2.203

Moore, C. M. (1994). Negative priming depends on probe-trial conflict: Where has all the inhibition gone? *Perception & Psychophysics, 56*(2), 133–147. PMID: 7971114

Neill, W. T. (1997). Episodic retrieval in negative priming and repetition priming. *Journal of Experimental Psychology, 23*(6), 1291–1305. doi: 10.1037/0278-7393.23.6.1291

Neill, W. T., & Valdes, L. A. (1992). Persistence of negative priming: Steady state or decay? *Journal of Experimental Psychology*, *18*(3), 565–576. doi: 10.1037/0278-7393.18.3.565

Neill, W. T., & Westberry, R. L. (1987). Selective attention and the suppression of cognitive noise. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 13,* 327–334. http://dx.doi.org/10.1037/0278-7393.13.2.327

Neill, W. T., Valdes, L. A., Terry, K. M., & Gorfein, D. S. (1992). Persistence of negative priming: Evidence for episodic trace retrieval. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 18*, 993–1000. doi: 10.1037/0278-7393.18.5.993

Nett, N., Bröder, A., & Frings, C. (2016). Distractor-based stimulus-response bindings retrieve decisions independent of motor programs. *Acta Psychologica 171*, 57–64. doi: 10.1016/j.actpsy.2016.09.006

Neumann, E., & DeSchepper, B. G. (1991). Costs and benefits of target activation and distractor inhibition in selective attention. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 17*(6), 1136–1145. PMID: 1838386

Neumann, E., & Levin, J. R. (2018). Can the use of seven key manipulations and predicted pattern testing bring more clarity to negative priming investigations? *The American Journal of Psychology, 131*, 3–18.

Neumann, E., & Russell, P. N. (2000, November). Persistence of token resistance: Once-unattended words produce longterm negative priming. In S. Grison, S. P. Tipper, & O. Hewitt (2005), *Long-term negative priming: Support for retrieval of prior attentional processes* (pp. 1199–1224). The Quarterly Journal of Experimental Psychology, 58A(7), 1199–1224. doi: 10.1080/02724980443000557

Neumann, E., McCloskey, M. S., & Felio, A. C. (1999). Cross-language positive priming disappears, negative priming does not: Evidence for two sources of selective inhibition. *Memory & Cognition, 27*(6), 1051–1063. PMID: 10586580

Neumann, E., Nkrumah, K. I., & Chen, Z. (2018). Excitatory and inhibitory priming by attended and ignored non-recycled words with monolinguals and bilinguals, *Memory*. doi: 10.1080/09658211.2018.1447132

Paivio, A., Yuille, J. C., & Madigan, S. A. (1968). Concreteness, imagery, and meaningfulness values for 925 nouns. *Journal of Experimental Psychology, 76*(1), 1–25. PMID: 5672258

Pramme, L., Dierolf, A. M., Naumann, E., & Frings, C. (2015). Distractor inhibition: Evidence from lateralized readiness potentials. *Brain and Cognition, 98*, 74–81. doi: 10.1016/j.bandc.2015.06.003

Pritchard, V. E., & Neumann, E. (2009). Avoiding the potential pitfalls of using negative priming tasks in developmental studies: Assessing inhibitory control in children, adolescents, and adults. *Developmental Psychology, 45*, 272–283.

Rothermund, K., Wentura, D., & De Houwer, J. (2005). Retrieval of Incidental Stimulus-Response Associations as a Source of Negative Priming. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 31*(3), 482-495. http://dx.doi.org/10.1037/0278-7393.31.3.482

Schooler, C., Neumann, E., Caplan, L. J., & Roberts, B. R. (1997a). A time course analysis of Stroop interference and facilitation: Comparing normal individuals and individuals with schizophrenia. Journal of Experimental Psychology: General, 126(1), 19-36. http://dx.doi.org/10.1037/0096-3445.126.1.19

Schooler, C., Neumann, E., Caplan, L. J., & Roberts, B. R. (1997b). Stroop theory, memory, and prefrontal cortical functioning: Reply to Cohen et al. (1997). Journal of Experimental Psychology: General, 126(1), 42-44. http://dx.doi.org/10.1037/0096-3445.126.1.42

Schrobsdorff, H., Ihrke, M., Behrendt, J., Herrmann, J. M., & Hasselhorn, M. (2012). Identity negative priming: A phenomenon of perception, recognition or selection? *PLoS ONE, 7*(3), e32946. doi: 10.1371/journal.pone.0032946

Spadaro, A., He, C., & Milliken, B. (2012). Response to an intervening event reverses nonspatial repetition effects in 2AFC tasks: Nonspatial IOR? *Attention Perception Psychophysics, 74*, 331–349. Doi: 10.3758/s13414-011-0248-x

Stadler, M. A., & Hogan, M. E. (1996). Varieties of positive and negative priming. *Psychonomic Bulletin & Review, 3*, 87–90. doi: 10.3758/BF03210745

Strayer, D. L., & Grison, S. (1999). Negative identity priming is contingent on stimulus repetition. *Journal of Experimental Psychology: Human Perception and Performance, 25*(1), 24–38. PMID: 10069026

Tipper, S. P. (1985). The negative priming effect: Inhibitory priming by ignored objects. *The Quarterly Journal of Experimental Psychology, 37*(4), 571–590. https://doi.org/10.1080/14640748508400920

Tipper, S. P. (2001). Does negative priming reflect inhibitory mechanisms? A review and integration of conflicting views. *The Quarterly Journal of Experimental Psychology, 54A*(2), 231–343. doi: 10.1080/713755969

Tipper, S. P., & Cranston, M. (1985). Selective attention and priming: Inhibitory and facilitatory effects of ignored primes. *The Quarterly Journal of Experimental Psychology, 37*(4), 591–611. PMID: 4081102

Tipper, S. P., & Milliken, B. (1996). Distinguishing between inhibition and episodic retrieval based accounts of negative priming. In A. F. Kramer, M. Coles, & G. Logan (Eds.), *Converging operations in the study of visual attention* (pp. 337-364). Washington, DC: American Psychological Association.

Tipper, S. P., Weaver, B., Cameron, S., Brehaut, J. C., & Bastedo, J. (1991). Inhibitory mechanisms of attention in identification and localization tasks: Time course and disruption. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 17*, 681–692. http://dx.doi.org/10.1037/0278-7393.17.4.681

Treisman, A., & Gormican, S. (1988). Feature analysis in early vision: Evidence from search asymmetries. *Psychological Review, 95*(1), 15–48.

Treisman, A., & DeSchepper, B. (1996). Object tokens, attention, and visual memory. In T. Inui, & J. McClelland (Eds.), *Attention and Performance XVI: Information Integration in Perception and Communication*. Cambridge, MA: MIT Press.

Wu, Y. J., & Thierry, G. (2017). Brain potentials predict language selection before speech onset in bilinguals. *Brain and Language*, *171*, 23–30. http://dx.doi.org/10.1016/j.bandl.2017.04.002

Zimmer, H. D., Mecklinger, A., & Lindenberger, U. (2006). *Handbook of Binding and Memory: Perspectives from Cognitive Neuroscience.* Oxford University Press. pp. 3--24

Appendix A

Stimuli used in the conditions of interest

Fried	Top	Enemy	Staple
Debt	Zone	Box	Class
Rifle	Garage	Hair	Roof
Bike	Saw	Nose	Set
Word	Vow	Spoon	Salesman
Fog	Clip	Teeth	Role
Billet	Peel	Chest	Ham
Zigzag	Arc	Mouse	Keeler
Batch	Lift	Milk	Dagger
Raft	Sabre	Sheep	Smoke
Gorge	Hide	Equal	Walk
Hunger	Froth	Feather	Snob
Scalp	Party	Cloud	Finance
Campus	Neighbour	Glass	Creche
Suburb	Agent	Knee	Chip
Swipe	Paddock	Tribe	Master
Drink	Trustee	All	Plane
Rut	Egg	Ladder	Virgin
Climate	Dummy	Leaf	Trail
Shop	Scythe	Pig	Laugh
Counter	Sentence	House	Choir

Verge	Switch	Eye	Portrait
Gas	Context	Hot	Waiter
Joint	Cab	Flower	Coach
Case	Step	Cake	Canal
Berry	Matron	Oil	Mess
Sun	Fat	Dive	Exam
Mirror	Neckband	Soap	Price
Horror	Cannon	Rope	Romance
Land	Spider	Ball	Yoke
Rabbit	Fiddle	Cave	Mark
Large	Mildew	Bed	Crazy
Venom	Danger	Smell	Weaver
Fluid	Illness	Fruit	Drop
Loom	Usher	Hen	Barley
Symbol	Towel	Road	Fall
Draft	Reward	Branch	Slime
Drain	Core	Summer	Circus
Hollow	Fable	Zero	Thunder
Soup	Poem	Table	Oxygen
Space	Parrot	Ski	Talent
Bronco	Martyr	Addict	Fact
Morning	Total	Grub	Patch
Warm	Fountain	Abbey	Ale

Basket	Knob	Spell	Pen
Dirty	Start	Bite	Raffle
Wind	Gypsy	Alien	Mud
Path	Mob	Calf	Tunnel
Moon	Sick	Truth	Chap
Rice	Sieve	Program	Crate
Salt	Pram	Shame	Sap
Bush	Study	Cabinet	Bog
Big	Tour	Dessert	End
Tongue	Dame	Tenant	Lid
Coat	Film	Kitten	Sketch
Friend	Trash	Dress	Support
Happy	Saucepan	Yoga	Dwarf
Ancestor	Curfew	Shape	Herd
Face	Prison	Ban	Lungs
Seagull	Saliva	Blob	Gun
Leg	Jingle	Senior	Premier
Warrior	Tea	Adopt	Nature
Taboo	Girdle	Bamboo	Junior
Country	Jug	Sandal	Clod
Sunk	Foam	Mole	Pet
Canyon	Paw	Germ	Evil
Heat	Cloth	Plumb	Tea

Mug	Wink	Axe	Girdle
Bonnet	Fly	Hamper	Jug
Wolf	Stag	Means	Foam
Hump	Rumpus	Warning	Paw
Rage	Event	Flaw	Cloth

Appendix B

Date:__________Time:________ **Participant Id:_________________**

Experiment Id: __________________ **Version: ___________________**

SAMPLE NAMING RESPONSE SHEET

Recorder Instructions: Please make sure that subject details on this sheet identify the subject data file. **Write down** only **incorrect** words in the space beside the listed word and use a dash (-) to indicate a missed response, leave blank if correct.

P1	facility
P2	fantasy
P3	equity
P4	proxy
P5	replacement
P6	duty
P7	loyalty
P8	development
P9	method
P10	democracy
P11	attribute
P12	event
P13	tendency
P14	amount
P15	hint
P16	jeopardy
P17	unit
P18	instance
P19	clemency
P20	spirit
P21	idea
P22	virtue
P23	interest
P24	blasphemy
1	victim
2	storeroom
3	woods

4	time
5	gadfly
6	hearing
7	institute
8	library
9	dweller
10	vegetable
11	month
12	fowl
13	kindness
14	oats
15	skillet
16	heredity
17	answer
18	bullet
19	forest
20	examination
21	book
22	clothing
23	nun
24	ink
25	decree
26	stub
27	baby
28	chloride
29	delirium
30	harness
31	square
32	green
33	sadness
34	hamlet
35	bard
36	alcohol
37	revolt
38	stagecoach
39	courtship
40	blood
41	barrel
42	flesh
43	evangelist
44	queen

45	appliance
46	coast
47	victory
48	derelict
49	dream
50	jury
51	peach
52	fox
53	market
54	orchestra
55	core
56	dust
57	idiom
58	exertion
59	belfry
60	link
61	quantity
62	harp
63	health
64	maker
65	procession
66	retailer
67	gravity
68	footwear
69	troops
70	poet
71	salary
72	ambassador
73	wife
74	pipe
75	author
76	tempest
77	sonata
78	ticket
79	gentleman
80	ritual
81	christmas
82	pact
83	truce
84	heaven
85	letter

86	semester
87	noose
88	shriek
89	velocity
90	spire
91	diamond
92	ankle
93	socialist
94	storm
95	captive
96	property
97	lubricant
98	cattle
99	person
100	profile
101	jail
102	tomb
103	power
104	trumpet
105	thorn
106	hardship
107	pressure
108	physician
109	locker
110	tool
111	cowhide
112	instructor
113	chasm
114	oven
115	chin
116	cellar
117	master
118	rheumatism
119	abode
120	residue
121	goddess
122	guardhouse
123	hammer
124	horsehair
125	periodical
126	nursery

127 loquacity
128 tank
129 vehicle
130 feudalism
131 dynasty
132 engine
133 mathematics
134 sulphur
135 daybreak
136 lecture
137 form
138 misery
139 infirmary
140 typhoon
141 sobriety
142 garden
143 stain
144 charm

Catch trial recall: _________________ / No recall

Catch Trial Recognition: LIBERAL / LITERAL / LYRICAL

Total Naming Errors: __________/144 **Percentage of Naming Errors: __________%**

Comments:____

____

____

Appendix C

Participant Id: ____________ Experiment Id :________________

(To be filled by the researcher)

POST EXPERIMENT QUESTIONNAIRE

Please fill in the questionnaire completely.

Age: __________ (in years) **Gender:** Male / Female / Others

Handedness: Right / Left / Mixed

Current/Recent educational Level:

Secondary School Undergraduate Postgraduate Others (specify): ________________

Any known sensory-motor or perceptual disability? Yes / No

How did you get informed about the experiment?

Psyc. Participant Pool UC Blog Subjects Wanted

On-Campus Ads Through a Friend Others (specify): __________

What sort of activity you were engaged in before the testing session?

Taking lectures/labs Job Exercise/Sports Socializing Other

Have you been part of a similar experiment before? Yes / No

If yes, when did you participate in a similar language experiment? What sort of activity you performed in that experiment?

____

____

1. Practice trials were helpful in developing strategy to execute the task, but do you think more practice should be done? Yes / No

2. What strategy did you used to execute task while maintaining speed and accuracy?

____

____

3. Were you able to read the uppercase word while naming the lowercase word in the first display? (encircle one)

Always Most of the time At times Rarely Never

4. Were you able to read the uppercase word while making a word/non-word judgment to the lowercase item in the second display? (encircle one)

Always Most of the time At times Rarely Never

5. How much were you concerned with maintaining speed and accuracy?

Always Most of the time At times Rarely Never

6. During the entire experiment, did you notice any systematic relationships between first and second display in a given trial? Yes / No

If yes, kindly describe the pattern(s) that you have observed during the experiment.

____

____

____

Any other comments you would like to make in this respect:

____

____

____

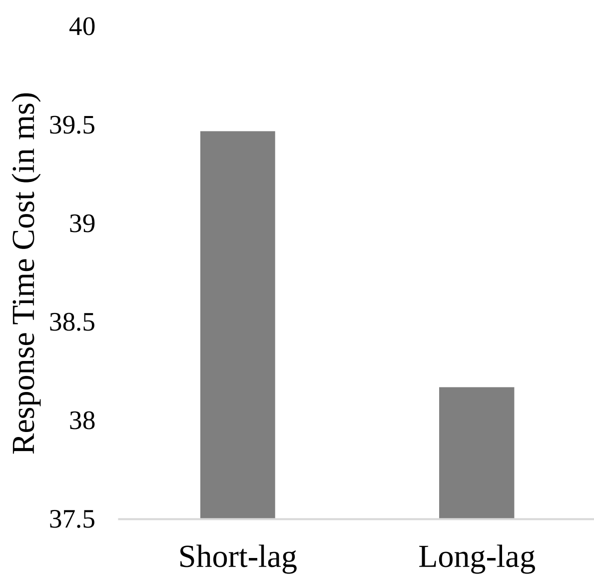
Thank you.

Appendix D

Supplementary analysis on NP

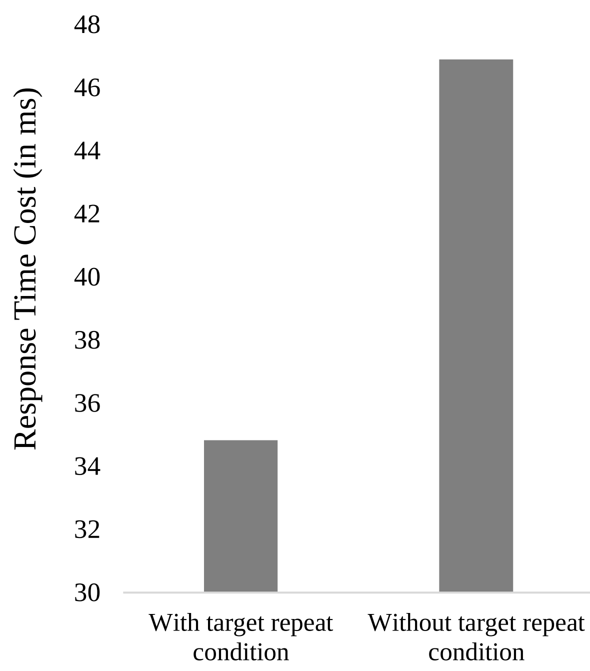
Because the short-lag and long-lag IR conditions were so consistent to obtain NP in the LD response time data, it might be useful to do a more powerful statistical analysis that combines all the six experiments involving the IR condition. If NP is significantly observed across experiments in the LD response time, then the findings will be taken as a strong counter-evidence that challenge the commonly held myth in the NP literature regarding the necessity of stimuli repetition to obtain NP (Grison & Strayer, 2001; Malley & Strayer, 1995; Strayer & Grison, 1999). A one-way ANOVA across six experiments indicated no LD response time differences between groups, F (5, 280) = 1.949, p =.09, η_p^2 = .03. A 2 (IR vs. CO) x 6 (1a, 1b, 2a, 2b, 3a, 3b) mixed ANOVA on the LD response time indicated overall NP effects (F (1, 280) = 3107.268, p = .00, η_p^2 = .92) and no priming by lag interaction (F (1, 280) = 1.537, p = .18, η_p^2 = .03), as expected. These findings provide a stronger test of the idea that stimuli repetition is not necessary to obtain NP.

Further analyses were carried out to examine the possibility of obtaining any differences in NP with a lag to pit the assumptions of episodic retrieval account (e.g., May et al., 1995; Niell & Valdes, 1992; Neill et al., 1992). A 2 (IR vs. CO) x 2 (short-lag vs. long-lag) mixed ANOVA on the LD response time indicated overall NP effects, F (1, 284) = 27.627, p = .000, η_p^2 = .09. A 2 (IR vs. CO) x 2 (short-lag vs. long-lag) mixed ANOVA on the LD response time indicated no NP by lag interaction, F (1, 284) = .008, p = .930, η_p^2 = .00. These findings were further confirmed as the NP (IR - CO) obtained in the short-lag experiments was not different than NP obtained in the long-lag experiments, t (268) = .229, p = .819, d = 0.03, two-tailed. Hence, challenging a commonly held notion in the NP literature asserts that when the prime distractor is repeated after a long protracting lag as a probe target in the IR condition, the probability of prime episode is less likely to be retrieved to obtain long- lag NP (Neill & Valdes, 1992). Contrary to these predictions, our findings suggest that the effect of prime distractor implicit processing remained reliably intact to obtain response time delays 151 trials (about 10 minutes) later like the short-lag ignored repetition condition. This implicit distractor processing was also confirmed as the participants were not able to recognise the uppercase distractor (LITERAL) in the catch trial above chance (0.33), p = .496 (two-tailed).



Comparison between the short-lag and long-lag negative priming obtained in the lexical decision response time in the ignored repetition (IR) conditions.

These findings also challenge May et al.'s (1995) assumption concerning the contexts that induce episodic retrieval (e.g., the AR, DR, and ARDR conditions) and the probability of obtaining long-lag NP decreases further. May et al. added that when the IR condition is examined with the target repeat conditions, the obtained NP effect would be larger compared to the manipulations in which the IR condition is not examined with the target repeat conditions. To examine the possibility of obtaining any differences in NP when the IR condition is examined with or without the target repeat conditions, further analyses were carried out on the LD response time using mixed ANOVAs. A 2 (IR vs. CO) x 2 (with target repeat versus without target repeat) mixed ANOVA on the LD response time indicated significant overall NP effects, F (1, 278) = 27.907, p =.0000, η_p^2 = .09. A 2 (IR vs. CO) x 2 (with target repeat vs. without target repeat) mixed ANOVA indicates no differences in NP obtained with or without target repeat trials, F (1, 278) = 0.460, p =.498, η_p^2 = .00.



Comparison between the negative priming obtained in the lexical decision response time in the ignored repetition (IR) conditions in an experiment with or without target repeat conditions.

The above findings challenge May et al. (1995) assumptions concerning the contextual effect of target repeat trials on size of NP. It is argued that the size of NP can be modulated by several experimental features and procedural contexts (Kane, May, Hasher, Rahhal, & Stoltzfus, 1997; Mayr & Buchner, 2007; Schrobsdorff et al., 2012; Tipper, 2001), such as selection cue, stimuli repetition, or percentage of target repeat trials. However, our findings consistently suggest NP be relatively independent of contextual effects suggested by May et al. Further research could be done to examine the effect of context on NP to provide a more comprehensive account of NP.