Hemispheric differences in the temporal updating in short narrative situation models using a LDT

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This thesis is presented in partial fulfilment of the requirements for the degree of Bachelor of Arts (Honours), in the School of Psychology at Murdoch University, Western Australia, 2011.

I declare that this thesis is my own account of my research and contains as its main content work which has not previously been submitted for a degree at any tertiary educational institution.

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Jasmin K. Landes
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Abstract

Recent research into situation model representations has demonstrated the neglect of the temporal dimension relative to the remaining dimensions that govern the formation of situation model representations. Furthermore, literature has recently demonstrated right hemisphere (RH) involvement in the processing, integrating and revising of semantic information. For the purpose of gaining a cohesive understanding of situation models and the mechanisms involved in their formation, the present study aimed to investigate whether the RH hosts at least the temporal dimension of situation model representations. Thirty-four right-handed psychology students from Murdoch University participated in a computerised go-nogo lexical decision task (LDT) in which participant reaction time and error rates were documented. Temporal shifts in situation model representations were controlled for by presenting participants with short narrative passages that included short or long temporal adverbials or none at all during baseline/ neutral condition. Words and non-words were projected to the left visual field (LVF)/RH, the central visual field (CVF) and the right visual field/ left hemisphere (RVF/LH). Contrary to the hypotheses, the results did not demonstrate any temporal shifts for targets presented to the CVF or LVF/RH, as the degree of facilitation of targets between the short and long temporal references did not vary significantly. These findings are contrary to Zwaan’s (1996) strong iconicity assumption as well as previous behavioural research to suggest temporal updating. Nonetheless, compelling theoretical support lead to the continued maintenance of the claim that temporal awareness is inherent to the LVF/RH.

Keywords: Situation model, temporal shift, hemisphere, visual field, lexical decision task.
Hemispheric differences in the temporal updating in short narrative situation models using a LDT

Over the past two decades, research across disciplines has exhibited a steadily growing interest in language comprehension (for review, see Jung-Beeman, 2005). Of particular interest has been the examination of the mechanisms involved in the formation of a coherent understanding of text. The research has been of great interest to cognitive psychologists as a better understanding of the mechanisms involved in linguistic comprehension puts more general theories into perspective.

Researchers (Graesser, Millis & Zwaan, 1997; Johnson-Laird, 1983; Kintsch, 1994; van Dijk and Kintsch, 1983) proposed that a reader comprehends text across 3 different levels of processing. At the most basic level, the surface structure, readers form verbatim representations of text; for example the word order, syntax and sounds (Gernsbacher, 1985; Radvansky, 2005). Next, during the text base, the original sentence is stripped of excess sentential components and converted into a combination of propositional units highlighting the meaning of the sentence (Graesser, Singer & Tabasso, 1994; Kintsch, 1986; Kintsch, 1988; Kintsch, 1992; Trabasso & Sperry, 1985; van Dijk & Kintsch, 1983; Zwaan, 1994). While a text base may help a reader to understand text and carry out textually bound activities, such as proof reading (Singer & Halldorson, 1996), it does not guarantee the understanding of the situation described in text (Graesser et al., 1994; Kintsch, 1986; for review, see Sanford & Garrod, 1998). For example, jokes (Coulson & Williams, 2005) and metaphors (for review, see Faust, Barak & Chiarello, 2006) require the integration of presenting information, inferences and idiosyncratic knowledge. A text base cannot sufficiently explain a reader’s ability to link the mental representation of a text's semantic structure - as conveyed by the propositions - with previously acquired general knowledge and individual inferences (Johnson-Laird, 1983; Van Dijk & Kintsch, 1983). Thus, to explain this link, researchers
have developed the third level of processing, the situation model (Johnson-Laird, 1983; van Dijk & Kintsch, 1983).

A situation model is a formation of multidimensional mental representations that capture the content or situations of a text, any inferences drawn by the reader, and the integration of his or her general knowledge to form an analogue representation of a real world situation (van Dijk & Kintsch, 1983). As such, researchers (Zwaan, Langston & Graesser, 1995; Zwaan, Magliano & Graesser, 1995; Zwaan & Radvansky, 1998; Zwaan, Radvansky, Hilliard & Curiel, 1998; Gernsbacher 1990) have conceptualised the content of a situation model representation according to the following 5 dimensions: space, time, causation, intentionality and protagonist activity. Thus each situational representation includes the spatial location and characteristics, the time frame in which an event takes place, the coherence between current and previously described events, the protagonist activity, and his or her intentions or goals (Zwaan et al., 1995). For the purpose of explaining the amalgamation of the aforementioned situational dimensions and the reader’s personal knowledge, researchers (Zwaan, et al., 1995, Zwaan & Radvansky, 1998) have proposed the event-indexing model.

This model suggests that readers parse text into sequential events according to the five dimensions. While the dimensions provide a framework, it is the reader’s general knowledge and real-world experience of the dimensions and their relations that allow for the simulation of a situation. It has been established that having formed a situation model representation of the first lines in text (current model), the next piece of information is integrated into the current model, to form an integrated model, which progresses to become the new current model (Gernsbacher, 1990; Rinck, Hähnel & Becker, 2001; Zwaan, Magliano, et al., 1995; Zwaan & Radvansky, 1998). For example, using predominantly spatial references, sentences 1(a)-(e) briefly illustrate how the updating procedure is assumed to occur (example adapted from Zwaan & Radvansky,
Sentence 1 (a) allows for the original situation model representation to be formed the *current model*, whereby it has likely been inferred by the reader that Dillan is male and the main character around whom the following story will centre. Furthermore, it is assumed that in the reader’s interpretation Dillan is in the apartment building where his friend lives. Conceivably, upon reading sentence 1(b) the reader extracts the information and integrates it into the *current model* (1a), to form the *integrated model* (1a + 1b). Consequently, the new current *model* (1a + 1b) will serve as a framework into which 1(c) is integrated to form the *integrated model* (1a + 1b + 1c) and so on.

1(a) Dillan ran up the steps to the third floor. (b) He went to meet with one of his best friends. (c) He was excited to play computers games with his friend. (d) He walked up to his friend’s apartment and rang the bell. (e) His friend’s mother opened the door.

This continuous integration is referred to as situation model updating and allows for the continuous understanding of an evolving text (Zwaan & Radvansky, 1998; Zwaan, Radvansky, Frederico & Franklin, 1998).

In support of the overall notion of a situation model is a study by Bransford, Barclay and Franks (1972). Prior to the introduction of the term situation model, Bransford, and colleagues (1972) empirically demonstrated that semantic inferences of a situation significantly influenced the reader’s memory. As a result, it was concluded that sentences are not only information conveyed, but rather sentences are tools to guide the construction of semantic information of a situation. From a current perspective this coincides with the understanding of what a situation model representation is (Rinck et al., 2001; Zwaan & Radvansky, 1998). Furthermore, studies to investigate cross-lingual translation (Zwaan, Ericsson, Lally & Hill, 1998), as well as the acquisition and integration of information from several different documents (Perfetti, Britt & Georgi,
and modalities (Gernsbacher, Verner & Faust, 1990) confirmed the utilisation of situation models.

Although the literature has extensively supported the conceptualisation of language comprehension through situation model representations, one of the shortcomings in the situation model research is that among specific research towards understanding the interplay of the dimensions (Morrow, Greenspan & Bower, 1987; Zwaan, Magliano, et al., 1995), the temporal dimension has been largely neglected (Rinck, et al., 2001; Zwaan & Radavsky, 1998; Rinck & Bower, 2000). This is somewhat surprising given that temporal references are inherent to language (e.g.: tenses) and can hardly be ignored in an investigation into the formation of situation model representation (Zwaan, 1996).

**Temporal dimension**

In reality, events appear to unfold seamlessly; in fluid succession without temporal gaps. In a narrative, however, the author controls not only which events occur but, more importantly, when and in what sequence events should be presented to the reader. For example, temporal cues determine the time frame; these include tense (Peter walked), active status (is walking), adverbs to indicate order (Before he walked) and temporal adverbials (e.g.: a few hours later; Rinck & Bower, 2000). Even when no temporal cues are implemented to explicitly indicate a time frame, individuals maintain a temporal understanding throughout a text. In support of this notion, investigators (Chafe, 1979) have proposed that readers interpret the order in which information is presented as the order in which the events occur.
For example, sentences 2 (a) and 2 (b) present the same information, but because the order in which the actions are presented changes from one sentence to another, sentences 2 (a) and 2 (b) essentially describe two different situations (adapted from Zwaan, 1996).

2 (a) The President opened the door, looked around and coughed.

2 (b) The President coughed, looked around and opened the door.

This illustrates that although temporal references may not be explicitly articulated through language, the reader assumes a chronological order of immediately following events (Rinck & Bower, 2000). This is referred to as the *iconicity assumption* (for review, see Zwaan, 1996).

Interestingly, in numerous behavioural experiments, investigators (Rinck & Weber, 2003; Speer & Zacks, 2005) behaviourally measured participants' reading times and found that when participants were presented with temporally continuous (i.e.: iconicity assumption) as opposed to discontinuous statements (a temporal gap that cannot be bridged by assuming a chronological order of events, such as an event that occurs a day later from the original time frame), a shorter reading time was recorded.

Zwaan (1996) accounted for these differences in reading time using the *strong iconicity assumption* (Dowty, 1986). The strong iconicity assumption purports that the iconicity assumption, by default, predicts minor temporal discontinuities in text as a *moment later*. Thus the reader maintains the activation of the current time frame and assumes that the events prior to and after a *moment later* are temporally contingent (Zwaan, 1996). When a temporal discontinuity is too large (e.g.: *Peter walked in the forest and then searched for a recipe*) or a temporal adverbial indicates a long temporal gap (e.g.: moving from a currently occurring event to an event that occurs *a few hours later*), the reader experiences a temporal shift, whereby he or she sets up a new time
interval accordingly (Zwaan, 1996). Furthermore, studies (Rinck & Bower, 2000; Zwaan, Langston et al., 1995; Zwaan, 1996) supported that the construction of a new interval requires the reader to deactivate the old situation model representation, create a new one, determine a new time frame, and assign the other 4 dimensional indices. These processes take time and mental capacity, which temporarily slow down processing and produce a change in the reading time (Rinck & Weber, 2003; Zwaan, 1996).

The notion that temporal discontinuities lead to an instant cost in the processing load of the reader (Rinck & Weber, 2003) is an important finding. It supports the influence of the temporal dimension in a situation model representation (e.g.: Zwaan, Langston et al., 1995; Zwaan & Radvansky, 1998). It also highlights that a reader’s construction of a situation model representation is highly reliant on temporal aspects as part of the contextual information.

Overall, the situation model is one of the most advanced behavioural models to explain language comprehension. While literature (e.g.: van Dijk & Kintsch, 1983; Zwaan, Langston et al., 1995; Zwaan & Radvansky, 1998) provides an extensive insight into the higher-level processes involved in language comprehension, the role of any neurological mechanisms (i.e.: continuous temporal awareness) in facilitating those processes is almost entirely omitted. This combined understanding is central to the overall understanding of language comprehension. Although no research has been conducted on the combined understanding, extensive research has been conducted to examine the neurological processes involved in more general language comprehension.
Lateralisation of language comprehension

For several decades it has been well established that language comprehension is facilitated by the left hemisphere (LH; for a review, see Jung-Beeman, 2005; Jung-Beeman & Chiarello, 1998). It was not until almost a century later that researchers (Coulson, Federmeier, van Petten & Kutas, 2005; St George, Kutas, Martinez & Sereno, 1999) introduced the facilitation of language aspects by the right hemisphere (RH). Through the employment of a lexical decision task (LDT), investigators (Gouldthorp & Coney, 2009a; 2009b) were able to behaviourally demonstrate that depending on the context of the stimuli, the RH exhibited word-level, which are the basic lexical associations of individual words and message-level processing that are aimed at eliciting a global grasp for message-level processes (Morris, 1994). For example, scrambled sentences, aimed to remove any contextual relationship between words for word-level processes, and unscrambled sentences aimed to establish sufficient context for message-level processes. In support of this special role of the RH in processing semantic stimuli, St George and colleagues (1999) suggested a high RH involvement in the development of a global understanding or message-level processing of semantically vague stimuli.

Consistent with suggestions of RH involvement in the processing of information at a semantic level (Gouldthorp & Coney, 2009a; 2009b), neuroimaging studies (for review, see Martin-Loeches, Casado, Hernandez-Tamames & Alvarez-Linera, 2008) have demonstrated that patients with RH damage were not able to understand jokes (i.e.: associating the general information with the punch line; Brownell, Michel, Powelson & Gardner, 1983) metaphors and ambiguous requests (Weylman, Brownell, Roman & Gardner, 1989). Also, patients were not able to draw inferences (Beeman, 1993) and revise these inferences upon the presentation of new information (Bihrlle, Brownell, Powelson & Gardner, 1986).
In short, researchers (for review, see Coulson & Williams, 2005; Faust, Barak & Chiarello, 2006) have highlighted, in order to understand, for example, jokes and metaphors, the reader must be able to integrate the presented information, inferences and general knowledge. The fact that patients with RH damage frequently fail to carry out this process of integration (for review, see Martin-Loeches et al., 2008), further strengthens the assumption that the RH plays a special role in the integration of information as well as message-level processing, allowing for a coherent understanding.

In light of situation model representations, these findings (Coulson & Williams, 2005), suggesting a special role of the RH in the processing and integration of semantic information, form the compelling argument that the RH is involved in the construction of situation model representations. Specifically, as the temporal dimension in situation model representations refers to contextual information that conveys temporal references, the argument can be broadened to include the assumption that the RH is involved in the facilitation of temporal references in text. As such, the focus of the present study is to examine whether the RH host at least the temporal dimension of a situation model representation.

Lexical decision task

Previous research regarding the exploration of the temporal awareness in situation models typically included explicit measurements (e.g.: reading time; Rinck & Weber, 2003; yes/no recognition tasks; Speer & Zacks, 2005). Again, while these support the insight that the temporal dimension is highly influential to the reader’s understanding of text, these explicit measures are not sensitive to the kinds of neurological processes (e.g.: hemispheric involvement) that occur. Furthermore, as these processes require participants to consciously consider the stimuli and to answer by choosing “yes” or “no”
(Speer & Zacks, 2005), various other thought processes can influence the reaction and distort reaction time. Lastly, based on numerous studies (e.g.: the stroop effect; see Jensen & Rohwer, 1966) it can be further assumed that there exists an inherent link between the physical appearance of words and their meaning.

In light of these considerations, the measurement tool utilised in the present study must allow for the formation of a situation model representation and must measure the implicit and automatic neurological responses to changes in temporal references in the stimuli. A task which fulfils these criteria and has frequently been utilised in language comprehension research (e.g.: Faust et al., 1993; Gouldthorp & Coney, 2009a; 2009b; 2011) is a LDT.

The present study

The first aim of the present study is to ensure that a LDT is an appropriate tool for measuring the neurological processes involved in the facilitation of temporal shifts in situation models. Although the frequent use of a LDT in previous research (Faust et al., 2003; Gouldthorp & Coney, 2009a; 2009b) encouraged the current application, it has not been established that the LDT is sufficiently sensitive to temporal shifts. Previous research (e.g.: Rinck & Weber, 2003) to measure temporal shifts has frequently relied on measurement tools that were strictly limited to central visual field (CVF) stimuli projection. As such, to ensure that a LDT is an appropriate measurement tool for temporal shifts, an aim will be made to replicate previous findings (e.g.: Rinck & Weber, 2003) that temporal shifts are apparent when stimuli is presented to the CVF. In line with the strong iconicity assumption (Zwaan, 1996), temporal shifts are intended to be evoked by alternating between short temporal references or adverbials (e.g.: *a few minutes later*/ no temporal shift) and long temporal adverbials (e.g.: *a few hours later*/...
temporal shift). Additionally, a neutral condition will be employed to act as a baseline measure.

The second aim is to examine whether the RH hosts at least the temporal dimension of situation models. For the purpose of examining any hemispheric involvement, particularly the RH in temporal shifts, participants will be presented with narrative passages that contain a probe and a temporal reference in the short and long adverbial condition and no temporal references in the neutral condition. Next, to contrast the hemispheric involvement, a prime/target item is presented to the left visual field (LVF), CVF or the right visual field (RVF). Due to contralateral pathways, visual input that is presented to the RVF is processed by the LH and vice versa (Young & Ellis, 1985). Hence it is expected that the memory traces of previous input are more prominent in opposing visual fields/hemispheres.

Consequently, it was hypothesised that the degree of target item facilitation was significantly greater in the CVF than in the RVF/LH for short temporal adverbials than for long temporal adverbials. It was also hypothesised that the facilitation was greater for the LVF/RH than the RVF/LH for short temporal adverbials than for long temporal adverbials.

It is expected that the outcomes of this study will contribute to the understanding of the neurological processes that maintain the higher-level cognitive processes involved in the facilitation of a temporal awareness in situation model representations. The outcomes of this study will also produce a greater understanding of the hemispheric biases involved in language comprehension, whereby a deeper understanding of the functions of the RH in language comprehension can be beneficial to the development of educational and rehabilitation programs for individuals with brain injury.
Method

Participants

Participants included 34, male (n = 13) and female (n = 21) undergraduate students, who were recruited through the School of Psychology online subject pool at Murdoch University, Australia. As compensation for their cooperation, participants received course credit towards their psychology degree. The sample age ranged from 19 to 43 years (M = 23.74 years, SD = 4.67 years). All participants were native English speakers and had normal or corrected-to-normal vision. Participants were right-handed, as indicated by Bryden's Simplified Hand Preference Questionnaire (Bryden, 1982; see Appendix A). The sample's mean lateral quotient was .68 (M = .85, SD = .73), on scales that ranged from +1.00 (extreme right-handedness) to -1.00 (extreme left-handedness).

Design and stimulus materials

A 2x3x3 repeated measure design was implemented to manipulate the independent variables of the lexical status of target items (word or non-word), temporal adverbials (neutral, short and long) and visual field presentation (LVF/RH, CVF and RVF/RH). The dependent variables were reaction time and error rate, reaction time being of primary interest.

Lexical status of target items. One hundred and eighty word target items of approximately the same length (3-6 letters, M = 4.68, SD = 1.05) were derived from the University of Western Australia (UWA) School of psychology online MRC database (1987; see Appendix B). All word items were highly imageable (M = 614.29, SD = 20.55), concrete (M = 593.94, SD = 33.37) and familiar (M = 552.77, SD = 46.53) nouns. One hundred and eighty non-word items were generated by altering at least one letter
of each of the 180 word nouns (i.e.: SILVER/SULVER) in order to produce phonetically and orthographically legitimate non-sense items (see Appendix C).

*Temporal adverbial.* For the purpose of providing sufficient contextual information to elicit a situation model, the 360 target words were embedded into 360 individual short narrative passages (180 for the word items and 180 for the non-word items). The narrative structure was constant throughout the word and non-word passages whereby all passages were written in past tense and third person. Each set of passages consisted of three lines and no single sentence exceeded 160 characters in length.

The word targets encompassed three different types of narrative passages, to produce the 3 conditions: the neutral, the short and long temporal adverbial condition. The first sentence provided contextual information to allow for the establishment of the situation model whilst simultaneously introducing a protagonist and a setting in which the protagonist might sensibly function for a few minutes or a few hours (see example below, sentence 3b). This first sentence remained unchanged across the neutral and the two adverbial conditions of every one passage. The second sentence logically followed on from the first, allowing for a continuation of the formation of a situation model. Moreover, in order to investigate any priming effects in both temporal adverbial conditions, participants were exposed to the target word /probe (see example, 3a/3c) or a neutral target during the second sentence (see example, 3d). The probes and neutral items maintained a standardised central position (of 6-8 words on either side of the probes) throughout the passages, as a control, standardising probe exposure. The third sentence served as the closing sentence and was preceded by either a short/long temporal adverbial for the corresponding short/long temporal adverbial condition (i.e.: no temporal shift/ a temporal shift, respectively, see example 3eii/3eiii) and no temporal adverbial for the neutral condition (i.e.: baseline, see example, 3ei). Importantly, in order to allow the third sentence to be part of the
preceding scenario, or the start of a new scenario, the third sentence was ambiguously constructed relative to the scenario introduced in sentences one and two. Furthermore, no spatial references were included in the third sentence, minimising the likelihood of spatial shifts occurring instead of temporal shifts. Lastly, variations of *a few minutes later* and *a few hours later* included *after a few minutes* and *a moment later* and *after a few hours* and *a few hours went by*, respectively, were employed in order to break up the otherwise repetitive temporal adverbials. For an overall illustration, see the example (sentences 1a-1e below, for more examples, see Appendix D)

3a  BEE
3b  Alison played with her bike in the backyard.
3c  As she rode past a bush, a *bee* stung her, but she continued riding her bike.
3d  As she rode past a bush, a *bird* flew out, but she continued riding her bike.
3e  (i)[No Adverbial], (ii)[*A few minutes later*], (iii)[*A few hours later*] Alison decided to help her mum drape the curtains.

In the non-word condition, the sentence structure was equivalent to the passage format in the word condition. This framework was carefully maintained throughout the experiment to minimise the likelihood of participants developing an awareness towards being presented with a word or a non-word.

**Counterbalancing**

The total target item pool of 360 items and matching passages was equally divided into the word-items and the non-word items. The total word-item pool of 180 target items and matching passages was divided into blocks of 20 and systematically coded and rotated by a custom-written computer program, in order to create nine stimulus files. The target items and passages within each block of 20 stimulus files were randomly redistributed across the file to represent all nine word conditions. The non-word target items and passages were not systematically rotated across the sample, as
the data they produced were of no greater interest beyond their purpose as distracters to participants. Instead, the 180 non-word items and passages were added to each of the nine stimulus files, after which all nine stimulus files were re-randomised. This produced nine stimulus files, with 20 blocks of 18 conditions each. Overall, this ensured that each item was presented once either to the LVF, the CVF or the RVF during each session and an equal number of times across the sample.

Furthermore, each of the nine files (now containing 360 word and non-word target items and passages) were further split into two sub-sets (File version A and B) and presented to participants across two sessions of one hour each (versus one session of two hours). This was to ensure that each participant had been exposed to the same level of stimuli difficulty the same number of times across the sample, and to reduce any fatigue effects. Across the entire sample, the nine files were rotated four times and the sub-set divisions (Version A and B) were presented to participants in reverse order, twice (i.e.: the first nine participants received version A in session one and version B in session two, while the next nine received version B in session one and version A in session two). In order to ensure that no one participant was exposed to the same order of target items (i.e.: an alphabetical or word-length order) and visual field exposure twice, the computer program randomised the items in each stimulus file again prior to every participant exposure. Overall, this comprehensive counterbalancing technique was implemented to minimise any potential stimuli- specific practise and order effects as well as confounds such as fatigue.

**Apparatus**

For the purpose of presenting the stimuli in a timed manner as well as detecting and recording participant responses to the target items, a FORTRAN control program was developed and installed on an Intel Pentium three processor with a Windows 98 Se
operating system and 256 Mb Ram. The stimuli narrative passages and target words were presented to the participants on a 17 inch ViewSonic VA721 anti-glare monitor, at a pixel resolution of 1280x1024, 32-bit colour and a refresh rate of 75 hertz.

Participants pressed a foot pedal to progress through the three-line narrative passages, determining the speed at which the passages were presented to them. A two-button (left/right) microswitch response box was utilised to record the participant’s reaction time in response to recognising target items. In order to ensure a standardised distance from the monitor across the sample, participants rested their chins on a chin-rest, individually adjustable for height, 60cm from the monitor. The participants were provided with ear defenders in the sessions to exclude any extraneous noises. A zoom lens captured a magnified image of the participant’s pupils and projected it onto a CCTV screen to ensure a continuous visual central fixation during the probe item presentation.

**Procedure**

Participants attended two one-hour sessions approximately two to three days apart, in order to minimise any practice effects across sessions. All participants were individually tested in the Murdoch University Cognitive Psychology Laboratory, which was illuminated by both natural and fluorescent lighting.

Prior to the commencement of the participant’s first session, individuals were presented with the information sheet (which also informed participants how to access the final results, once released see Appendix E), the LDT task instructions, which were read out to them (see Appendix F) and participants provided their written consent (see
Appendix G). The individuals were also administered the Bryden’s Simplified Hand Preference Questionnaire (1982) and potential questions and concerns were answered.

After these standard procedures were carried out, the participant was requested to sit down in the testing cubicle and adjust the chin-rest to a comfortable height. All participants were exposed to a randomised practise-run to ensure that they had understood the task, after which any questions or concerns were answered. Subsequently, the participant’s age and sex was recorded in an excel spread sheet, as well as their allocated stimulus file (i.e.: file one to nine) and the specific file sub-set (i.e.: version A or B), after which the participants were ready to commence their experimental trials (i.e.: press ‘Enter’ on the keyboard in front of them).

The passages were configured for black letters in Verdana font against a grey background. All passages were centrally presented on the computer screen. The participant read the passages at a speed that was comfortable to him/her. For the purpose of indicating that he/she had finished reading the passages, the participant tapped the foot pedal under the table. Once the participant had tapped the pedal, the passages disappeared and a blank cross replaced the passages, in the centre of the screen. After 700ms, the cross was replaced with a target item (word/non-word), which was configured for black uppercase letters in Verdana font size 26, whereby a capital letter A was 6mm at the base and 9mm in height. The target items were presented either at a set angle of 2.1° to the left of where the central cross had been (LVF/RH), in place of the cross (CVF) or at a set angle of 2.1° to the right of the cross (RVF/LH; Young & Ellis, 1985). Although the targets did not necessarily appear in place of the cross, participants were asked to maintain a visuo-central focus throughout the target presentation. This ensured the successful offset from central fixation at an angle of 2.1°. Furthermore, this also supported the target presentation to the independent
visual fields and stimulated subsequent visual field/hemifield specific processing (Young & Ellis, 1985).

As this LDT was a go-nogo, the participant was asked to only respond to the target word items (as opposed to non-word items). Hence, if the participant interpreted the target as a word item, he/she was instructed to depress the left and right microswitches on the switch box in front of them simultaneously. If the target was interpreted as a non-word item, the participant was asked not to respond. For every false target item interpretation (i.e.: falsely indicating that a target item was a word when it was a non-word), or failure to respond to target word items within 1500ms, the word 'ERROR' in red, uppercase letters, size 26 Verdana font, was displayed in the centre of the screen. The lexical decision in response to the target item characterises the boundaries of every one trial.

For the purpose of allowing a sufficient rest break between sessions, the sessions were conducted on two different days, two to three days apart. Each session was divided into blocks of six (30 trials). After every 30 trials, the participant's mean RT and error rates were displayed on the computer screen. As an accuracy-speed trade off dominated the mean RT and error rates, the participant was asked to monitor his/her results closely and make around four mistakes per block. The participant was asked to make adjustments to his/her speed-accuracy trade off (i.e.: reduce response speed target items to improve accuracy) when +/- four errors occurred. The breaks between blocks were self-timed, thus whenever the participant felt ready to continue, he/she was asked to press 'Enter' to commence a further block.
Results

Two outliers were removed from the sample, as both participants’ data exceeded the total mean RT by more than 2 standard deviations.

Reaction Time Analyses

The raw RT data was further screened for outliers, using a customised program and the Winsorization method (Barnett & Lewis, 1994). The program utilised a deletion criterion of +/- 2.5 standard deviations from each participant mean RT, per condition, which resulted in the removal of 1.5% of the total number of observations (n=5760). An additional 0.2% of the mean RT data was adjusted for by the Winsorisation method; whereby single responses that were more than 2 standard deviations above or below the sample RT mean were replaced with values equivalent to above or below 2 standard deviations from the sample RT mean. An alpha level of .05 was employed during all evaluations in the analyses reported below.

A 2x3x3 repeated measures analysis of variance (ANOVA) was conducted on the screened RT data, to assess the general effects of the independent variables: session (one and two); temporal adverbial (neutral, short and long); and visual field presentation (LVF/RH, CVF and RVF/LH) on the primary dependent variable of RT to target items. The mean RT values and standard deviations are summarised in Table 1.
Table 1

Mean reaction time and standard deviation (displayed in parentheses), in milliseconds (ms) as a function of session, temporal adverbial and visual field presentation.

<table>
<thead>
<tr>
<th>Session</th>
<th>Temporal Adverbial</th>
<th>Left visual field</th>
<th>Central visual field</th>
<th>Right visual field</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Neutral</td>
<td>510 (88)</td>
<td>415 (66)</td>
<td>472 (71)</td>
</tr>
<tr>
<td></td>
<td>Short</td>
<td>448 (85)</td>
<td>386 (57)</td>
<td>439 (69)</td>
</tr>
<tr>
<td></td>
<td>Long</td>
<td>455 (78)</td>
<td>389 (63)</td>
<td>433 (66)</td>
</tr>
<tr>
<td>2</td>
<td>Neutral</td>
<td>499 (81)</td>
<td>419 (77)</td>
<td>499 (82)</td>
</tr>
<tr>
<td></td>
<td>Short</td>
<td>456 (73)</td>
<td>392 (62)</td>
<td>436 (70)</td>
</tr>
<tr>
<td></td>
<td>Long</td>
<td>462 (82)</td>
<td>392 (67)</td>
<td>440 (76)</td>
</tr>
</tbody>
</table>

The repeated measures ANOVA did not reveal a significant main effect for session, indicating that participants’ RT was not influenced by a practice effect, $F(1,33) = .33$, $p = .567$, partial $\eta^2 = .01$. A violation of a Mauchly’s Test of Sphericity for the main effect of temporal adverbial resulted in the implementation of the Huynh-Feldt Epsilon correction for the interpretation of this instance. The effect of temporal adverbial was significant, $F(1.78, 58.84) = 124.45$, $p < .001$, partial $\eta^2 = .79$. Pairwise comparisons (Bonferroni) indicated that participants’ RT was significantly slower during the neutral condition, than the short ($M = 43$ms, $p < .001$) and long temporal adverbial condition ($M = 40$ms, $p < .001$). The mean RT was slightly higher for the long temporal adverbials than the short temporal adverbials, but this difference was not significant ($M = 3$ms, $p = 1.000$). The significant difference between the neutral and both temporal references
was expected, as targets were primed during the short and long temporal adverbial condition, but not during the neutral condition (see Figure 1).

![Figure 1](image)

**Figure 1.** The mean reaction time (ms) as a function of the main effect of temporal adverbial. Vertical lines represent +/- 1 standard error of the mean.

The main effect of visual field presentation was also statistically significant, $F(2,66) = 121.94, p < .001$ partial $\eta^2 = .79$. Pairwise comparisons (Bonferroni) showed that target items presented to the CVF were responded to significantly quicker than when targets were presented to the LVF/RH ($M = 73$ms, $p < .001$) and the RVF/LH ($M = 54$ms, $p = .003$). Moreover, participants responded to targets presented to the LVF/RH significantly slower, than to targets presented to the RVF/LH ($M = 19$ms, $p < .001$). These findings are expected, as the significant differences in RT across all visual field presentations confirms that participants maintained central fixation throughout the task, which allowed for the intended target projection to the individual visual fields. Furthermore, the relative superiority of the CVF in recognising stimuli, as well as the quicker time taken to produce a lexical decision for targets projected to the RVF/LH than the LVF/RH is entirely consistent with past lateralisation literature (Babkoff, Faust & Lavidor, 1997, see Figure 2).
Figure 2. The mean reaction time (ms) as a function of the main effect of visual field presentation. Vertical lines represent +/- 1 standard error of the mean.

Session did not significantly interact with the variables; however, a statistically significant interaction was found between temporal adverbial and visual field presentation, as well as between session, temporal adverbial and visual field presentation, $F(4,132) = 4.72, p < .001$, partial $\eta^2 = .13$ and $F(4,132) = 3.90, p = .005$, partial $\eta^2 = .11$, respectively. Planned comparisons (2x2 repeated measures ANOVA) showed that in session one, the main effects of temporal adverbial and visual field presentation were significant. The difference in the mean RT between the CVF and the LVF/RH was significantly higher for the neutral condition ($M = 95$ms) than the short temporal adverbial ($M = 62$ms), $F(1,33) = 7.16, p = .011$, partial $\eta^2 = .18$. Although not significant, there was a slightly higher mean RT difference of 57ms for the neutral condition than the short temporal adverbial ($M = 53$ms) between the CVF and the RVF/LH, $F(1,33) = .17, p = .684$, partial $\eta^2 = .01$. The difference in the mean RT between the LVF/RH and RVF/LH were significantly higher for the neutral condition ($M = 38$ms) than the short temporal adverbial ($M = 9$ms), $F(1,33) = 8.28, p = .007$, partial $\eta^2 = .20$. 
Upon first exposure to the task, the CVF and RVF/LH target presentation in conjunction with primed targets elicited a significantly faster RT, as expected.

In session two, the significance levels for the interaction effects were reversed. The main effects of temporal adverbial and visual field presentation were significant across all the conditions, except the visual field presentation between the LVF/RH and RVF/LH, $F(1,33) = 2.50, p = .124$, partial $\eta^2 = .07$. Participants’ mean RT was not significantly influenced by the varying target projection to either peripheral visual field ($M = 11ms$). The difference in mean RT between the CVF and LVF/RH was not significantly greater for the neutral ($M = 80ms$) or short temporal adverbial condition ($M = 76ms$), it approached significance, $F(1,33) = 4.10, p = .051$, partial $\eta^2 = .11$. The difference in mean RT between the CVF and the RVF/LH was significantly larger for the neutral ($M = 80ms$) condition than the short temporal adverbial ($M = 44ms$), $F(1,33) = 13.15, p < .001$, partial $\eta^2 = .29$. Finally, the difference in the mean RT between the LVF/RH and RVF/LH were not significantly higher for the neutral ($M = 0ms$) than the short temporal adverbial ($M = 20ms$), $F(1,33) = 3.33, p = .077$, partial $\eta^2 = .09$.

Surprisingly, although there was no significant practise effect to alter participants’ overall RT across sessions, the repeated exposure to the task elicited a significant change in the RT towards targets in the RVF/LH and the LVF/RH. The RVF/LH appeared to benefit from priming significantly more in session two, than the LVF/RH.

Arguably, session was employed to reduce the potential confound of fatigue and was not intended to be a primary variable in the present study. Furthermore, as explored in more detail below (see Error Rate Analyses), the number of errors in the interaction between temporal adverbial and visual field presentation, did not change significantly as a function of session, $F(4, 132) = 0.34, p = .849$, partial $\eta^2 = .01$. Nonetheless, the number of errors were higher in session 1 ($M = 3, SD = .37$) than in session 2 ($M = 2, SD = .53$), which may indicate a small speed-accuracy trade off that influenced the results.
greatly. While this does not explain for the significant session effect, it provides a possible direction.

Overall, this 2x3x3 repeated measures ANOVA highlighted important main and interaction effects that are of great interest; however, in line with the hypotheses, the facilitation of the target items, as a function of session and visual field presentation/hemispheres required a direct comparison. Thus, a 2x2x3 repeated measures ANOVA was conducted to assess the level of facilitation across each condition, whereby facilitation was measured by subtracting the RT mean for the short and long temporal adverbial from the neutral condition, respectively. The mean facilitation and standard deviations are summarised in Table 2.

Table 2

*Mean reaction time and standard deviation (displayed in parentheses), in milliseconds (ms) as a function of session, facilitation effects and visual field presentation.*

<table>
<thead>
<tr>
<th>Session</th>
<th>Temporal Adverbial</th>
<th>Left visual field</th>
<th>Central visual field</th>
<th>Right visual field</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Short</td>
<td>62 (56)</td>
<td>29 (37)</td>
<td>33 (38)</td>
</tr>
<tr>
<td></td>
<td>Long</td>
<td>55 (39)</td>
<td>26 (33)</td>
<td>39 (33)</td>
</tr>
<tr>
<td>2</td>
<td>Short</td>
<td>43 (38)</td>
<td>27 (35)</td>
<td>63 (51)</td>
</tr>
<tr>
<td></td>
<td>Long</td>
<td>37 (45)</td>
<td>27 (43)</td>
<td>59 (47)</td>
</tr>
</tbody>
</table>

The repeated measures ANOVA indicated that the main effect for session or temporal adverbial did not significantly influence the degree of target facilitation, $F(1, 33) = .20, p = .660$, partial $\eta^2 = .01$ and $F(1, 33) = .84, p = .366$, partial $\eta^2 = .03$, respectively. Parallel
to the results of the RT main effect of temporal adverbial, but contrary to expectations, a change in the temporal reference did not significantly affect the availability of the prime and thus no changes in the degree of facilitation of targets took place between the short and long temporal adverbial ($M = 2$ms).

The main effect of visual field presentation significantly influenced target facilitation, $F(2,66) = 7.11, p = .002$, partial $\eta^2 = .18$. Pairwise comparisons (Bonferroni) indicated that, as expected, the CVF was significantly better at facilitating targets than the LVF/RH ($M = 22$ms, $p = .008$) and the RVF/LH ($M = 21$ms, $p = .011$). However, contrary to expectations, no significant difference was apparent between the facilitation of targets by the LVF/RH and the RVF/LH ($M = 1$ms; see Figure 3).

![Figure 3](image.png)

**Figure 3.** The relative facilitation (ms) as a function of the visual field/hemisphere. Vertical lines represent +/- 1 standard error of the mean.

The two-way interaction between target location and session was significant, $F(2,66) = 5.76, p = .005$, partial $\eta^2 = .15$. In order to investigate this effect more closely, planned comparisons (paired samples t-tests) were conducted. During session one, the CVF was able to facilitate targets significantly better than the LVF/RH ($M = 31$ms), $t(33) = 3.07, p = .004, d = .82$, but not significantly better than the RVF/LH ($M = 8$ms), $t(33) = 1.00, p = .31$. However, during session two, the CVF was able to facilitate targets significantly better than the LVF/RH ($M = 19$ms), $t(33) = 2.24, p = .03, d = .66$, but not significantly better than the RVF/LH ($M = 12$ms), $t(33) = 1.13, p = .26$.
.327, d = .25. Targets presented to the RVF/LH were significantly better facilitated than when presented to the LVF/RH (M = 23ms), t(33) = 2.83, p = .008, d = .61. These results corresponded with the RT data and repeatedly reflect the ease with which the CVF and the RVF/LH facilitated targets.

In session two, the CVF was still able to maintain a more superior level of facilitation of targets than the LVF/RH (M = 13ms); however this relative difference was not significant, t(33) = 1.51, p = .140, d = .30. While the CVF was able to facilitate targets significantly better than the RVF/LH (M = 33ms), t(33) = 3.49, p < .001, d = .81, the RVF/LH was no longer able to facilitate targets better than the LVF/RH (M = 21ms), t(33) = 1.98, p = .057, d = .50. Although the LVF/RH was not able to facilitate targets significantly better than the RVF/LH, it was approaching significance (see Figure 4).

Figure 4. The relative facilitation (ms) of visual field/ hemisphere projections as a function of session. Vertical lines represent the standard error of the mean.

Lastly, although the two-way interaction between the temporal adverbial and visual field presentation was not significant, $F(2,66) = .80, p = .451$, partial $\eta^2 = .02$, this interaction was of specific interest in relation to the aims of this study. To no surprise, any follow-up analyses (Tests of Within-Subject contrasts), specifically between the
LVF/RH and RVF/LH exhibited a significant interaction. However, looking at inherent nature of the interaction, the LVF/RH appears to confirm the expectation that the long temporal adverbial reduces the availability of the prime. This trend is of great interest and will be explored further in light of previous research (see Figure 5).

![Figure 5](image.png)

*Figure 5.* The relative facilitation (ms) of visual field/hemisphere projections as a function of the temporal adverbial condition. Vertical lines represent the standard error of the mean.

**Error Rate Analyses**

A repeated measures ANOVA was conducted on the error rate. Due to the nature of the LDT (i.e.: go-nogo), non-word items served as a distracter to participants and thus no analyses was performed. A preliminary ANOVA indicated that the session effect was not significant once again, \(F(1.00, 33.00) = 2.70, p = .110\), partial \(\eta^2 = .08\), nor were any interactions between session and the other variables (temporal adverbial and target location) statistically significant. Thus, prior to further error rate analyses, the data was
collapsed across sessions. Importantly, the relevant mean error rates and standard deviations are summarised in Table 3.

Table 3

_Mean error rates recorded in percent and standard deviation (displayed in parentheses), as a function of temporal adverbial and visual field presentation._

<table>
<thead>
<tr>
<th>Temporal Adverbial</th>
<th>Left visual field</th>
<th>Central visual field</th>
<th>Right visual field</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neutral</td>
<td>7.69 (9.71)</td>
<td>2.21 (3.06)</td>
<td>4.13 (5.45)</td>
</tr>
<tr>
<td>Short</td>
<td>2.67 (5.54)</td>
<td>0.60 (1.68)</td>
<td>1.63 (2.72)</td>
</tr>
<tr>
<td>Long</td>
<td>1.65 (4.10)</td>
<td>0.15 (0.86)</td>
<td>1.93 (4.49)</td>
</tr>
</tbody>
</table>

A Mauchly's Test of Sphericity indicated a violation of the sphericity assumption for the main effects of temporal adverbial and visual field presentation as well as their interaction effect. The Huynh-Feldt Epsilon correction was implemented to adjust their degrees of freedom for the analysis. Parallel to the RT data, the 3x3 repeated measures ANOVA revealed a statistically significant main effect of temporal adverbial, _F_(1.37, 45.05) = 25.03, _p_ < .001. Pairwise comparisons (Bonferroni) indicated that higher percentage of errors occurred in the neutral condition than in the short (_M_ = 3.04%, _p_ < .001) or the long temporal adverbial (_M_ = 3.43%, _p_ < .001). No significant difference was observed for the error rates between the short and long temporal adverbials (_M_ = .39%, _p_ = .707). Corresponding with the RT data, these findings suggested that participants made fewer errors when targets were primed, such as during the short and long temporal adverbial condition, than the neutral condition (see Figure 5).
Figure 5. The mean error rate (%) as a function of the main effect of temporal adverbial. Vertical lines represent +/− 1 standard error of the mean.

Further consistent with the RT data analyses was the statistically significant main effect of visual field presentation, $F(1.51, 49.80) = 5.80, p = .010$, partial $\eta^2 = .15$, whereby pairwise comparisons (Bonferroni) confirmed the expectation of a significantly smaller error rate percentage in the CVF, when compared to the LVF/RH ($M = 3.02\%, p = .021$) and the RVF/LH ($M = 1.58 \%, p = .025$). As expected, the mean error rate was higher for targets presented to the LVF/RH than the RVF/LH; however, this differences was not significant ($1.44\%, p = .438$). This suggested that participants made fewer errors in response to targets that were projected to the CVF, than the peripheral visual fields (see Figure 6).
A significant interaction effect between the temporal adverbial and target location, $F(3.21, 105.83) = 3.77, p = .011$ partial $\eta^2 = .10$, was apparent. Follow-up analyses (Tests of Within-Subject contrasts) highlighted that participants did not make significantly more mistakes in the context of the neutral and short temporal adverbial and visual field presentation. However, it was highlighted that the difference in mean error rates between the LVF/RH and RVF/LH and the LVF/RH and CVF were significantly greater in the neutral condition ($M = 3.56\%; M = 5.49\%$) than in the long temporal adverbial condition ($M = 0.28\%; M = 1.50\%$), $F(1,33) = 6.27, p = .017$, partial $\eta^2 = .16$ and $F(1,33) = 6.40, p = .016$, partial $\eta^2 = .15$, respectively.
Discussion

The principal focus of this study was to investigate whether the LVF/RH hosts at least the temporal dimension of situation model representations, using a LDT. Based on the strong iconicity assumption (Zwaan, 1996) the temporal dimension was tapped into by controlling the temporal references in text, which included short temporal adverbials such as *a few minutes later*, long temporal adverbials such as *a few hours later* or none at all for the neutral condition, which acted as a baseline measure. Furthermore, although the LDT is a commonplace methodology in literature (Chiarello, Liu & Faust, 2001; Faust, Bar-lev & Chiarello, 2003; Faust, Kravetz & Babkoff, 1993; Gouldthorp & Coney, 2009a, 2009b; Lavidor & Whitney, 2005), the present study was unique in that the implementation of the LDT task allowed for the examination of the hemispheric differences involved in the facilitation of temporal updating of situation model representations.

Fundamental to the first hypothesis was the strong iconicity assumption (Zwaan, 1996). Briefly, this assumption summarised the notion that minor temporal discontinuities such as *a few minutes later* (short temporal adverbials) allowed readers to assume that events were temporally contingent and integrate the information into the same time frame, whereas major temporal discontinuities such as *a few hours later* (long temporal adverbials) were assumed to be large enough to create a temporal shift, whereby a new situation model representation was established, into which subsequent information was integrated. Furthermore, previous central presentation research demonstrated this pattern using explicit measures such as reading time (Rinck & Weber, 2003; Speer & Zacks, 2005). In the context of utilising the implicit measure of a LDT, it was expected that a temporal shift would offset the association between the probe and the prime, resulting in a reduction of the availability of the prime and decreased target facilitation. Thus it was hypothesised that the facilitation for centrally
presented targets was greater for the short temporal adverbial than for the long
temporal adverbial condition. The successful demonstration of a decreased facilitation
of targets in the long temporal adverbial condition would replicate the previous
findings (Rinck & Weber, 2003; Speer & Zacks, 2005) for temporal shifts. This would
demonstrate the suitability of the LDT as a measurement of temporal updating, which
would contribute to the limited body of research on the temporal dimension in
situation model representations.

The statistical calculations of the present study did not support this hypothesis. The
level of facilitation for centrally presented targets did not change significantly as a
function of the short or long temporal adverbials. Thus the results did not successfully
replicate previous research (Rinck & Weber, 2003; Speer & Zacks, 2005) and the
suitability of the LDT was questioned. Given this outcome, it might be argued that for
example, participants may not have maintained central fixation throughout the task,
producing disconfirming results; however, as analyses showed, participant RT varied
significantly as a function of the main effects of temporal adverbial and visual field
presentation, which indicated that the overall finding was considered genuine.

In light of this genuine finding, the parsimonious conclusion that the LDT is not
sensitive enough to the implicit processes and cannot yield changes in the target
facilitation as a function of a temporal shift needs to be considered. However, as
previous research (Jensen & Rohwer, 1966) demonstrated an inherent link between
the meaning of a word and its physical appearance, considered alongside recent
advances suggesting a special role for the LVF/RH in the processing of meaning
(Coulson et al., 2005; Coulson & Williams, 2005; Gouldthorp & Coney, 2009a, 2009b; St
George et al., 1999), the relative strength of the claim that the LDT is an appropriate
tool for assessing the implicit nature of temporal references should not be undermined.
Thus, it is suggested that more research needs to be conducted in order to formulate a
firm conclusion regarding the suitability for the LDT in the measurement of temporal shifts.

Alternatively, this observation is consistent with the notion (Coney & Judge, 2006) that centrally presented stimuli can best be explained by the simultaneous activation and processing of both hemispheres. However, as recent lateralisation studies (Gouldthorp & Coney, 2009a, 2009b) suggested a strong LVF/RH involvement in the processing, integrating and revising of semantic information, one may need to assume that CVF presentation did not allow for sufficient exposure to the LVF/RH to produce significant changes in the target facilitation across temporal references.

Furthermore, the failure to produce evidence of temporal updating for centrally presented targets in support of the first hypothesis, does not detract from the compelling research suggesting that a LDT is the appropriate tool for measuring hemispheric mechanisms involved in the temporal updating of situation model representations.

The second hypothesis is underpinned by the theoretical motivations of the first; including the strong iconicity assumption (Zwaan, 1996) and the notion that a temporal shift would offset the association between the probe and the prime and result in decreased target facilitation. Furthermore, fundamental to the second hypothesis were relatively recent developments in literature suggesting a RH superiority over LH in processing, integrating and revising of semantic information (Bihrle, et al., 1986; Gouldthorp & Coney, 2009a, 2009b). In light of this research, it was expected that the RH would be similarly superior in terms of maintaining a continuous temporal awareness of text. As such it was hypothesised that the facilitation for targets presented to the LVF/RH rather than the RVF/LH would be significantly greater for targets in the short as opposed to the long temporal adverbial condition. The successful demonstration of a decreased facilitation of targets in the long temporal adverbial
condition, presented to the LVF/RH, would provide an insight into the principal focus of this study, whether the LVF/RH hosts at least the temporal dimension of situation model representations as measured using a LDT.

The statistical calculations of the present study did not support this hypothesis. The level of facilitation for the targets presented to the LVF/RH as opposed to the RVF/LH did not change significantly as a function of the short or long temporal adverbials. This pattern was supported by the constant RT as a function of the interaction of the short and long temporal adverbials and the peripheral visual field presentations. Interestingly, even though follow-up analyses did not indicate any significant interactions, a trend towards the expected direction was evident. It appeared as if the RH was neatly confirming the hypothesis; however, as this was not significant, this trend needed to be interpreted with caution. Nonetheless, this second set of results demonstrating that the LVF/RH did not facilitate targets significantly differently across temporal adverbials, was in distinct contrast to previous research (e.g.: Bihrle, et al., 1986; Gouldthorp & Coney, 2009a, 2009b), leading to the repeated questioning of the strong iconicity assumption (Zwaan, 1996) and whether is might be intrinsically flawed.

As acknowledged above, fundamental to both hypotheses is the strong iconicity assumption (Zwaan, 1996). Zwaan (1996) suggested that long temporal references such as *a few hours later* produced a temporal discontinuity large enough to create a temporal shift and therefore ruled out that even more distant temporal references, including *a few days later*, would result in an additional or perhaps an even larger temporal shift (if one could be justified). Seemingly, the research studies undertaken to support Zwaan’s (1996) notion were exclusively based on explicit measures, such as reading time (Rinck & Weber, 2003) and yes/no recognition tasks (Speer & Zacks, 2005) as primary measures. These explicit tasks required the reader to consciously
think about the task and make an effort to respond, meaning the changes in behaviour towards temporal discontinuities caused by long temporal adverbials (as opposed to short or extra long) were attributed to a temporal shift. Thus the temporal shift that was reportedly observed between short and long temporal references and the lack of any temporal shift between long and extra long temporal references may be specific to the behaviour a person exhibits during reading and may not be entirely representative of the automatic and implicit processes that occur during a temporal shift. In support of this notion is the trend in the expected direction, which perhaps reflects that long temporal references do elicit a change in the level of facilitation, but do not induce a change large enough to produce a temporal shift.

In addition to the findings to disconfirm the hypotheses, the statistical calculations revealed a third point of interest; that session significantly influenced the relative facilitation of targets when presented to the LVF/RH and the RVF/LH. Prior to making any further inference, it must be reiterated that session was not intended as a main variable and may not have produced reliable data. Furthermore, as evidence could not verify powerful explanations within the present framework of this study, nor could the relative influence of this unexpected finding on the main investigation be determined, two main directions of this unexpected result were considered below.

Firstly, this unexpected finding may be a function of a change in the participant error rate, whereby a change in the error distribution influenced the degree of priming required by either hemisphere. Nonetheless, although this reduction in error rate was not significant, it may have influenced the results significantly. While this does not explain the significant session effect, it offers a possible direction for the change.

Alternatively, it might be considered that this finding was indicative of a convergence with recent literature (Gouldthorp & Coney, 2009a; 2009b, Zwaan, 1994). First, investigators (Gouldthorp & Coney, 2009a; 2009b) proposed that the LH was superior
in processing information at the word-level (basic lexical associations) compared with message-level (semantic associations), as the RH required sufficient context to be able to exhibit message-level processing of a similar strength to the LH. Second, previous research (Zwaan, 1994) suggested that the expectation of a task significantly influences the level of hemispheric activation and the degree of stimuli analysis. Hence, given the novelty of the task and the instructions to carefully read the narrative passages still fresh in the participants’ minds, the larger LVF/RH facilitation demonstrated in session one was perhaps a result of more thorough processing, which resulted in relatively greater target facilitation by the LVF/RH. Simultaneously, the relatively weaker facilitation of targets presented to the RVF/LH was not surprising as the ability of the LH to process words is greater than the RH as discussed above (Babkoff, et al., 1997). While this accounts for the pattern in session one, the change from session one to session two remains puzzling. Perhaps the reduction of the degree of target facilitation by the RH demonstrated that the RH had learned to carry out the task and was thus less reliant on primes to perform the same task. Again, while this explains the reduction in facilitation by the RH, it does not explain the simultaneous increase in the dependence on primes by the LH. It appears that participants may have habituated to the previously novel structure of the sentences and attempted session two with prior expectations of the task, altering the facilitation relative to the RH. Although not practical or suggested for future research, it would be interesting to monitor the facilitation pattern of stimuli presented to the individual visual fields/hemispheres across more than two sessions. This may provide a greater insight as to whether the facilitation pattern in session two would maintain or change again, and whether this overall significant effect is of greater importance or a result of error.
Overall, although the two hypotheses were not supported by this data, it remains elusive whether the present research framework documented, at least to some extent, the changes in the relative RH facilitation as a result of varying temporal references. Moreover, the potential impact and importance of the unexpected, significant interaction between session and visual field presentation on the first two findings could not be separated nor determined. Also, no firm conclusion regarding the suitability of the LDT as a measure of temporal updating was reached. In order to determine the relative influence of these unexpected finding on the main investigation, as well as reach a firm conclusion regarding the suitability of the LDT, future research should include the suggestions considered below.

The most serious methodological problem with the LDT is the relative sensitivity. In order to reliably quantify a phenomenon, large amounts of data points are required. This may not always be practical and may have an adverse effect on participant performance. For example, in the present study, participants were asked to form 360 situation model representations. Although these were split into two sessions of 180 data points each, and again into blocks of six-per-session to combat the effects of fatigue, participants' inclination to comply with the instructions and form these situation model representations, could not be controlled. However the opportunity for participants to immerse themselves in the each narrative can be created. Thus, it may be feasible for future research to implement only one third of the trials, but increase the depth of information for each stimuli. As such, the number of sentences conveying background information should be increased to perhaps four or more and the scenario after the temporal reference should also be increased from one sentence to two or three. This will help to increase the impact of the new time frame relative to the original one.
Furthermore, to increase the certainty that the information is being properly read, the frequent prompting of comprehension tasks should be considered. A main benefit of which would be that participants are being informed of their assessment, positively influencing their inclination to carry out the task out according to the instructions (e.g.: the Hawthorne effect, for review, see van Krieken, Habibis, Smith, Hutchins, Haralambos & Holborn, 2000). Secondly, another benefit is the systematic exclusion of any participant who did not comprehend the task sufficiently. Again, this may not be practical within the current framework, as the length of the current LDT is demanding, even without any additional cross-checks. Thus, this suggestion should only be introduced in conjunction with the aforementioned suggestion, as participants will be assessed according to fewer narratives, making the employment of a comprehension task a realistic option.

Additionally, as this was the first time that a LDT was implemented to examine temporal shifts and simultaneous neurological processes, it might be more feasible to separate the hypotheses and conduct a study on each hypothesis in isolation. This will reduce the focus and allow for an intricate exploration of each hypothesis, to determine whether error or variance significantly influenced the present results while also increasing the relative ease with which the abovementioned suggestions could be integrated.

Finally, findings of the current study suggested that the temporal differences between short and long temporal references may not be distinct enough to create a temporal shift. Thus future studies should consider increasing the distance between time frames by utilising short and extra long temporal references or maintaining the long temporal adverbial but reducing the short from *a few minutes later* to, perhaps, *a few seconds later*. Alternatively, investigators may also consider replacing the strong iconicity assumption with its competing theory, by Anderson, Sanford and Garrod.
(1983), which suggests that when the protagonist in text carries out a particular task (e.g.: watching a movie at the movie theatre) the reader infers the average length of time it takes for the protagonist to carry out that task. Further information that fits in with the inferred time frame (e.g.: buying popcorn) is regarded as occurring within the same time frame, whereas events outside their temporal frame (e.g.: doing homework) will produce a temporal shift. This theory has received considerable critique. It was argued that upon the encounter of a new event, which the reader has not experienced before, no approximate duration of the event and thus no time frame could be inferred (Zwaan, 1996). As this theory has remained unexplored relative to Zwaan's (1996) strong iconicity assumption, readers may bridge an unfamiliar event with a default time frame assumption. However, that is yet to be explored.

**Conclusion**

The present study aimed to investigate the relatively unexplored temporal dimension in situation model representation as well as the recent suggestion that the LVF/RH plays a role in the processing and integration of semantic information, using a LDT. The findings of the present study were able to demonstrate potential evidence of temporal updating, however further research, utilising the suggested, more concise research framework, is required. Furthermore, no definite conclusion was drawn regarding the suitability of the LDT for the measurement of the temporal shift, however extensive research continues to suggest its successful implementation, thus it should be utilised in future research. Lastly, future research is also required to further investigate the puzzling interaction effect between session and visual field/hemisphere presentation.
Theoretically, the present study has far-reaching implications. The successful demonstration of temporal updating in situation models is a valuable contribution to the language comprehension research as it amplifies the notion that the temporal dimension is a realistic construct. It further demonstrates that while a particular text physically remains the same, the reader’s interpretation is idiosyncratic. This emphasises the notion that text not just a set of black marks on a white background (Zwaan & Singer, 2003), rather text is a device that facilitates an interactive process, stimulating cognitive processes in the brain and enabling individuals to extract information from sentences.

Practically, a greater understanding of the interplay between neurological mechanisms (i.e.: the RH involvement) and higher-level processes (i.e.: temporal updating of situation model representations) is required to improve educational reading programs as well as rehabilitation programs for individuals with RH damage.
References


Appendix A

Bryden’s (1977) Simplified Hand Preference Questionnaire

Instructions

For each of the activities listed below, indicate with a + which hand you would normally used to perform the activity.

If you would only use the other hand when forced to, mark a + +.

If you would used both hands equally as often, place a + in each column.

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## Appendix B

### Word Target Items

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NUN           PRINCE
NURSE         QUEEN
OCEAN         RABBIT
OIL           RADIO
ONION         RAIN
ORANGE        RING
PALACE        ROAD
PANTS          ROCK
PEACH         ROCKET
PEG           ROSE
PENCIL        RIVER
PENNY         SALAD
PIANO         SAND
PICKLE        SEA
PIE            SHARK
PIG            SHED
PILLOW        SHIP
PIMPLE        SHIRT
PINE          SHORE
PLANT         SHOWER
PLUM          SIGN
| SILVER       | TRUCK        |
| SISTER      | TOE          |
| SKIN        | TOILET       |
| SKULL       | TOMATO       |
| SKUNK       | TULIP        |
| SKY         | VIOLIN       |
| SNAKE       | VODKA        |
| SMILE       | WALLET       |
| SMOKE       | WATER        |
| SOAP        | WEB          |
| SODA        | WHALE        |
| SOUP        | WINDOW       |
| SQUARE      | WINE         |
| STAR        | WINTER       |
| STEAK       | WOLF         |
| SUN         | WOMAN        |
| SUNSET      | YACHT        |
| SWAMP       | ZIPPER       |
| TEETH       | ZOO          |
| THORN       |              |
| TIGER       |              |
| TISSUE      |              |
| TREE        |              |
### Appendix C

**Non-Word Target Items**

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Appendix D

01 W N L

PLANT
Chelsea was house-sitting for a friend who was on holiday in America.
She was throwing out a dried up pot plant when the cat jumped up and scared her.
Chelsea sat down to read her new book.
She was throwing out a dried up kitchen sponge when the cat jumped up and scared her.

02 W N C

SUN
Abby took her puppy down to the local park for some exercise.
The puppy seemed to be enjoying the sun, while playing in the moist grass.
Abby remembered that she still hadn’t watered her plants.
The puppy seemed to be enjoying the outing, while playing in the moist grass.

03 W N R

GUN
John loved to watch his children play.
He gave his sons a toy gun to play with in the backyard.
John wanted to make a cheese and salad sandwich.
He gave his sons a paddle pool to play with in the backyard.

04 W S L

WINTER
Eva went to the nursery to buy some plants.
She bought luscious indoor plants for the winter, as they are most practical inside.
Eva felt like watching her favourite TV show and eating some rice crackers and hummus.
She bought luscious indoor plants for her office, as they are most practical inside.
Charlotte was in a lecture on human development at her university. She was studying to become a nurse, because she found it very interesting. Charlotte started to feel cold and realised that she must have forgotten to bring a jacket. She was studying to become a dentist, because she found it very interesting.

On Sunday afternoon, Joylyn’s favourite thing to do was to read a novel in her living room. To get ready, she turned on the lamp and put warm socks on for comfort. Joylyn wondered if the clothes that she had ordered had been delivered to the store yet. To get ready, she turned on the kettle and put warm socks on for comfort.

Jane helped her son Peter to clean his room. When she turned around and knocked her elbow on the table, she decided to stop cleaning. Jane wondered what Peter’s grandmother was making them for dinner. When she turned around and knocked over a cup on the table, she decided to stop cleaning.

Julia met up with three of her closest friends to have lunch. She enjoyed the stunning view from the window, while waiting for the food to arrive. Julia remembered that she should not forget to pick up her car from the mechanic.
She enjoyed the stunning view from the terrace, while waiting for the food to arrive.

09 W L R

**SILVER**

Charmaine thought her son was hyperactive and hard to discipline.
She ordered him to polish all the silver in the house whenever he was incompliant.
Charmaine thought that it might be a good idea to go for a swim with her son.
She ordered him to fold all the linen in the house whenever he was incompliant.

10 N N L

**BINK**

Rebecca was visiting her dad in Royal Perth Hospital.
She didn’t stay long as he was hours away from being prepped for open heart surgery.
Rebecca thought about calling her sister to let her know her favourite band was in town.
She didn’t stay long as he was hours away from being prepped for open heart surgery.

11 N N C

**MEADOC**

Gene was sitting at home on the computer.
He was looking up costumes for Halloween on the internet and decided to go as a knight.
Gene wondered what to make for dinner.
He was looking up costumes for Halloween on the internet and decided to go as a knight.

12 N N R

**FON**

Alyce was in the lounge room putting in a new light bulb.
She slipped off the ladder and fell, chipping her tooth on the table. 
Alyce thought of going to the pharmacy to get some Vitamins, as she wasn’t well. 
She slipped off the ladder and fell, chipping her tooth on the table.

13 N S L 
**HERP**
Hayley was at the Little Creatures brewery in Fremantle. 
She didn’t like beer, so she decided to get her favourite pear cider instead. 
Hayley ordered some nibbles and her main course. 
She didn’t like beer, so she decided to get her favourite pear cider instead.

14 N S C 
**NOTMAG**
Ella had come home sick from school and was lying on the couch. 
She watched the movie Beauty and the Beast, which was her most favourite movie. 
Ella fell asleep and had a dream that her teddy bear was alive. 
She watched the movie Beauty and the Beast, which was her most favourite movie.

15 N S R 
**PUC**
Chris and his brothers were waiting for the bus down the road from their house. 
They were going to be late for school because Chris took a long time to find his shoes.

Chris wondered whether he had remembered to give his mum the permission slip for his excursion.

They were going to be late for school because Chris took a long time to find his shoes.

16 N L L 
**NUME**
Adam sat down to start his project on a popular musician from the past.
He loved rock and roll and chose to write his on Elvis Presley.

Adam took some pain killers as he had a bad headache.

He loved rock and roll and chose to write his on Elvis Presley.

17 N L C

COE

Frank was at a party with many of his friends.

He was drunk, and challenging everyone to an arm wrestle to see who was the strongest.

Frank was exhausted and wanted to pass out.

He was drunk, and challenging everyone to an arm wrestle to see who was the strongest.

18 N L R

REBIN

Andrew was packing his car to go on a camping trip.

He tied his tent and bags to the roof rack and hoped that they wouldn’t fall off.

Andrew remembered to go to the shop to buy some dog food.

He tied his tent and bags to the roof rack and hoped that they wouldn’t fall off.
Appendix E

Information Sheet

We invite you to participate in a research study that involves the investigation of a situation model. A situation model is a multidimensional mental representation that simulates a situation described in text, based on elements of time, space, protagonist activity etc. This study is part of Jasmin Landes’ Bachelor in Psychology (Hons), supervised by Dr. Jeffrey Coney at Murdoch University.

Nature and Purpose of the Study

Previous research has exhibited that data collected via a Lexical Decision Task (LDT) consistently demonstrated hemispheric involvement during linguistic comprehension tasks. Despite the widespread use of a LDT, no current research has applied the task to situation modelling research. In order to further broaden the research base, this study aims to assess whether a LDT can be utilized to measure temporal updating in situation models, as well as assess any hemispherical involvement in the process.

What the Study will Involve

If you decide to participate in this study, you will be asked to complete the following task:

Partake in two individual sessions held on two separate days, one hour each. Each session will be broken up into blocks of four. During each session, you are required to complete a LDT. The task involves sitting in front of a computer screen and reading short narrative passages of three lines each, after
which you are required to discriminate between a word (i.e.: dog) or a non-word (i.e.: dof).

Voluntary Participation and Withdrawal from the Study

Your participation in this study is entirely voluntary. You may withdraw at any time without discrimination or prejudice. All information is treated as confidential and no names or other details that might identify you will be used in any publication arising from the research. If you withdraw, all information you have provided will be destroyed.

If you consent to take part in this research study, it is important that you understand the purpose of the study and the procedures you will be asked to undergo. Please make sure that you ask any questions you may have, and that all your questions have been answered to your satisfaction before you agree to participate.

Benefits of the Study

For your personal benefit this study will provide you with the opportunity to gain experience in an immediate interaction with a LDT and more generally allow you to gain a greater understanding of the procedures of cognitive psychological research.

While there is no guarantee that you will personally benefit from your participation, your data will help Jasmin greatly to conduct her honours thesis. Furthermore, your participation will also help others in the future as this study contributes to the wider research base and provides a greater understanding around the situation model phenomenon.
If you are willing to consent to participation in this study, please **complete the Consent Form.** If you have any questions about this project please feel free to contact either myself, Jasmin Landes at 040 81 34 855 or 30743425@student.murdoch.edu or my supervisor, Dr. Jeffrey Coney at 9360 2387 or J.Coney@murdoch.edu.au.

My supervisor and I are happy to discuss with you any concerns you may have about this study.

You can expect to receive feedback in November 2011 on the Murdoch University, School of Psychology website:


Thank you for your assistance with this research project.

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This study has been approved by the Murdoch University Human Research Ethics Committee (Approval 2011/052). If you have any reservation or complaint about the ethical conduct of this research, and wish to talk with an independent person, you may contact Murdoch University’s Research Ethics Office (Tel. 08 9360 6677 (for overseas studies, +61 8 9360 6677) or e-mail ethics@murdoch.edu.au). Any issues you raise will be treated in confidence and investigated fully, and you will be informed of the outcome.
Appendix F

Task Instructions to Participants

During each trial, short 3-line narrative passages will be presented to you on the computer screen. As the narrative passages will be presented to you, read each sentence at a pace that feels comfortable to you and tap the foot switch that is located under the desk to indicate that you have finished reading. Please do not simply “skim read”, but ensure that you understand the story. Your reading time will be documented, in order to ensure that you have read each passage thoroughly. However, as this variable is not of any interest to us beyond its monitoring function it will not influence your results.

Once you have read all 3 sentences of a narrative passage and have tapped the foot switch once, an ‘x’ will appear in the centre of the screen. Focus on the blank cross. It is very important that you do not divert your gaze away from this blank cross. The CCTV camera above the monitor will project an enlarged image of your pupils onto a screen, which will help me ensure that you are maintaining central vision. No recordings of your pupils will be made. The cross will disappear and a target word will appear in the centre of the screen or on the left or right side of the monitor. When you see the target word, you must decided whether it is a real word (i.e.: GRAVE) or a non-word (i.e.: GREVA). Beware that all non-words are orthographically and phonetically legitimate words and easily readable. Again, do not move your eyes away from the focal point to read the target word more clearly, but simply stare at the centre of the screen, where the blank cross had been. Although this may appear difficult at first, you will accustom to this task fairly quickly. If you have decided that the target word is a word, simultaneously press down the 2 microswitches with both index fingers. If you think that the target word is a non-
word, do not do anything. In the event of having falsely indicated the target word to be a non-word when it was in fact a word or vice versa, the word ‘ERROR’ will appear in red letters on the screen. A few errors are ok, as this only means that you are trying to complete this task as fast as you can; however, try to be as accurate as possible.

Each one hour session will be broken up into 4 blocks. After each block, the program will stop and show you your average reaction time and error rate. If you have made 4 or more errors, try to slow down to improve your accuracy. Similarly, if you are not making any mistakes, try and speed up your reaction time. If you find that your concentration is waning, feel free to have a drink of water and a stretch before you press ‘Enter’ on the keyboard to commence your next block.

If you have understood these instructions and have no further questions, please sign the consent form.

To get ready for your practise session, position your chin on the chin-rest in front of you, your index fingers on the microswitches and your foot on the foot switch. Please put on the ear defenders to minimize any extraneous noises that may distract you and press ‘Enter’ on the keyboard to commence your practise session.
Appendix G

Consent Form

1. I agree voluntarily to take part in this study.

2. I have read the Information Sheet provided and been given a full explanation of the purpose of this study, of the procedures involved and of what is expected of me. The researcher has answered all my questions and has explained the possible problems that may arise as a result of my participation in this study.

3. I understand I am free to withdraw from the study at any time without needing to give any reason.

4. I understand I will not be identified in any publication arising out of this study.

5. I understand that my name and identity will be stored separately from the data, and these are accessible only to the investigators. All data provided by me will be analysed anonymously using code numbers.

6. I understand that all information provided by me is treated as confidential and will not be released by the researcher to a third party unless required to do so by law.

Signature of Participant: ___________________________ Date: 

......../......../........

(Name)

Signature of Investigator: ___________________________ Date: 

......../......../........

(Name)
APPENDIX H

GUIDE FOR AUTHORS

NEUROPSYCHOLOGIA: AN INTERNATIONAL JOURNAL IN BEHAVIOURAL AND COGNITIVE NEUROSCIENCE

1. NEUROPSYCHOLOGIA IS AN INTERNATIONAL INTERDISCIPLINARY JOURNAL DEVOTED TO EXPERIMENTAL, CLINICAL AND THEORETICAL CONTRIBUTIONS THAT ADVANCE UNDERSTANDING OF HUMAN COGNITION AND BEHAVIOR FROM A NEUROSCIENCE PERSPECTIVE. THUS, THE JOURNAL WILL CONSIDER FOR PUBLICATION STUDIES THAT EXPLICITLY ADDRESS FUNCTIONAL ASPECTS OF THE BRAIN AND USE DATA TO LINK NEURAL PROCESSES WITH PERCEPTION, ATTENTION AND AWARENESS, ACTION AND MOTOR CONTROL, EXECUTIVE FUNCTIONS AND COGNITIVE CONTROL, MEMORY, LANGUAGE, AND EMOTION AND SOCIAL COGNITION. NEUROPSYCHOLOGIA HAS A LONG TRADITION OF PUBLISHING STUDIES ON PATIENTS WITH BRAIN LESIONS. WHILE CONTINUING THIS TRADITION, WE WOULD LIKE ALSO TO STRONGLY ENCOURAGE SUBMISSION OF PAPERS USING OTHER APPROPRIATE METHODOLOGIES. THESE INCLUDE, BUT ARE NOT LIMITED TO, FUNCTIONAL NEUROIMAGING, COGNITIVE ELECTROPHYSIOLOGY, AND TRANSCRANIAL MAGNETIC STIMULATION. STUDIES EXPLORING BRAIN AND BEHAVIOUR IN PRIMATES OR OTHER ANIMALS ARE ALSO WELCOME, PROVIDED THEY HAVE AN IMPACT ON UNDERSTANDING HUMAN COGNITION AND BEHAVIOR AND THIS IMPACT IS EXPLICITLY SPECIFIED IN THE REPORT. FINALLY, "NEURODEVELOPMENTAL", "NEUROPSYCHIATRIC" AND "NEUROGENETIC" STUDIES ARE APPROPRIATE, PROVIDED THE LINK BETWEEN THE FINDINGS IN SUCH STUDIES AND NORMAL BRAIN FUNCTION IS DIRECT, COMPELLING AND EXPLICIT. STUDIES OF CLINICAL POPULATIONS THAT ARE PRIMARILY DESCRIPTIVE OR INTENDED TO ELUCIDATE A CLINICAL DISORDER, OR THAT EVALUATE A THERAPEUTIC INTERVENTION, ARE NOT APPROPRIATE FOR THE JOURNAL. SPECIAL ISSUES AND REVIEW PAPERS ARE PUBLISHED REGULARLY WITH THE OBJECTIVE OF PROVIDING AUTHORITATIVE SURVEYS OF TOPICS OF MAJOR INTEREST.

2. SUBMISSIONS: Submission to this journal proceeds totally online. Use the following guidelines to prepare your article. Via the online submission page of this journal (http://ees.elsevier.com/NSY/) you will be guided stepwise through the creation and uploading of the various files. The system automatically converts source files to a single Adobe Acrobat PDF version of the article, which is used in the peer-review process. Please note that even though manuscript source files are converted to PDF at submission for the review process, these source files are needed for further processing after acceptance. All correspondence, including notification of the Editor’s decision and requests for revision, takes place by e-mail and via the author’s homepage, removing the need for a hard-copy paper trail. A manuscript will be returned to the author without external review if, in the judgment of the editorial team, it falls outside the stated scope of the journal or describes findings that will have only minimal impact on the field.

3. THE FOLLOWING ARTICLE TYPES ARE ACCEPTED:
(A) **Research Reports** (up to 20 printed journal pages or about 17,000 words)

(B) **Brief Communications** (up to five printed journal pages or 3500 words including abstract, references and figure legends, and no more than four figures and/or tables). **Brief Communications** are short research articles which convey findings judged to be of high potential impact to the field of cognitive neuroscience. They should follow the same sectionalisation as regular research articles (i.e. abstract, introduction, materials and methods, results, discussion, references and figure legends). The total word count must be listed on the title page. There should be no more than 30 references. **Brief Communications** will undergo expedited review and, if accepted, will be available online within five working days. Only manuscripts requiring no or minor revision will be accepted. A short covering letter should be included with your submission describing why the paper is considered appropriate for publication as a **Brief Communication**.

(C) **Reviews and Perspectives** (up to 30 printed journal pages or 26,000 words). These should also provide critical accounts and comprehensive surveys of topics of major current interest within the scope of the journal.

4. **(A) Papers will be accepted in English only.**

B) The title page should include: the name(s) of the author(s); the name of the department and institution where the study was carried out; the institutional affiliation of each author; the name, the postal and email address and the telephone and fax number of the corresponding author. A shortened title (a caption of no more than 5 words) to appear on the front cover of Neuropsychologia should it be chosen.

(C) Abstracts should be up to 250 words, and should be followed by a list of up to six keywords (which do not appear in the title) to be used for indexing purposes.

(D) **Research Reports** and **Brief Communications** as a rule should include an abstract, an introduction, a section on methods, a section on results and a discussion. The description of methods and results should be sufficiently detailed so as to allow a critical assessment of their appropriateness and validity.

(E) Footnotes should be used sparingly. Number them consecutively throughout the article, using superscript Arabic numbers. Many wordprocessors build footnotes into the text, and this feature may be used. Should this not be the case, indicate the position of footnotes in the text and present the footnotes themselves on a separate sheet at the end of the article. Do not include footnotes in the reference list. Table footnotes. Indicate each footnote in a table with a superscript lowercase letter.

(F) Tables should be presented at the end of the article. High-resolution graphics files must always be provided separate from the main text file.

(G) Manuscripts must be in the correct format, i.e. doubled-spaced, references in correct format, and top-quality figures or it will be returned to the author.

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