Studies in Linguistic Attention Control

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ABSTRACT

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The research reported in this thesis examined the nature of attention shift costs during the processing of complex linguistic stimuli. Experiment 1 tested the hypothesis that linguistic attentional shift costs would occur during the processing of grammaticized linguistic stimuli (function words embedded in sentence-like stimuli). In addition, potential underlying shift cost mechanisms were also investigated. Attention control was operationalized as shift costs obtained by adult English speakers in a 3-stage alternating runs paradigm (Wylie & Allport, 2000). This design enabled results to be analyzed in terms of whether task set reconfiguration processes or task set inertia processes underlie linguistic shift costs. Experiment 1 (Manuscript 1) revealed significant attention shift costs when shifting between tasks involving judgments regarding the meanings of grammatical (function) words. Further, the pattern of results that emerged from the 3-stage design implicated task set reconfiguration processes, but not task set inertia processes, in these linguistic shift costs. Experiment 2 (Manuscript 1) was designed to replicate these linguistic shift costs and investigate whether the degree of grammatical similarity between tasks affects shift costs. Findings again revealed robust linguistic shift costs and demonstrated that shift costs were lower when tasks involved shared attentional resources (processing the same grammatical dimension) as compared to unshared resources (processing different grammatical dimensions). Experiment 3 (Manuscript 2) investigated attention shifting in tasks involving the processing of grammaticized

linguistic stimuli (as in Experiment 1 and 2) as well as nongrammaticized linguistic stimuli (content words) in both a first and second language. Participants were adult English-French bilinguals with greater proficiency in their first (English) than in their second (French) language as determined on a speeded word classification task. Findings revealed that participants displayed greater shift costs when performing in their less proficient language. This finding was found to be specific to performance with grammaticized linguistic stimuli and was not obtained with nongrammaticized linguistic stimuli. The results from all three experiments were consistent with a cognitive linguistic perspective that holds that the grammaticized elements of language play an attention-directing role. The results extend previous work by demonstrating shift costs with complex, contextualized stimuli and shift costs in a second language.

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GENERAL INTRODUCTION

Human beings are capable of performing a wide range of very complex skills, including playing the piano or chess, performing complex mental calculations, making medical diagnoses as well as speaking and reading in a second language. Such capabilities have been an important object of psychological research (e.g., Charness, 1991; Patel & Groen, 1991; Proctor & Dutta, 1995; Reingold, Charness, Schultetus & Stampe, 2001; Segalowitz, 1997, 2000, 2003; Staszewski, 1988). This thesis will explore some of the questions that have guided this research, and will do so with specific reference to language skills. As will become clear, the study of these questions in relation to language raises some interesting issues not encountered in psychological studies of skill in other domains.

How does one develop the ability to execute such complex skills efficiently to the point of a high level of proficiency? To some extent, of course, basic knowledge of the domain (about chess, mathematics etc.) is necessary for skilled performance. However, beyond that, research has shown that attentional control processes are an integral part of performance of any complex task. Control processes "specify, establish and preserve the contextual shell within which the direct perception transformation and response activities operate to carry out goal-directed behaviour" (Gopher, Armony & Greenshpan, 2000, p. 308). For example, Chase and Simon (1973, see also De Groot, 1978) found that increased abilities of expert chess players were attributable to a superior memory for *meaningful relations* between the chess pieces – the kind of relations that would exist in a real chess game. They suggested that expert players, unlike novices, were better able to focus their attention on relevant dimensions between the chess pieces and chunk meaningful relationships together. This allowed for a greater memory recall due to a decreased burden on their attentional resources.

The study of control in complex skills often focuses on the way in which individuals configure and reconfigure different tasks, select among subgoals, and monitor, correct, and optimize performance and resource allocation (e.g., Arthur, Strong, Jordan & Williamson, Shebilske & Regian, 1995; Gopher, 1993; Gopher, Weil & Siegel, 1989). In order to study cognitive control processes, it is useful to employ an experimental paradigm in which the nature and influence of control can be isolated and manipulated. A paradigm that allows for such investigations is the attention task-shifting design, originally developed by Jersild (1927) and recently modified by Rogers and Monsell (1995). In the following paragraphs, this paradigm will be discussed with respect to its development and design, which has enabled well-controlled investigations of attentional control processes. More recently, this design has also been employed to investigate how attention control is involved in second language proficiency. Mastery of a second language is an example of a complex skill in which the role of attention and cognitive control, although important, has been little explored. As will be discussed, the studies in this thesis focused on attention control, operationalized through measures of task shifting, and on linguistic processing in both a first (L1) and second (L2) language.

This literature is reviewed in the proceeding sections in the following manner. Attention control is initially discussed with regard to task-shifting paradigms, specifically focusing on Rogers and Monsell's (1995) development of the alternating runs paradigm. An overview of potential shift cost mechanisms are then discussed, as well as important issues that are currently being investigated by researchers in this field. Attention control is then discussed in the context of language skill, focusing on different components of attention and how they relate to language as well as attention-directing aspects of language that have been proposed by cognitive linguists. These two literatures (i.e., task shifting and language skill) are then brought together in a discussion of recent research that has focused on investigating attention control and language proficiency with task-shifting paradigms. An overview of the current experiments is then provided.

Attentional Control and Task-Shifting Paradigms

Every object encountered in our environment requires some type of action in response to it. There can be numerous appropriate responses depending on each particular object or task. For example, when driving a car the appropriate response to a red light is to put one's foot on the brake whereas when a green traffic light appears one can then put one's foot on the gas pedal. The act of performing a specific task implies that a particular *task set* has been implemented. This adoption of a task set implies elements of a chain of processes have been selected, linked and configured, allowing for the accomplishment of a particular task (Rogers & Monsell, 1995). Task sets can generally be thought of as a group of component cognitive processes or operations involved in the performance of each task. A task set includes three major classes of components: (1) perception or encoding of the stimulus; (2) manipulation of or judgment regarding the stimulus, and (3) response selection, programming and execution. In our daily lives we are constantly performing different tasks and, therefore, calling upon different task sets. We have many task sets stored in memory for particular stimuli that we have previously encountered. Furthermore, when exposed to novel stimuli, we may have to then learn the appropriate task set through proper training and instructions. There are also times when we must shift between various task sets that are called upon by different stimuli encountered. The mechanisms by which we carry out execution of these task sets have become an interesting area of study within cognitive laboratories. The methods used to explore these mechanisms will be discussed in the following section.

Development of the Task-Shifting Paradigm

Researchers for many years have been studying attention and cognitive control through the behavioural effects of shifting attention from one task to another. Jersild (1927) originally introduced this idea when he asked participants to perform blocks of trials where tasks were constantly repeated (e.g., …AAAA… or …BBBB…) and compared this to performance on blocks of trials where tasks constantly alternated every other trial (e.g., …ABABAB…). He found that there was an increased difficulty, as reflected by increased reaction time (RT), when participants had to perform the alternating trial blocks compared to the repeating trial blocks. This increased difficulty was said to reflect the extra difficulty that an individual endures when he or she must re-adjust to a new upcoming task. This extra burden, or extra time needed for alternating blocks, was termed "shift loss" by Jersild (1927).

Task-shifting mechanisms were rarely studied for almost 70 years following the work of Jersild (1927, but see Spector & Biederman, 1976, for a replication of Jersild's design). However, Rogers and Monsell (1995) then revisited this paradigm and modified the methodology used to study task shifting. They believed that there were difficulties with the way in which Jersild (1927) went about estimating shift costs. First, during the alternating trial blocks, participants were required to do two things that were not required of them in the repeating trial blocks: (1) two task sets had to be kept available, as opposed to just the one in the repeating trial blocks and (2) task sets had to be reconfigured (i.e., shifted) on every trial. Second, since performance was being compared between blocks in order to provide a measure of shift costs, there was the possibility that there could be differences in effort, arousal, response criterion, within-task strategy and so on between these blocks. Due to these various factors and confounds, Rogers and Monsell (1995) stated that the true index of what the shift cost represented was difficult to verify.

Their solution to these problems led to the development of the *alternating runs design*. In this design, shift and repeat trials are compared within the same block – eliminating the between-block comparisons of Jersild (1927) (see also Spector & Biederman, 1976). Participants learn two tasks, for example, task A and task B, and they are cued to alternate between repeat and shift trials in a predictable sequence (e.g., …AABBAABB…). The cue to alternate trials is apparent by the position of the stimuli for the task within one of four quadrants that appear on a computer screen in a 2 x 2 presentation matrix. This sequence results in a predictable alternation between repeating (R) (performing the same kind of task, A or B, as was just performed on the previous trial) and shifting (S) (performing a different task from the one performed on the previous trial), yielding the sequence "…SRSRSRSRSRSR…". As the participant must keep both task sets in a state of adequate readiness, the within-block index gained from this design was said to provide a "purer" measurement of shift costs.

Rogers and Monsell (1995) performed six different experiments, all employing two tasks consisting of letter and digit stimuli. In the letter task, participants indicated whether the stimulus appearing on the screen was a consonant or vowel. In the digit task, participants indicated whether the stimulus appearing on the screen was an even or odd digit. Two different types of trials were presented – one in which *crosstalk* was created (meaning that two different target stimuli appeared on the screen but only one was to be responded to) and one in which there was no crosstalk (meaning that of the two stimuli on the screen one was a target stimulus and the other was a stimulus neutral to both tasks). They found that shift trials were significantly more difficult to perform than repeat trials, resulting in significant *shift costs,* which were said to reflect the extra burden placed on the attentional system. It was also found that error rates were reliably greater on shift trials as compared to repeat trials. Also, the induction of crosstalk significantly increased RTs for both the shift and repeat trials. Furthermore, it was found overall that shift costs were consistently greater when crosstalk was elicited than when it was not. These findings established that the alternating runs design provided results, similar to Jersild (1927, as well as Spector & Biederman, 1976), that shifting predictably between two simple cognitive tasks yields large and reliable increases in both RT and error rate.

Interestingly, it was also found that allowing participants increased time to prepare (up to1200 ms) attenuated resulting shift costs, but, importantly, did not *eliminate* them. This aspect of the shift cost that was not amenable to elimination with practice was referred to as a *residual shift cost*. On the basis of their findings, Rogers and Monsell (1995) attributed part of the shift cost to a "stagelike (but incomplete) process of task set reconfiguration, which is endogeneously controlled and can be carried out in anticipation of [an upcoming] stimulus" (p. 228). This remaining residual shift cost was said to be part of a control process that is not carried out until after the actual stimulus onset and was referred to as the "exogenous" component of the shift cost. They suggested that an external stimulus must trigger this control process that is involved in the retrieval or reinstatement of the relevant task set. This idea has been referred to as the task set reconfiguration hypothesis.

Alternative Explanations of Shift Cost Mechanisms

Since Rogers and Monsell's (1995) development of the alternating runs design, there has been a substantial amount of research conducted in the field of attention task shifting. A great deal of recent research has focused on possible mechanisms underlying task-shifting processes. Many different hypotheses have been proposed to explain these mechanisms and the following discussion will review some recent ones that are commonly cited in the literature.

Task Set Inertia Hypothesis. At approximately the same time when Rogers and Monsell (1995) were developing the alternating runs paradigm, Allport, Styles and Hsieh (1994) conducted a series of seven exploratory experiments, using the Jersild (1927) paradigm, in order to investigate different attentional components involved in task shifting. One of the main findings from these studies was that when a pair of tasks (say, A and B) are each cued by potentially the same stimuli, but in which A is a more dominant task (meaning more strongly learned and more compatible) than B, the shift cost from B to A (i.e., in returning to the dominant task) was observed as being greater than from A to B. This was found when task shifting between many different types of stimuli. This was explained in terms of what they called the task set inertia hypothesis – a form of proactive interference, which arises from the task that the participant is disengaging from as it interferes (resulting in a shift cost) with performance of the new upcoming task.

Wylie and Allport (2000) later designed a paradigm in order to further test their hypothesis using a 3-stage version of the alternating runs design. They examined the extent to which residual shift costs reflect the demands of shifting *to* the forthcoming trial (as stated by Rogers & Monsell, 1995) or of shifting *away from* the previous trial (as stated in the task set inertia hypothesis). They used Stroop stimuli in order to test out these hypotheses in a series of studies. One task was a word-reading task that consisted of color names printed in matching or non-matching ink colors. The other task was a color-naming task that consisted of either *x*s appearing in a specific color or, again, color names printed in matching or non-matching ink colors. It has been well-established that it is more difficult for an individual to name an ink color that is incongruent with the color name than it is to read the color name (Stroop, 1935, as cited in MacLeod & Dunbar, 1988). In Stage 1, participants were required to read aloud neutral color words in the word task (i.e., color name and ink color matched) and name the color of rows of black *x*s in the color task. Therefore, all stimuli were neutral in this stage – or monovalent. In Stage 2, participants were required to read aloud incongruent Stroop stimuli in the word task (i.e., color name and ink color did not match, making the stimuli bivalent) while the color task remained neutral as before. Finally, in Stage 3, both tasks became bivalent which required participants to again read aloud incongruent Stroop stimuli in the word task and name the color of incongruent Stroop stimuli in the color task. The comparison of Stage 1 and Stage 2 examined the effect of the word task becoming bivalent and, therefore, more difficult to process, while the color task remained unchanged. Greater shift costs in Stage 2 as compared to Stage 1 would have indicated that reconfiguration processes were involved in shift cost mechanisms, as the participant prepared for the more difficult task. However, Wylie and Allport (2000) found similar shift costs existed between performance in Stage 1 and Stage 2. The comparison of Stage 2 and Stage 3 examined the effect of the color task becoming bivalent and, therefore, more difficult to disengage from, while the word task remained unchanged. Greater shift costs in Stage 3 as compared to Stage 2 would have indicated that participants were unable to overcome inhibition that was established in the trial preceding the shift trial. This was exactly what Wylie and Allport (2000) found, illustrating evidence for what they referred to as the task set inertia hypothesis.

Following a series of experiments using the 3-stage alternating runs design, Wylie and Allport (2000) not only found supporting evidence for the task set inertia hypothesis (as stated above) but they also found evidence that caused them to expand on the task set inertia hypothesis. They proposed that participants learn stimulus (S) – response (R) associations during task shifting. When tasks are then repeatedly performed during the attention-shifting task these associations may be triggered. This causes interference and results in subsequent shift costs. Although the tenets of this updated hypothesis were the same, there was more emphasis placed on these memorial processes.

Long-Term Memory Retrieval Hypothesis. A different hypothesis, proposed by Mayr and Kliegel (2000) also places an emphasis on memorial processes in task shifting. They investigated a particular aspect of task shifting – preparation for the upcoming task set-shift. They suggested that this component of task shifting involves retrieval of S-R associations (learned from instruction sets at the beginning of an experiment) from long-term memory. Shift costs, therefore, to some degree, reflect the process of re-activating these instructions on the next trial from long-term memory. They conducted three experiments, using the alternating runs design, to provide evidence for this hypothesis. Shift costs were found to be higher when long-term memory retrieval demands were greater. Also, retrieval demands (measured by differences in shift costs on a high retrieval demand task compared to a low retrieval demand task) were eliminated when either the time for advanced preparation or the task cues explicitly specifying the task rules were provided. They suggested that their results were consistent with the hypothesis that a component of shift costs reflect time demands involved in retrieving appropriate task rules stored in long-term memory. This retrieval-demand effect was also found to be associated with the proactive or endogenous component of task shifting identified by Rogers and Monsell (1995) as well as Meiran (1996).

More recently, Mayr and Kliegel (2003) separated shift cost mechanisms into both cue-shifting processes and task-shifting processes. Results allowed for them to distinguish two stages of processing during attention shifting. In the first stage the currently relevant task rules are retrieved from long-term memory into an active representation. This *retrieval stage* could be triggered through any internal or external signal that indicates an upcoming task. In the second stage, the *application stage,* task rules are applied in a relatively automatic manner once the stimulus is actually presented. This two-stage account of task shifting was said to be similar in spirit to two-stage accounts that have been proposed by researchers such as Rogers and Monsell (1995) as well as Meiran (2000).

Response-Set Reconfiguration Hypothesis. Meiran (1996, 2000) proposed that task shift costs involve at least three separate components: (1) the passive dissipation of the previous task set (as hypothesized in the task set inertia hypothesis), (2) the preparation for the new task set (as hypothesized in the task set reconfiguration hypothesis), and (3) a residual component. Meiran, Chorev and Sapir (2000) conducted a series of studies in order to attempt to reconcile these opposing views of task set reconfiguration and task set inertia as well as to further understand reconfiguration and its relationship to general preparation. A cueing paradigm was used in which participants identified the location of a target stimulus presented inside a 2 x 2 matrix. Participants then shifted between two randomly ordered tasks and the instructional cues for each task were kept on the screen until a response was made. Results indicated that both preparatory reconfiguration and passive dissipation of the previous task set were involved in this task-shifting design. For example, when a response cue interval (RCI) was prolonged, allowing for manipulation of passive dissipation, shift costs were reduced, thus providing support for the task set inertia hypothesis. However, when the cue target interval (CTI) was prolonged, allowing for investigation of increased preparation, shift costs were also reduced, thus providing support for the task set reconfiguration hypothesis. Meiran et al. (2000) also found evidence allowing them to conclude that reconfiguration processes are an independent component of preparation (see also Meiran, 1996, 2000). Based on all their findings, they suggested that task-shifting costs should not be taken as a measure of a single process.

Incomplete Preparation Hypothesis. De Jong (2000) proposed that residual shift costs represent incomplete preparation or occasional failures to prepare for the upcoming task. This may be due to a lack of motivation, failure to appreciate the advantage of preparation or the amount of effort required. De Jong (2000) had participants perform repeat and shift trials randomly, varying response stimulus intervals (RSI) from very short intervals (150 ms) to very long intervals (1500 ms). Also, one group of participants performed short blocks of trials whereas another group performed longer blocks of trials. It was hypothesized that holding the intention to engage in advance preparation during task shifting must be done at a sufficiently high level of activation to ensure that advance preparation will be successfully triggered. If people are able to sustain this effort for only brief periods of time then trigger failures (i.e., failures to engage in advance preparation) would be more prevalent during long blocks of trials as opposed to short blocks of trials. In support of this, responses were found to be significantly faster in the short blocks than in the long blocks, especially during shift trials. Further, a mathematical model that measured cumulative distribution functions of the RTs revealed that failures to engage in advance preparation occurred twice as often in the long trial blocks as in the short ones.

Participants also performed intermixed short and long blocks with results illustrating that trigger failures were more prevalent in the short blocks when intermixed with the long blocks as compared to when they were not. De Jong (2000) suggested that individuals must set an initial level of intention-activation based on prior knowledge of the potential block length(s) they were being exposed to. This was said to be further evidence for the proposal that shift costs are simply a reflection of incomplete preparation processes on the part of the participant.

Future Directions in Task-Shifting Research

Researchers now acknowledge that more than one mechanism may underlie shift costs (e.g., Logan & Gordon, 2001; Meiran et al., 2000; Sohn & Anderson, 2001) – although the proportion that each mechanism is responsible for is still somewhat unclear (see Monsell, 2003). For example, De Jong's (2000) proposal of incomplete preparation has recently been followed-up by Nieuwenhuis and Monsell (2002) who found that strong incentives for preparation had only modest effects on shift costs. They therefore suggested that while an aspect of shift costs may be due to a failure to engage in advance preparation, other processes must also underlie shift costs. In a similar vein, Monsell (2003) stated that although long-term memory retrieval effects play a role in task shifting (e.g., Mayr & Kliegel, 2000), the function of this mechanism when participants learn only a small set of task stimuli is unclear. Further, although transient carry-over effects of task set activation have been established as contributing to shift costs (e.g., Mayr, 2002; Meiran et al., 2000; Wylie & Allport, 2000), it remains undetermined whether the effect is to slow down task-specific processes and/or to stimulate extra control processes (Monsell, 2003). Also, many researchers now believe that while these task set inertia processes are important, they constitute only one component of shift costs (e.g., Monsell, Yeung & Azuma, 2000; Ruthruff, Remington & Johnston, 2001; Sohn & Anderson, 2001). Overall, some consensus has developed regarding the idea that the preparation effect reflects a time-consuming, endogenous, task set reconfiguration process which, if not done prior to the stimulus onset, must be done after it (see Monsell, 2003 for a review of these discussions).

Recent studies, including those conducted in the present thesis, have focused on other interesting elements of task shifting. One study that particularly relates to the experiments of this thesis is that of Arrington, Altmann and Carr (2003). These researchers decided to investigate how shift costs are affected by the extent to which task sets share specific component operations along different dimensions. For example, if perceptual encoding operations and operating characteristics are the same in two tasks, then these two tasks are more similar than if the perceptual encoding components and their operating characteristics were dissimilar. They conducted two experiments to determine the effects of this type of task similarity using an attention task-shifting design.

In the first experiment, similarity of perceptual encoding was manipulated by requiring participants to make judgments regarding four different tasks on qualities of height, width, hue and brightness of a rectangular target. Judgments of height and width both involve processing aspects of the spatial extent of a target whereas judgments of hue and brightness both involve processing surface properties of a target. Therefore, shifting attention between height and width judgments were considered to both involve the same, or *shared attentional control* setting for *form* whereas shifting between hue and brightness judgments were considered to both involve the same, or *shared attentional control setting* for *color*. Therefore, shifting attention between height and width or between hue and brightness does not require a change in the shared attention control setting whereas shifting attention between height and hue or width and brightness does. Results revealed a facilitation of task shifting (as reflected by a decrease in shift costs) when participants shifted attention between the tasks that were similar. In the second experiment, similarity in response output modality was manipulated by requiring participants to shift between four different tasks where two tasks required manual responses and the other two tasks required vocal responses. Shift costs were found to be smaller when participants shifted between using similar response output modalities as opposed to when they shifted between using different response output modalities.

Overall, these experiments by Arrington et al. (2003) provided evidence for the idea that increased task component similarity (be it attentional control settings or response modality outputs) placed less of a burden on the attention system, as reflected by the decreased shift costs. Results were said to support the idea of "task space" whereby similar tasks that share similar component operations will be closer in task space and are, therefore, easier to shift attention between. Results were also said to support task-shifting hypotheses that emphasize cognitive control in preparatory components of task shifting (e.g., Meiran, 2000; Rogers & Monsell, 1995; see also Rubenstein, Meyer & Evans, 2001) as task similarity may reduce the amount of preparation carried out when attention shifting. Experiment 2 of the current thesis extends the findings of Arrington et al. (2003) into the domain of language through an investigation of task shifting on tasks that have a shared attentional control in the grammatical domain. The design and results of that study will be described at a later point in this thesis.

In summary, there is a great deal of evidence to suggest that the use of the alternating runs task-shifting design is very appropriate for researching attention mechanisms during cognitive performance. However, the studies conducted with these task-shifting designs have employed simple and decontextualized stimuli such as letters and digits (Rogers & Monsell, 1995), pictures (Waszak, Hommel & Allport, 2003) and single words (Wylie & Allport, 2000). One would expect to see that shift costs also exist when individuals engage in more naturalistic complex skills and activities, such as reading or speaking. For example, when individuals engage in a conversation, the rapid stream of sentences will require the conversants to engage attentional control processes to allow them to shift between the various ideas being expressed. However, language use and attention-shifting abilities have been relatively unexplored in the literature. Nevertheless, the involvement of attention in language has been discussed and examined in different ways by researchers. An overview of these investigations will be provided in the proceeding paragraphs.

Attention Control and Language: Example of a Complex Skill

Skilled language use, as other complex skills, requires the coordination of a number of cognitive abilities. Examples of language skills include attending to a conversation, attending to changes in a linguistic environment (i.e., change in tone of voice; introduction of unexpected ideas), as well as inhibiting and selecting particular expressions. Language use also involves skills such as retrieving appropriate words from the mental lexicon, organizing their structure and producing speech in an organized and efficient manner. These skills are often highly efficient in our first language whereas in our second language some of these processes may become so, depending on an individual's level of mastery. Mastery of a second language is an appropriate complex skill in which attention and cognitive control can be studied since there are a variety of cognitive resources recruited when one learns and uses a second language (e.g., Robinson, 2003). In order to understand the involvement of attention in language skill, the following section will begin with a review of different elements of attention and their relation to language use.

Component Processes of Attention and Their Relation to Language

Recent views of attention have proposed that attention is a multi-component system related to distinct anatomical and physiological bases (Stuss, Shallice, Alexander & Picton, 1995). For example, Stuss et al. (1995) discuss five component processes important for attentional control: energizing, inhibiting, monitoring, contention-scheduling adjustment and controlling of if-then logic. They propose that these processes combine in different ways on tasks measuring attention control. For example, when attention must be sustained, such as when relevant events occur at slow rates over prolonged periods of time, monitoring, energizing and inhibiting processes are involved. When attention must be concentrated, such as when events are demanding and responses are required quickly, inhibiting, energizing and contention-scheduling adjustment processes are involved. When attention must be shared between two or more unrelated tasks simultaneously, energizing and monitoring processes are involved. When attention must be suppressed, such as when automatic processes select factors that are inappropriate to task requirements, logic and inhibiting processes are involved. When attention must be shifted, such as when tasks require the shifting of attention from one concept to another between sets of stimuli, inhibiting and energizing processes are involved. When attention must be prepared, such as when an operation must be carried out later in time, energizing processes are involved. When attention must be set, such as when attention must be consistently mobilized across testing sessions, energizing and monitoring processes are involved.

These various component processes of attention have been shown to be important during skilled language performance and in acquisition of a second language (L2). For example, the ability to selectively attend to language is a widely researched area and involves the above-mentioned processes of concentration, suppression and sharing. Research on selective attention focuses on the manner in which attention mechanisms both enhance and inhibit the processing of stimuli, depending on the requirements of the task at hand (Eviatar, 1998; see also Fischler, 1998). The classic technique used to study selective attention was originally designed by Cherry (1953, as cited in Wood & Cowan,

1995) who investigated the extent to which task-irrelevant information is both processed and recalled. Briefly, this paradigm, referred to as a shadowing task, requires participants to immediately repeat, or "shadow", information heard through one ear while ignoring information heard through the other ear. Research on selective attention paradigms have often focused on the ability of individuals to discern different types of messages within noisy environments as well as the ability to shift attention between relevant and irrelevant messages delivered in selective listening paradigms (see Wood & Cowan, 1995 for both a review and reexamination of Cherry's work). This skill is particularly relevant for L2 users as the environments in which language is used are often noisy, presenting challenges to speakers who are not fluent. Therefore, acquiring selective attention skills in a second language are essential for developing proficiency within that language.

Self-monitoring attention skills, involving processes of monitoring, energizing and inhibiting, have been included in Levelt's (1989, 1999) multi-component model that outlines a "blueprint" for first language speaking. In this model, a "Conceptualizer" component generates the idea that a speaker intends to communicate and a "Formulator" component packages the idea into language by making use of the appropriate devices available in the language. Attentional resources are recruited to detect any mismatches between the speaker's intentions and the ways they have been linguistically packaged, with corrective action being taken where necessary. Speaking as an intentional activity involves conceiving of an intention, selecting the relevant information to be expressed, ordering this information for expression and monitoring what has been said before and, thus, what still needs to be articulated. This type of an activity requires the speaker to constantly pay attention to his or her own productions as well as the individual with whom he or she is engaged in a conversation with. When an individual engages in conversation numerous factors are involved, including: considering alternative expressions; being reminded of relevant information; and developing a train of thought. Being able to construct a message, monitor speech and self-correct enables an individual to attend to both internal and overt speech when interacting with others. These abilities involve highly controlled attentional processing, as both message construction and speech self-monitoring involve attentional awareness. However, not all processing in message encoding is under executive control. An adult's experience with speaking is so extensive that whole messages can, in fact, become available and retrievable from long-term memory. Many conversational skills, such as knowing when to speak, allowing others to speak, as well as directness and politeness of speech have been acquired over the course of a lifetime and are often under highly efficient processing.

Levelt's model has been extended to cover the case of second language speaking by De Bot (1992). The attentional resources required for the Conceptualizer in a second language may be greater than in a first language since fewer aspects of language use are initially under automatic processing (see Segalowitz, 1997, 2000, 2003 for a review on automaticity and second language use). In addition, some responsibilities required of the Conceptualizer may occur more often when speaking one's second language. For example, when an individual wants to express a concept in an L2, he or she may not have the lexical items needed to express the concept, or may be unable to find the relevant item quickly enough. This can cause difficulties during the grammaticized encoding phase of speech production. The Conceptualizer, at some point prior to or during speech production, will become aware that this given concept cannot be properly expressed as a word. In addition, a less proficient L2 user may make more errors due to missing important cues necessary for correct language use. These can include: incorrect retrieval of information to be expressed, incorrect ordering of information, as well as greater difficulty keeping track of what was previously stated.

Attention-Directing Aspects of Language

Levelt's model stresses the importance of attending to language when speaking in order to produce appropriate speech and to be aware of one's current linguistic environment. A different perspective on the role of attention and language has been proposed by various cognitive linguists[1] (e.g., Langacker, 1987; Slobin, 1996; Talmy, 1996, 2000; Tyler & Evans, 2003) where *language itself acts as an attention-directing mechanism.* It is suggested that language directs the interlocutor to make particular focal adjustments (Langacker, 1987, p. 116) as he or she creates a mental representation of the meaning packaged in the incoming message. For example, the expressions "the lamp on the table" and "the table with the lamp on it" describe similar scenarios but convey different perspectives on or *construals* of that scene that might be generated by the speaker (Langacker, 1987). In this way, the fashion in which the information is linguistically packaged, directs the listener's or reader's attention to the scenario in specific ways. Talmy (2000, especially Chapter 4) similarly describes how language makes possible a *windowing* of attention, where any referent scene may be windowed (highlighted for attention) in particular ways.

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[1] Cognitive linguists study both linguistics and cognitive science and provide accounts of language that integrate with current understandings of the human mind. Researchers in this area attempt to explain language use with regards to the understanding of underlying mental processes. (Wikipedia, 2004).

Slobin (1996, 1997, 2003) has proposed that specific elements of language, which he refers to as *grammaticized elements*, are responsible for this attention-directing mechanism. These include function words, grammaticized morphemes and other grammaticized devices that express aspect, definiteness, spatial and temporal relationships, active versus passive voice, etc. These grammaticized elements of language all have in common the fact that they cannot be experienced in a direct perceptual, sensorimotor or pragmatic manner (Slobin, 1996, p. 91). For example, in sentences such as, "Mary called her parents *because of* their argument", or "Mary called her parents *despite* their argument", the referents of the conjunctions (or connectives) "despite" and "because of" do not draw the recipient's attention to specific concepts or images. Instead, they shape the way that the recipient construes the scene. This *construal* is conveyed by the choice of conjunctions chosen by the speaker in these cases ("because of" and "despite" in the examples above).

A skilled listener will construct different representations of what was spoken as a direct result of these grammaticized elements of language. For example, in the sentences above *because of* indicates that "their argument" is to be emphasized as the cause for Mary to call her parents whereas *despite* specifies that "their argument" is not the cause for Mary to call her parents. These types of conjunctions (e.g., *because*, *due to*, *despite*, etc.) direct the listener or reader's attention to either foreground or background specific events in terms of their causal links with the overall meaning of the statement. Other examples of these grammaticized elements include prepositions such as in, "The picture is *above* the table". Although "above" can be experienced in a sensorimotor manner to a slightly greater extent than "because of" or "despite", it is still not possible to perceive or indicate "above" in the same way that the referents for nouns (i.e., content words) such as "picture" or "table" can be. In order for these types of messages to be understood, the receiver must create a mental construction that actually corresponds to the sender's meaning – as opposed to just registering the sequence of the words that have been spoken or written. These grammaticized elements specifically direct the receiver's attention to important aspects of the representation under construction ensuring that it is modified, updated and, ultimately, understood properly.

Slobin (1996, 1997, 2003) has discussed another attention-directing function of language. Within all languages these distinctions of aspect, definiteness, active versus passive voice and the like can only be expressed through language – they are not categories of thought in general, but instead categories of what he has termed "thinking for speaking" (Slobin, 1996, p. 91). Slobin (1996, 1997, 2003) has suggested that during any type of language production the speaker must (1) develop a conceptualization of the event as well as (2) pick characteristics of language that are readily encodable in the language to be spoken (Slobin, 2003). Further, Slobin (1996, 2003) proposes that the effects of language on attention are beyond that required when speaking or listening – it involves mental activity during the formulation and interpretation of utterances. Experiences must be mentally encoded in such a way that one is then able to describe them later – in the terms required by that particular language (Slobin, 2003). Thus, the activity of thinking is said to take on a specific quality during the act of speaking since utterances in discourse are mentally constructed through the available linguistic frames available.

Slobin (1996, p. 89) argues that each native language has trained its speakers to pay attention to different kinds of events and experiences when discussing them. This training is carried out in childhood and is extremely resistant to adult second language acquisition. Once our minds have been trained to take particular points of view for the purposes of speaking, it becomes exceptionally difficult to retrain them. Cross-linguistic comparison studies have revealed that it is precisely these grammaticized aspects of language that are more difficult to master when learning and speaking a foreign language and, furthermore, that are particularly relevant for developing language proficiency. Since languages employ these grammaticized elements differently, L2 learners may experience particular difficulty with their use (Slobin, 1996). This renders grammaticized elements more difficult to acquire than nouns, adjectives, etc. because there is less consistent, concrete evidence presented to the learner in any given learning episode as to what the grammaticized elements refer to, compared to evidence available for the nongrammaticized (i.e., content) words. The result is that there will be a significant and possible persistent L1-L2 gap in performance with grammaticized elements, and a smaller or no gap at all with nongrammaticized words.

In summary, two different ways in which language functions as an attention-directing mechanism have been identified. First, language affects the way in which one attends to the world by shaping one's mental representations and communicative interactions. These linguistic constraints have been termed "thinking for speaking" by Slobin (1996, 1997, 2003) and are found in every language spoken. The argument could be made that if all individuals spoke one universal language, thinking for speaking would still exist given that language constrains and shapes the way in which one interacts with their environment. Second, grammaticized elements of language will direct an individual's attention to relationships that exist within the linguistic message (e.g., Slobin, 1996, 1997, 2003; Talmy, 2000; Tyler & Evans, 2003). These grammaticized elements of language include those aspects of language that cannot be experienced in a direct perceptual, sensorimotor or pragmatic manner and will differ from one language to another, resulting in L2 learners often mastering them with great difficulty.

Attention Control and Language Proficiency: Task-Shifting Paradigms

The aforementioned ideas regarding grammaticized elements and their attention-directing functions have been based on theoretical linguistic research (e.g., Slobin, 1996; 1997; 2003; Tyler & Evans, 2003). Some investigators have recently examined these linguistic elements of language from a cognitive psychological approach, illustrating interesting distinctions in different aspects of linguistic processing as well as relationships between grammaticized elements of language and L2 proficiency. The studies reviewed in the following paragraphs have operationalized attention control by employing task-shifting paradigms to examine the relationship between attentional control measures and different aspects of language use.

Processing of Spatial and Temporal Language

One area explored by researchers regarding these linguistic elements of language is the question of processing targets involving shared versus differentiated representations. An interesting study conducted recently by Gentner, Imai and Boroditsky (2002) investigated the psychological distinction of spatial metaphors that are often used to describe temporal language. For example, in "We are looking *forward* to a brighter tomorrow", "forward" is a spatial preposition that is being used to refer to a temporal event. Researchers (e.g., Lehrer, 1990; Tyler & Evans, 2003) have proposed that there is an orderly systematic correspondence between the domains of time and space in language. Gentner et al. (2002) wanted to investigate the psychological status of the correspondence between these domains. Although these metaphoric systems may exist during language use, they may not have psychologically distinct mappings. In order to establish whether there was a psychological reality to these different *space→time* metaphoric systems, Gentner et al. (2002) set out to distinguish between them empirically.

Two different *space→time* metaphoric systems have been proposed to exist (see Gentner et al., 2002 for further details). Briefly, one metaphoric system is referred to as the *ego-moving* metaphor, where the observer's context progresses along a time-line towards the future. The second metaphoric system is referred to as the *time-moving* metaphor, where events progress along a time-line from the future to the past as if on a river or conveyer belt. These two systems will lead to different assignments of front/back on a time line. In the ego-moving system, front will be assigned to a future event such as "The war is *behind* us" whereas in the time-moving system, conversely, front will be assigned to a past event such as "I will see you *before* 4 o'clock".

In order to assess the psychological status of these metaphors they conducted a series of three experiments. It was examined whether participants were faster to process the *space→time* metaphor if the preceding sentence referred to either the same metaphoric system or a different metaphoric system (i.e., requiring an attention processing shift between systems). In one of the experiments, participants read a set of three sentences, referred to as setting sentences, on a computer screen followed by a test sentence. For all sentences, participants had to respond to whether the first event in the test sentence took place in the past or in the future relative to the second event in the sentence. Responses were indicated on a time line and the test sentence was either consistent with the metaphoric system of the previous three sentences or inconsistent. For example, in the consistent time-moving condition one of the setting sentences might be "I will take the Math exam before the English exam" with the corresponding test sentence, "Dinner will be served preceding the session". Conversely, in the inconsistent time-moving condition, one of the setting sentences might be "I am looking forward to the concert with the corresponding test sentence, "Dinner will be served preceding the session". Participants in the consistent conditions were found to respond significantly faster than when performing in the inconsistent conditions. This demonstrated that comprehension was facilitated when processing metaphors belonging to the same system as opposed to unexpectedly having to shift attention to a different metaphoric system.

Gentner et al. (2002) also conducted a naturalistic version of this experiment by asking travelers commonsense time questions at an airport. For example, an experimenter would pose two time-related questions (one was termed a setting question and the other a test question) using either the same metaphoric systems or different metaphoric systems. Individuals again responded significantly faster when exposed to a consistent setting and test question. Overall, results illustrated that when people make inferences about temporal relations during reading or oral comprehension, performance is more efficient if the sequence of metaphors continuously belongs to the same global metaphor system. These findings provide interesting evidence for two distinct psychological systems that are employed when processing event-sequencing statements. They also speak to a decreased burden on the attention system when processing similar task relations (as in Arrington et al., 2003), although in this case the "task relations" were in the language domain – specifically metaphoric systems used for linguistic processing.

Language-Specific Attention and Second Language Proficiency

While the focus of Gentner et al.'s (2002) research was on differentiation in processing across linguistic metaphoric systems, researchers have also begun to explore linguistic processing in relation to second language skill. For example, linguistic versions of attention task-shifting designs have recently been developed to investigate the relationship between attention control and L2 proficiency. Segalowitz and Frenkiel-Fishman (in press) studied this relationship in participants who were bilinguals (English = L1; French = L2), with varying degrees of L2 proficiency. In order to measure L2 proficiency, participants performed a two-alternative forced-choice animacy classification task in separate first and second language blocks. On each trial, a single word appeared on a computer screen and participants had to classify it as either referring to something living (e.g., dog) or something non-living (e.g., table). This task produced indices of both L1 and L2 ability (as measured by RT) in lexical access. Individual differences in speed and cognitive efficiency in lexical access were interpreted as reflecting the degree and scope of an individual's experience within the target language. These measures of cognitive efficiency were based on the intra-individual variation obtained from performance in this lexical access task, yielding a measure of bilingual proficiency (see Segalowitz & Segalowitz, 1993). Further, in order to control for individual differences in aspects of task performance not related specifically to L2 proficiency, each participant's performance in the L1 version of this lexical access task served as a baseline measure.

Attention control was measured using a linguistic version of the alternating runs paradigm that employed grammaticized elements of language. One task consisted of time adverbials; words used to direct attention to the temporal location of an event as being closer to or further from some reference point, such as the present moment (e.g., *now, next* versus *tomorrow, never*). The second task consisted of conjunctions; words used to link ideas together by indicating the presence or absence of a casual connection between events named in two parts of a sentence (e.g., *because, therefore* versus *although, despite*). These tasks were performed in both L1 and L2. In order to obtain an index of L2-specific attention control measures, L1 performance was partialled out from L2 performance.

The goal of this research was to assess the extent to which attentional control measures and bilingual proficiency measures were related. Results indicated that overall attention control measures (i.e., L1 and L2 attention control together) accounted for 59% of the variance of proficiency and the L2 attention control measures alone accounted for 32% of the unique variance of proficiency. This indicated that the speed of bilinguals' attention control in L2 accounted for a significant proportion of unique variance of independently assessed proficiency in that language.

Chung and Segalowitz (2003) have recently done further research on attention control and second language proficiency. Participants tested were again bilinguals (English = L1; French = L2) with varying degrees of L2 proficiency measured as in Segalowitz and Frenkiel-Fishman (in press). The task used to measure attention shifts in this study was a nonmatching-to-sample task in which concrete nouns (e.g., apple, church) abstract nouns (e.g., hour, idea) and grammaticized stimuli (e.g., pronouns, prepositions, conjunctions and verb forms) were used. On each trial, participants were shown four test stimuli on a computer screen as well as a sample item at the bottom of the screen. Two of the test words were drawn from the same category as the sample and the remaining two test words were drawn from two other categories. For example, on a matching trial, the test stimuli could be four words drawn from three categories (e.g., *cat*, *peach*, *leg*, *pear*) and the sample word drawn from one of these three categories (e.g., *apple*). This sample word is associated with two of the test words – peach and pear (i.e., from the category fruit). Therefore, a response of either peach or pear would be appropriate. Conversely on a non-matching trial, the correct responses would have been cat or leg as these words were drawn from a different category than the sample word. Participants' performed blocks of matching trials (providing a measure of baseline performance) and non-matching trials (providing a measure of attention shifts) in both L1 and L2. Results revealed that the efficiency of attention control for the L2 grammaticized elements accounted for a significant amount of the unique variance of L2 proficiency whereas attention control for the nongrammaticized elements (i.e., abstract and concrete nouns) did not. As all L2 measures had been residualized against L1 measures, results reflected a language specific form of attention and not just general processing abilities.

Chung and Segalowitz (2004) recently replicated these results and removed what they believed to be a potential confound. It was possible that meta-linguistic knowledge regarding the grammaticized categories was used in order to perform the nonmatching-to-sample task and, further, that this knowledge may have correlated with L2 proficiency.

Therefore, in order to correct for this confound they employed words drawn from four different subsets of spatial prepositions (e.g., *above, below, far, close)* as opposed to different categories of function words. Nongrammaticized words were employed in control conditions. One control condition used concrete words drawn from four different subsets of the category "living being" (e.g., *cat, ant, trout, sparrow*) and in the other condition they were drawn from four different subsets of the more abstract category "human qualities" (e.g., *happy, smart, polite, hungry*). Language proficiency and attention control were operationalized and measured as before. Results confirmed that in the more highly proficient bilinguals efficiency of L2 attention control for grammaticized elements accounted for 42% of the unique variance of L2 proficiency, after controlling for nongrammaticized attention. Once again, these results spoke to a language-specific form of attention.

In summary, the research discussed in this section illustrates the existence of a form of attention that is specific to linguistic proficiency. Participants' performance on tasks of attention shifting with grammaticized linguistic stimuli in the L2 was found to be specifically related to their proficiency in the L2. Further, this relation between attention control and L2 proficiency was not observed when processing nongrammaticized stimuli. These findings provide a cognitive psychological grounding for an approach to language that has, until recently, been based more on considerations of a purely theoretical linguistics nature (cognitive linguistics). The studies presented below will build on and extend these findings by studying further questions of the relation between attention control and attention-directing aspects of language within the novel context of naturalistic linguistic processing.

Overview of the Experiments

Attentional control is required for a number of complex skills that people engage in on a daily basis including driving, cooking and social interactions. These activities require that people constantly shift back and forth between different actions and skills in order to carry out the activity. However, the study of attentional control mechanisms with the alternating runs design has focused, to a great extent, on task-shifting processes found when engaging in simple tasks using decontextualized stimuli (e.g., Rogers & Monsell, 1995; Waszak et al., 2003; Wylie & Allport, 2000). In addition, the more recent studies employing grammaticized elements of language in attention-shifting designs have used single word stimuli (e.g., Chung & Segalowitz, 2003, 2004; Segalowitz & Frenkiel-Fishman, in press). However, language is typically used in a contextualized manner – with words being organized and understood as part of a syntactic structure. As discussed, when engaged in a conversation, the rapid stream of sentences will require the conversants to engage attentional control processes, allowing them to shift between various ideas being expressed. Therefore, the studies in this thesis were designed to investigate contextualized language processing within the context of a well-controlled design that measures cognitive control. The alternating runs attention-shifting design was chosen for this purpose as it has yielded robust results and was easily amenable to modification with contextualized linguistic stimuli.

The three studies were designed as follows. Experiment 1 examined whether attentional shift costs would be obtained with tasks involving the attention-directing functions of language, as the language targets, embedded in sentence-like contexts. A second goal of Experiment 1 was to investigate the question of reconfiguration versus inertial mechanisms that may underlie any observed linguistic shift costs by employing the 3-stage Wylie and Allport (2000) adaptation of the alternating runs design with contextualized grammaticized stimuli. Experiment 2 built on the findings of Experiment 1 by attempting to replicate any shift cost effects. In addition, Experiment 2 was designed to extend the findings of Arrington et al. (2003) with tasks that were of a grammatical nature. This was accomplished by investigating whether "intra-dimensional shifts of attention" (two tasks involving spatial attention-directing functions of language) as compared to "extra-dimensional shift of attention" (two tasks involving spatial and temporal attention-directing functions of language) affected resulting shift costs. Experiment 3 was then designed to build on both Experiment 1 and 2 by studying these attention-directing elements of language in both L1 and L2. Two hypotheses were investigated. The first was that performing a task requiring the use of linguistic attention-directing functions would be more difficult in the L2 than in the L1. The second was that this L2 effect would be observed most strongly when the task involved grammaticized words (those with the attention-directing function), but less strongly or not at all when the same task involved nongrammaticized words (those lacking the attention-directing function). Altogether, the experiments in this thesis were designed to explore different elements of attention control with contextualized naturalistic linguistic stimuli in both L1 and L2 performance using the alternating runs paradigm.

These experiments are presented in the next two chapters, in manuscript format, as submitted for journal publication. The first chapter reports findings from Experiments 1 and 2 and the second chapter reports findings from Experiment 3, both in a stand-alone manuscript format. Following these reports of the experimental data is the concluding chapter of the thesis that provides an overview of interesting issues raised by these three studies. Although not referred to as Experiment 3 in the manuscript text, the last experiment will be called this in the concluding chapter of this thesis.

EXPERIMENT 1 AND 2

This chapter contains Experiments 1 and 2, presented in manuscript-style format, entitled "Linguistic attention control: Attention-shifting governed by grammaticized elements of language". The references for these studies have been integrated in the general reference section that is included at the end of this thesis.

ABSTRACT

Two experiments are reported that investigated attention control for tasks involving the processing of grammaticized linguistic stimuli (function words). Attention control was operationalized as shift costs obtained with adult speakers of English in an alternating runs experimental design (Rogers & Monsell, 1995). Stimuli were contextualized by the use of complex sentence fragments. Experiment 1 yielded significant attention shift costs for shifting between tasks involving judgments about the meanings of grammatical function words. A 3-stage experimental design was used (Wylie & Allport, 2000) and the emerging pattern of results implicated task set reconfiguration and not task set inertia in these shift costs. Experiment 2 further demonstrated that shift costs were lower when tasks involved shared attentional resources (processing the same grammatical dimension) versus unshared resources (different grammatical dimensions). The results are discussed from a cognitive linguistic perspective and for their implications for the view that language itself can serve a special attention-directing function.

Linguistic attention control: Attention-shifting governed by grammaticized elements of language

Every day, people engage in complex goal-directed activities in which at any given moment they have to execute one of a variety of possible actions. Examples include driving, cooking and social interactions. To carry out these activities people must intentionally select appropriate responses, often referred to as *task sets*. Moreover, individuals may have to repeat or shift between various task sets in order to complete the job at hand. A central question, then, is how people select and implement appropriate task sets and, further, how they shift from the execution of one task set to another. The present studies examine two explanations for how people may do so *during language processing* and they offer support for the view that certain elements in language play a specific role in focusing attention on task sets.

The involvement of attention in language use has been discussed from several different perspectives. Levelt (1989, 1999), for example, proposed a multi-component model for speaking that incorporates a self-monitoring role for attention. In this model, a "conceptualizer" component generates the idea that a speaker intends to communicate and a "formulator" component packages the idea into language by making use of the appropriate lexical and syntactic devices available in the language. Attention is recruited to detect any mismatches between the speaker's intentions and the ways those intentions have been linguistically packaged, with corrective action being taken where necessary.

Several cognitive linguists (e.g., Langacker, 1987; Slobin, 1996; Talmy, 1996, 2000) have proposed another way to think about the relationship between attention and language. Here, the language itself acts as an attention-focusing mechanism, directing the interlocutor to make particular focal adjustments (Langacker, 1987, p. 116) as he or she creates a mental representation of the meaning packaged in the incoming message. For example, the expressions "the clock is above the picture" and "the picture is below the clock" describe similar scenes but convey different perspectives on or *construals* of the scene (Langacker, 1987). In this sense, the manner in which the information is linguistically packaged directs the listener's or reader's attention to the scene in specific ways. Talmy (2000, especially Chapter 4) similarly discusses how language makes possible a *windowing* of attention, where a referent scene may be windowed (highlighted for attention) in specific ways. Slobin (1996, 2003) speaks about "thinking for speaking", referring to how language can shape the way people pay attention to certain aspects of a scene in order to be able to talk about it.

Language achieves such attention-directing functions through its grammaticized elements – conjunctions, prepositions, bound morphemes and other grammatical devices that express tense and aspect, definiteness, spatial and temporal relationships, active versus passive voice etc. These linguistic elements have in common the fact that their "referents" cannot be experienced in a direct perceptual, sensorimotor or pragmatic manner (Slobin, 1996, p. 91) in the same direct way as are the referents of many nouns, verbs, adjectives, adverbs, etc. For example, in the sentence "the clock is above the picture" the meaning of the preposition "above" cannot be associated with a sensorimotor experience in the same direct way as can the referents for "clock" and "picture". The word "above" refers to a relationship, not a concrete object-like referent. The receiver is thus able to create a mental construction that corresponds to the sender's meaning, with the specific *construal* of the scene conveyed by these grammaticized elements (the scene is construed in terms of the clock being above the picture, not the picture being below the clock). The grammaticized elements of language direct the receiver's attention to important aspects of the representation under construction, ensuring that it is modified, updated and ultimately understood as intended by the speaker or writer. In the normal course of listening or reading an extended message, people have to shift attention focus frequently and rapidly as they encounter grammatical elements in the message. The ability to shift attention between these grammaticized elements of language is the main focus of the following two experiments.

The present research employed the alternating runs task-shifting design of Rogers and Monsell (1995) to investigate people's ability to control attention when shifting between grammaticized elements of language and to explore some of the mechanisms underlying these attention control processes. In Rogers and Monsell's use of this design, participants learned two tasks—Task A and Task B (letter and digit judgment tasks)—presented in a predictable sequence (...AABBAABB...). This resulted in an alternation between repeat trials (R) (performing the same kind of task, A or B, as was just performed on the previous trial) and shift trials (S) (performing a different task), yielding the sequence "...SRSRSRSR...". Reaction time (RT) was measured on each trial. The design allowed for individuals' performance on both shift and repeat trials to be compared within a single block of trials, thereby eliminating the possibility of confounds in arousal, effort, response criterion and working memory demands due to having to hold the information regarding one task (i.e., pure blocks) versus two tasks (i.e., alternating blocks) in memory as had been the case in earlier experiments on task shifting (see Jersild, 1927; Spector & Biederman, 1976).

Rogers and Monsell (1995) found that shift trials were significantly more difficult to perform than repeat trials, resulting in significant *shift costs,* which were said to reflect the extra burden placed on the attentional system. These authors also found that allowing participants more time to prepare (up to one second or more) attenuated resulting shift costs but, importantly, did not *eliminate* them. The component of the shift cost that was not amenable to elimination was called the *residual shift cost*. Rogers and Monsell (1995) attributed part of the shift cost to a "stagelike (but incomplete) process of task set reconfiguration, which is endogenously controlled and can be carried out in anticipation of [an upcoming stimulus]" (p. 228). The remaining, residual cost was attributed to a control process that was not carried out until after actual stimulus onset. It was referred to as the "exogenous" component of the shift cost, the idea being that the external stimulus must trigger this retrieval or reinstatement of the relevant task set. This idea has been referred to as the *task set reconfiguration hypothesis.*

Wylie and Allport (2000) challenged this explanation in their *task set inertia hypothesis*. This hypothesis holds that the slowing down observed on a shift trial reflects the extra time needed to overcome carryover inhibition of the irrelevant task set on the previous trail (as opposed to creating a new, reconfigured task set for the upcoming shift trial). To test this hypothesis, they introduced an extension to the alternating runs design involving 3-stages. This design is used in Experiment 1 below. In Wylie and Allport's use of the design, stimuli were sometimes monovalent (possessing features relevant to only one task) or bivalent (possessing features relevant to both tasks). In Stage 1, all the stimuli were monovalent and so shift costs reflected a shift from a monovalent stimulus on a repeat trial to a monovalent stimulus on a shift trial. In Stage 2, stimuli were monovalent for one task (Task A) and bivalent for the other (Task B), and so shift costs to the second task reflected a shift from a monovalent stimulus on a repeat trial to a bivalent stimulus on a shift trial. Wylie and Allport reasoned that a greater shift cost for Task B in Stage 2 than in Stage 1 would indicate that more preparation had been necessary for the shift in Stage 2 due to the bivalent nature of the stimulus on that shift trial. Such a result would support the reconfiguration hypothesis (task set reconfiguring should be more costly for a bivalent than for a monovalent stimulus) over the task set inertia hypothesis. In Stage 3 stimuli for both Tasks A and B were bivalent and so all shift costs reflected a shift from a bivalent stimulus on the repeat trial to a bivalent stimulus on the shift trial. Wylie and Allport reasoned that a result showing shift a greater shift cost to Task B in Stage 3 than in Stage 2 would indicate support for the task set inertia hypothesis. This is because, on the shift trial in Stage 3 there would be an inertial carryover of inhibition from the repeat trial where the Task B features had been irrelevant to the shift trial where they are now relevant. This carryover of inhibition would have to be overcome on the shift trial, resulting in slower responses. By contrast, in Stage 2 there would be no need for inhibition on the repeat trial (and hence no inertial carry over of inhibition) because the stimuli are monovalent. Wylie and Allport (2000) used this design with word-reading and color-naming tasks involving Stroop stimuli and found, in contrast to Rogers and Monsell (1995), support for the task set inertia hypothesis.

Since Rogers and Monsell's (1995) work first appeared, many researchers have continued to investigate the mechanisms underlying shift costs. Many of the hypotheses proposed actually fit one of two contrasting positions: task set reconfiguration versus task set inertia. For example, in support of the reconfiguration hypothesis, Meiran (1996) concluded that task shifting involves specific processes operating prior to task execution (i.e., task set preparation), based on evidence that increased cue-target intervals had a greater impact on RTs following a task shift trial as opposed to a task repeat trial. In addition, Mayr and Kliegel (2000) proposed that long-term memory processes are involved in retrieving appropriate task set rules and that these processes are a part of the endogenously controlled component of task-shifting processes. De Jong (2000), although making no distinction between endogenous and exogenous components of task shifting, also proposed that task set reconfiguration processes do occur—and that they do so in an all-or-none fashion. That is, participants either succeed in engaging the appropriate processing mechanisms prior to stimulus onset or they "fail to engage" entirely until after stimulus onset. In sum, different researchers have proposed the existence of some variant of the task set reconfiguration account of the mechanisms underlying shift costs (see also Meiran, 2000; Monsell, Sumner & Waters, 2003; Rubenstein, Meyer & Evans, 2001; Yeung & Monsell, 2003).

In support of the task set inertia hypothesis, Allport et al. (1994) found (as did Wylie & Allport, 2000) that shifting attention *from* the weaker task *to* the dominant task resulted in significant shift costs (see also Meuter & Allport, 1999; Waszak, Hommel & Allport, 2003). More recently, Meiran, Cherov and Sapir (2000) employed a cued task-shifting paradigm and measured both reconfiguration and task set inertia processes involved in shift costs. They provided evidence for both these processes, leading them to conclude that shift costs should not be taken as a measure of a single process. Although other researchers (e.g., Monsell, Yeung & Azuma, 2000; Ruthruff, Remington & Johnston, 2001; Sohn & Anderson, 2001) have also provided evidence for the existence of underlying task set inertia processes, they have suggested that they constitute only one component of shift costs.

The two experiments reported below extend the Rogers and Monsell (1995) and Wylie and Allport (2000) designs to explore language-based attention shifts on tasks involving stimuli embedded in linguistic contexts. Previous research on task-shifting mechanisms has only employed decontextualized stimuli such as letters and digits (De Jong, 2000; Rogers & Monsell, 1995), symbols (Arbuthnott & Woodward, 2002), pictures (Waszak et al., 2003), location judgments (Meiran, 1996, 2000), or identification of colors or words using Stroop stimuli (e.g., Wylie & Allport, 2000). However, one would expect to encounter shift costs when individuals engage in more naturalistic activities, such as reading or speaking. For example, when individuals engage in a conversation, the rapid stream of sentences will require conversants to engage attention control processes to allow shifting between various ideas being expressed. Shifting attention in these situations may, therefore, involve either task set reconfiguration or task set inertia as people deal with the ebb and flow of ideas in an unfolding verbal message. For example, in processing "The food remained on the plate because the boy wasn't hungry", a person first has to focus attention on the spatial relationship between "food" and "plate" (triggered by "on") and then shift attention to the causal connection between the upcoming second clause and the first clause (triggered by "because"), etc. Contrast this with the much reduced on-line attention focusing demands of "There was food and a plate and a boy and the boy wasn't hungry". The idea that language processing involves this form of attention control has been relatively unexplored in the literature. Experiment 1 investigated whether task set reconfiguration or task set inertia processes underlie shifts that may arise during the processing of more naturalistic sentences of the type presented in the example above.

To summarize, this paper reports two experiments using the alternating runs design (Rogers & Monsell, 1995) with linguistic stimuli presented in a contextualized manner (embedded in sentence fragments). The target stimuli in these sentence fragments were grammatical elements of language (function words) that represented two different attention-directing functions of language. The main goal of Experiment 1 was to investigate whether attentional shift costs would be obtained with tasks involving linguistic stimuli embedded in sentence-like contexts The burden placed on the attention system when shifting attention between these grammaticized elements of language will be referred to as *linguistic shift costs*. A second goal was to investigate the question of reconfiguration versus inertial mechanisms that may underlie any observed shift costs by employing the 3-stage Wylie and Allport (2000) adaptation of the alternating runs design. Experiment 2 built on the findings of Experiment 1 by attempting to replicate the shift cost effect and by investigating an additional question regarding the nature of linguistic attention shifting.

EXPERIMENT 1

Participants in Experiment 1 performed tasks with linguistic stimuli involving a location judgment task and a temporal judgment task in a 3-stage adaptation of the alternating runs design as used by Wylie and Allport (2000). The stimuli in the location judgment task were phrases, referring to spatial location in the vertical dimension signaled by spatial location prepositions, embedded in sentence fragments. This "above/below" judgment task used stimuli such as "...all alone above the location..." and

"...from below the site with them...". The stimuli in the temporal judgment task were phrases referring to events occurring in the past or present signaled by verb tense, embedded in sentence fragments. This "past/present" judgment task used stimuli such as "...since we waited with someone..." or "...when he's standing all alone...". As in Rogers and Monsell (1995), these two tasks were presented, one at a time, with stimuli appearing on the screen on successive trials in an adjacent cell of a 2 x 2 presentation matrix, moving in a clockwise fashion around the matrix. The location task (L) and temporal task (T) alternated in the predictable sequence "...LLTTLLTT...".

The three stages were designed as follows. In Stage 1, all stimuli were monovalent, in Stage 2 the stimuli in one task were monovalent and in the other task were bivalent and in Stage 3 all stimuli were bivalent. As in Wylie and Allport (2000), the comparison of shift costs in Stage 1 and Stage 2 examined the effect of *shifting to* a task with monovalent stimuli (Stage 1) versus *shifting to* a task with bivalent stimuli (Stage 2), and where in both cases the previous trial involved monovalent stimuli. In Stage 2, the shift was expected to be more difficult because of the need to reconfigure for an upcoming stimulus that was bivalent compared to Stage 1 where the upcoming stimulus remained monovalent. Greater shift costs in Stage 2 compared to Stage 1 would indicate that task set reconfiguration (preparation for an upcoming stimulus) was involved.

The comparison of Stage 2 and Stage 3 examined the effect of *shifting from* a task with monovalent stimuli (Stage 2) versus *shifting from* a task with bivalent stimuli (Stage 3) and therefore more difficult to *disengage from*, while the other task remained unchanged. Greater shift costs in Stage 3 as compared to Stage 2 would indicate task set inertia was involved.

Method

Participants

Participants were 24 undergraduate Concordia University students (*M*=23 years, range 20 to 28 years; 22 females, 2 males). Participants were paid C$7/hour for participating or received partial credit or course fulfillment for taking part. Participants were retained for this study if they declared English to be their first language (L1) and were clearly dominant in their L1 according to self-rated abilities and frequency of use of L1 as reported in a language background questionnaire.

Materials

Language background questionnaire. Because participants were sampled from a multilingual population, it was essential to screen all individuals to ensure that their native language was English. This was accomplished by using a self-report questionnaire requiring participants to self-rate native language abilities ion 5-point Likert scales with respect to speaking, reading and writing (1 = no ability at all; 5 = native-like ability) and frequency of using the native language in speaking, reading and writing activities (1 = never/almost never; 5 = main language used).

Attention-shifting task. The attention-shifting task consisted of a training stage and three experimental stages, with a location target and temporal target condition in each. Stimuli consisted of sentence fragments made up of target expressions (either one or two target expressions depending on whether the stimuli were monovalent or bivalent), surrounded by a location filler word (e.g., place, spot, site) and other filler phrases and words (e.g., while, from, with someone).

In the location judgment task, participants decided whether an event took place above or below a particular location. In the temporal judgment task, participants decided whether an event took place took place "now" (i.e., in the present) or "yesterday" (i.e., in the past). For each of these tasks, targets were selected quasi-randomly and in a counterbalanced manner from the lists shown in the Appendix, and matched with appropriate fillers to create sentence fragments. Fillers were chosen in a quasi-random fashion to ensure that their selection was appropriately counterbalanced across conditions and targets within conditions, that the sentence fragments were grammatically acceptable and that different sentence fragment lengths, ranging from 5-10 words (across all 3 stages), occurred in a fairly equal manner. Stimuli were always present with leading and following ellipsis dots ("...") to indicate a sentence fragment (e.g., "... *with someone she stood there watching*...").

For the training stage, a list of 16 alternating blocks of 24 task trials were created for the location judgment task and the temporal judgment task, for a total of 384 trials. The target and fillers were randomly selected with replacement from their respective pools. Each target was paired with a neutral filler, making the stimuli monovalent.

For the experimental stages, eight quasi-randomized lists of sentence fragments were created for each task. The first 48 trials of each list served as a practice block, followed by the experimental trials. These lists were counterbalanced in terms of quadrant and response assignments as described in the procedure section below. Other counterbalancing constraints were the following: no two consecutive trials contained identical phrases; target and filler phrases occurred approximately equally often across the lists; positioning of target and filler phrases within each sentence fragment (front, middle, end) was approximately evenly distributed; equal numbers of task targets occurred in alternating sequences of shift and repeat trials; half the trials required a left and half a right key response. In addition, the type of key response on any given trial was counterbalanced with respect to the correct target response on the previous trial as well as on the upcoming trial (to control for response priming). The starting point within the 2 x 2 presentation matrix was counterbalanced across participants to control for potential eye movement confounds. In addition, no more than four consecutive left or right button presses were ever required.

In Stage 1, all of the location and temporal target phrases were paired with neutral expressions, thus making all trials monovalent (e.g., *...while above the spot all alone...*). In Stage 2, half the trials were monovalent (target phrases paired with neutral expressions) and half the trials were bivalent (target phrases paired with target expressions from the other task) (e.g., *...while above the spot she stood...*). For half the participants in Stage 2, the location task was bivalent and the temporal task remained monovalent and the reverse for the other half of the participants, thereby counterbalancing task valency in Stage 2 across participants. Finally, in Stage 3, all trials were bivalent. In stages that involved bivalent stimuli, response congruency between a target and the competing expressions was counterbalanced across trials.

Apparatus

All stimuli were presented on an iMac G4 laptop computer with a 14-inch screen set to 1024 x 768 pixel resolution. Stimuli were shown in uppercase 20 point Arial font. Hypercard version 2.3 software was used to program all presentations and to collect both

RT and accuracy data. A machine language subroutine was used to measure RTs and to toggle trials with the onset of each screen frame.

Procedure

The participants were tested individually in one session lasting approximately one hour. Participants were informed that the experiment was divided into Part 1 (training) and Part 2 (experimental), the latter being further divided into three stages.

Language background questionnaire. Participants began by filling out the language background questionnaire.

Attention-shifting task. The attention-shifting task consisted of a training stage and three experimental stages. In the training stage, participants practiced making the two different kinds of judgments (temporal judgments; location judgments) without having to shift attention. Participants were given written instructions on how to classify the sentence fragments they were shown. The training stage was divided into 16 blocks of 24 task trials, alternating between blocks of location and temporal judgments, for a total of 384 trials. Participants initiated each block of trials and were informed as to what type of phrases (above-below; past-present) would be shown. At the end of each training block, the participant's percentage error and mean reaction time were displayed on the screen as feedback to increase interest and motivation.

In the experimental stages, attention control was tested using the alternating runs attention-shifting task. Participants proceeded through the training stage and three experimental stages in a predetermined order. They started with a block of 192 training trials (no attention shift involved), followed by the three experimental stages (attention shifts required), each stage consisting of one 48-trial practice block and one 192-trial test block. Of these 192 test trials, the first 12 were warm-up trials and data from them were not included in the analyses.

After completing Stage 1, participants proceeded to Stage 2 in which either the temporal or location judgment stimuli became bivalent. For half the participants the sentence fragments in the temporal judgment task became bivalent by the addition of location target phrases whereas for the other half of the participants the reverse was true. When participants then proceeded to Stage 3, both the temporal and location judgment tasks became bivalent.

The stimulus remained on the screen for 5000 ms or until the participant responded. On successive trials, stimuli were presented in one of four quadrants in a 2 x 2 matrix on the computer screen, in the predictable sequence top-left, top-right, bottom-right, bottom-left, top-left, etc. The Response-Stimulus Interval (RSI) was zero ms. If participants made an error, they received auditory feedback from the computer and an RSI of 1500 ms to allow recovery and preparation for the next trial. Information at the bottom of the screen reminded participants about the response key assignment for each task. This information remained visible throughout the training stage and for the first 48 practice trials of each experimental block. This response key information was denoted by pictograms. For the location task, a black horizontal bar with a black circle above it and a black horizontal bar with a black circle below it, placed on the sides (left, right) of the screen, designated the response keys for "above" and "below" responses, respectively. For the temporal task, a black horizontal bar with a black circle to the immediate left of the bar and a black horizontal bar with a black circle directly on the center of the bar designated the sides (left, right) for the response keys for "past (yesterday)" and "present (now)" responses, respectively. A numeric keypad was used for responses with the "4" and "6" keys labeled "L" and "R" (left, right) respectively.

Participants were instructed to read silently each stimulus sentence fragment in full and to respond as quickly as possible without sacrificing accuracy. They were also asked to generally try to remember the sentence fragments for a recognition task to be conducted at the end of the experiment (this was included only for the purpose of encouraging full reading of the stimuli; with 720 items presented, the recognition test results were not expected to be meaningful). It was emphasized in both the instruction set and by the experimenter that they were simply to gain familiarity with the sentence fragments and to not attempt to memorize them. Following completion of the 3 stages of the alternating runs paradigm participants completed the short recognition test requiring them to respond whether a given sentence fragment was "new" (i.e., had not been presented in the experiment) or "old" (i.e., had been presented).

Design

The attention-shifting task conformed to a 3 x 2 within-subject factorial design. There were 3 levels of condition (Stage 1, Stage 2 and Stage 3) and 2 levels of attention trial type (repeat, shift).

For half the participants the above and below responses were assigned to the left and right keys respectively, and the reverse for the other half. Past and present responses were always assigned to the left and right keys respectively.

In the attention-shifting task, the quadrant on the screen selected as the location for stimulus presentation on the first trial was counterbalanced across participants. Crossing quadrant positions with the response key assignments resulted in eight counterbalanced sets. These counterbalancing measures controlled for potential confounds due to eye movements and position preference factors.

Results

For all statistical tests reported below, N=24, the alpha level for significance was set at .05. All t-tests are two-tailed.

Participant selection. The language background questionnaire revealed that mean self-rated abilities in English were 4.9 for speaking, 4.8 for reading and 4.9 for writing. The mean score for frequency of each skill in English were 5 for speaking, 4.8 for reading and 4.8 for writing. These data confirmed that the participants were English dominant L1 speakers of the language.

Attention-shifting task. Mean RTs on correct responses not following an error trial were calculated for each participant (see Table 1 for means, standard errors, and percent errors in each stage). To remove outlier RTs within a participant's data set, the data were winsorized by replacing the slowest and fastest 10% of the individual's RTs by the next slowest or fastest RT, separately for each of the twelve conditions obtained by crossing the stage (Stage 1, Stage 2, Stage 3), attention (repeat, shift) and task (location, temporal) factors.

--------- Insert Table 1 about here ---------

One purpose of this study was to investigate shift costs using a multi-word context with grammaticized linguistic elements in the alternating runs design. Inspection of the data indicated that there were shift costs (slower responses on shift than on repeat trials) for 23, 24 and 23 out of 24 participants within Stage 1, Stage 2 and Stage 3, respectively. A priori t-tests of shift versus repeat RTs in each of these three conditions yielded significant shift costs, $t\ (23) \geq 7$, $p < .0001$, in all cases.

The data were also examined for congruency effects, that is, whether left or right responses normally associated with the foil element in a stimulus affected switch costs to the target. The analyses were performed on the Stage 3 data, because all trials were bivalent. Data were submitted to a repeated-measures analysis of variance with the factors being shift (repeat, shift), task (location, temporal) and congruency (congruent, incongruent). The analysis revealed that all main effects and interactions involving congruency were not significant (F's < 1), indicating that the congruency of response associated with relevant and non-relevant dimensions of the bivalent stimulus had no effect on the response time to the relevant dimension.

A second purpose of this experiment was to investigate the nature of the underlying mechanisms involved in these linguistic shift costs. In order to accomplish this, it was initially necessary to re-combine the data into appropriate sets because in Stage 2 for a given participant, trials for one task were monovalent and trials for the other task were bivalent with the actual valency assignments counterbalanced across participants. The re-organization made it possible to compare trials that shared the same valency, regardless of the task (location, temporal) the trial had come from. Thus, trials were no longer being compared according to task but according to the valency of the trial itself.

Because we were interested in Stage 1-Stage 2 comparisons and Stage 2-Stage 3 comparisons, it was necessary to make appropriate but different selections for these comparisons. Therefore, for the Stage 1-Stage 2 comparison (test of the reconfiguration hypothesis), it was necessary to compare trials from Stage 1 where participants shifted from a monovalent repeat trial to a monovalent shift trial versus trials in Stage 2 where participants shifted from a monovalent repeat trial to a bivalent shift trial. For the Stage 2-Stage 3 comparison (test of the inertia hypothesis), it was necessary to compare trials from Stage 2 where participants shifted from a monovalent repeat trial to a bivalent shift trial versus in Stage 3 where participants shifted from a bivalent repeat trial to a bivalent shift trial. This selective recombination by valency ensured that, in the overall analyses, comparisons were also counterbalanced in terms of the data included. These analyses also ensured that comparisons involved data from trials with the same valency, ruling out the possibility that any observed effects could be due to valency differences resulting from the tasks from which data were selected comparison. Table 2 shows the means, standard errors, and percent errors in each stage for the re-combined data.

--------- Insert Table 2 about here ----------

Data were then submitted to 2 separate repeated-measures analyses of variance with the factors being shift (repeat, shift) and stage (Stage 1, Stage 2) in one analysis and shift (repeat, shift) and stage (Stage 2, Stage 3) in the other. These analyses provided information as to whether there were significant differences in shift costs between Stage 1 and Stage 2 (a test of the reconfiguration hypothesis) and between Stage 2 and Stage 3 (a test of the inertia hypothesis).

Stage 1 versus Stage 2. Results from Stage 1 versus Stage 2 showed a main effect of shift, F (1,23) = 17.96, MSE = 432856.47, $p < .0005$, Partial eta squared = .438 as well as a main effect of stage, F (1,23) = 6.94, MSE = 60495.57, $p < .05$, Partial eta squared = .232. The interaction of shift and stage was also significant, F (1,23) = 23.97, MSE =

23279.51, $p < .0001$, Partial eta squared = .510, indicating (as shown in Table 2) that shift costs were significantly greater in Stage 2 than in Stage 1.

Stage 2 versus Stage 3. Results from Stage 2 versus Stage 3 showed a main effect of shift, F (1,23) = 17.11, MSE = 434880.68, $p < .0005$, Partial eta squared = .427. There was also a main effect of stage, F (1,23) = 19.61, MSE = 46715.11, $p < .0005$, Partial eta squared = .460. The interaction of shift and stage was also significant, F (1,23) = 26.06, MSE = 24998.02, $p < .0001$, Partial eta squared = .531, indicating that shift costs were greater in Stage 2 than in Stage 3 (as shown in Table 2). Inspection of the data revealed that the repeat RTs in Stage 2 were faster than in Stage 3. This might have been due to the fact that, after recombining the data as described above, Stage 2 repeat trials involved monovalent stimuli whereas in Stage 3 they involved bivalent stimuli. This possibility in turn suggested that repeat trial RTs from *bivalent* trials in Stage 2 would not differ from the corresponding trials in Stage 3. This was confirmed by comparing bivalent trial repeat data in Stage 2 with the corresponding bivalent repeat data from Stage 3, t (23) = 1.34, SE = 50.92, $p = .20$.

Discussion

The main purpose of this experiment was to investigate whether linguistic shift costs existed when using the alternating runs paradigm with stimuli embedded in contextualized, sentence-like stimuli. The second purpose was to test whether inertial or reconfiguration processes underlie shift costs involved in this form of language-based processing. Two important findings were established: (1) robust shift costs were found when using sentence-like stimuli, and (2) reconfiguration, rather than inertial processes, were found to underlie the linguistic attention shifts obtained.

The evidence for attention shift costs was very robust. The effect was replicated in each of the three stages with the same participants, with 96% or 100% of the participants showing the effect each time and the shift costs were sizable (see Table 1). These results strongly indicate that the alternating runs paradigm is appropriate for studying issues of language and cognitive control with the use of contextualized stimuli.

The comparisons performed on the results from the 3-stages of the modified alternating runs paradigm clearly supported the reconfiguration hypothesis as proposed by Rogers and Monsell (1995). Recall that in Stage 1 all stimuli were monovalent and thus there were no competing stimuli on any given trial for participants to contend with. In Stage 2, however, one of the tasks became bivalent, thereby increasing the difficulty of preparing (reconfiguring the task set) for the upcoming trial. Consistent with the reconfiguration hypothesis, participants experienced greater shift costs in Stage 2 compared to Stage 1. These findings contrast with those of Wylie and Allport (2000) who found equivalent shift costs between Stages 1 and 2 in a similar design, leading them to conclude that shift costs were not the result of preparatory processes for the upcoming task.

Results from the comparison of Stage 2 and Stage 3 also contrasted with those of Wylie and Allport (2000) who found greater shift costs in their Stage 3 than in Stage 2. They argued that because Stage 3 involved only bivalent stimuli (unlike Stage 2 which involved both bivalent and monovalent stimuli), the trial prior to a shift required inhibiting the competing task set, resulting in greater shift costs. In contrast, in Stage 2 the trial prior to a shift was monovalent half the time and so did not require inhibiting a competing task set. In the current experiment, there was a significant interaction between shift costs in Stage 2 and Stage 3. However, as can be seen from Table 2, there were smaller shift costs in Stage 3 than in Stage 2, ruling out task set inertia as an explanation. The data indicated, in fact, that this interaction effect was a result of repeat trials in Stage 2 being performed faster than repeat trials in Stage 3. This may have occurred because in Stage 2 the critical repeat trials were monovalent whereas in Stage 3 they were bivalent. The results from this analysis also provided support for a reconfiguration account of linguistic attention shifting, as evidenced by the lack of slower performance on the shift trials when attention was shifted to a bivalent task from either a monovalent or a bivalent task.

Results from this experiment are consistent with the idea that the grammaticized elements of a sentence can give rise to attentional shift costs, insofar as they require an individual to refocus attention on a different aspect of the mental representation of the meaning contained in a phrase. In the present study, participants were required to shift attention between sentence-like stimuli that contained temporal and spatial attention-directing function words. Of course, in natural language, speakers may sometimes have to shift attention between attention-directing words that are grammatically more similar in nature (e.g., from one spatial dimension to another) and sometimes more different (e.g., from a spatial to a temporal dimension). Investigating attentional processes with tasks that are similar on a particular dimension has recently been carried out with simple decontextualized stimuli. Arrington, Altmann and Carr (2003) found that shift costs were lower when the tasks were similar on a particular dimension (intra-dimensional shifting) than when they were dissimilar (extra-dimensional shifting). The next experiment extended this investigation of dimensional similarity to the case of linguistic attention shifting.

EXPERIMENT 2

Experiment 2 was designed to accomplish two main goals. First, it attempted to replicate the finding in Experiment 1 of linguistic shift costs using the attention-shifting task involving attention-directing functions of language. Second, it examined the effect of task similarity on attention shifting by comparing intra-dimensional to extra-dimensional shifting, where the dimensions were relationships signaled by grammaticized elements of language.

Arrington et al. (2003) manipulated task similarity of simple cognitive tasks within an attention-shifting design. Participants shifted attention between judgment tasks that were relatively similar (height versus width; hue versus brightness) and between tasks that were relatively dissimilar (height versus hue; width versus brightness). Shift costs were found to be lower when tasks were similar in nature than when they were dissimilar. The authors concluded that this enhanced ability to shift attention reflected the operation of a *shared attentional control* for *form* (the height and width judgments) and *color* (the hue and brightness judgments). These results suggested that shifting between tasks that shared perceptual operations decreased the burden placed on the attentional system, resulting in decreased shift costs, and the reverse for tasks not sharing perceptual operations.

It is an open question as to whether the idea of contrasting shared and unshared attentional control, as used by Arrington et al. (2003), can be applied to linguistic situations involving grammaticized elements of language. Results from research by Kemmerer and his colleagues, demonstrating that different neural representations underlie different types of linguistic processing, suggests that this idea is indeed relevant. For example, Kemmerer (in press) found a double dissociation between the processing of temporal and spatial aspects of language in left-hemispheric brain damaged patients. This result demonstrates that different categories of grammaticized elements of language are dissociable on a neurological level. One implication of this finding is that attentional processing may be affected differently when shifting within one category of grammaticized elements (intra-dimensional shifting) as opposed to shifting between two categories of grammaticized elements (extra-dimensional shifting).

Experiment 2 was designed to investigate whether the findings in Arrington et al. (2003) could be extended to the case of attention-directing grammaticized elements of language. Participants were tested in two different conditions. One was a grammatically-dissimilar condition, a replication of the temporal-location judgment task from Experiment 1. As before, the target stimuli in the temporal judgment task were phrases referring to temporal aspects of events (past, present) embedded in sentence fragments. The target stimuli in the location judgment task were phrases referring to spatial location in the vertical dimension (above, below). The other condition was the grammatically-similar condition, involving two different location judgment tasks. In one task, the target phrases again referred to spatial location in the vertical dimension, embedded in sentence fragments, employing stimuli such as "*...all alone above the spot...*" and "*...from below the site with them...*". In the second task, the target phrases referred to relative spatial proximity, labeled as "near/far" judgments, with stimuli such as "*...while next to the spot with them...*" or "*...while beyond the place with someone...*". This design made it possible to compare performance in the above-below task when shifting intradimensionally (i.e., between two spatial dimensions) and when shifting extra-dimensionally (i.e., between a spatial and temporal dimension). Given the results reported in Arrington et al. (2003), it was hypothesized that linguistic shift costs would be lower for intra- compared to extra-dimensional shifts.

Method

Except where noted, the method was the same as described in Experiment 1.

Participants

Participants were 24 undergraduate Concordia University students (*M* = 24 years, range = 19 to 32 years; 17 females, 7 males; L1 = English).

Materials

Attention-shifting task. The attention-shifting task consisted of a training stage and an experimental stage, with a grammatically similar and dissimilar condition in each. All stimuli were monovalent in this experiment, consisting of sentence fragments made up of one set of target expressions surrounded by filler words.

The two judgment tasks for the dissimilar condition were identical to the temporal-location judgment tasks of Experiment 1 (the above-below task and the past-present task), as described in the method section of Experiment 1. The two judgment tasks for the similar condition required decisions about whether an event took place above or below (i.e., the above-below task) a particular location or near or far from a particular location (the near-far task). Fillers were created and selected in the same manner as described in the method section of Experiment 1. All stimuli are shown in the Appendix.

The method for creating and counterbalancing the training and experimental stimuli lists was identical to that used in Experiment 1. For the training stage, a list of 16 alternating blocks of 24 task trials were created for the dissimilar condition (i.e., above-below, past-present) and in the similar condition (i.e., above-below, near-far), for a total of 384 trials in each condition. For the experimental stage, eight quasi-randomized lists of sentence fragments were created for each task, with the first 48 trials again serving as a practice block, followed by the experimental trials. The apparatus used to present all of the stimuli was identical to that of Experiment 1.

Procedure

Participants were tested individually, in one session that lasted approximately one hour. Participants were informed that the experiment was divided into two conditions that were each divided into Part 1 (training) and Part 2 (experimental). Except where noted, the procedure was as described in Experiment 1.

Attention-shifting task. As before, the attention-shifting task consisted of a training stage and an experimental stage. In the training stage, participants practiced making different kinds of judgments (temporal judgments, location judgments) without having to shift attention. In the experimental stage, attention control was again tested using the alternating runs attention-shifting task. Participants proceeded in either the dissimilar or similar condition in an order that was counterbalanced across all participants. In each condition they started with a block of 384 training trials (no attention shifts), followed by the experimental stage (attention shifts required), consisting of one 48-trial practice block and one-192 trial experimental block. Of these 192 test trials, the first 12 were warm-up trials and data from them were excluded from the analysis.

Response key information was denoted by pictograms. The above-below task and past-present task pictograms were illustrated as described before. For the near-far task, a black vertical bar with two adjacent black circles on either side of it and a black vertical bar with two adjacent circles far apart on either side designated the sides (left, right) for the response keys "near" and "far" responses, respectively.

Design

The attention-shifting task conformed to a 2 x 2 within-subject factorial design. There were 2 levels of condition (dissimilar, similar) and 2 levels of attention trial type (repeat, shift).

For half the participants in the dissimilar condition, the "above" and "below" responses were assigned to the left and right keys respectively, and the reverse for the other half. "Past" and "present" responses were always assigned to the left and right keys respectively. For half the participants in the similar condition, the "above" and "below" responses were assigned to the left and right keys respectively, and the reverse for the other half. "Near" and "far" responses were always assigned to the left and right keys respectively. Other counterbalancing measures were identical to those described in Experiment 1.

Results

For all statistical tests reported below, N=24, the alpha level for significance was set at .05. All t-tests are two-tailed.

Language background questionnaire. Results from the language background questionnaire indicated mean self-rated abilities in English were 4.9 for speaking, 4.7 for reading and 4.6 for writing. The mean score for frequency of each skill in English were 5 for speaking, 5 for reading and 5 for writing.

Attention-shifting task. Mean RTs on correct responses not following an error trial were calculated for each participant (see Table 3 for means, standard errors, and percent errors in each condition). To remove outlier RTs within a participant's data set, the data were winsorized by replacing the slowest and fastest 10% of the individual's RTs by the next slowest or fastest RT, separately for each of the eight conditions formed by crossing the condition (grammatically-similar, grammatically-different), attention (repeat, shift) and judgment task (above-below, near-far or past-present) factors.

--------- Insert Table 3 about here ----------

One goal of this experiment was to replicate the existence of shift costs using linguistic stimuli in the alternating runs paradigm. Therefore, tests were again conducted to ensure that the alternating runs design yielded shift costs as expected in the dissimilar and similar conditions. Inspection of the data found that there were 24 and 20 participants who did so respectively. A priori t-tests of shift versus repeat RTs in each of these two conditions yielded significant shift costs, $t\ (23) \geq 5$, $p < .0001$, in all cases.

A second goal of this experiment was to test whether task similarity affects attention shift costs in linguistic task shifting. For this purpose, only the data from the above-below task were included in the analyses (see Table 4 for means, standard errors, and percent errors in each task). These data were submitted to a 2 by 2 repeated measures analysis of variance, with the factors being shift (repeat, shift) and condition (similar, dissimilar). The results yielded no main effect of condition, $F < 1$, suggesting no significant difference in overall performance on the above-below task as a function of whether it was accompanied by a similar or dissimilar task. There was a main effect of shift, indicating faster RTs on repeat trials, overall, than on shift trials, $F\ (1,23) = 71.61$,

MSE = 22587.09, $p < .0005$, Partial eta squared = .757. Finally, the Shift X Condition interaction was significant, indicating smaller shift costs in the similar condition than in the dissimilar condition, F (1,23) = 8.51, MSE =19224.79, $p < .01$, Partial eta squared = .270.

--------- Insert Table 4 about here ----------

Discussion

The two main purposes of this experiment were the following. First, the experiment was designed to replicate the linguistic shift cost effect using the alternating runs design with contextualized, sentence-like stimuli. Second, the experiment investigated task similarity effects (intra- versus extra-dimensional shifting) on linguistic attention shift costs. Two important findings were established: (1) shift costs were replicated using contextualized linguistic stimuli, and (2) task similarity affected linguistic attention shift costs. The evidence for shift costs was, as in Experiment 1, very robust. This effect was obtained in the dissimilar condition (as used in Experiment 1) with 100% of the participants showing the effect, and showing a sizeable shift cost (see Table 3). Shift costs, albeit to a significantly lesser extent, were also found in the grammatically-similar condition (see Table 3) with 83% of the participants showing the effect each time. These results provide further evidence to support the use of the alternating runs paradigm for studying issues of language and cognitive control with contextualized stimuli.

The similarity effects found here with linguistic attention shifting were consistent with the findings of Arrington et al. (2003). Since they obtained their results using simple cognitive tasks (judging colored rectangles), the current data extend these effects to complex language processing. The current study investigated the impact of shared attentional control on performance with the *same* task—the above-below task—in the context of both a similar (near-far) and dissimilar (past-present) contrasting task. This ruled out any task-specific effects that might in principle have accounted for the results. This conclusion was further supported by the finding that overall mean RTs for performance on the above-below task did not differ between the similar and dissimilar conditions; only the magnitude of the attention shift did. This finding rules out the possibility that a general slowing down occurred in the dissimilar condition.

Whereas Arrington et al. (2003) explored the effects of shared attentional resources on resulting task-shifting processes, others have recently investigated shared versus differentiated representations of attentional resources in processing linguistic metaphoric systems. Gentner, Imai and Boroditsky (2002) investigated the psychological status of two metaphoric systems used in English to describe temporal events in terms of spatial metaphors (time flowing by the observer versus the observer moving through the environment; see Gentner et al., 2002, for specific details). These two systems lead to different assignments of front/back to a time line. For example, in the time-moving system a sentence such as "I will see you *before* 4 o'clock", will cause *before* to be assigned to a past (earlier) event. However, in the observer-moving system a sentence such as "His whole future is *before* him", *before* is assigned to a future (later) event.

They conducted three experiments to examine whether participants were faster to process *space-time* metaphors if the preceding sentence unpredictably referred to the same metaphoric system or if it unpredictably referred to a different metaphoric system. Participants responded faster and made fewer errors during both reading and oral comprehension when the sequence of sentences presented all referred to the same metaphoric system. Results suggested that during language processing distinctions are made between these two metaphoric systems, thereby supporting the idea of two separate ways of representing temporal information. Although the focus of the experiments reported in Gentner et al. (2002) was metaphoric conceptualization as opposed to grammaticized processing as such, their results support the idea that representations regarding temporal and spatial judgments are organized in psychologically distinct and dissociable ways, and hence make different demands on attention. The current results are consistent with these ideas as well as with the recent neurological evidence illustrating a distinction between temporal and spatial information processing (Kemmerer, in press) discussed earlier.

Overall, Experiment 2 demonstrated that distinctions within linguistic processing of grammaticized dimensions are significant for attentional processing. These results, along with those of Gentner et al. (2002) as well as Kemmerer (in press) illustrate important distinctions that exist within grammatical processing of an individual's native language system.

General Discussion

The following results were obtained in the two experiments reported here. First, shifting attention between contextualized attention-directing elements of language in an alternating runs design resulted in significant shift costs. Second, task set reconfiguration mechanisms underlie these linguistic shift costs. Third, intra-dimensional attention shifting yielded lower shift costs than extra-dimensional attention shifting with grammaticized stimuli. These findings support and build on recent results regarding attentional processing and language use. These experiments also provide a cognitive psychological (as opposed to a purely theoretical linguistic) grounding for the proposed attention-directing nature of grammaticized elements of language.

These experiments complement and extend what is known about grammaticized elements of language. The cognitive linguistic perspective proposes that language itself acts as an attention-directing mechanism, shaping the creation of a mental construction by the recipient that corresponds to the sender's meaning. This attention-directing function is specifically carried out by the grammaticized elements of language (e.g., Langacker, 1987; Slobin, 1996). The results from the current studies demonstrate that when the grammaticized elements of a sentence force an individual to re-focus his or her attention, a shift cost is involved.

In addition, the results demonstrated that processing the grammaticized elements of language in an attention-shifting context involved task set reconfiguration and not task set inertia. Why might attention shifting within the language domain involve only reconfiguration mechanisms? As pointed out by Monsell et al. (2000) and Yeung and Monsell (2003), evidence for task set inertia processes has been found mainly when there is a marked asymmetry of strength for one of the tasks compared to the other (e.g., for word-reading over color-naming in Wylie & Allport, 2000). Language use, particularly within an individual's first language, would not be expected to produce such asymmetries for particular grammaticized categories, given the high level of proficiency within that language. Conversely, shifting attention *between* languages might be expected to produce these types of asymmetries. Meuter and Allport (1999) have shown this in a study where bilingual participants were required to shift unpredictably between naming digits in their first (i.e., dominant) and second (i.e., weaker) language. Results showed that, paradoxically, there was a greater shift cost in digit-naming when switching to the dominant language from the nondominant language than vice versa, providing evidence for the involvement of task set inertia processes. This occurred, however, in the context of *shifting between two languages*, and not in the context of shifting attention *within* one language, as examined in the two experiments reported here. The present findings thus broaden what is known about shift cost mechanisms involved in the use of contextualized, grammaticized language within one's native language system.

Given that the participants only performed within their native language, it could be argued that the effects demonstrated were not specifically linguistic, but reflected non-language conceptually-based shifts (e.g., visuospatial concept shifting) that were cued by language labels. While this is a logical possibility, it is important to note that the findings from Experiments 1 and 2 complement previous findings that more directly support the idea of language-based shift costs. Segalowitz and Frenkiel-Fishman (in press) tested bilingual participants on a linguistic version of the alternating runs design. Their procedure required participants to shift attention between tasks involving time-related adverbials and conjunctions. They found that shift costs in the second language were correlated with second language proficiency, even after statistically controlling for conceptually-based processing by partialling out shift costs obtained in the first language. In addition, Taube-Schiff and Segalowitz (2004) tested moderate bilinguals on an attention shifting task similar to Experiment 2 in the present study and found a greater shift cost effect (i.e., reflecting a greater attentional burden) in the participants second, less proficient language than in their first language, and this relationship between attention and proficiency obtained only when the task stimuli were grammatical elements (function words) and not when they were concrete nouns (content words). Viewed in the context of these other studies, the present results provide further evidence regarding linguistic attentional control that is obtained in task shifting involving grammatical elements of language.

The findings from Experiment 2 also complement the results reported by Gentner et al. (2002) and Kemmerer (in press) who demonstrated dissociations in the processing of grammaticized elements at the psychological and neurological levels; Experiment 2 demonstrated the existence of *attentional* processing differences within such domains. Kemmerer and Tranel (2000) recently extended their findings to neurological representations in perceptual domains. They found neurological evidence for dissociations between linguistic (e.g., "around, above, below") and nonlinguistic/perceptual (e.g., two inches long) representations of space. Although the present studies did not address questions regarding linguistic attention for nongrammaticized language expressions (nouns, adjectives, etc.), the findings reported by Kemmerer and Tranel (2000) suggest that the processing of grammaticized elements may in fact be different from the processing of nongrammaticized elements (see Chung & Segalowitz [2003] and Taube-Schiff & Segalowitz [2004] for support).

Kemmerer and Tranel's (2000) neurological findings complement the cognitive linguistic perspective regarding some differences between grammaticized and nongrammaticized elements of language. Slobin (1996) pointed out, for example, that nongrammaticized elements (e.g., content words) of language relate to categories of thought directly associated with sensorimotor experiences. In contrast, grammaticized elements are not directly associated with these types of experiences. Therefore, this renders them more difficult to acquire than nouns, adjectives, etc. because the learner receives less consistent, concrete evidence about their meaning in a given learning episode, compared to the evidence available for nongrammaticized words. Because of these fundamental differences between grammaticized and nongrammaticized elements in language, it becomes particularly important to investigate the differences in mechanisms recruited for attentional processing by these two broad categories of language elements and the implications such differences might have for understanding language development (see, for example, Chung & Segalowitz [2003], Segalowitz & Frenkiel [in press] and Taube-Schiff & Segalowitz [2004] for studies of these issues in relation to second language development).

In summary, the present study provided support for a type of attention that is based on a cognitive linguistic perspective regarding the attention-directing role of grammaticized elements in language. The evidence was obtained using an adaptation of the alternating runs paradigm, in which the stimuli were presented in a contextualized manner, adding greater ecological validity to the outcome, and demonstrating the potential that this particular research design may have for future studies in this area. The results indicated that task set reconfiguration, not task set inertia, underlies the attention shifts obtained with this experimental design, and possibly therefore, with the attention shifts that occur in natural language use. Together, the results of the two experiments reported here provide encouraging behavioral support for the view that one important function of language is to serve as an attention-directing system.

AUTHORS' NOTE

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Table 1. Mean response times (milliseconds) and percent error, with standard errors in parentheses, for shift and repeat trials for each stage in the 3-stage attention-shifting task in Experiment 1.

	RT	% error
Stimulus Condition		
Stage 1		
Shift	1836 (57.85)	1.28 (0.17)
Repeat	1493 (55.84)	0.55 (0.93)
Shift cost	343 (34.57)	
Stage 2		
Shift	1996 (83.80)	1.03 (0.22)
Repeat	1655 (74.60)	0.69 (0.19)
Shift cost	341 (34.20)	
Stage 3		
Shift	2085 (78.61)	1.26 (0.28)
Repeat	1801 (84.57)	0.96 (0.26)
Shift cost	284 (39.29)	

Note: $N = 24$ in a fully repeated measures design. The shift costs means shown are the differences between mean shift and repeat RTs.

Table 2. Mean response times (milliseconds) and percent error, with standard errors in parentheses, for shift and repeat trials for the re-combined data in the 3-stage attention-shifting task in Experiment 1.

	RT	% error
Stimulus Condition		
Stage 1		
Shift	1849 (93.62)	1.27 (0.25)
Repeat	1433 (84.22)	0.58 (0.16)
Shift cost	417 (136.24)	
Stage 2		
Shift	2134 (127)	1.30 (0.34)
Repeat	1413 (84.29)	0.53 (0.13)
Shift cost	722 (139.46)	
Stage 3		
Shift	2165 (104.40)	1.02 (0.34)
Repeat	1773 (106.75)	1.09 (0.29)
Shift cost	392 (137.38)	

Note: $N = 24$ in a fully repeated measures design. The shift costs means shown are the differences between mean shift and repeat RTs.

Table 3. Mean response times (milliseconds) and percent error, with standard errors in parentheses, for shift and repeat trials for each condition in the attention-shifting task in Experiment 2.

	RT	% error
Stimulus Condition		
Dissimilar		
Shift	1646 (88.42)	1.40 (0.23)
Repeat	1284 (57.69)	0.88 (0.17)
Shift cost	362 (46.50)	
Similar		
Shift	1402 (82.95)	0.90 (0.20)
Repeat	1209 (73.81)	0.66 (0.15)
Shift cost	193 (36.15)	

Note: $N = 24$ in a fully repeated measures design. The shift costs means shown are the differences between mean shift and repeat RTs.

Table 4. Mean response times (milliseconds) and percent error, with standard errors in parentheses, for shift and repeat trials for each above-below task in the attention-shifting task in Experiment 2.

	RT	% error
Stimulus Condition		
Above-Below Task:		
Dissimilar		
Shift	1394 (88.16)	1.13 (0.32)
Repeat	1052 (53.20)	0.44 (0.16)
Shift cost	342 (47.16)	
Above-Below Task:		
Similar		
Shift	1291 (84.36)	1.00 (0.29)
Repeat	1114 (80.47)	0.63 (0.16)
Shift cost	177 (35.50)	

Note: $N = 24$ in a fully repeated measures design. The shift costs means shown are the differences between mean shift and repeat RTs.

APPENDIX

Target and filler stimuli used in the attention-shifting task.

Experiment 1	
Above-Below:	above the, over the, high above the, on top of the; below the, beneath the, under the, underneath the
Past-Present:	we waited, she stood, he was, they were; he's standing, she is, we are, they are
Neutral Expressions:	with someone, all alone, with her, with them
Location Fillers:	place, spot, site, location
Other Fillers:	while, from, when, because, since, there quietly, there looking, there thinking, there watching
Experiment 2	
Dissimilar Condition	
Above-Below:	above the, over the, high above the, on top of the; below the, beneath the, under the, underneath the
Past-Present:	we waited, she stood, he was, they were; he's standing, she is, we are, they are
Location Fillers:	place, spot, site, location
Other Fillers:	while, from, with someone, all alone, with her, with them, when, because, since, there quietly, there looking, there thinking, there watching
Similar Condition	
Above-Below:	above the, over the, high above the, on top of the; below the, beneath the, under the, underneath the
Near-Far:	near the, next to the, close to the, by the; far from the, away from the, past the, beyond the
Location Fillers:	place, spot, site, location
Other Fillers:	while, from, always, sometimes, with someone, all alone, with her, with them

EXPERIMENT 3

This chapter contains Experiment 3, presented in manuscript-style format entitled, "Within-language attention control in second language processing". The references for this study have been integrated in the general reference section that is included at the end of this thesis.

ABSTRACT

This study investigated attention control in tasks involving the processing of grammaticized linguistic stimuli (function words) and nongrammaticized linguistic stimuli (content words) in a first and second language. Participants were adult English-French bilinguals with greater proficiency in their first (English) than in their second (French) language as determined on a speeded word classification task. Attention control was operationalized in terms of shift costs obtained in an alternating runs experimental design (Rogers & Monsell, 1995). Target stimuli were contextualized in complex sentence fragments. As hypothesized from a cognitive linguistic perspective on the attention-directing function of language, participants displayed greater shift costs (lower attention control) when performing in their less proficient language. Also as hypothesized, this finding was specific to task performance with grammaticized linguistic stimuli and was not obtained with nongrammaticized stimuli. The results are discussed from a cognitive linguistic perspective and in relation to second language proficiency development.

Within-language attention control in second language processing

In recent years, there has been growing interest in the role played by attention in second language acquisition and functioning (see Tomlin & Villa, 1994). The questions addressed by researchers have included, among others, whether attention to particular elements of language is necessary for successful learning (e.g., focus on form; Robinson, 1995; Schmidt, 1993, 2001), what the impact is of such attention focusing on learning (Leow, 1997; Williams, 1999), what are the underlying mechanisms recruited when a person shifts attention from responding in one language to another (Meuter & Allport, 1999), interference effects across languages (Altarriba & Mathis, 1997; Kroll & Stewart, 1994) and how to keep one's languages separate (Bialystok, 1994; Green, 1998). Although the specific questions addressed in various studies clearly differ from each other, they do have the following in common: they all approach the relation between language and attention in terms of how a general attention capacity is recruited for focusing on particular linguistic targets (particular forms, meanings, etc.). In this respect, research on attention in *second* language processing resembles research on attention and language in general in that attention is approached in terms of the mechanisms that enhance and inhibit selected target representations (Eviatar, 1998; Fischler, 1998; Stuss, Shallice, Alexander, & Picton, 1995). The study to be reported here, however, proceeds from a complementary but somewhat different perspective on the relationship between language and attention.

In this study, language is viewed, in addition to being a possible target for attention focusing, as itself an attention-directing system. This point of view derives from a cognitive linguistic approach to language (Langacker, 1987; Talmy, 1996, 2000; see Croft & Cruse, 2004, for an overview), and with respect to second language functioning, from the view expressed in the work of Slobin (1996, 1997, 2003). The central idea here is that when we speak about an event or a scene, its elements are *construed* to be in some particular relationship to one another. For example, one can view a scene of a lamp on a table as "A lamp is on the table", where the focus is on the location of the lamp with respect to the table. Alternatively, one can view the same scene as "The table is under the lamp", where the focus is now on the table and its role in holding up the lamp (Langacker, 1987, p. 116). The way the scene is construed or focused upon will determine how a speaker packages the idea into language for communicating to a recipient. The form of the message thus directs the recipient's attention to the *relationships* between elements contained within that very same message, in a manner intended to make the recipient construe the scene in the same way as the speaker. In Langacker's (1987) terms, the sentence will cause the recipient to make particular focal adjustments in the mental representation (image) of the scene. It is in this sense that language serves an attention-directing function.

Language achieves this attention-directing function through its grammaticized elements—function words, grammatical morphemes and other grammatical devices that express aspect, definiteness, spatial and temporal relationships, active versus passive voice, etc. In the example above, the nongrammaticized elements—the content words such as "lamp" and "table"—will draw the recipient's attention to the specific concepts corresponding to *lamp* and *table*, but they do not shape the way the recipient construes the scene. The construal in this case is conveyed by the choice of prepositions ("on" and "under" in the example above).

Previously, Taube-Schiff and Segalowitz (2004) reported evidence of the attention-directing function of language in the first language (L1). The goal of the research reported here was to study this attention-directing function of language in bilinguals' second language (L2) using the same experimental technique. Data, however, were also collected in the L1, providing baseline reference measures for the L2 performance. This controlled for individual differences in general linguistic and nonlinguistic processing capabilities. Two hypotheses were investigated. The first was that performing a task requiring the use of linguistic attention-directing functions would be more difficult in the L2 than in the L1 – an L2 effect. The second hypothesis was that this L2 effect would be observed when the task involved grammaticized words (those with the attention-directing function), and not when the same task involved nongrammaticized words (those lacking the attention-directing function). These hypotheses derive from three considerations.

First, as Slobin (1996) pointed out, grammaticized elements relate to categories of thought that are not directly associated with sensorimotor experiences in the way most content words are (compare the kinds of sensorimotor experiences associated with learning the function words "a, the" to those associated with the content words "table, lamp"). This renders grammaticized elements more difficult to acquire than nouns, adjectives, etc. because there is less consistent, concrete evidence presented to the learner in any given learning episode as to what the grammaticized elements refer to, compared to the evidence available for the nongrammaticized words. Grammaticized elements may thus be expected to be among those linguistic elements that are mastered late, if indeed they are mastered at all (consider how difficult it often is to master completely the correct use of prepositions in an L2 compared to particular nouns). The result is that there will be a significant and possibly persistent L1-L2 gap in performance with grammaticized elements, and a smaller gap or no gap at all with content words.

Second, the kind of processing required by grammaticized elements is inherently different from the processing required by nongrammaticized elements. Grammaticized elements direct one's attention to *relationships* between items named in an utterance whereas nongrammaticized elements activate mental representation of the referents named. The relationships that grammaticized elements focus on reflect the particular way that the speaker intends to construe the event being talked about. Often, there will be little direct evidence from the scene itself regarding what that particular construal is. Compare, for example, the statements "The dog ran down the street" with "The dog was running down the street". Nothing in the scene itself points to one or the other construal. With nongrammaticized elements (e.g., dog, street), however, there will usually be more direct evidence available about how to map elements on to their referents.

Finally, L1 and L2 will usually differ in the way grammaticized elements are used for conveying construals. For example, L2 prepositions seldom map in a one-to-one fashion onto L1 prepositions (compare Tyler & Evans, 2003, and Vandeloise, 1991, for differences between English and French; see also Bowerman, 1996; Bowerman & Choi, 2003). In contrast, L2 nongrammaticized elements tend to map in a more direct and consistent way across languages. Therefore, when acquiring an L2, the learner has to discover how the grammaticized elements happen to operate for directing attention in the L2 since the knowledge about how this is done in L1 can be misleading.

The alternating runs experimental design (Rogers & Monsell, 1995) was used in this study to investigate this form of attention control. This design has been successfully employed by many researchers to examine attention in cognitive control (for a review see Monsell, 2003, and Waszak, Hommel, & Allport, 2003). In this technique, the participant is given a sequence of trials, typically two-alternative-forced-choice (2AFC) judgments to make about a stimulus. There are usually two different subtasks embedded in the stream of trials. For example, in Rogers and Monsell (1995), the subtasks were to judge the consonant/vowel status of letters and the even/odd status of digits. The presentation sequence was arranged so that on alternate trials the participant must switch from one judgment task to the other (attention shift) and on the other trials the participant repeats the same judgment task as on the previous trial. In the Rogers and Monsell (1995) version of the task, on each trial the stimulus appeared in one of four quadrants in a 2 x 2 presentation matrix on the screen, moving on successive trials predictably in a clockwise manner to the next adjacent quadrant. Stimulus location (e.g., either of the top two quadrants versus either of the bottom two quadrants) signaled which task had to be performed. Typically, performance on shift trials is slower than on repeat trials. This difference is known as the *shift cost* and is taken as a measure of the processing burden of having to shift focus of attention. The ability to manage this burden when processing attention-directing elements of language will henceforth be referred to as *linguistic attention control*.

The alternating runs task seemed especially relevant for studying linguistic attention control because it is inherent in the nature of speech communication for the listener (or reader) to have to continually shift focus of attention while "unpacking" the message from one dimension of construal or perspective to another. The alternating runs task provides a measure of a person's ability to handle shifts in attention focus. In natural language, of course, the requirement to shift attention will often be unpredictable, since the message is not known beforehand. Although attention control has been investigated with both predictable and unpredictable shifting (e.g., Monsell, Sumner & Waters, 2003), the current study involved predictable shifting. In this case, the alternating runs design probably provides, if anything, a conservative estimate of the difficulty a person faces in handling attention shifts in the L2.

In previous work in our laboratory, this technique was adapted to study the processing of individually presented grammaticized word stimuli in L1 and L2 (Segalowitz & Frenkiel-Fishman, in press) and grammaticized word stimuli in more naturalistic, multi-word contexts in L1 only (Taube-Schiff & Segalowitz, 2004). The present study extends this work to stimuli involving more naturalistic multi-word contexts in L1 and L2, and it makes an explicit contrast between grammaticized and nongrammaticized stimuli.

In the present experiment, one condition was the grammaticized target condition, involving two different location judgment tasks. The stimuli for this condition were spatial location prepositional phrases embedded in sentence-like fragments. In one task, the target phrases referred to spatial location in the vertical dimension, labeled here as "above/below" judgments, with stimuli such as " ...all alone above the spot... " and

"...from below the site with them...". In the second task the target phrases referred to relative spatial proximity, labeled here as "near/far" judgments, with stimuli such as "...while next to the spot with them..." and "...while beyond the place with someone...". As mentioned earlier, Taube-Schiff and Segalowitz (2004) found that there were significant shift costs when these stimuli were judged in L1 within the context of an alternating runs design. The present experiment attempted to replicate this finding and to further test the hypothesis that the shift cost would be greater in L2 than in L1.

The second condition was a nongrammaticized target condition, also involving two different judgment tasks. Here the stimuli were noun phrases, also embedded in sentence fragments that referred to modes of transport. In one task, participants had to judge whether the stimulus referred to a two-wheeled (e.g., "...while the new bicycle was going...") or four-wheeled vehicle (e.g., "...since the old car was here..."). In the second task, the participant had to judge if the stimulus referred to a mode of transport involving air travel (e.g., "...since the old glider is coming...") or travel on water (e.g., "...because the old boat was here..."). In this way it was possible to test the hypothesis that, in contrast to shift costs with grammaticized stimuli, the shift costs with nongrammaticized stimuli in L1 and L2 would not differ significantly.

Participants were moderately skilled bilinguals living in Montréal, a bilingual community offering ample opportunities to make frequent use of the two languages. To test these hypotheses, it was necessary to recruit bilinguals with sufficient L2 skill to perform speeded judgment tasks. Potential participants were thus screened, first by means of a questionnaire asking them to self-rate their abilities to speak, read and write in each language, and then on a speeded word classification (animacy judgment) task to test their ability to rapidly access the meanings of words. The word classification task was used because a primary element of language proficiency is the ability to access word meanings, and level of ability in this skill will reflect one's general level of exposure to and use of the language and thus a useful marker of general proficiency in that language (Segalowitz, 1997; 2000; 2003). In each condition, trials were blocked by language. In each block, participants had to judge if a target word referred to a living or nonliving object. Reaction times (RTs) were collected for performance in each language. Only participants who self-rated themselves as clearly dominant in their L1 (English), as revealed by their self-rated abilities in speaking, reading and writing frequency of use of the L1 and L2 (French) and speed of word classification, were retained for the study.

In sum, the experiment involved measuring shift costs obtained in four blocks of 2AFC trials with an alternating runs design, formed by crossing L1-L2 conditions with grammaticized-nongrammaticized stimulus conditions. Within each block, two judgment tasks were presented with shift and repeat trials alternating. It was predicted that there would be an interaction effect revealing the following pattern: Shift costs (the degree to which shift RTs were slower than repeat RTs) were expected to be observed in all conditions. However, shift costs for grammaticized stimuli were expected to be lower in L1 than in L2, indicating a greater burden on attention control mechanisms for processing grammaticized stimuli in L2. At the same time, shift costs for nongrammaticized stimuli were expected to not differ significantly between L1 and L2, indicating no special burden on attention control in the L2 for processing nongrammaticized stimuli.

Method

Participants

Participants were 32 bilingual (English=L1; French=L2; 23 females, 9 males) undergraduate Concordia University students (*M* = 22 years, range = 20 to 35 years). Participants were paid CAD$8/hour or received partial credit for course fulfillment for taking part. Participants were retained for the study if they declared English to be their L1, were clearly dominant in their L1 according to self-rated abilities and frequency of use of L1 and L2 in speaking, reading and writing as reported in a language background questionnaire, and if they performed faster in L1 than in L2 on a word classification (animacy judgment) task.

Materials

Language background questionnaire. This questionnaire provided 5-point Likert scales for participants to self-rate their abilities in the L1 and L2 with respect to speaking, reading and writing (1 = no ability at all; 5 = native-like ability) and their frequency of using the L1 and L2 in speaking, reading and writing activities (1 = never/almost never; 5 = main language used).

Word classification (animacy judgment) task. Speed of word classification was tested using an animacy judgment task in which the participant had to judge if a noun referred to a living or nonliving object. Stimuli were 176 animate and 176 inanimate nouns, half in English and half in French, not translation equivalents. These lists were divided into 4 English and 4 French blocks of 44 words each, with half the words in each block referring to animate and half to inanimate objects. Blocks were alternated from one language to the other in a counterbalanced fashion.

The English words were selected from the MRC Psycholinguistic database (MRC, 2003) on the basis of concreteness, frequency and familiarity. The words chosen were highly prototypical of their category (animate/inanimate) and were well known to participants. The French words were translations of these English words and pre-screened to ensure that moderate bilinguals would know them. English words were preceded by the articles *the* and *a*, and French words were preceded by the articles *la*, *le*, *un* and *une*, counterbalanced across animate and inanimate nouns. These articles were used in order to highlight the English/French character of the target words and, in English, to ensure that the words were read as nouns as opposed to verbs, since many English nouns can be interpreted as verbs (e.g., *hammer*).

Attention-shifting tasks. The attention-shifting task consisted of a training stage and an experimental stage, with a grammaticized target and nongrammaticized target condition in each. Stimulus lists for both stages and for both conditions were prepared in English and French. As much as possible, the French stimuli were direct translations of the English. Stimuli consisted of sentence fragments made up of target expressions surrounded by filler words.

The two judgment tasks for the grammaticized target condition required the participant to decide whether an event took place above or below (above-below task) a particular reference location or whether an event took place near or far from a reference location (near-far task). For each of these subtasks, targets were selected quasi-randomly and in a counterbalanced manner from the English and French lists shown in the Appendix, and matched in a counterbalanced way with appropriate fillers to create sentence fragments. The two tasks in the nongrammaticized target condition required the participant to decide whether a sentence fragment described a two-wheeled or four-wheeled mode of transport (two-four task) or an air or water mode of transport (air-water task). For these subtasks targets and fillers were selected from the lists shown in the Appendix. Fillers were selected in a quasi-random fashion to ensure that their selection was roughly counterbalanced across conditions and for targets within conditions, that the sentence fragments were grammatically acceptable, and that different sentence fragment lengths, ranging from 5-8 words, occurred roughly equally frequently. Stimuli were always present with leading and following ellipsis dots ("...") to indicate a sentence fragment (e.g., "... while far away from the spot all alone...)".

For the training stage, a list of eight alternating blocks of 24 task trials were created for the grammaticized target condition (i.e., above-below, near-far) and for the nongrammaticized target condition (i.e., two-four, air-water), for a total of 192 trials in each condition. Two lists were created in the training stage for each condition – one in L1 and one in L2. The target and fillers were randomly selected with replacement from their respective pools.

For the experimental stage, eight quasi-randomized lists of sentence fragments were created for each task. The first 48 trials of each list served as a practice block, followed by the experimental trials. These lists were counterbalanced in terms of quadrant and response assignments described in the procedure section below. Other counterbalancing and ordering constraints were the following: no two consecutive trials contained identical phrases; target and filler phrases occurred approximately equally often across the lists; positioning of target and filler phrases within each sentence fragment (front, middle, end) was approximately evenly distributed; equal numbers of task targets occurred in alternating sequences of shift and repeat trials; half the trials required a left and half a right key response. In addition, the type of key response on any given trial was counterbalanced with respect to the correct target response on the previous trial as well as on the upcoming trial (to control for response priming). Starting quadrant within the 2 x 2 presentation matrix was counterbalanced across participants to control for potential eye movement confounds. In addition, no more than four consecutive left or right button presses were ever required.

Apparatus

All stimuli in the attention-shifting task and word classification task were presented on an iMac G4 desktop computer with a 14-inch screen set to 1024 x 768 pixel resolution. Stimuli in the attention-shifting task were shown in uppercase 20 point Arial font whereas stimuli in the lexical access task were shown in uppercase 30 point Geneva font. Hypercard version 2.3 software was used to program all presentations and to collect both RT and accuracy data. A machine language subroutine was used to measure RTs and to toggle trials with the onset of each screen frame.

Procedure

The participants were tested individually in one session lasting approximately two hours. Participants were informed that the experiment was divided into two different tasks (word classification; attention shift), each of which would be performed in English and French. In the second task (i.e., the attention-shifting task) there were two different conditions, each divided into Part 1 (training) and Part 2 (experimental).

Language background questionnaire. Participants began by filling out the language background questionnaire.

Word classification task. Participants next performed the word classification task in which they had to indicate if nouns appearing on the screen referred to a living (e.g., "THE DOG") or nonliving object (e.g., "A TABLE"). A numeric keypad was used for responses with the "4" and "6" keys labeled with "L" and "R" (left, right) respectively. For all participants, choosing the "R" key on the numeric keypad indicated that the item referred was judged to be a "living" object and the "L" to a "nonliving" object. Stimuli remained on the screen for 3000 ms or until a response was made. The Response-Stimulus Interval (RSI) was zero ms, and a tone was sounded to signal errors.

Attention-shifting task. The attention-shifting task consisted of two conditions, the grammaticized and the nongrammaticized target conditions. Each condition consisted of a training stage and an experimental stage. In the training stage, participants practiced making the two different kinds of judgments (location judgments; classifying methods of transportation) without having to shift attention. Participants were given written instructions on how to classify the sentence shown. The training stage was divided into eight blocks of 24 trials that alternated in each condition (grammaticized, nongrammaticized) in each language, for a total of 384 trials. Participants were only trained in one language at a time. Participants initiated each block of trials and were informed as to what type of phrases would be shown (above-below; near-far, two-four, air-water). At the end of each training block, the participant's percentage error and mean reaction time were displayed on the screen as feedback to increase interest and motivation.

In the experimental stage, attention control was tested using the alternating runs attention-shifting task. Participants proceeded in either English or French, in either the grammaticized or nongrammaticized target condition in a predetermined order. In each condition they started with a block of 192 training trials (no attention shift involved), followed by the experimental stage (attention shifts required), consisting of one 48-trial practice block and two 96-trials test blocks. Of these192 test trials, the first 12 were warm-up trials and data from them were not included in the analyses. Participants alternated between the different language blocks within each condition.

The stimulus remained on the screen for 5000 ms or until the participant responded. The RSI was zero ms. If participants made an error, they received auditory feedback from the computer and an RSI of 1500 ms to allow recovery and preparation for the next trial. Information at the bottom of the screen reminded participants about the response key assignment for each task. This information remained visible throughout the training stage and for the 48 practice trials of each experimental block. This information was denoted by pictograms. For the above-below task, a black horizontal bar with a black circle above it and a black horizontal bar with a black circle below it, placed on the sides (left, right) of the screen designated the response keys for "above" and "below" responses, respectively. For the near-far task, a black vertical bar with two adjacent circles on either side of it and a black vertical bar with two circles far apart on either side of it designated the sides (left, right) for the response keys for "near" and "far" responses, respectively. Similarly, simple line drawing pictograms designated the "two" versus "four" wheeled response key locations and the "air" versus "water" response key locations. Stimuli appeared in a 2 x 2 presentation matrix as in the Rogers and Monsell (1995) study.

Participants were instructed to read each stimulus sentence fragment in full and to respond as quickly as possible without sacrificing accuracy. There were also asked to generally try to remember the sentence fragments for a recognition task to be conducted at the end of the experiment (this was included to encourage full reading of the stimuli).

Following each condition within one language, participants completed a short recognition test requiring them to respond whether a given sentence fragment was "new" (i.e., did not appear in the experiment) or "old" (i.e., appeared in the experiment).

Design

The attention-shifting task conformed to a 2 x 2 x 2 within-subject factorial design. There were 2 levels of language (English, French), 2 levels of condition (grammaticized, nongrammaticized) and 2 levels of attention trial type (repeat, shift).

For half the participants in the grammaticized target condition, the "above" and "below" responses were assigned to the left and right keys respectively, and the reverse for the other half. "Near" and "far" responses were always assigned to the left and right keys respectively. For half the participants in the nongrammaticized target condition, the "air" and "water" responses were assigned to the left and right keys respectively, and the reverse for the other half. "Two"-and "four-wheel" responses were always assigned to the left and right keys respectively.

In the attention-shifting task, the location of the first trial in one of the four quadrants on the screen was counterbalanced across participants. Crossing quadrant positions with the response key assignments resulted in eight counterbalanced sets. These counterbalancing measures controlled for potential confounds due to eye movements and position preference factors.

Results

For all statistical tests reported below, $N = 32$ and the alpha level for significance was set at .05. All t-tests are two-tailed.

Participant selection. Table 1 shows the data from the language background questionnaire, indicating the self-rated abilities and frequency of language use, and the mean RTs from the word classification task for the participants retained in the study.

----------Insert Table 1 here---------

Attention-shifting task. Mean RTs on correct responses not following an error trial were calculated for each participant (see Table 2 for means, standard errors, and percent errors in each condition). To remove outlier RTs within a participant's data set, the data were winsorized by replacing the slowest and fastest 10% of the individual's RTs by the next slowest or fastest RT, separately for each of the sixteen conditions formed by crossing the language (L1, L2), task (above-below; near-far, air-water; two-four wheel) and attention (repeat, shift) factors.

----------Insert Table 2 here---------

Preliminary tests were conducted to ensure that the alternating runs design yielded shift costs as expected in the L1-grammaticized, L1-nongrammaticized, L2-grammaticized and L2-nongrammaticized conditions in each language. Inspection of the data indicated that 26, 31, 26 and 26 participants respectively did so. A priori t-tests of shift versus repeat RTs in each of the four conditions yielded significant shift costs in each condition, $t\ (31) \geq 3.36, p < .0005$ in all cases.

The two main hypotheses were tested as follows. Shift costs were calculated for each participant by subtracting repeat trial RTs from shift trial RTs, separately for each of the eight conditions. These shift cost scores were then submitted to a 2 by 2 repeated measures analysis of variance, with the factors being language (L1, L2) and condition (grammaticized, nongrammaticized). The results yielded a significant language effect $F(1,31) = 5.12$, $MSE = 4679.91$, $p < .04$, Partial eta squared = .141, a significant condition effect, $F(1, 31) = 8.53$, $MSE = 12093.65$, $p < .007$, Partial eta squared = .216, and a significant Language X Condition interaction effect, $F(1, 31) = 5.51$, $MSE = 9740.37$, $p < .03$, Partial eta squared = .151. Post hoc Bonferroni corrected t-tests revealed that this interaction effect was due to a significantly greater shift cost in the L2 in the grammaticized target condition than in the nongrammaticized target condition ($t(31) = 4.10$, $SE = 23.86$, $p < .01$ after Bonferroni correction) but not in the L1 condition ($t(31) = .56$, $SE = 28.20$, *n.s.*). Post hoc tests also revealed that in the grammaticized target condition, the shift cost in L2 was significantly greater than in L1 ($t(31) = 2.76$, $SE = 24.78$, $p < .04$ after Bonferroni correction) but not in the nongrammaticized target condition ($t(31) < 1$, $SE = 16.94$, *n.s.*) (see Table 2). In fact, if anything, the shift cost in L2 was *lower* than in L1 (90 versus 104 ms) in the nongrammaticized target condition, ruling out the possibility that shift costs were, in general, larger in the L2 than in the L1.

Further analysis revealed that RTs in the grammaticized target condition were slower overall than in the nongrammaticized target condition, suggesting that the grammaticized target condition was more difficult to perform. To see whether the significant interaction reported above was attributable to this greater overall difficulty, the repeat data were taken as a measure of baseline performance (no attention shifts involved) and submitted to a 2-way repeated measures analysis of variance with the factors being language (L1, L2) and condition (grammaticized, nongrammaticized). This analysis revealed a significant language effect indicating that RTs in L2 were slower than in L1 (F (1, 31) = 68.05, MSE = 18360.31, p< .0001, Partial eta squared = .687) and a significant condition effect indicating that responses in the grammaticized target condition were slower than in the nongrammaticized target condition (F (1, 31) = 87.39, MSE = 36160.99, p < .0001, Partial eta squared = .738). However, there was no significant interaction between language (L1, L2) and condition (grammaticized, nongrammaticized), F (1, 31) = 1.12, MSE = 22466.47, p > .2, Partial eta squared = .035. This established that the ability to read, understand and make judgments in the grammaticized target condition as compared to the nongrammaticized target condition was no more difficult in L2 than it was in L1 and hence the shift *cost* differences reported earlier were attributable to performance on the shift trials and were not due simply to the greater difficulty of processing grammaticized as opposed to nongrammaticized stimuli in L2 than in L1.

Discussion

The two main hypotheses of this study were supported. First, as expected, *linguistic attention control was weaker in the less proficient L2* than in the more proficient L1. Support for this conclusion came from the finding that, in the grammaticized target condition, L2 shift costs were significantly greater than L1 shift costs. Second, also as expected, linguistic attention control was related to language proficiency (it was weaker in L2 than in L1) *as a function of task performance with grammaticized stimuli*, rather than nongrammaticized stimuli.

Support for this conclusion came from the finding that, in the L2 but not in the L1, the shift cost for grammaticized stimuli was greater than for nongrammaticized stimuli. These conclusions were strengthened by the fact that the data ruled out two potential alternative explanations. One was that the grammaticized stimuli might have somehow been more difficult to process than the nongrammaticized stimuli, especially when given in the L2, either in general or because of the particular stimuli selected. This explanation was ruled out by the analysis of RTs from the baseline repeat trials. The other was that there might have been a general tendency for all shift costs to be greater in the L2 than in the L1. This explanation was ruled out by the comparison of L1 versus L2 shift costs in the nongrammaticized condition.

The findings of this study support and build upon recent results reported in Segalowitz and Frenkiel-Fishman (in press) and Chung and Segalowitz (2003). Those studies also demonstrated that L2 proficiency in bilinguals was related to performance on tasks requiring the kind of L2 attention control discussed here. However, although Segalowitz and Frenkiel-Fishman (in press) did employ an alternating runs design, they used single, decontextualized, grammaticized stimuli that differed from the stimuli used here. Also, although Chung and Segalowitz (2003) included contrasts between grammaticized and nongrammaticized stimuli in L1 and L2, they did not use the alternating runs design, and in addition they used only single word, decontextualized stimuli. The present findings, therefore, extend these earlier results to stimuli in contextualized situations and provide contrasts between grammaticized and nongrammaticized conditions within the alternating runs design.

The present results also complement and extend what is known about the role attention plays in L2 functioning. Previous work focused on how attention mechanisms help keep the bilingual's two languages from interfering with each other (Bialystok, 1994;

Green, 1998) and on what happens when a bilingual switches from one language to another (Meuter & Allport, 1999). Other models, such as De Bot's (1992) adaptation of Levelt's (1989, 1999) model of speaking to the bilingual case, have addressed the role of attention in terms of focusing on the language itself (e.g., to keep it distinct from the competing L1), or on elements within the language, such as particular phonological, morphological or lexical items that need to be produced correctly (e.g., self-monitoring). The present work complements these approaches by demonstrating the importance of understanding how language itself serves an attention-directing function. In addition, the current findings depart somewhat from these other approaches regarding the perspective taken between language and attention. Whereas attention is often described and studied in terms of the role it plays in language processing (i.e., translating from L1 to L2 or inhibiting L1 while speaking in L2), the present study describes the role *language* plays in directing *attention*. The current approach, therefore, speaks specifically to this idea of linguistic attention.

The results were fully consistent with the cognitive linguistic viewpoint that sentences convey a speaker's *construal* of a situation, and not just a neutral itemization of actions, objects and attributes that compose it. From a cognitive linguistic perspective, there are a number of different dimensions along which construal of meaning (Croft & Cruse, 2004) or a speaker's perspective (MacWhinney, 1999) can vary. Croft and Cruse (2004, p. 46), for example, list four main categories of "linguistic construal operations as instances of general cognitive processes" with three to four subcategories in each and further breakdowns within those. Only their first category—Attention/Salience—is explicitly associated with attention insofar as the construal operation involves manipulating salience or importance of an element or aspect of an element. The spatial preposition examples used in the present study involve what Croft and Cruse (2004) called "figure/ground" judgments (curiously, spatial prepositions were not included in their linguistic treatment of the topic under the main category of "Attention/Salience"). An important direction for future research in this area would be to examine from an empirical cognitive perspective the other categories of linguistic construal operations listed by Croft and Cruse, thereby adding a cognitive psychological (as opposed to a purely theoretical linguistic) grounding to this approach to language.

The present research proceeded from the view that second language proficiency involves, among other things, the ability to focus and refocus attention on the mental representation one is constructing in real time while processing the incoming message (Segalowitz, 1997, 2000). Some of this focusing will be directed toward *conceptual categories* as, for example, when a sentence names particular events, objects or their attributes. In addition, however, some attention focusing will involve *relations* between elements within the sentence as, for example, when one encounters function words that connect clauses or nouns to each other in particular ways. The hypothesis guiding the present study was that the L2 provides a special attention control challenge with respect to focusing on relations compared to focusing on conceptual categories (consistent with Slobin, 1997). The results obtained here provided evidence for this view and in doing so, they enrich our understanding of how cognitive control underlies second language fluency and proficiency.

AUTHORS' NOTE

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Table 1. Means, with standard errors in parentheses, of participant characteristics.

Mean self-rated abilities[a]	in English (L1)	in French (L2)
Speaking	4.84 (0.07)	3.66 (0.12)
Reading	4.91 (0.05)	3.75 (0.14)
Writing	4.71 (0.11)	3.16 (0.17)
Mean self-rated usage[b]		
Speaking	4.97 (0.03)	3.38 (0.17)
Reading	4.81 (0.10)	2.50 (0.22)
Writing	4.72 (0.14)	1.84 (0.22)
Animacy judgment task		
RT (ms)	866 (20.62)	972 (24.91)
Error rate (%)	4.76 (0.38)	8.09 (0.65)

Note: [a] 1 = "no ability" and 5 = "native-like ability"; [b] 1 = "never or almost never use the language" and 5 = "main language used". All L1-L2 differences on a given measure were statistically significant, $p < .0001$.

Table 2. Means reaction times (milliseconds) and percent error, with standard errors in parentheses, for shift and repeat trials in the attention-shifting task.

	English (L1)		French (L2)	
	RT	% error	RT	% error
Stimulus Condition				
Grammaticized				
Shift	1249 (45.93)	1.49 (0.20)	1543 (52.15)	2.12 (0.26)
Repeat	1130 (44.13)	0.67 (0.12)	1355 (47.40)	1.65 (0.30)
Shift cost	119 (35.61)		188 (28.39)	
Nongrammaticized				
Shift	947 (32.51)	1.36 (0.21)	1103 (49.14)	1.06 (0.19)
Repeat	843 (31.26)	0.70 (0.11)	1013 (43.95)	0.73 (0.10)
Shift cost	104 (16.61)		90 (23.06)	

Note: $N = 32$ in a fully repeated measures design. The shift costs means shown are the differences between mean shift and repeat RTs.

APPENDIX

English (E) and French (F) target and filler stimuli used in the attention-shifting task.

Grammaticized Target Condition		
Above-Below	E:	above the, over the, on top of the; below the, beneath the, under the
	F:	au-dessus de [above the], par-dessus le [above/over the], bien au-dessus de [high above the]; dessous le [under the], sous le [under the], au-dessous de [below the]
Near-Far	E:	near the, next to the, close to the; far from the, away from the, beyond the
	F:	tout près de [right near to], à côté de [next to], près de [close to]; loin de [far from], éloigné de [far from], au-delà de [far from]
Location Fillers	E:	place, spot, site
	F:	emplacement [location], espace [space], endroit [spot]
Other Fillers:	E:	with someone, all alone, with her, with them, while, from, always, sometimes
	F:	avec quelqu'un [with someone], tout seul [all alone], avec elle [with her], avec eux [with them], étant [while], toujours [always], quelques fois [sometimes]
Nongrammaticized Target Condition		
Two-Four	E:	bicycle, motorcycle, scooter; bus, car, truck
	F:	bicyclette [bicycle], moto [motorcycle], vélo [bicycle]; autobus [bus], voiture [car], camion [truck]
Air-Water	E:	jet, rocket, glider; boat, ship, raft
	F:	avion [airplane], hélicoptère [helicopter], planeur [glider]; bateau [boat], navire [ship], paquebot [steamship]
Fillers:	E:	nice, old, new, is/was here, is/was there, is/was coming, is/was going
	F:	beau/belle [nice], vieux/vieille [old], nouveau/nouvelle [nice], est/était ici [is/was here], est/ était là-bas [is/was there], vient/venait [is/was coming], va/allait [is/was going]

GENERAL DISCUSSION

The experiments presented in this thesis were designed to explore linguistic attentional control involved in processing contextualized sentence stimuli. Attention control was operationalized as linguistic shift costs obtained from the alternating runs design (Rogers & Monsell, 1995). Each experiment was designed to investigate a different aspect of linguistic attention shifting while simultaneously replicating findings from the previous study. Specifically, in Experiment 1 (reported in Manuscript 1) it was found that shift costs existed when participants shifted attention between contextualized stimuli. These stimuli were comprised of attention-directing grammaticized elements of language that required participants to make either location or temporal judgments upon reading them. A second goal of Experiment 1 was to investigate possible shift cost mechanisms that underlie the processing of these contextualized attention-directing grammaticized stimuli. Specifically, reconfiguration and task set inertia processes were investigated by using the 3-stage alternating runs paradigm as designed by Wylie and Allport (2000, Experiment 1). Results from this study revealed that reconfiguration processes underlie attentional control processes during the reading of naturalistic grammaticized elements of language.

In Experiment 2 (reported in Manuscript 1) the existence of these linguistic shift costs were replicated by again requiring participants to shift attention between location and temporal judgments tasks containing grammaticized target phrases. In addition, a second goal of Experiment 2 was to further explore the idea put forth by Arrington et al. (2003) that specific task elements (i.e., task similarity) influence resulting shift costs. This was investigated within the language domain by exploring the effects of intra-dimensional shifts of attention (using two tasks that both require linguistic spatial attention-directing processes) compared to extra-dimensional shifts of attention (using one task requiring spatial and one task requiring temporal attention-directing processes) on resulting shift costs. It was found that intra-dimensional attention shifting resulted in lower shift costs than extra-dimensional attention shifting within the grammatical domain. This study illustrated that shifting attention when there is *no shared attentional control setting* (as defined by Arrington et al., 2003) for grammar causes a greater burden on the attention system than when there is this shared attentional control setting for grammar.

In Experiment 3 (reported in Manuscript 2) linguistic similarity was further explored – in this case in the context of L1 and L2 language use. Participants again performed the condition from Experiment 2 in which intra-dimensional shifting with spatial linguistic elements were examined, with sentence stimuli now presented in both L1 and L2 language blocks. Participants also performed a condition in which attention shifting was required between noun phrases (i.e., nongrammaticized phrases), all of which referred to modes of transportation, embedded in sentence fragments. Experiment 3 also investigated differences in attention shifting between grammaticized as compared to nongrammaticized elements of language in both L1 and L2. It was found that when increased demands were placed on the attention system (i.e., when shifting attention), there was a greater impact when processing grammaticized sentence stimuli as compared to nongrammaticized sentence stimuli. Furthermore, this impact interacted with language skill such that shift costs were greater in participants' weaker language (i.e., L2) than in their native language (i.e., L1). In sum, these three studies illustrated that the alternating runs design is an appropriate one to employ for studying aspects of attention control and naturalistic language use. These results speak to interesting findings on shift cost mechanisms, attention-shifting task elements as well as different aspects of skilled language use and attention control. Each of these areas will be discussed in turn as well as implications for second language learning and future directions for research.

Shift Cost Mechanisms

As discussed, researchers have proposed different theories to explain underlying shift cost mechanisms. Support has been found for reconfiguration mechanisms (e.g., Rogers & Monsell, 1995), task set inertia mechanisms (e.g., Wylie & Allport, 2000), both types of mechanisms (Meiran, 2000), as well as other mechanisms (e.g., De Jong, 2000). In Experiment 1 potential shift cost mechanisms involving naturalistic linguistic stimuli were explored. Results supported the idea of reconfiguration over task set inertia processes being involved when shifting attention between contextualized linguistic stimuli. Given these findings, future research can now begin to investigate other types of underlying shift cost mechanisms that may be involved in linguistic processing. In order to pursue this, it would be necessary to ensure that the tasks and stimuli used are relevant to language use. For example, in the study by Mayr and Kliegel (2000) the retrieval demands imposed by the tasks participants performed varied in terms of difficulty level. This allowed for an exploration of underlying long-term memory processes involved in shift costs. In order to study this within the context of naturalistic language use this design may have to be adapted and, more importantly, demonstrated to be relevant to processes involved in language. It could be argued that spatial prepositions (e.g., above, below) and temporal verb tenses (e.g., we waited, she stood) are learned to such a proficient level within one's native language that the issue of long-term memory retrieval cost may not be extremely relevant. However, within an individual's second language it may be possible that particular expressions are not as well learned and may involve certain long-term memory retrieval processes that then place a burden on the attention system. These types of considerations and modifications should be made prior to further explorations of other potential shift cost mechanisms underlying attention control during language use.

It should be noted that, following Experiment 1, all experiments in this thesis employed only monovalent stimuli, that is, trials in which there was no creation of crosstalk. There has been some debate in the literature concerning effects on shift costs when stimuli employed in task-shifting paradigms do not overlap in terms of their response-sets (e.g., Jersild, 1927; Spector & Biederman, 1976; Wylie & Allport, 2000; Yeung & Monsell, 2003). For example, both Jersild (1927) and Spector and Biederman (1976) found that participants did not exhibit shift costs when responding to stimuli considered to be univalent, or non-overlapping (e.g., one task involved naming the antonym of an adjective and the other task involved subtracting 3 from a two-digit number). Nonetheless, various researchers have shown that shift costs are obtained when stimuli used are considered to be monovalent, or, do not appear to overlap in terms of response-sets (e.g., Rogers & Monsell, 1995; Segalowitz, Poulsen & Segalowitz, 1999; Wylie & Allport, 2000). Although beyond the scope of the current discussion, it may be possible that some stimulus sets employed in different tasks, although not intended to overlap, may in some manner do so. Importantly, for the purpose of the current discussion, if all experiments in this thesis had employed only bivalent, or overlapping stimuli, it could have been argued that the shift cost effects were due to difficulties in processing two target phrases within one sentence fragment. However, given the monovalent comparison condition, it was established that shifting between these language elements themselves (as opposed to the difficulties that would arise from having to read more complex sentences containing two phrases) resulted in significant shift costs. Given these findings, monovalent stimuli were then only employed in Experiment 2 and 3 to further understand processes involved in attention shifting with sentence-like stimuli.

It is also important to discuss the use of the short RSI (0 ms) employed in this thesis as opposed to longer RSIs (e.g., 500 ms) often employed by other researchers to study residual shift costs. A main goal of the studies in this thesis was to investigate attention control in naturalistic, yet well-controlled tasks. For this reason, a short RSI was used to simulate a more naturalistic form of reading. During the process of reading, sentences quickly unfold and the reader has to continually shift their focus of attention while "unpacking" the message that is being delivered. However, further investigations of shift cost mechanisms in the context of language processing may benefit from prolonging the RSI in order to gain further insight into potential residual shift cost mechanisms.

Attention control has been investigated with both predictable and unpredictable attention shifting (e.g., Monsell, et al., 2003). In natural language, of course, the requirement to shift attention will often be unpredictable, since the message is not known beforehand. Therefore, the decision to employ a predictable task-shifting design allowed for, if anything, a conservative estimate of the difficulty a person faces when handing attention shifts in both his or her L1 and L2. However, as skilled language users are often prepared for uncued changes in their linguistic environment it would be interesting to investigate attention control in an unpredictable environment. A recent study by Monsell et al. (2003) looked at predictable and unpredictable shifting in an alternating runs design. They found that with predictable shifting (as in Rogers & Monsell, 1995), the shift cost was limited to the first trial of a run in runs of 2, 4 and 8 trials. Since no further improvement in RT was observed following trial 2 of a particular run, one trial was said to be sufficient to "recover" from the task shift. This suggested that task set inertia processes, if involved, do not extend past this initial trial and, therefore, do not contribute to resulting shift costs. However, when using the alternating runs design with unpredictable shifting, they found a more gradual approach to asymptomatic performance after a task shift, such that two or three trials were needed to recover. It was proposed that after one trial of the changed task, if another shift is possible, individuals might voluntarily decrease or restrain their state of readiness (in order to preserve attentional resources for the constant and unpredictable shifting). The nature of task set readiness in a complex task skill such as language use could be further explored by employing naturalistic linguistic stimuli in an unpredictable shifting paradigm. Further, differences in L1 as compared to L2 would also be interesting to investigate in the context of an unpredictable shifting paradigm. Individuals may be better able to handle unpredictable shifting in their L1 given the higher levels of proficiency and flexibility that are attained in a native language as compared to a second language.

Task Relations and Shift Costs

In addition to exploring underlying task-shifting mechanisms, the current thesis also investigated the effect of specific task relations on resulting attention shift costs.

Results from Experiments 2 and 3 speak to interesting findings regarding the effect of task elements on attention shifting and language. The results of Arrington et al. (2003) revealed that increased similarity in terms of a shared attentional control setting, and response output modality decreased participant's shift costs in a cued task-shifting paradigm. Experiment 2 of the current thesis was designed to test out the effects of a shared attentional control setting for grammar on linguistic attention shift costs. Results supported the idea that shifting attention within an intra-dimensional grammatical domain places less of a burden on the attention system than shifting attention between an extra-dimensional grammatical domain. Since Experiment 2 only examined this within the context of L1 processing, these findings were further explored in the context of both L1 and L2 processing in Experiment 3. Experiment 3 also investigated attention shifting with grammaticized elements of language compared to nongrammaticized elements of language (i.e., nouns). It was hypothesized that the distinction made between the nongrammaticized stimuli (i.e., categories of modes of transport) in the nongrammaticized target condition seemed more dissimilar than the distinction made between the grammaticized stimuli (i.e., categories of spatial prepositions) in the grammaticized target condition. However, results revealed that shifting attention between the air-water versus the two-four wheel task was no more difficult than between the above-below versus the near-far task. This was illustrated by the finding that the L1 shift costs, overall, were very comparable in both the grammaticized and nongrammaticized target conditions. L1 shift costs provide a reflection of attentional burden when language proficiency is not a factor. Therefore, there was no greater attentional burden on the system when shifting within the grammaticized target condition compared to shifting within the nongrammaticized target condition because of the actual stimuli.

Significant shift costs were found in both L1 and L2 in the grammaticized target condition as well as the nongrammaticized target condition in Experiment 3. Given that shift costs occurred in all four conditions (L1-grammaticized; L2-grammaticized; L1-nongrammaticized; L2-nongrammaticized), it could be argued that any type of shift from one "category" to another will result in significant shift costs. However, the data speak against this explanation. Significant differences were found only in *L2*—the weaker language—and not in L1, between grammaticized and nongrammaticized conditions involving intra-dimensional shifts. Therefore, the findings do not reflect general shift costs that might result due to any nonspecific attention shifting. Instead they suggest a specific form of linguistic shift cost that is related to both language skill and these attention-directing elements of language.

Second Language Proficiency

Experiment 3 also focused on task shifting and second language skill. This was accomplished by investigating two specific questions: (1) Does attention control in L2 differ for attention shifts between grammaticized elements versus nongrammaticized elements? (2) Are linguistic attentional shift costs similar in L1 and L2? After having confirmed the existence of shift costs in Experiment 1 and 2 as well as establishing that intra-dimensional grammatical shifting decreased shift costs, Experiment 3 built on these findings and extended them into the domain of second language skill.

As discussed, Slobin (1996) has proposed that these grammaticized elements of language are harder to master in a second language due to the fact that their referents of meaning are not experienced in a sensorimotor or perceptual manner in the same way as are those of nongrammaticized elements of language. In support of this idea, previous research has demonstrated that second language proficiency was significantly related to attention shifting with grammaticized words as opposed to abstract or concrete nouns (Chung & Segalowitz, 2003, 2004). In order to further test these findings in the current studies, participants were now required to not only shift attention between contextualized grammaticized elements in L1 and L2 but also between contextualized nongrammaticized elements in L1 and L2. Results illustrated that attention shifting was significantly more difficult in the grammaticized target condition as opposed to the nongrammaticized target condition in L2 than L1. This provided further support for the idea that these grammaticized elements of language are more difficult to master in L2. In addition, unlike previous studies, this result was found when participants were shifting between more naturalistic, contextualized sentence-like stimuli. Since this difference was not found for shifting attention between these nongrammaticized elements in L2 as compared to L1, the findings provided further evidence that individuals do not have as much difficulty with conceptual distinctions compared to grammaticized distinctions within a second language (consistent with Slobin, 1996, 1997).

Second Language Learning

It is well known that individuals differ in the success with which they attain second language proficiency (see Segalowitz, 1997, for a review on individual differences in L2 acquisition). In addition, L2 learners usually attain levels of language skill that are far below that of their first language. A review of the literature on L2 acquisition is beyond the scope of this paper but what will be provided is the framework proposed by Segalowitz (1997) regarding individual differences in L2 learning. The role of learning grammaticized elements of language in L2 and the findings from the present studies will also be discussed in light of this framework.

Segalowitz (1997) discussed three main premises about cognitive systems that mediate L2 learning and performance. The first premise is that L2 skill is an open one, meaning that it takes place in fairly unpredictable environments and involves an attempt to bring about particular effects on the environment (e.g., affect the behaviour of the interlocutor). This contrasts with closed skills where the goal is to simply repeat a particular action without an intention to change the environment (e.g., mechanically reciting a phrase or expression in the absence of an interlocutor). When people use a language, they do so in a linguistic and social environment that is constantly changing and taking unpredictable turns. This can occur, for example, during conversations when the topic may change or new information is introduced. Another example is in noisy environments where there is attentional interference from other nearby conversations. Since a goal during communication is to bring about changes within the interlocuter (e.g., persuade someone or enlighten them), an L2 speaker must be perceptually sensitive to these relevant properties of his or her environment in order to have an impact on it. This can be accomplished in two stages: (1) a listener will perceptually analyze incoming speech as a sequence of acoustic information that maps onto phonemic categories and, ultimately, onto semantic representations (e.g., Levelt, 1999); and (2) a skilled individual must negotiate through changing environments to bring about the communicative goal.

The ability to "think for speaking" and, ultimately, achieve these communicative goals requires various skills in any language. As discussed earlier, this idea refers to one's mental representation of the world and how this is shaped and communicated through the language spoken – a form of mental activity that is assembled for communication. When using a second language, the requirements of thinking for speaking may be different from those in one's first language.

As discussed by Slobin (1996), there are particular ways of thinking for speaking within each language that call for retraining within a second language. For example, languages may differ with regards to distinguishing between *relative* versus *absolute* orientation in describing locations of objects (Slobin, 2003). Relative systems, often employed by speakers of European languages, refer to objects by reference to position and orientation of the viewer of a scene as in, "to the left of the house" or "in front of the tree" (Slobin, 2003). However, in an absolute system, reference for location will be to a fixed bearing, such as compass points or landscape features as in, "west of the house" or "north of the tree" (Slobin, 2003). When using an absolute system, speakers must be aware of where they are in relation to fixed external referent points and must constantly update their locations accordingly. Another example is that of the use of gender pronouns in different languages. For example, third-person pronouns used in English will indicate gender and, therefore, an English speaker engaged in a conversation regarding his or her "friend" will eventually describe the gender of this person. However, if the conversation continues and the third person is consistently referred to as "they" or simply "friend", it will arouse suspicion since this is not typical of English language use (Slobin, 2003). However, when the language used is Turkish, Chinese or Hungarian, there will be no expectation for gender to be revealed, as there are no gendered pronouns. Thus, English will cause an individual's thinking for speaking processes to be tuned into gender and its communicative importance (Slobin, 2003). Therefore, when a native English speaker begins to speak Chinese his or her basic cognition of gender does not easily change with this shift in language use – even though the social and cultural cognition does. Communication becomes embedded in culture and a great portion of one's culture is carried out and constructed by language (Slobin, 2003).

Other examples of concepts that can only be expressed through language and have no other use except to be expressed through language are distinctions of aspect, definiteness, as well as use of both the active and passive voice (Slobin, 1996). For example, there is nothing in everyday sensorimotor interactions with the world that clearly correlates with the use of elements of language referring to aspect (the manner in which an event unfolds over time) such as, "She *has gone* to work" versus "She *was going* to work". This is also true of elements of language that refer to definiteness such as when an object is referred to as "*a* table" versus "*the* table". These are not categories of thought in general, but truly categories of "thinking for speaking". The present research demonstrated that particular attention must be paid to these specific grammaticized elements of language when learning to use a second language. In doing so speakers will learn to pay different kinds of attention to events and experiences when discussing them in a second language. Although this type of restructuring is most resistant in adult second language acquisition (Slobin, 1996), it is most important for skill mastery to be gained.

The second premise proposed by Segalowitz (1997) is that L2 performance involves sensitivity to "environmental affordances" (Gibson, 1977). This means that words, sentences, speech etc. need to not only be perceived as arrays of sounds but also as vehicles for carrying out speech acts (Halliday, 1973). When we make requests, report events, and persuade others we are carrying out communicative goals in a social/linguistic medium. The physical and sociolinguistic features of speech that carry this information signal certain possibilities (i.e., the interlocutor is friendly or understanding) and constrain certain possibilities (i.e., the interlocutor is hostile or stubborn). These perceptions of the linguistic environment shape the listener's communicative decisions. The idea that skilled communication involves perception of these environmental aspects has important implications for individual differences in L2 attainment. For example, the L2 user must demonstrate *fluency* by processing information rapidly and in an automatic fashion (see Ackerman, 1989), as well as *flexibility* by shifting attention from one stimulus dimension to another (e.g., Stuss et al., 1995) in the surrounding linguistic and non-linguistic environment.

The present results demonstrated the importance of flexibility within processing linguistic stimuli in both L1 and L2. This type of attentional flexibility develops over time and is required when the complexity of linguistic input must be handled skillfully. This flexibility, beyond what we are able to observe in laboratory testing situations, increases when one must interact with their environment. Thus, full processing of linguistic input requires the recognition of the interlocutor's intentions based on speech sound perception, recognition of lexical items, processing of syntactic patterns, generation of semantic representations and so on (Segalowitz, 1997). One must be able to coordinate their own responses with the evolving communicative environment which can become complex, consisting of subtexts and hidden agendas.

Similar to the development of expertise in other skills (e.g., Ericsson & Charness, 1994), fluency within a language develops over time and often arises following extensive practice in a consistent environment. For example, in order to attain a professional or expert level of skill in many different domains, approximately 10,000 hours of deliberate practice are said to be necessary (Ericsson, Krampe & Tesch-Römer, 1993; Ericsson & Charness, 1994). Segalowitz (2003) pointed out that in the case of L1 development, calculations reveal that by age 4 or 5 (or possibly even earlier), a child will have often logged in these many hours of communicative activity. It is not known whether time spent in communicative activities as one learns a native language is completely analogous with what has been termed "deliberate practice" (i.e., specifically setting aside time in an organized fashion to practice a specific skill). Nonetheless, this idea of extensive practice being necessary when developing expertise in a complex skill, such as second language acquisition, has important implications for the mature L2 learner. The amount of time that an adult can devote to learning a second language is often much more constrained and, therefore, often has to occur over shorter periods of time (i.e., weeks or months) in an organized fashion (Segalowitz, 2003). However, with extensive practice, fluency will be gained through increased automatization of many of the lower level components underlying the skill and this in turn will make available more of an individual's attentional resources for higher level processing where attention is really needed. This then allows for both increased fluency and flexibility with regards to the perception of speech and nonspeech features that are related to these sociolinguistic aspects of the environment (Segalowitz, 1997).

A third premise discussed by Segalowitz (1997) is that psychological resources may be organized differently in successful performers as compared to unsuccessful performers (see also Scheffler, 1985, for a further discussion of what kinds of factors limit full expression of talent and expertise). This premise does not directly relate to the findings of the present study and will, therefore, only be discussed very briefly. When learning and executing complex skills, there are many different mechanisms operating and individuals will differ in terms of factors that impede their performance. Identifying any internal sources of interference may help individuals learn how to overcome them.

Segalowitz (1997) discusses two specific types of mechanisms that may be implicated in cognitive interference: (1) failure to meet requirements of transfer appropriate processing and (2) failure to reduce resource competition and cognitive crosstalk. Briefly, transfer appropriate processing refers to the idea that the "expression of previous learning will be successful to the extent that the learner's psychological state (reflecting the nature of the context, the individual's orientation, intentions etc.) existing at the time of learning, matches that required at the time of expression" (Segalowitz, 1997, p. 105). If a strong match exists then learning is referred to as transfer appropriate (see Blaxton [1989] and Roediger [1990] for reviews of transfer appropriate processing). Therefore, failure to recall or recognize a stimulus could indicate difficulties in recreating the appropriate psychological context for information retrieval. Individual differences can arise due to inappropriate strategies that are learned and do not transfer well or due to exposure to environments where learning does not transfer well.

Difficulties in L2 performance with grammaticized elements of language in Experiment 3 may, to a certain extent, reflect previous learning that was not transfer appropriate. For example, the learning of these grammaticized elements in a classroom setting may not have focused on the ability to shift between these elements in a flexible manner, as required in this experiment. However, proficiency within an L2, as discussed, requires this type of flexibility in order to keep up with rapidly shifting linguistic environments. Focusing on transfer appropriate learning during L2 acquisition with these grammaticized elements of language may play an important role in developing skilled language use.

Finally, internal competition can also occur due to demands placed on the individual that exceed the resources available. For example, a given communicative situation, such as understanding a message in a noisy environment, may require too many resources such that an individual is not able to engage in all the complex processing required (Segalowitz, 1997). In addition to this idea of demands that may exceed one's capacity, is the proposal that an individual may use his or her resources inefficiently. For example, information crosstalk (i.e., interference) may occur when performance becomes limited due to an insufficient segregation of information. Given that complex processing involves many mechanisms operating in parallel, information may not always be separated properly. If this occurs then crosstalk of information within parallel-processing systems may occur, resulting in interference and processing failures (Hirst & Kalmar, 1987). Individual differences in learning may arise when the environment or strategy of the learner fails to create the appropriate partitioning of information.

In Experiment 3 individuals were attempting to make judgments in an L2 which, according to Slobin (1996, 2003), is harder to accomplish than in an L1. Individuals have been trained to conceptualize incoming messages in their native language – which was L1 in the present research. This implies that insufficient segregation of information may occur as individuals may have their "thinking for speaking" mode operating in an L1 yet the judgment currently required of them is that of a linguistic message in an L2.

Crosstalk, therefore, may have resulted, causing processing failures. This would be expected to occur most with these grammaticized elements of language in the L2 (as opposed to the nongrammaticized ones), as they are more difficult to conceptualize and do not map in a one-to-one fashion onto L1 grammaticized elements of language.

Overall, these three premises provide a useful framework in which we can conceptualize different processes in terms of L2 learning and L2 mastery. In order for native-like linguistic ability to be achieved, the learner must possess skills that allow for recollection of linguistic information under difficult conditions and with a high degree of flexibility. This requirement for attention flexibility, as demonstrated by linguistic attention control, was significantly impaired when processing L2 grammaticized aspects of language in the present research. Gaining proficiency within an L2 thus requires these elements of language to be mastered, allowing them to then be used in challenging environments where attentional flexibility is of utmost importance. Therefore, individuals will differ in L2 proficiency as a function of how well they can meet the types of perceptual and cognitive demands discussed within the context of this framework.

Neurological Research on Grammaticized Elements

Exciting new research has demonstrated that different neural systems underlie the processing of different categories of grammaticized elements, challenging the often-assumed view that there is a relatively undifferentiated grammatical processor in the brain. This new evidence lends strong support to the perspectives on language and attention that led to the present research. For example, Kemmerer and his colleagues have recently been investigating neural representations of grammaticized elements of language. For example, Kemmerer (in press) tested four brain-damaged subjects, all with left perisylvian lesions experiencing different types of aphasia, in order to investigate the neural representation of processing spatial and temporal meanings of prepositions. As discussed by Gentner et al. (2002), several English prepositions possess both spatial and temporal meanings, depending on the linguistic context in which they are used. Kemmerer tested participants on a battery of tests that assessed spatial meanings of prepositions as well as on a test that assessed temporal meanings of the same prepositions. Two of the four individuals passed the temporal meaning test but failed the spatial meaning tests. The other two individuals exhibited the opposite dissociation – they performed better on the spatial tests than they did on the temporal test. This double dissociation provides evidence that impaired knowledge of spatial meanings of prepositions does not necessarily lead to disrupted processing of the analogous temporal meanings of the same prepositions. Participants were also tested on visuospatial processing, visual object recognition and word-picture naming to ensure that deficits observed were specific to the semantic structures of the prepositions. Overall, these findings provided evidence for the idea that spatial and temporal meanings of prepositions can be represented and processed independently of each other in the brains of modern adults.

Other research by Kemmerer and colleagues has demonstrated interesting differences in the neural representation of linguistic meanings of language compared to perceptual/non-linguistic meanings of language. For example, in one study neuroanatomical correlates of linguistic versus perceptual representations of space were investigated (Kemmerer & Tranel, 2000). Locative prepositions are linguistic representations of space and constitute a class of grammaticized morphemes that are used to describe static spatial relationships between objects (e.g., *in*, *on*, *around, above, below*). Their meanings are highly schematic and are independent of mental representations that are used in visuospatial tasks such as drawing, recognizing and constructing spatially complex objects. Conversely, perceptual representations of space encode metric relations of distance, orientation and size (e.g., *two inches long*), are not highly schematic in nature and are not considered to be linguistic representations of space. These representations of space are often very precise and are useful for guiding action.

Kemmerer and Tranel (2000) administered four tests assessing both production and comprehension of English locative prepositions. In addition, four standardized neuropsychological tests that probe high-level nonlinguistic visuospatial perception and cognition were administered. One brain-damaged individual was significantly impaired on all of the preposition tests (i.e., linguistic) but exhibited normal performance on all visuospatial tests (i.e., non-linguistic). Conversely, the other brain-damaged individual exhibited normal performance on all of the preposition tests but was significantly impaired on all of the visuospatial tests. These individuals also had completely different brain lesions. The individual who was impaired on the preposition tests had a left hemispheric lesion in the frontoparietal region whereas the other individual had a right hemispheric lesion in the frontoparietal and temporal regions. In sum, these results suggested a double dissociation such that performance on the preposition tests and the visuospatial tests require cognitively and neurally distinct mechanisms that can be disrupted independently of each other. These results were said to provide support for the neurological independence of linguistic and perceptual (i.e., non-linguistic) representations of space.

Another neurological study conducted by Kemmerer (2000) focused on neural substrates underlying grammatically relevant and grammatically irrelevant features of verb meaning. Three brain-damaged individuals performed two tests evaluating knowledge of grammatically relevant and grammatically irrelevant components of verb meaning. The grammatically irrelevant components were assessed by evaluating knowledge of perceptual and conceptual features of verb meaning using a verb-picture matching paradigm. The grammatically relevant components were assessed by evaluating knowledge of correct grammaticized usage of the same verbs that appeared in either grammatical or ungrammatical sentences. All individuals had suffered a left hemispheric cerebrovascular accident with damage extending into similar regions of the left hemisphere and, therefore, results were not localized to well-defined areas of the brain. It was found that two of the three individuals were selectively impaired on performance of the grammatically relevant semantic structures whereas the third individual was selectively impaired on performance of grammatically irrelevant aspects of verb meaning. These results provide neurological evidence for the cognitive linguistic view that grammatically relevant aspects of language are unique and processed differently as compared to non-grammatically relevant aspects of language. The results from this thesis have also provided evidence for this proposal in terms of attentional processing in both a first and second language.

Implications and Future Research

The present findings suggest a number of avenues for future research. For example, a great deal of research has focused on shift cost mechanisms using simple decontextualized stimuli. The research from this thesis has shown that mechanisms of shift costs can now be explored using contextualized stimuli, thereby illustrating how these processes may function in more naturalistic activities. Future research can also focus on other mechanisms involved in linguistic shifting as Experiment 1 has already illustrated that reconfiguration mechanisms play an important role in the language attention system. As discussed previously, it is important to ensure that the tasks and stimuli used are relevant to language use. In addition, extending research on shift cost mechanisms into domains of other languages may be beneficial as different languages afford different syntactic structures and organization. Therefore, understanding the extent to which these findings generalize to other languages would provide further insight in skilled language use, language organization and its impact on the attention system.

Researchers have also begun to investigate unpredictable shifting paradigms, which may be interesting to pursue in the context of linguistic shifting, as language mostly operates in environments which are consistently changing. An interesting area of research to explore with these paradigms is that of the relation between L1 and L2 proficiency and flexibility. Given that individuals are more proficient in their L1 it would be expected that their ability to handle an unpredictably shifting language environment would be easier in their L1 than in their L2. As flexibility in naturalistic language environments provides insight into skilled language use, this type of paradigm would allow for a further understanding of the development of proficiency within the L2. It would also be interesting to investigate varying levels of L2 proficiency within the context of an unpredictable attention-shifting design. Highly proficient L2 users would be expected to have greater flexibility, as would be demonstrated by increased attentional control, as compared to less proficient L2 learners. Comparisons of varying degrees of L2 proficiency within both predictable and unpredictable attention-shifting tasks would provide a further understanding of the ability to handle linguistic input in these naturalistic environments. Further, comparison of these types of environments (predictable with unpredictable) would also provide insight into the development of language skill in environments that, to varying degrees, reflect the demands that bilinguals must handle in everyday language use.

It is important to note that the population tested in this paradigm was that of university students. In order to increase the generalizability of these findings, different populations should be employed. For example, some researchers have begun to study task-shifting processes with elderly populations (e.g. Kramer, Hahn & Gopher, 1999; Mayr & Liebsher, 2001; Salthouse et al., 2000) and it would be interesting to investigate whether there are differences between younger and older participants when attention shifting with these linguistic stimuli. In fact, interesting findings with regards to age differences, bilingualism and cognitive control has recently been reported by Bialystok, Craik, Klein and Viswanathan (2004). These researchers employed a simple cognitive task, the Simon task, which assesses inhibitory processes. This task involves both congruent and incongruent responses to colored stimuli. Manipulations involve colors being presented on both the left and right sides of a computer screen with responses being required on either the left or right side of the computer keyboard. Congruent responses occur when the required response and target color are presented on the same side of the screen and keyboard whereas incongruent responses involve the reverse. They found that controlled cognitive processing was carried out more effectively by bilinguals as opposed to monolinguals. In addition, they found that bilingualism reduced age-related decrements often observed on performance with this task. This suggested that the ability to manage two languages over the course of one's lifespan decreases this normally seen age-related decline in the efficiency of inhibitory processing (Bialystok et al., 2004). Further, older bilinguals also did not experience as great working memory costs as did their monolingual counterparts, implying that bilingualism may be involved in offsetting age-related losses observed in various executive processes.

Given the decontextualized nature of this cognitive task, it would be interesting to investigate the effects of bilingualism on cognitive age decline by comparing older and younger participants processing more naturalistic stimuli, such as of the type employed in the present thesis. As previously discussed, mastery of a second language not only involves managing two languages in terms of keeping them separate and inhibiting one while using another but it also involves *flexibility*, as currently observed in the present thesis during attention shifting with grammaticized stimuli. Therefore, using these stimuli would provide insight as to whether other aspects of skilled language use are also related to these potential protective factors of bilingualism. The extent to which one is able to master and use such aspects of language may, above and beyond other elements of bilingualism, speak to important advantages for executive processing abilities in older bilinguals.

Another interesting area of investigation is the neurological research by Kemmerer and his colleagues. This research has begun to illustrate a neurological basis for attentional control differences found when processing grammaticized elements of language. Future research may pursue investigations of neural representations of grammaticized elements during online attentional processing by employing the alternating runs design or other paradigms amenable to yielding attentional measures of control. Researchers may also focus on more specific localization of brain areas involved in processing grammaticized versus nongrammaticized elements of language in both L1 and L2. This may shed light on these different aspects of linguistic processing as well as neural distinctions that may exist when using these elements of language in an L1 as opposed to in an L2.

The results of the current thesis also speak to pedagogical implications for second language learning. Findings have demonstrated that developing cognitive fluency and efficiency with regards to attention control and grammaticized elements of language is especially important when using a second language (e.g., Chung & Segalowitz, 2003, 2004; Segalowitz & Frenkiel-Fishman, in press). Further, nongrammaticized elements of language do not appear to be difficult to process flexibly within a second language. Therefore, it is not just a matter of learning to efficiently shift their attention during any aspect of linguistic processing in a second language. Rather, one must specifically attain attentional flexibility when processing grammaticized elements of language – a skill not necessarily achieved during second language acquisition, as demonstrated by Experiment 3 of the current thesis.

Results from this thesis suggest that during second language learning it is important to promote the attainment of flexibility for the processing of grammaticized elements of language. Proposals for enhancing second language acquisition often focus on the idea that extended practice in organized environments involving language use will increase one's fluency, as a result of increasing cognitive efficiency (e.g., Robinson, 2001; Segalowitz, 2003). Segalowitz (2003) has suggested that fluency in a language represents the ability to speak and read both quickly and accurately, without great hesitation. Therefore, increases in fluency may result in automatic and flexible execution of processes such as pronunciation, grammaticized processing and word recognition. The best way in which to promote these skills has been under debate (see Segalowitz, 2003 for a review of different theories) although Gatbonton and Segalowitz (1988) have suggested, as discussed earlier, that the principle of transfer appropriate processing plays an important role in language learning situations. In the case of L2 grammaticized processing, this may include paying specific attention to the organization and meaning of grammaticized elements in L2 as compared to in L1. This may allow for a greater understanding of differences in comprehension as opposed to just differences in form or syntactic arrangement. Future research, as a result, should focus on L2 curricula and further understand the contexts in which this processing can best occur. It has been speculated that the context for transfer appropriate learning may extend beyond similarities in the linguistic context and may incorporate psychological similarities as well such as the learner's intentions and feelings (e.g., Shebilske, Goettl & Regian, 1999). These are important issues to be explored in future research.

Since the attention-shifting design used in the current studies was a task of comprehension, it would be beneficial for future research to explore the relationship of cognitive control processes to speech proficiency. Research by Segalowitz and Freed (2004) illustrates that cognitive abilities are significantly related to oral fluency (i.e., the degree to which a learner's speech is free of self-generated pauses) both prior to intensive language study as well as afterwards (for further discussion on these relationships the reader is referred to Segalowitz & Freed, 2004). It might be hypothesized that speech proficiency with respect to grammaticized aspects of language would follow a similar pattern as that of comprehension proficiency. When a person engages in conversation, utterances can require the individual to shift attention from one element of speech to another in an appropriate manner in order to construe the intended message. The ability to master and appropriately deliver these grammaticized elements is crucial to conveying the anticipated message to the speaker and for any speaker and recipient to engage in a meaningful conversation. Thus, cognitive control and attentional self-monitoring (e.g., Levelt, 1999) are as important for speech proficiency as they are for comprehension proficiency, as both these aspects of communication are related to skilled language use. Therefore, exploring these questions empirically in future research will add to the current understanding of the relationship of cognitive processes to skilled language development.

The results of the studies presented in this thesis provide encouraging support for novel ways of examining the relationship between attention and language. These findings speak to new directions of research to be pursued and demonstrate the feasibility of using some of the powerful research paradigms that have recently emerged. Future research may broaden these understandings to issues regarding not only language use and proficiency but other complex skills as well.

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APPENDIX A

Sample of Training (Part 1) and Experimental (Part 2) Instructions from the 3-Stage Attention-Shifting Task in Experiment 1

Instructions: Part 1

In a moment you will be shown a series of phrases in a square on the computer screen. These phrases will refer to either an event that takes place above or below a certain location or an event that takes place yesterday (i.e. in the past) or now (i.e. in the present).

For the **location task**, you are to indicate if the phrase refers to an event occurring above (e.g., …ABOVE THE SPOT…) or below (e.g., …BENEATH THE PLACE…) a location.

If it refers to an event **above**, press the key marked "L" with your **left** index finger.
If it refers to an event **below**, press the key marked "R" key with your **right** index finger.

Example 1

…WHILE OVER THE SPOT…

(above phrase)

L R

(L index)

Example 2

…FROM BENEATH THE PLACE…

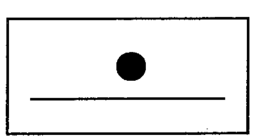
(below phrase)

L R

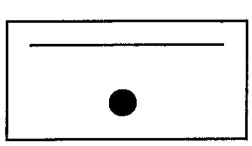
(R index)

To help you remember which key to press, reminders will appear at the bottom of the screen.

"**Above**" will be represented by the following symbol on the screen:



"**Below**" will be represented by the following symbol on the screen:



For the **time task**, you are to indicate if the sentence refers to an event occurring yesterday (e.g., …WE WAITED…) or now (e.g., …HE'S STANDING…).

If the phrase refers to something that occurred in the past (a "**yesterday**" phrase), press the "L" key with your **left** index finger.

If the phrase refers to something that is occurring at this moment (a "**now**" phrase), press the "R" key with your **right** index finger.

Example 1

…SINCE WE WAITED…

(yesterday phrase)

L R

(L index)

Example 2

…BECAUSE HE'S STANDING…

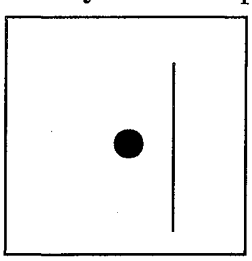
(now phrase)

L R

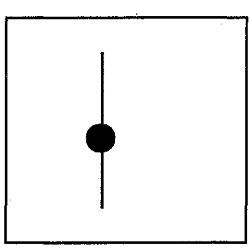
(R index)

To help you remember which key to press, reminders will appear at the bottom of the screen.

"**Yesterday**" will be represented by the following symbol on the screen:



"**Now**" will be represented by the following symbol on the screen:



TASK SUMMARY CHART

	(left)	(right)
Time Task:	yesterday	now
Location Task:	above	below

PLEASE READ THE ENTIRE SENTENCE PHRASE IN ORDER TO GET THE WHOLE MEANING.

You will complete 8 blocks of trials, each consisting of a sequence of 24 above-below phrase trials followed by a sequence of 24 past-present phrase trials, or vice-versa.

If you make an INCORRECT response, you will hear a "boing" and will be given extra time to prepare for the next trial.

Please try to respond as quickly as you can!

TIP: To ensure that you can respond quickly, keep your fingers resting lightly on the keys at all times!

Do you have any questions? You may press any key to begin. ***Good Luck!!***

Instructions: Part 2

Part 2 will involve 3 different stages. In each stage, you will be shown a sentence fragment in one of the four boxes appearing on the computer screen.

This sentence fragment will refer to either an event that takes place above or below a particular place or an event that takes place in the past (i.e. yesterday) or in the present (i.e. now).

You will need to read these sentences over in order to remember them for a **recognition test.** This recognition test will be given at the end of the experiment after you have finished making all the meaning judgments. In this recognition test you will see a list of 20 sentences, half of which you have seen during the experiment ("old sentences") and half which will be "new" sentences. You will have to indicate which are "old" and which are "new". One aim of this research is to see how well people can learn sentences from casual repeated exposure to them. Therefore, when you make the judgment described below, please be sure to pay attention to the whole sentence. It is not necessary to actively memorize the sentences – there are far too many for this. Just read them to get the overall sense and to make the meaning judgment required.

If the sentence appears in either of the **top two boxes**, you should **read the entire sentence** and judge whether its meaning refers to an event occurring **yesterday or now.**

If the sentence refers to an event occurring **yesterday** (i.e. in the past), press the "**L**" key with your **left** index finger.

If the sentence refers to an event occurring **now** (i.e. in the present), press the "**R**" key with your **right** index finger.

Example 1

...WHILE THEY ARE ALL ALONE...	

(now)

L **R**

(R index)

Example 2

	...SINCE SHE STOOD WITH THEM...

(yesterday)

L R

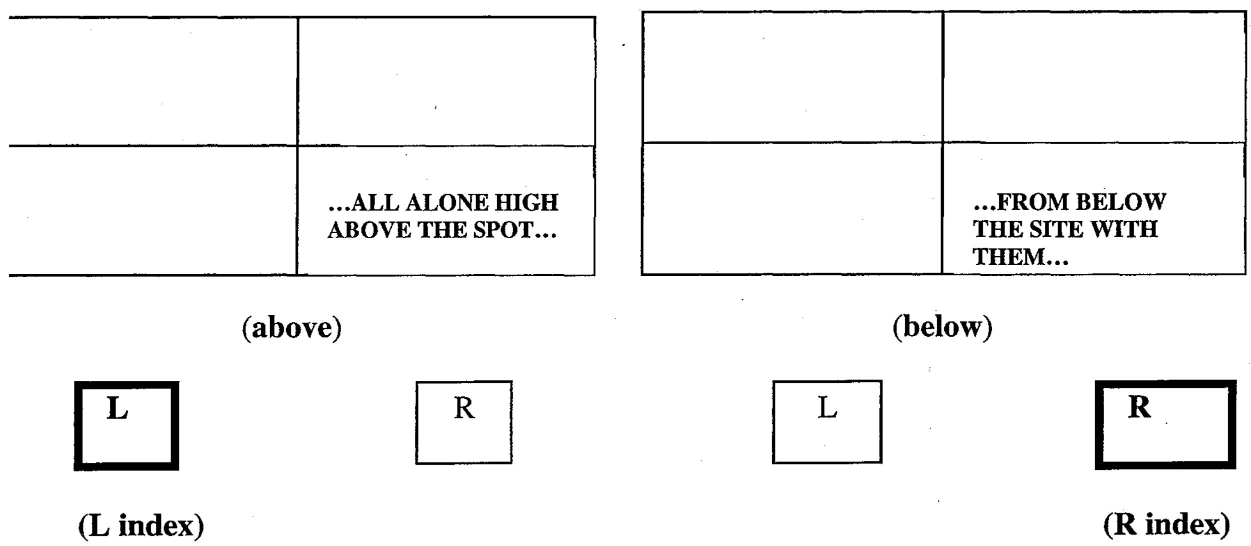
(L index)

If the pair of items appears in either of the **bottom two boxes**, you should **read the entire sentence** and indicate whether it refers to an event taking place **above or below** a location. On these trials you should ignore any other information appearing in the sentence.

If the sentence refers to an event taking place **above a location**, press the "**L**" key with your **left** index finger.

If the sentence refers to an event taking place **below a location**, press the "**R**" key with your **right** index finger.

Example 1 **Example 2**



Each trial will show the sentence you are to respond to in the box next to the one used on the previous trial, moving in a clockwise manner from trial to trial around the four boxes.

TASK SUMMARY CHART

time task	time task
location task	location task

(left)	(right)
L	R

Time Task:	yesterday	now
Location Task:	above	below

Please try to respond as quickly as possible and making as few errors as you can – whil(making sure to read the entire sentence in order to get the whole meaning.

Good luck!

Instructions: Part 2A

In Part 2A, there will be information accompanying both the TIME task (yesterday vs. now sentence fragment) and the LOCATION task (above vs. below sentence fragment). This information will not refer to either TIME or LOCATION (e.g. all alone, with someone, with her, with them). You are to read the **entire sentence** in order to understand its meaning and only respond to that aspect of the sentence that refers to TIME or LOCATION, depending on the required response.

Remember – there will be a recognition test at the end of the experiment! So make sure you read through the entire sentences.

TIP: To ensure that you can respond quickly, keep your fingers resting lightly on the keys at all times!

Do you have any questions?

You may press any key to begin.

Good Luck!!

TASK SUMMARY CHART

time task	time task
location task	location task

	(left) L	(right) R
Time Task:	yesterday	now
Location Task:	above	below

Please try to respond as quickly as possible while reading the entire sentence and making as few errors as you can.

Instructions: Part 2B

Part B is similar to Part A in that you are again going to perform the TIME task when the sentence appears in the top two boxes and the LOCATION task when it appears in the bottom two boxes. However, this time, when you are performing the TIME task, the extra information in the sentence fragment will now be information referring to LOCATION. You are to continue, as before, reading the **entire sentence** and focus on the meaning of the sentence that refers to TIME (i.e. whether the event that took place yesterday or is occurring now). The LOCATION task (above vs. below sentence fragment) is the same as before.

In sum, when doing the TIME task, you read the entire sentence and respond to the meaning that refers to TIME only. The LOCATION task is the same as in Part 2A.

Remember – sentences you see during this stage will also be appearing on the **recognition test** at the end of the experiment. So, it is important that you **read through the entire sentences**, while still trying to **respond quickly** and make as **few errors** as possible.

Do you have any questions?
You may press any key to begin.

Good Luck!!

<u>**TASK SUMMARY CHART**</u>

...SINCE SHE STOOD ABOVE THE SPOT WITH HER... time task	**...FROM UNDER THE PLACE THEY ARE ALL ALONE ...** time task
...WITH THEM OVER THE SITE... location task	**...FROM BENEATH THE SPOT ALL ALONE ...** location task

	(left) L	(right) R
Time Task:	yesterday	now
Location Task:	above	below

Please try to respond as quickly as possible, while reading the entire sentence and making as few errors as you can.

Instructions: Part 2C

In Part C you are again going to perform the TIME task in the top two boxes and the LOCATION task in the bottom two boxes. However, this time, the extra information in the LOCATION task will now be information referring to TIME. You are to continue, as before, reading the **entire sentence** for each task and only respond to the required meaning of the sentence. You will decide whether the TIME refers to an event yesterday or now and whether the LOCATION event refers to an event above or below a location.

In sum, when doing the TIME task, you must not respond to the LOCATION information and when doing the LOCATION task, you must not respond to the TIME information.

Remember – sentences you see during this stage will also be appearing on the **recognition test** at the end of the experiment. So, it is important that you **read through the entire sentences**, while still trying to **respond quickly** and make as **few errors** as possible.

Do you have any questions?
You may press any key to begin.

Good Luck!!

<u>TASK SUMMARY CHART</u>

... ABOVE THE SPOT SHE STOOD WITH HER... time task	**...WHEN THEY ARE UNDER THE PLACE ALL ALONE...** time task
...WHILE OVER THE SITE HE'S STANDING WITH THEM... location task	**...SINCE THEY WERE BENEATH THE SPOT ALL ALONE...** location task

	(left) L	(right) R
Time Task:	yesterday	now
Location Task:	above	below

Please try to respond as quickly as possible, while reading the entire sentence and making as few errors as you can.

APPENDIX B

Sample of Training (Part 1) and Experimental (Part 2) Instructions from the Attention-Shifting Task, Grammatically-Similar Condition, in Experiment 2

Instructions: Part 1

In a moment you will be shown a series of phrases in a square on the computer screen. These phrases will refer to either an event that takes place above or below a certain location or an event that takes place near or far from a location.

For the **above/below task**, you are to indicate if the phrase refers to an event occurring above (e.g., …ABOVE THE SPOT…) or below (e.g., …BENEATH THE PLACE…) a location.

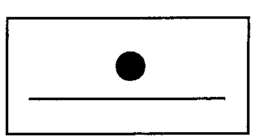
If it refers to an event **above**, press the key marked "**L**" with your **left** index finger.

If it refers to an event **below**, press the key marked "**R**" key with your **right** index finger.

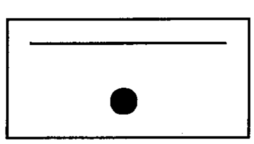
Example 1	Example 2
…WHILE OVER THE SPOT…	**…FROM BENEATH THE PLACE…**
(above phrase)	(below phrase)
[L] [R]	[L] **[R]**
(L index)	**(R index)**

To help you remember which key to press, reminders will appear at the bottom of the screen.

"**Above**" will be represented by the following symbol on the screen:



"**Below**" will be represented by the following symbol on the screen:



For the **near/far task**, you are to indicate if the phrase refers to an event occurring near (e.g., …CLOSE TO THE SPOT…) or far from (e.g., …PAST THE PLACE…) a location.

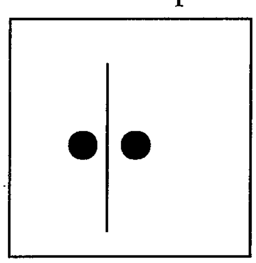
If it refers to an event **near**, press the key marked "**L**" with your **left** index finger.

If it refers to an event **far**, press the key marked "**R**" key with your **right** index finger.

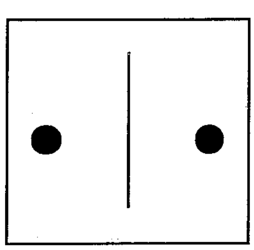
Example 1	Example 2
… WHILE CLOSE TO THE PLACE …	**… SOMETIMES FAR FROM THE SITE…**
(near phrase)	(far phrase)
L R	L R
(L index)	**(R index)**

To help you remember which key to press, reminders will appear at the bottom of the screen.

"**Near**" will be represented by the following symbol on the screen:



"**Far**" will be represented by the following symbol on the screen:



TASK SUMMARY CHART

	(left)	(right)
Above/Below Task:	above	below
Near/Far Task:	near	far

PLEASE READ THE ENTIRE SENTENCE PHRASE IN ORDER TO GET THE WHOLE MEANING.

You will complete 8 blocks of trials, each consisting of a sequence of 24 above-below phrase trials followed by a sequence of 24 past-present phrase trials, or vice-versa.

If you make an INCORRECT response, you will hear a "**boing**" and will be given extra time to prepare for the next trial.

Please try to respond as quickly as you can!

TIP: To ensure that you can respond quickly, keep your fingers resting lightly on the keys at all times!

Do you have any questions? You may press any key to begin. ***Good Luck!!***

Instructions: Part 2

Part 2 will involve two conditions. In each condition, you will now be shown a sentence fragment in one of four boxes appearing on the computer screen.

In this condition, each sentence fragment will refer to either an event that takes place above or below a location or an event that takes place near or far from a location.

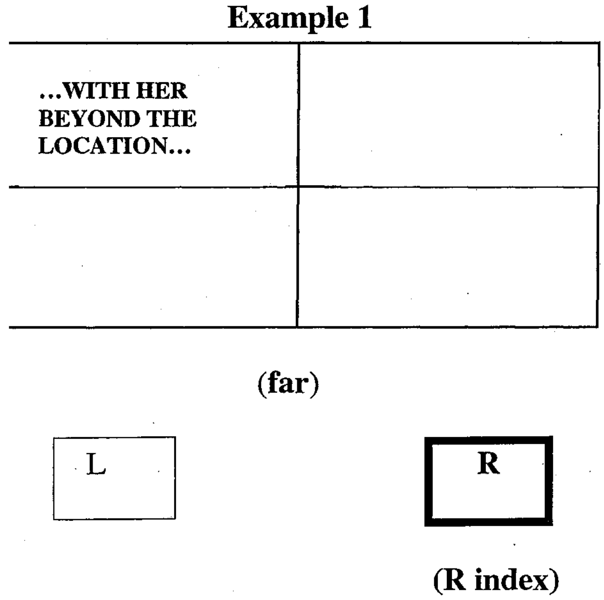
You will need to read the sentences over in order to remember them for a recognition test. This recognition test will be given at the end of the experiment after you have finished making all the meaning judgments. In this recognition test you will see a list of 30 sentences, half of which you have seen during the experiment ("old sentences") and half of which will be "new" sentences. You will have to indicate which are "old" and which are "new". One aim of this research is to see how well people can learn sentences from casual repeated exposure to them. Therefore, when you make the judgment described below, please be sure to pay attention to the whole sentence. It is not necessary to actively memorize the sentence – there are far too many for this. Just read them to get the overall sense and to make the meaning judgment required.

If the sentence appears in either of the **top two boxes**, you should read the **entire sentence** and judge whether its meaning refers to an event that takes place **near or far from a location**.

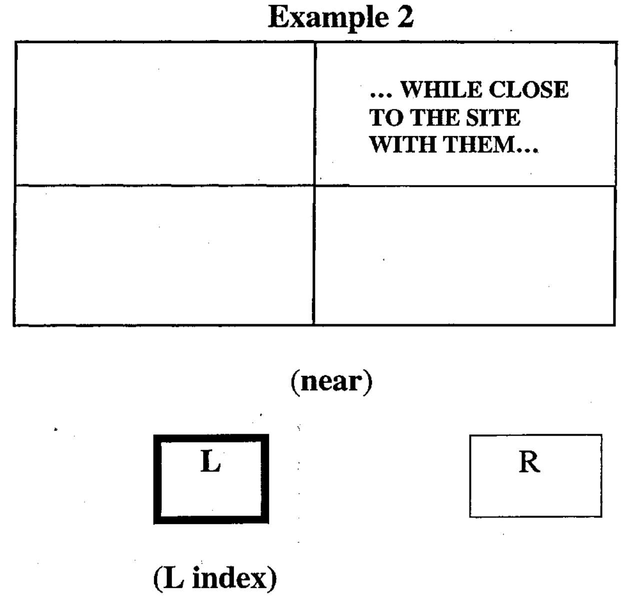
If the sentence refers to an event occurring **near a location**, press the "**L**" key with your **left** index finger.

If the sentence refers to an event occurring **far from a location**, press the "**R**" key with your **right** index finger.

Example 1



Example 2

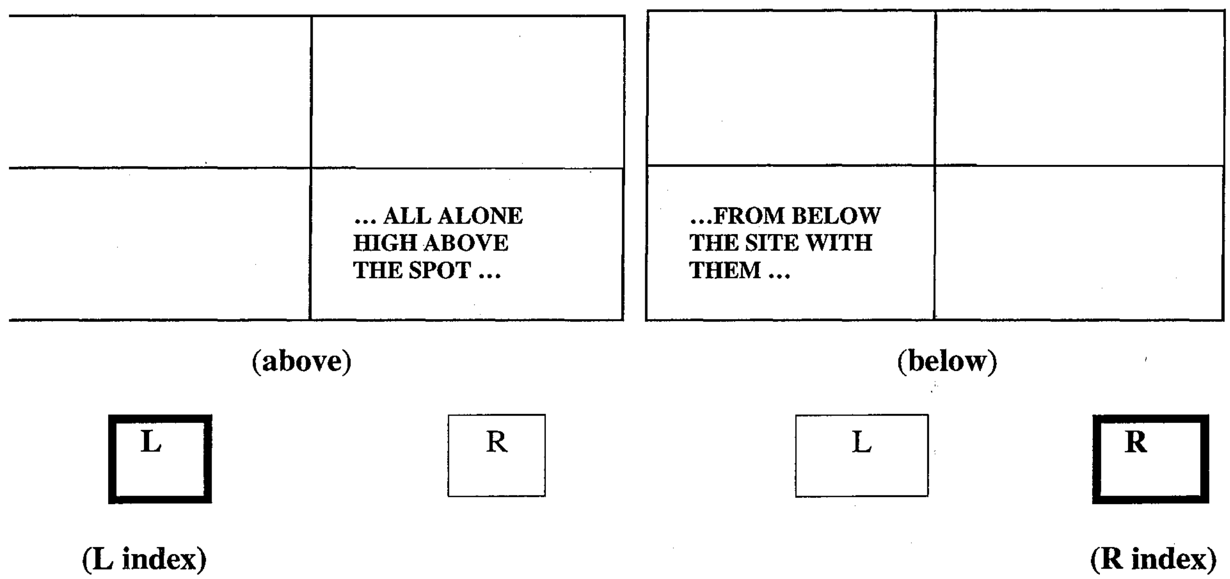


If the pair of items appears in either of the **bottom two boxes**, you should **read the entire sentence** and indicate whether it refers to an event taking place **above or below a location**.

If the sentence refers to an event occurring **above a location**, press the "L" key with your **left** index finger.

If the sentence refers to an event occurring **below a location**, press the "**R**" key with your **right** index finger.

Example 1 **Example 2**



Each trial will show the word you are to respond to in the box next to the one used on the previous trial, moving in a clockwise manner from trial to trial around the four boxes.

TASK SUMMARY CHART

near/far task	near/far task
above/below task	above/below task

(left) (right)

L	R

Near/Far Task:	near	far
Above/Below Task:	above	below

Please try to respond as quickly as possible and making as few errors as you can – whil making sure to read the entire sentence in order to get the whole meaning.

Good luck!

APPENDIX C

Sample of Training (Part 1) and Experimental (Part 2) Instructions from the Attention-Shifting Task, Nongrammaticized English Condition, in Experiment 3

Instructions: Part 1

In a moment you will be shown a series of phrases in a square on the computer screen. These phrases will refer to a mode of transportation (either air or water transportation or a two-wheeled or four-wheeled vehicle). These phrases will be in **English**.

For the **air/water transportation task**, you are to indicate if the phrase refers to a mode of **air** (e.g., ...AS THE NICE JET...) or **water** (e.g., ...WHILE THE NEW RAFT...) transportation.

If it refers to **air** transportation, press the key marked "**L**" with your **left** index finger.

If it refers to **water** transportation, press the key marked "**R**" key with your **right** index finger.

Example 1

...AS THE NICE JET...

(air phrase)

L R

(L index)

Example 2

...WHILE THE NEW RAFT...

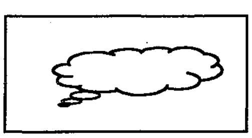
(water phrase)

L R

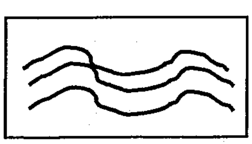
(R index)

To help you remember which key to press, reminders will appear at the bottom of the screen.

"**Air**" will be represented by the following symbol on the screen:



"**Water**" will be represented by the following symbol on the screen:



For the **two-wheel/four-wheel task,** you are to indicate if the phrase refers to a mode of transportation that is two-wheeled (e.g., ...SINCE THE NEW BICYCLE…) or four-wheeled (e.g., …BECAUSE THE NEW CAR…).

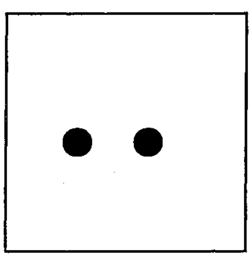
If it refers to **two-wheeled** transportation, press the key marked "**L**" with your **left** index finger.

If it refers to **four-wheeled** transportation, press the key marked "**R**" key with your **right** index finger.

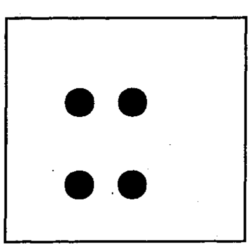
Example 1	Example 2
… SINCE THE NEW BICYCLE …	**… BECAUSE THE NEW CAR…**
(two-wheel phrase)	(four-wheel phrase)
[L] [R]	[L] **[R]**
(L index)	**(R index)**

To help you remember which key to press, reminders will appear at the bottom of the screen.

"**Two Wheel**" will be represented by the following symbol on the screen:



"**Four Wheel**" will be represented by the following symbol on the screen:



TASK SUMMARY CHART

	(left)	(right)
Air/Water Task:	air	water
Two-/Four-Wheel Task:	two-wheel	four-wheel

PLEASE READ THE ENTIRE SENTENCE PHRASE IN ORDER TO GET THE WHOLE MEANING.

You will complete 8 blocks of trials, each consisting of a sequence of 24 air-water phrase trials followed by a sequence of 24 two-wheel/four-wheel phrase trials, or vice-versa.

If you make an INCORRECT response, you will hear a "**boing**" and will be given extra time to prepare for the next trial.

Please try to respond as quickly as you can!

TIP: To ensure that you can respond quickly, keep your fingers resting lightly on the keys at all times!

Do you have any questions? You may press any key to begin. ***Good Luck!!***

Instructions: Part 2

In this condition, you will now be shown a sentence fragment in one of four boxes appearing on the computer screen.

In this condition, each sentence fragment will refer to a mode of transportation (either air or water transportation or a two-wheeled or four-wheeled vehicle). These sentence fragments will be in **English**.

You will need to read the sentence fragments over in order to remember them for a **recognition** task. This will be given at the end of this condition after you have finished making all the meaning judgments. In this recognition test you will be asked to identify some of the sentence fragments that you have read. One aim of this research is to see how well people can learn sentences from casual repeated exposure to them. Therefore, when you make the judgment described below, please be sure to pay attention to the whole sentence fragment. It is not necessary to actively memorize the sentence fragment – there are far too many for this. Just read them to get the overall sense and to make the meaning judgment required.

If the sentence fragment appears in either of the **top two boxes**, you should read the **entire sentence fragment** and judge whether its meaning refers to a mode of transportation that is **two-wheeled** or **four-wheeled**.

If the sentence fragment refers to a mode of transportation that is **two-wheeled**, press the "**L**" key with your **left** index finger.

If the sentence fragment refers to a mode of transportation that is **four-wheeled**, press the "**R**" key with your **right** index finger.

Example 1

... SINCE THE OLD CAR WAS HERE ...	

(four-wheel)

L　　**R**

(R index)

Example 2

	... WHILE THE NEW SCOOTER WAS GOING...

(two-wheel)

L　　R

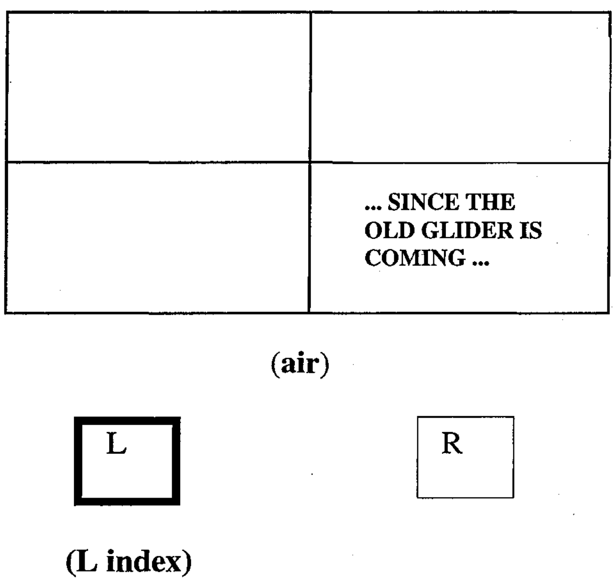
(L index)

If the pair of items appears in either of the **bottom two boxes**, you should **read the entire sentence fragment** and indicate whether it its meaning refers to a mode of **air or water transportation**.

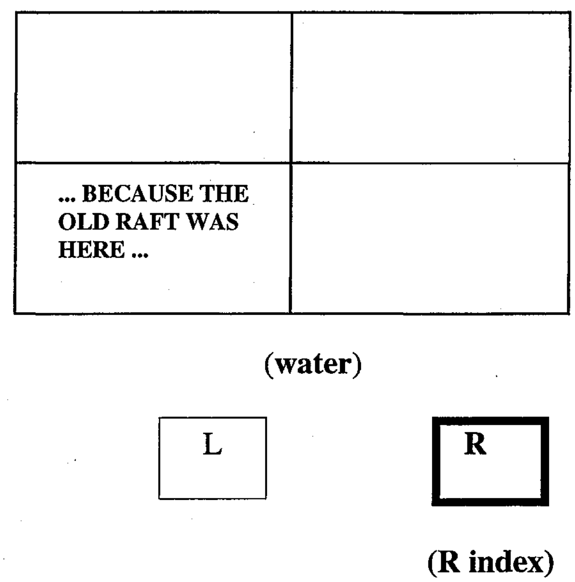
If the sentence fragment refers to a mode of **air transportation**, press the "**L**" key with your **left** index finger.

If the sentence fragment refers to a mode of **water transportation**, press the "**R**" key with your **right** index finger.

Example 1



Example 2



Each trial will show the word you are to respond to in the box next to the one used on the previous trial, moving in a clockwise manner from trial to trial around the four boxes.

TASK SUMMARY CHART

two/four-wheel task	two/four-wheel task
air/water task	air/water task

(left)	(right)
L	R

Two/Four-Wheel Task:	two-wheel	four-wheel
Air/Water Task:	air	water

Please try to respond as quickly as possible and making as few errors as you can – whil making sure to read the entire sentence fragment in order to get the whole meaning.

Good luck!

APPENDIX D

Instructions from the Word Classification Task

Instructions

You will be shown words, one at a time, in the centre of the computer screen. The words represent either a living or a nonliving thing. Living refers to things normally capable of being alive, such as fish, trees, animals and humans. Nonliving refers to lifeless things, e.g., table, truck, rock.

Your job is to indicate whether the words are in the living or nonliving category. Sometimes you will see words in English, sometimes in French.

You'll have to respond as fast as possible, while trying to be as accurate as possible, in the following way: If the word is living, press "R" on the numeric keypad. If the word is nonliving, press "L" on the keypad.

After about 5 minutes, the computer will stop displaying words. That will signal the end of the task.

APPENDIX E

Consent Form to Participate in Research

CONSENT FORM TO PARTICIPATE IN RESEARCH

This is to state that I agree to participate in a program of research being conducted by Marlene Taube-Schiff of the Department of Psychology at Concordia University as a requirement for completion of the Ph.D. Thesis, under the supervision of Dr. Norman Segalowitz.

A. PURPOSE

I have been informed that the purpose of this research is to study processes underlying attention and fluency development in a second language.

B. PROCEDURES

I have been informed that this study will take place at Concordia University, in the laboratory of Dr. Segalowitz. I have been informed that the task I will be asked to accomplish consists of identifying stimuli which will appear on a computer screen by responding on a keypad. I am aware that my responses will be timed. The total testing time will be of approximately one hour.

C. CONDITIONS OF PARTICIPATION

- I understand that I am free to decline to participate in the experiment without negative consequences.
- I understand that I am free to withdraw my consent and discontinue my participation at any time without negative consequences.
- I understand that my participation in this study is confidential (i.e., the researcher will know but will not disclose my identity).
- I understand that the data from this study may be published or presented at a scientific conference; data will be reported in a way that protects each participant's identity.
- I understand the purpose of this study and know that there is no hidden motive of which I have not been informed.
- I will be paid $8.00 per hour upon completion of my participation or earn course credit upon completion of my participation.
- I understand that I may receive a copy of the final research report when the study has been completed (expected to take several months) by writing to Prof. Segalowitz at segalow@vax.concordia.ca
- I may have a copy of this agreement.

I HAVE CAREFULLY STUDIED THE ABOVE AND UNDERSTAND THIS AGREEMENT.
I FREELY CONSENT AND AGREE TO PARTICIPATE IN THIS STUDY.

NAME (please print): ______________________________
SIGNATURE: ______________________________
RESEARCHER SIGNATURE: ______________________________
DATE: ____________________, 2003.

APPENDIX F

Language Background Questionnaire

PARTICIPANT QUESTIONNAIRE

Name: ______________________________________

Age: ______________________________________ Sex: M F

Field of Study: ______________________________________

1. Where were you born? (city, country) ____________________
2. What do you consider to be your first language? English French Other_______
3. What do you consider to be your second language? English French Other_______
4. What language do you consider your dominant language? English French Other_______
5. At what age did you learn your second language? ______________________________
6. What language do you speak at home now? ______________________________
7. What is the first language of your mother? ____________ and father? ____________
8. In what language did you attend school (Please circle the appropriate one):
   - Elementary school: English French Other____________________
   - High school: English French Other____________________
   - CEGEP: English French Other____________________
   - University: English French Other____________________
9. Do you have a known visual impairment that is NOT corrected by wearing glasses or contact lenses? Yes No
10. Do you have a known reading disability (e.g., dyslexia)? Yes No
11. Please rate your level of ability for each of the three skills listed below by using the following rating scheme and circling the appropriate number in the boxes below:

1 = no ability at all **2** = very little **3** = moderate **4** = very good **5** = native-like ability

Language	Speaking	Reading	Writing
English	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
French	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Other	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Other	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5

12. Please fill out column 1 first. Then rate the time spent each week using each language. Use the following rating scheme and circle the appropriate number in the boxes:

1 = never/almost never **3** = four to six times/week **5** = main language used
2 = one to three times/week **4** = more than six times but less than my main language

Language	Speaking	Reading	Writing
First language:	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Second language:	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Other:	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Other:	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5