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Linguistic Attention Control: Attention Shifting Governed by Grammaticized Elements of Language

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In 2 experiments, the authors investigated attention control for tasks involving the processing of grammaticized linguistic stimuli (function words) contextualized in sentence fragments. Attention control was operationalized as shift costs obtained with adult speakers of English in an alternating-runs experimental design (R. D. Rogers & S. Monsell, 1995). Experiment 1 yielded significant attention shift costs between tasks involving judgments about the meanings of grammatical function words. The authors used a 3-stage experimental design (G. Wylie & A. 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 the tasks involved shared attentional resources (processing the same grammatical dimension) versus unshared resources (different grammatical dimensions). The authors discuss the results from a cognitive linguistic perspective and for their implications for the view that language itself can serve a special attention-directing function.

Keywords: attention, skill, attention-shifting, cognitive linguistics

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 interacting socially. To carry out these activities, people must intentionally select appropriate responses, which are also known as *task sets*. Moreover, individuals may have to repeat or shift among various task sets in order to complete the job at hand. A central question, then, is how do people select and implement appropriate task sets and, further, how do they shift from the execution of one task set to another? In the present studies, we examined two explanations for how people may do so during language processing, and they offered 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 multicomponent 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 in which 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 Chap. 4) similarly discusses how language makes possible a *windowing* of attention in which 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 in which people pay attention to certain aspects of a scene in order to be able to talk about it.

One way language achieves such attention-directing functions is 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, and so forth. 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, and so forth. For example, in the sentence "the clock is above the picture," the meaning of the preposition "above" cannot be associated with a sensorimotor

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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 among these grammaticized elements of language is the main focus of the following two experiments.

In the present research, we used 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 because of 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 1 s 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 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. Rogers and Monsell referred to it 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 trial (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 three-stages. We used this design in Experiment 1. 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 of 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 (2000) reasoned that a result showing 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, in which the Task B features had been irrelevant, to the shift trial, in which 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 carryover of inhibition), because the stimuli are monovalent. Wylie and Allport used this design with word-reading and color-naming tasks involving Stroop stimuli and found, in contrast with 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 or 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) on the basis of 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 Kliegl (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; Rubinstein, Meyer, & Evans, 2001; Yeung & Monsell, 2003).

In support of the task set inertia hypothesis, Allport, Styles, and Hsieh (1994) found (as did Wylie & Allport, 2000) that shifting attention to the weaker task from the dominant task resulted in significant shift costs (see also Meuter & Allport, 1999; Waszak, Hommel & Allport, 2003). More recently, Meiran, Chorev 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.

In the two experiments reported here, we 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 task-shifting mechanism researchers have used only 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 the 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*), and so forth. Contrast this with the much reduced online 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. In Experiment 1, we 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, in this article, we report 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. Our main goal in Experiment 1 was to investigate whether attentional shift costs would be obtained with tasks involving linguistic stimuli embedded in sentence-like contexts. We refer to the burden placed on the attention system when shifting attention between these grammaticized elements of language as *linguistic shift costs*. Our second goal was to investigate the question of reconfiguration versus inertial mechanisms that may underlie any observed shift costs by employing the three-stage Wylie and Allport (2000) adaptation of the alternating-runs design. In Experiment 2, we 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 three-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's (1995) study, 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 × 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 . . . ."

We designed the three stages as follows. In Stage 1, all stimuli were monovalent; in Stage 2, the stimuli in one task were monovalent, and the stimuli 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 Stages 1 and 2 examined the effect of shifting to a task with monovalent stimuli (Stage 1) versus shifting to a task with bivalent stimuli (Stage 2), when in both cases, the previous trial had 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 with Stage 1, in which the upcoming stimulus remained monovalent. Greater shift costs in Stage 2 compared with Stage 1 would indicate that task set reconfiguration (preparation for an upcoming stimulus) was involved.

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

Method

Participants

Participants were 24 undergraduates from Concordia University, Montréal, Québec, Canada (M = 23 years, range 20–28 years; 22 women and 2 men). Participants were paid Cdn$7 per hour or received partial credit for 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. We accomplished this by using a self-report questionnaire requiring participants to self-rate native language abilities in 5-point Likert-type scales with respect to speaking, reading, and writing (1 = *no ability at all*; 5 = *native-like ability*) and with respect to 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, each of which included a location target and temporal target condition. 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, we selected targets quasi-randomly and in a counterbalanced manner from the lists shown in the Appendix and matched them with appropriate fillers to create sentence fragments. We chose fillers 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 three stages), occurred in a fairly equal manner. Stimuli were always presented with leading and following ellipsis dots (. . .) to indicate a sentence fragment (e.g., . . . *with someone she stood there watching* . . .).

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

For the experimental stages, we created eight quasi-randomized lists of sentence fragments for each task. The first 48 trials of each list served as a practice block, followed by the experimental trials. We counterbalanced these lists in terms of quadrant and response assignments as described in the *Procedure* section. Other counterbalancing constraints were the following: No 2 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, and end) was approximately evenly distributed; equal numbers of task targets occurred in alternating sequences of shift and repeat trials; half of the trials required a left key response, and half required a right key response. In addition, we counterbalanced the type of key response on any given trial 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 × 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, we paired all of the location and temporal target phrases with neutral expressions, thus making all trials monovalent (e.g., . . . *while above the spot all alone* . . .). In Stage 2, half of the trials were monovalent (target phrases paired with neutral expressions), and half of the trials were bivalent (target phrases paired with target expressions from the other task; e.g., . . . *while above the spot she stood* . . .). For half of the participants in Stage 2, the location task was bivalent and the temporal task remained monovalent, and the reverse was the case 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-in. screen set to 1,024 × 768 pixel resolution. Stimuli were shown in uppercase 20-point Arial font. Hypercard Version 2.3 software (Apple Computer, 1993) 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 1 hr. Participants were informed that the experiment was divided into Part 1 (training) and Part 2 (experimental), and that the latter was 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 and 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 or past–present) would be shown. At the end of each training block, each participant's percentage of error and mean RT were displayed on the screen as feedback to increase interest and motivation.

In the experimental stages, we tested attention control 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) in which each stage consisted 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 of 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 5,000 ms or until the participant responded. On successive trials, stimuli were presented in one of four quadrants in a 2 × 2 matrix on the computer screen in the predictable sequence: top–left, top–right, bottom–right, bottom–left, top–left, and so forth. The response–stimulus interval (RSI) was 0 ms. If participants made an error, they received auditory feedback from the computer and an RSI of 1,500 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 and 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 and 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 and right), respectively.

Participants were instructed to silently read 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 not to attempt to memorize them. Following completion of the three 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 × 2 within-subject factorial design. There were 3 levels of condition (Stages 1–3) and 2 levels of attention trial type (repeat and shift).

For half of the participants, the *above* and *below* responses were assigned to the left and right keys, respectively, and the reverse was true 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.

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 scores 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

We calculated mean RTs on correct responses not following an error trial for each participant (see Table 1 for means, standard errors, and percentages of error in each stage). To remove outlier RTs within a participant's data set, we winsorized the data by replacing the slowest and fastest 10% of each individual's RTs with the next slowest or fastest RT, separately, for each of the 12 conditions obtained by crossing the stage (Stages 1–3), attention (repeat and shift), and task (location and temporal) factors.

One of our purposes in this study was to investigate shift costs using a multiword 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 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.

Table 1
Mean Response Times (in Milliseconds) and Percentages of Error for Shift and Repeat Trials for Each Stage in the Three-Stage Attention-Shifting Task in Experiment 1

	Response time		Percentage of error	
Stimulus condition	*M*	*SE*	*M*	*SE*
Stage 1				
Shift	1,836	57.85	1.28	0.17
Repeat	1,493	55.84	0.55	0.93
Shift cost	343	34.57		
Stage 2				
Shift	1,996	83.80	1.03	0.22
Repeat	1,655	74.60	0.69	0.19
Shift cost	341	34.20		
Stage 3				
Shift	2,085	78.61	1.26	0.28
Repeat	1,801	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 response times.

We also examined the data 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. We performed the analyses on the Stage 3 data, because all trials were bivalent. We submitted data to a Shift (repeat or shift) × Task (location or temporal) × Congruency (congruent or incongruent) repeated measures analysis of variance (ANOVA) . 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 nonrelevant dimensions of the bivalent stimulus had no effect on the response time to the relevant dimension.

Our second purpose in 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 recombine 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 reorganization made it possible to compare trials that shared the same valency, regardless of the task (location or temporal) from which the trial had come. 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 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, in which participants shifted from a monovalent repeat trial to a monovalent shift trial, with trials in Stage 2, in which 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, in which participants shifted from a monovalent repeat trial to a bivalent shift trial with Stage 3, in which 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 for comparison. Table 2 shows the means, standard errors, and percentages of error in each stage for the recombined data.

We then submitted the data to two separate repeated measures ANOVAs: Shift (repeat and shift) × Stage (Stages 1 and 2) in one analysis and Shift (repeat and shift) × Stage (Stages 2 and 3) in the other. These analyses provided information as to whether there were significant differences in shift costs between Stages 1 and 2 (a test of the reconfiguration hypothesis) and between Stages 2 and 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, $F(1, 23) = 17.96$, $MSE = 432{,}856.47$, $p < .0005$, partial $\eta^2 = .438$; as well as a main effect of stage, $F(1, 23) = 6.94$, $MSE = 60{,}495.57$, $p < .05$, partial $\eta^2 = .232$. The Shift × Stage interaction was also significant, $F(1, 23) = 23.97$, $MSE = 23{,}279.51$, $p < .0001$, partial $\eta^2 = .510$, indicating (as shown in Table 2) that shift costs were significantly greater in Stage 2 than they were in Stage 1.

Stage 2 versus Stage 3. Results from Stage 2 versus Stage 3 showed a main effect of shift, $F(1, 23) = 17.11$, $MSE = 434{,}880.68$, $p < .0005$, partial $\eta^2 = .427$. There was also a main effect of stage, $F(1, 23) = 19.61$, $MSE = 46{,}715.11$, $p < .0005$, partial $\eta^2 = .460$. The Shift × Stage interaction was also significant, $F(1, 23) = 26.06$, $MSE = 24{,}998.02$, $p < .0001$, partial $\eta^2 = .531$, indicating that shift costs were greater in Stage 2 than they were in Stage 3 (as shown in Table 2). Inspection of the data revealed that the repeat RTs in Stage 2 were faster than they were 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. We confirmed this by comparing bivalent trial repeat data in Stage 2 with the corresponding bivalent repeat data from Stage 3, $t(23) = 1.34$, $SE = 50.92$, $p = .20$.

Table 2
Mean Response Times (in Milliseconds) and Percentages of Error for Shift and Repeat Trials for the Recombined Data in the Three-Stage Attention-Shifting Task in Experiment 1

	Response time		Percentage of error	
Stimulus condition	*M*	*SE*	*M*	*SE*
Stage 1				
Shift	1,849	93.62	1.27	0.25
Repeat	1,433	84.22	0.58	0.16
Shift cost	417	136.24		
Stage 2				
Shift	2,134	127	1.30	0.34
Repeat	1,413	84.29	0.53	0.13
Shift cost	722	139.46		
Stage 3				
Shift	2,165	104.40	1.02	0.34
Repeat	1,773	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 response times.

Discussion

Our main purpose in this experiment was to investigate whether linguistic shift costs existed when using the alternating-runs paradigm with stimuli embedded in contextualized, sentence-like stimuli. Our 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: (a) we found robust shift costs when using sentence-like stimuli; and (b) we found that reconfiguration, rather than inertial processes, underlay the linguistic attention shifts obtained.

The evidence for attention shift costs was 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 three 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 with which participants had to contend. 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 with Stage 1. These findings contrast those of Wylie and Allport (2000), who found equivalent shift costs between Stages 1 and 2 in a similar design that led them to conclude that shift costs were not the result of preparatory processes for the upcoming task.

Results from the comparison of Stages 2 and 3 also contrasted those of Wylie and Allport (2000), who found greater shift costs in their Stage 3 than in their 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 of the time and so did not require inhibiting a competing task set. In our experiment, there was a significant interaction between shift costs in Stages 2 and 3. However, as can be seen from Table 2, there were smaller shift costs in Stage 3 than there were 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 (intradimensional shifting) than they were when they were dissimilar (extradimensional shifting). In the next experiment, we extended this investigation of dimensional similarity to the case of linguistic attention shifting.

Experiment 2

We designed Experiment 2 to accomplish two main goals. First, we attempted to replicate the finding in Experiment 1 of linguistic shift costs using the attention-shifting task involving attention-directing functions of language. Second, we examined the effect of task similarity on attention shifting by comparing intradimensional with extradimensional 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 vs. width and hue vs. brightness) and between tasks that were relatively dissimilar (height vs. hue and width vs. brightness). Arrington et al. found that shift costs were lower when tasks were similar in nature than they were 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 that the reverse was true for tasks not sharing perceptual operations.

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 is an open question. Results from research by Kemmerer and his colleagues (Kemmerer, 2005; Kemmerer & Tranel, 2000), demonstrating that different neural representations underlie different types of linguistic processing, suggest that this idea is indeed relevant. For example, Kemmerer (2005) 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 neurologic level. One implication of this finding is that attentional processing may be affected differently when shifting within one category of grammaticized elements (intradimensional shifting) as opposed to shifting between two categories of grammaticized elements (extradimensional shifting).

We designed Experiment 2 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 and present) embedded in sentence fragments. The target stimuli in the location judgment task were phrases referring to spatial location in the vertical dimension (above and 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, using 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 extradimensionally (i.e., between a spatial and temporal dimension). Given the results reported in Arrington et al. (2003), we hypothesized that linguistic shift costs would be lower for intra- compared with extradimensional 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 = 19–32 years; 17 women and 7 men; L1 = English).

Materials

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 and past–present) and the similar condition (i.e., above–below and 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 1 hr. 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.

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 and location judgments) without having to shift attention. In the experimental stage, we tested attention control again 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), which consisted 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 in the Experiment 1 *Method* section. 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 and right) for the response keys *near* and *far*, respectively.

Design

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

For half of the participants in the dissimilar condition, the *above* and *below* responses were assigned to the left and right keys, respectively, and the reverse was the case for the other half. *Past* and *present* responses were always assigned to the left and right keys, respectively. For half of the participants in the similar condition, the *above* and *below* responses were assigned to the left and right keys, respectively, and the reverse was the case 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 the Experiment 1 section.

Results

For all statistical tests reported below ($N = 24$), the alpha level for significance was set at .05.

Language Background Questionnaire

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

Attention-Shifting Task

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

Table 3
Mean Response Times (in Milliseconds) and Percentages of Error for Shift and Repeat Trials for Each Condition in the Attention-Shifting Task in Experiment 2

Stimulus condition	Response time		Percentage of error	
	M	*SE*	*M*	*SE*
Dissimilar				
Shift	1,646	88.42	1.40	0.23
Repeat	1,284	57.69	0.88	0.17
Shift cost	362	46.50		
Similar				
Shift	1,402	82.95	0.90	0.20
Repeat	1,209	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 response times.

One of our goals in this experiment was to replicate the existence of shift costs using linguistic stimuli in the alternating-runs paradigm. Therefore, we again conducted tests to ensure that the alternating-runs design yielded shift costs as expected in the dissimilar and similar conditions. Inspection of the data revealed 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.

Our second goal in this experiment was to test whether task similarity affects attention shift costs in linguistic task shifting. For this purpose, we included only the data from the above–below task in the analyses (see Table 4 for means, standard errors, and percentages of error in each task). We submitted these data to a 2 × 2 Shift (repeat, shift) × Condition (similar, dissimilar) repeated measures ANOVA. 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, $F(1, 23) = 71.61$, $MSE = 22{,}587.09$, $p < .0005$, partial $\eta^2 = .757$. Finally, the Shift × Condition interaction was significant, indicating smaller shift costs in the similar condition than in the dissimilar condition, $F(1, 23) = 8.51$, $MSE = 19{,}224.79$, $p < .01$, partial $\eta^2 = .270$.

Discussion

The two main purposes of this experiment were the following. First, we designed the experiment to replicate the linguistic shift cost effect using the alternating-runs design with contextualized, sentence-like stimuli. Second, we investigated task similarity effects (intra- vs. extradimensional shifting) on linguistic attention shift costs. Two important findings were established: (a) shift costs

Table 4
Mean Response Times (in Milliseconds) and Percentages of Error for Shift and Repeat Trials for Each Above–Below Task in the Attention-Shifting Task in Experiment 2

	Response time		Percentage of error	
Stimulus condition	*M*	*SE*	*M*	*SE*
Dissimilar				
Shift	1,394	88.16	1.13	0.32
Repeat	1,052	53.20	0.44	0.16
Shift cost	342	47.16		
Similar				
Shift	1,291	84.36	1.00	0.29
Repeat	1,114	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 response times.

were replicated using contextualized linguistic stimuli, and (b) task similarity affected linguistic attention shift costs. The evidence for shift costs was, as in Experiment 1, robust. We obtained this effect in the dissimilar condition (as used in Experiment 1) with 100% of the participants showing the effect and showing a sizable shift cost (see Table 3). Shift costs were also found in the grammatically similar condition (see Table 3), albeit to a significantly lesser extent, with 83% of the participants showing the effect each time. These results provide further evidence supporting 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). Because they obtained their results using simple cognitive tasks (judging colored rectangles), with the current data, we extend these effects to complex language processing. In this study, we 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. The finding that overall mean RTs for performance on the above–below task did not differ between the similar and dissimilar conditions, and that only the magnitude of the attention shift did, further supported this conclusion. 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 vs. the observer moving through the environment; see Gentner et al., 2002, for specific details). These two systems led 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, in a sentence such as *His whole future is before him*, *before* is assigned to a future (later) event.

Gentner et al. (2002) 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 and thereby supported the idea of two separate ways of representing temporal information. Although the focus of the experiments reported in Gentner et al. 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 neurologic evidence illustrating a distinction between temporal and spatial information processing (Kemmerer, 2005) 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 (2005), illustrate important distinctions that exist within grammatical processing of an individual's native language system.

General Discussion

We obtained the following results 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 underlay these linguistic shift costs. Third, intradimensional attention shifting yielded lower shift costs than extradimensional 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 carried out especially 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 refocus 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 with 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 in which bilingual participants were required to shift unpredictably between naming digits in their first (i.e., dominant) and second (i.e., weaker) languages. 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 we 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 nonlanguage conceptually based shifts (e.g., visuospatial concept shifting) that were cued by language labels. Although 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 partialing out shift costs obtained in the first language. In addition, Taube-Schiff and Segalowitz (in press) 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 was 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 (2005), who demonstrated dissociations in the processing of grammaticized elements at the psychological and neurologic levels; Experiment 2 demonstrated the existence of *attentional* processing differences within such domains. Kemmerer and Tranel (2000) recently extended their findings to neurologic representations in perceptual domains. They found neurologic 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, and so forth), the findings reported by Kemmerer and Tranel 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, in press, for support).

Kemmerer and Tranel's (2000) neurologic 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, and so forth because the learner receives less consistent, concrete evidence about their meaning in a given learning episode, compared with 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 (for studies of these issues in relation to second language development, see, e.g., Chung & Segalowitz, 2003; Segalowitz & Frenkiel-Fishman, in press; Taube-Schiff & Segalowitz, in press,).

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, 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.

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Appendix

Target and Filler Stimuli Used in the Attention-Shifting Task

Condition	Stimuli
	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	
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	
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

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