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# Within-language attention control in second language processing*

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*This study investigated attention control in tasks involving the processing of relational terms (more highly grammaticized linguistic stimuli: spatial prepositions) and non-relational terms (less highly grammaticized lexical stimuli: nouns) in a first (L1) and second language (L2). Participants were adult bilinguals with greater proficiency in their L1 (English) than in their L2 (French) as determined by self-report and performance on a speeded word classification task. Attention control was operationalized in terms of shift costs obtained in an alternating runs experimental design (Rogers and Monsell, 1995). As hypothesized from consideration of the attention-directing functions of language, participants displayed significantly greater shift costs (lower attention control) for relational terms when performing in the L2 as compared to the L1, but no difference in shift costs for non-relational terms between the two languages. The results are discussed from a cognitive linguistic perspective and in relation to second language proficiency development.*

## Introduction

Most people have superior linguistic skills in their first language (L1) compared to a later acquired second language (L2). One interesting proposal about a possible source for this difference focuses on challenges inherent in mastering the use of grammaticized elements in the L2 (Slobin, 1996). The present research examines one implication this proposal may have regarding attention control during L1 and L2 processing.

Slobin (1997) argues that there is an important distinction to be made, in the context of second language acquisition, between lexical elements that refer to objects, events and their properties versus more grammaticized elements that "relate bits of experience to each other and to the discourse perspectives of the speaker" (p. 265f.). Lexical elements include nouns, verbs and many adjectives that refer to objects, events, concepts, and their characteristics. Grammaticized elements include function words such as prepositions, conjunctions, pronouns, as well as bound morphemes on lexical items that mark tense, case, numbers, etc. (see Talmy, 2000). Citing Talmy, Slobin (1997) focuses on the following difference between lexical and grammatical elements in a sentence as being especially relevant to L2 acquisition: "The grammatical specifications in a sentence . . . provide a conceptual framework or, imagistically, a skeletal structure or scaffolding, for the conceptual material that is lexically specified" (Talmy, 1988, p. 166; see also Talmy 2000, vol. 1, chapter 1, for an update of Talmy, 1988). Grammaticized elements, according to Slobin, are inherently more difficult to master in the L2 than are lexical elements. This is because grammaticized elements have structural rather than conceptual referential functions, and so their acquisition does not require that they be "experienced directly in our perceptual, sensorimotor, and practical dealings with the world" (1996, p. 91) to the same extent as do lexical elements that typically refer to observable objects and events. Rather, grammaticized elements "can only be learned through language, and have no other use except to be expressed in language" (1996, p. 91).[1] Thus, Slobin (1996) proposed that grammaticized elements are more difficult to learn in an L2 because

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[1] Of course, grammaticized words can vary in the degree to which perceptual experiences may underlie their meanings. For example, elements that refer to aspect (*John **went** to school* versus *John **has gone** to school*) or definiteness (***a** school* versus ***the** school*) would appear to involve specific perceptual experiences far less consistently than do spatial prepositions (***to** the school* versus ***from** the school*) even though both serve structural functions (Slobin, 1996, acknowledges such variability; see also Coventry and Garrod, 2004, on perceptual issues regarding spatial prepositions). Also, many words can simultaneously serve both lexical and grammatical functions (e.g. verbs can refer lexically to specific actions while at the same time governing the argument structure of the sentence). The important point here is that, in the context of L2 acquisition, a useful distinction can be made between grammaticized aspects of a sentence serving primarily structural functions that RELATE different parts of a message to one another and lexical aspects serving primarily referential functions that specify the CONTENT of a message.

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they are part and parcel of the structural aspects of language in a way that lexical elements are not. Often, the structural aspects of the L2 do not correspond directly to the structural aspects of the L1. For example, spatial prepositions in one language may "carve" up geometric space differently from prepositions in another language, thereby posing a challenge for L2 learning (Bowerman, 1996; Bowerman and Choi, 2003). This can lead to cross-language interference when the speaker attempts to use grammaticized elements in the L2 as though they functioned in the way they do in the L1 (resulting, for example, in English speakers' inaccurate use of Spanish *para* and *por* because they do not map perfectly onto English *for* and *by*). By contrast, L1 and L2 lexical elements will generally correspond to each other much more closely in how they refer to conceptual categories (in many conceptual domains corresponding nouns in different languages will refer more or less to the same items; e.g. the primary meanings of French *camion* and English *truck* are essentially identical).

In sum, Slobin (1996, 1997) is saying that elements in a language that refer to relationships between other linguistic elements within a message (the more highly grammaticized elements) pose a greater cognitive challenge for L2 learners than do non-relational elements. One obvious prediction that flows from this idea is that L2 learners will find it more difficult to fully master the processing of relational elements in their L2 compared to their L1, and not experience a similar challenge concerning non-relational elements. This can manifest itself as persistence in making errors with the use of prepositions, conjunctions, and other grammaticized elements long after having mastered a great deal of the lexical word vocabulary. This indeed would appear to be the typical experience of most learners, given the emphasis often placed in language instruction texts on how grammatical structures operate in the target language. Beyond considerations of ACCURACY, however, there may exist other ways that relational elements can pose greater challenges in the L2 than in the L1. The present research explores one such possibility – ATTENTION CONTROL DIFFERENCES in the processing of relational elements in the two languages.

### *Language and attention control*

In recent years there has been growing interest in the way elements of language serve to direct attention. This interest can be seen especially in cognitive linguistic approaches to language (Langacker, 1987; Talmy, 1996, 2000; see Croft and Cruse, 2004, for an overview). The central idea is that when people speak about an event or a scene, their goal is to draw attention both to the relevant content elements of the scene and to the way these elements are to be CONSTRUED in terms of their relationships to one another. For example, the utterance *A man was standing under the clock* directs attention in several ways. The lexical elements in the utterance elicit conceptual representations corresponding to *man*, *stand* and *clock*, and these establish the primary content of the message. The utterance also directs the listener to relate *man* and *clock* in terms of a particular spatial relationship, namely "man under clock". However, this message also directs attention to a particular construal of that spatial relationship insofar as it is reported as "man under clock" and not "clock above man". Whereas these two expressions are equivalent on the content level, they differ in terms of emphasis (one is about the man, the other about the clock) and this may have special relevance to the speaker's intentions. The message also directs attention in other ways, all reflecting particular construals of the situation (e.g. definiteness – *The man* versus *A man*; aspect – *was standing* versus *stood*). Thus, the way the scene is construed by the speaker will determine how the speaker packages the idea into language. In Langacker's (1987) terms, the sentence, by virtue of how it packages the information, will direct the listener to make particular focal adjustments in the mental representation (image) of the scene. It is in this sense that language fulfills an attention-directing function.

Thus, both the lexical and grammaticized elements of the sentence serve to direct attention, and they do so in different ways (see Langacker, 1987, and Talmy, 2000, for extensive discussions of the issues involved here). The lexical elements direct attention by evoking representations of the conceptual content of the message. The more highly grammaticized elements direct attention by structuring that content for the recipient in particular ways. As the message unfolds, the recipient has to redirect attention to the content in order to revise previous mental representations of the message to take into account the newly signaled RELATIONSHIPS among the content elements. That is, there is a continuous focusing and refocusing of attention as relational elements in the message are encountered. The implication for attention control in L2 is this: when a person is less dominant in the L2 than in the L1, the ability to shift focus of attention for processing relational elements may be weaker in the L2. Moreover, if Slobin is correct that there is something special about the challenge posed by such elements in the L2, then this L2 versus L1 difference in attention control for relational elements should be greater than the corresponding difference for attention control for non-relational elements. The present study tests these predictions by assessing attention control for relational elements versus non-relational elements in L2 and L1.

This study adopted the alternating runs design of Rogers and Monsell (1995) as a means for operationalizing attention control. This design has been successfully

employed by many researchers to examine attention control in other research contexts (for reviews see Monsell, 2003 and Waszak, Hommel and Allport, 2003). In this technique, the participant is given a sequence of trials, typically two-alternative forced-choice 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 whether letters were consonant or vowels and whether digits were even or odd. The presentation sequence was arranged so that on alternate trials the participant had to shift from one task to the other (necessitating a shift of attention focus) and on the other trials the participant repeated the same task as on the previous trial (no attention shift). In the Rogers and Monsell (1995) version of the task, the type of trial (letter or digit judgment) was cued by the location of the stimulus on the screen; on each trial the stimulus appeared in one of four quadrants in a $2 \times 2$ presentation matrix on the screen, moving on successive trials predictably in a clockwise manner to the next adjacent quadrant. Stimulus location (for example, either of the top two quadrants versus either of the bottom two quadrants) cued which task had to be performed. Performance on shift trials was found to be slower than on repeat trials; this difference became known as the SHIFT COST.

In this design, the repeat trials thus provide a baseline control measure of processing against which to view the performance on the shift trials where there is the added task demand of shifting attention to the other task. The slower performance on shift trials thus reflects the greater processing burden placed on the individual by virtue of having to shift attention, a burden absent on repeat trials. The extent to which performance is slower on shift trials relative to repeat trials reflects the challenge to the individual in handling that additional processing burden. This logic was exploited in the present study, where the tasks involved judgments about words that varied in terms of their linguistic attention directing functions (relational terms [spatial prepositions] versus non-relational terms [nouns]).

The alternating runs design seemed especially relevant for studying language-based attention control. This is because it is inherent in the nature of speech communication for the listener (or reader) to have to continually shift focus of attention from one dimension of construal or perspective to another while "unpacking" the message. The alternating runs design provides a measure of a person's ability to handle the demands of shifting 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 and Waters, 2003), the current study involved predictable shifting. Because of this predictability, the alternating runs design probably provides, if anything, a conservative estimate of the difficulty a person faces in handling attention shifts in the L2.

### *The present study*

The present study builds on three previous studies conducted in our laboratory. First, Segalowitz and Frenkiel-Fishman (2005) used the alternating runs design to study attention shifting in L1 and L2. In that study, however, only relational stimuli were used (time adverbials and conjunctions which normally specify temporal relationships between events or causal relationships between main and subordinate clauses) and these were presented as decontextualized one- or two-word stimuli. On a given trial participants saw either time adverbials (e.g. *later*, *soon*) or conjunctions (e.g. *because*, *despite*, etc.). In a speeded reaction time task, they had to judge whether the time adverbials typically referred to a moment in time relatively close to (e.g. *soon*) or far from (e.g. *later*) the present moment, and whether the conjunctions typically signaled the presence (e.g. *because*) or the absence (*despite*) of a causal link between two clauses. Trials were sequenced so that participants had to alternate between repeating trial types (say, conjunction trial following a conjunction trial) or shifting attention from one trial type to another (say, to a conjunction trial following a time adverbial trial). Attention shifting ability was found to vary as a function of general processing ability in the L2, after controlling for performance levels in L1.

Second, in a related study, Chung and Segalowitz (2004) tested bilinguals in an attention shifting task that involved a non-matching to sample task instead of the alternating runs design where attention had to be shifted from one category of word to another. As in Segalowitz and Frenkiel-Fishman, stimuli were single, decontextualized words and the task was a speeded reaction time task. In this study, participants saw four words at the top the screen and a sample word at the bottom. On shift trials, they had to indicate which one belonged to a different category from the sample (e.g. if the sample was over, the correct selected target might be *beside*) by pressing one of four reaction time buttons that corresponded to the location of the selected word. On non-shift trials, they had to indicate which target belonged to the same category as the sample (e.g. if sample = *over*, then select above). Shift and non-shift trials were administered in separate blocks and each in separate language blocks. Unlike the Segalowitz and Frenkiel-Fishman study, this study also contrasted performance between relational and NON-relational stimuli (concrete nouns, abstract nouns) and found that attention control with relational stimuli was

more strongly associated with L2 proficiency as compared to attention control with non-relational stimuli, after controlling for performance on the identical tasks in the L1.

Finally, Taube-Schiff and Segalowitz (2005) reported evidence on attention control within language again using the alternating runs design. That study, however, involved only relational stimuli (time adverbials, locational prepositions) and only the L1. The task and design were similar to the one used in the Segalowitz and Frenkiel-Fishman (2005) study. However, the stimuli were embedded in phrases instead of being presented as single words in order to test the generalizability of the attention shifting effect observed in Segalowitz and Frenkiel-Fishman to somewhat more complex stimuli. The study yielded significant attention shifting effects for these contextualized, relational stimuli in the L1.

The present study builds on these three previous results by combining the techniques used. This was accomplished by employing the design of Taube-Schiff and Segalowitz (2005) using the more contextualized stimuli, by using both L1 and L2 stimuli as in Segalowitz and Frenkiel-Fishman (2005), and by contrasting, in different conditions, performance with two types of stimuli – more highly grammaticized relational stimuli (spatial prepositions) versus less highly grammaticized non-relational stimuli (nouns) as in Chung and Segalowitz (2004).

The hypothesis investigated in this research was that, whereas it is expected that there will be significant shift costs in each experimental condition, the shift cost for tasks involving the relational stimuli will be greater in the L2 than in the L1, compared to the shift costs for tasks involving non-relational stimuli, where little or no difference between the L2 and L1 is expected. Put another way, it was hypothesized that in the less dominant second language attention control involving relational words would be weaker than in the more dominant first language, whereas attention control involving non-relational words that named conceptual categories would not differ as much, if at all, between the two languages.

The experiment thus included a word type condition with two levels (relational, non-relational) each using two subtasks necessary for there to be attention shifting. The relational condition involved two different location judgment tasks, using stimuli that were spatial location prepositional phrases (participants only saw the linguistic stimuli, never pictures of objects in the relationships described). In one location task, the target phrases referred to spatial location in the vertical dimension, with stimuli such as "... all alone above the spot ..." and "... from below the site with them ...". The participant had to judge whether the phrase referred to a position that was higher than or lower than the hypothetical reference point mentioned. In the other location task the target phrases referred to relative spatial proximity, with stimuli such as "... while next to the spot with them ..." and "... while beyond the place with someone ...". The participant had to judge whether the phrase referred to a position that was close to or distant from a reference point. As mentioned earlier, Taube-Schiff and Segalowitz (2005) found that there were significant shift costs when such 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 (French) than in L1 (English).

It should be noted that spatial prepositions in English and French do not correspond exactly to each other on a one-to-one basis (compare Tyler and Evans, 2003 on English with Vandeloise, 1991 on French regarding spatial prepositions). However, the stimuli selected for this study did not pose any systematic cross-language differences in the way they are typically used and they were chosen for their relative ease of processing by even moderately skilled bilinguals.

The non-relational condition used lexical targets and involved two different object judgment tasks. Here the stimuli were noun phrases 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 ...").

The relational and non-relational conditions were presented in separate blocks and each of these was presented in separate language blocks (L1 and L2). By comparing shift costs in the relational and non-relational conditions in the two languages it became possible to test the hypotheses based on the analysis presented earlier, namely that attention shift costs would be greater in the L2 than in the L1, especially for relational stimuli.

Participants were English dominant bilinguals with French as a second language, living in Montréal, a bilingual community offering ample opportunities to make frequent use of the two languages. For this study, it was necessary to recruit bilinguals with sufficient L2 skill to perform speeded judgment tasks but who were nevertheless dominant in the L1. Potential participants were therefore 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 well-known 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. Performance on this task thus provides a useful

marker of general proficiency in the language (Segalowitz, 1997; 2000; Segalowitz and Freed, 2004; Segalowitz and Hulstijn, 2005). In each condition, trials were blocked by language. In each block, participants had to judge if a target word referred to an animate or inanimate object. Reaction times (RTs) were collected for performance in each language. Only participants who rated themselves as clearly dominant in their L1 (English), as revealed by self-rated abilities in speaking, reading and writing frequency of use of the L1 and L2 (French), and who were faster on word classification in L1 than in L2 were retained for the study.

In sum, the experiment involved measuring attention shift costs obtained in four blocks of two-alternative forced-choice trials using an alternating runs experimental design. The four blocks were formed by crossing two levels of language (L1, L2) condition with two levels of word type (relational, non-relational). Within each block, two judgment tasks were presented with shift and repeat trials alternating. It was predicted that there would be the following pattern of results: Shift costs (slower RTs on shift compared to repeat trials) were expected to be observed in all conditions. However, an interaction effect was predicted in which shift costs with relational stimuli were expected to be greater in L2 than in L1 while at the same time corresponding L2 and L1 shift cost differences with non-relational stimuli were expected to be non-significant or significantly smaller, indicating a greater burden on attention control mechanisms for processing relational stimuli in the L2 compared to the L1.

Finally, it should be noted that the present study differed in important ways from most previous bilingualism studies of language and attention. For example, Meuter (2005; Meuter and Allport, 1999) and Costa and Santesteban (2004) have studied attention shifting using numeral naming and picture naming in contexts that required switches from one language to another. Other researchers, also using adaptations of the Rogers and Monsell paradigm, have studied attention shifts using more complex comprehension tasks. For example, von Studnitz and Green (2002) studied shifts between languages when participants were required to make semantic categorizations (e.g. judging whether visually presented words referred to animate or inanimate objects). Thomas and Allport (2000) investigated language switching costs when participants were cued to shift attention by language-specific orthographic cues in an attempt to determine whether shift costs arise from within, or outside of, the bilingual lexicon (see also von Studnitz and Green, 1997). However, the present study distinguishes itself from these other investigations in that it looked only at attention shifts made WITHIN a given language. In addition, Schmidt (1993, 2001), Robinson (1995), Leow (1997) and Williams (1999) addressed issues related to focus on form during learning experiences, whereas the present study was not concerned with the learning process as such nor with explicit focusing by the participants on grammatical form as opposed to meaning. Other researchers have studied interference effects between languages (Kroll and Stewart, 1994; Altarriba and Mathis, 1997) during lexical access, an issue not addressed here. Still others have looked at how bilingual speakers keep their languages separate (Bialystok, 1994; Green, 1998). In summary, the present study differed from most previous studies of language and attention by focusing on attention control WITHIN A GIVEN LANGUAGE and in addressing attention control as a function of the nature of the linguistic 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 $8/hour or received partial credit for course fulfillment for taking part. All participants self-reported on a screening questionnaire that English was their L1 and French was their L2. Retained participants rated themselves on a five-point Likert scale for English ability in reading, speaking and writing (where 1 = no ability and 5 = native-like ability) ($M = 4.8$, $SE = .07$) and French ability in reading, speaking and writing ($M = 3.5$, $SE = .13$), confirming that L1 was indeed their dominant language. Retained participants also rated themselves on a 5-point Likert scale for frequency of use of English in reading, speaking and writing (where 1 = never or almost never used and 5 = main language used) ($M = 4.8$, $SE = .09$) and corresponding frequency of use of French as well ($M = 2.6$, $SE = .17$). All participants rated their overall usage of English as more frequent than French, which was important given the bilingual nature of Montréal. Each participant also performed faster on a speeded word classification (animacy judgment) task in L1 ($M = 866$ ms, $SE = 20.62$) than in L2 ($M = 972$ ms, $SE = 24.92$).

### *Materials*

The attention-shifting task consisted of a training stage and an experimental stage, with relational and non-relational conditions 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 chosen to be 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 relational stimulus condition required the participant to decide whether an event took place above or below (verticality judgment task) a particular reference location or whether an event took place near or far from a reference location (proximity

judgment 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. The two tasks in the non-relational 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 filler words were selected from the lists shown in the Appendix. For all tasks, filler words 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 presented with leading and following ellipsis dots (" . . . ") to indicate a sentence fragment (e.g. " . . . while far from the spot all alone . . . ").

For the training stage, a list of eight alternating blocks of 24 task trials were created for the relational target condition (i.e. above-below, near-far) and for the non-relational 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.

### *Apparatus*

All stimuli in the attention-shifting task were presented on an iMac G4 desktop computer with a 14-inch screen set to 1024 × 768 pixel resolution. Stimuli in the attention-shifting task 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 align trial onsets 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 a speeded word classification task in which they had to indicate if nouns appearing on the screen referred to an animate or inanimate object. Reaction time and accuracy measures were collected. Data were collected in separate L1 and L2 blocks with the order counterbalanced across participants.

#### *Attention-shifting task*

The attention-shifting task consisted of two conditions, one involving relational stimuli and the other involving non-relational stimuli. 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 stimuli. The training stage was divided into eight blocks of 24 trials that alternated in each condition (relational, non-relational) 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 relational or non-relational condition in a predetermined order.

In each condition they started with a block of 192 training trials (no attention shift involved). This was followed by the experimental stage (repeat and attention shift trials intermixed), consisting of one 48-trial practice block and two 96-trial test blocks. Of these 192 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 until the participant responded, for a maximum of 5000 ms. 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 was inserted to allow for 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 (two versus four black circles) and the "air" versus "water" (a picture of a cloud versus wavy lines) response key locations. Stimuli appeared in a $2 \times 2$ 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. 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 purposes of encouraging full reading of the stimuli; the data were not analyzed).

### *Design*

The attention-shifting task conformed to a $2 \times 2 \times 2$ within-subject factorial design. There were 2 levels of language (English, French), 2 levels of word type (relational, non-relational) and 2 levels of attention trial type (repeat, shift).

For half the participants, in the relational 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 non-relational 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 starting location (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 (same as in Rogers and Monsell, 1995).

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 response on the previous trial as well as on the upcoming trial (to control for response priming). In addition, no more than four consecutive left or right button presses were ever required.

## 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.

### *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 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.

Preliminary tests were conducted to test that the alternating runs design had yielded shift costs as expected in each of the L1-relational, L1-non-relational, L2-relational and L2-non-relational conditions. Inspection of the data indicated that of the 32 participants, 26, 31, 26 and 26 individuals revealed shift costs in the four conditions respectively. 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, indicating that the experimental manipulation was effective in creating shift costs in the four main conditions.

Table 1 also shows that the participants performed the tasks to a very high level of accuracy. In particular, performance was very accurate in the repeat condition, the reference point against which performance in the shift condition was compared, with less than 2 % errors on repeat trials in each language and for relational and non-relational stimuli.

The main hypothesis underlying this research was that there would be a shift cost interaction effect between word type and language in the form of a greater shift cost in the L2 than in the L1 for relational stimuli than for non-relational stimuli. This hypothesized interaction was tested by submitting the shift cost RT data to a $2 \times 2$ repeated measures analysis of variance (ANOVA) with the

Table 1. *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 |
| Word Type | | | | |
| Relational | | | | |
| 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) | |
| Non-relational | | | | |
| 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.

factors being language (L1, L2), and word type (relational, non-relational). The results yielded a significant language effect $F$ (1,31) = 5.12, $MSE = 4679.91$, $p < .04$, Partial eta squared = .141, a significant word type effect, $F$ (1, 31) = 8.53, $MSE = 12093.65$, $p < .007$, Partial eta squared = .216, and a significant Language X Word type 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 relational target condition than non-relational 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 relational 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 non-relational condition ($t$ (31) < 1, $SE = 16.94$, *n.s.*) (see Table 1). In fact, if anything, the shift cost in L2 was SMALLER than in L1 (90 versus 104 ms) in the non-relational target condition. This finding, in addition to supporting the hypothesis, also ruled out the possibility that shift costs were larger in general in the L2 than in the L1.

Further analysis revealed that RTs in the relational target condition were slower overall than in the non-relational target condition, suggesting that the relational target condition was more difficult to perform. To see whether the significant interaction reported above was attributable to this greater overall difficulty, the data from the repeat trials were taken as a measure of baseline performance (no attention shifts involved) and submitted to a two-way repeated measures ANOVA with the factors being language (L1, L2) and word type (relational, non-relational). 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 word type effect indicating that responses in the relational condition were slower than in the non-relational 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 word type (relational, non-relational), $F$ (1, 31) = 1.12, $MSE = 22466.47$, $p > .2$, Partial eta squared = .035. This result indicates that the ability to read, understand and make judgments in the relational as compared to the non-relational target condition was no more difficult in L2 than in L1. This result in turn indicates that the shift COST differences reported earlier were attributable to the attention shift requirement of the shift trials and not due simply to any greater difficulty of processing the relational versus non-relational stimuli in L2 than in L1.

Finally, the data were examined to see if differences between the two different subtasks involved in the relational word type condition (proximity, verticality) interacted with the demands of shifting attention focus. To assess this, the RTs from the relational word type condition were submitted to a 2 × 2 × 2 repeated measures ANOVA with the conditions being attention (shift, repeat), task (proximity, verticality) and language (L1, L2). The analysis yielded a significant attention effect, indicating that RTs on shift trials were significantly slower than on repeat trials (the shift cost), ($F$ (1, 31) = 26.77, $MSE = 56{,}553.27$, $p < .0001$, Partial eta squared = .463). The results also yielded a significant language effect, indicating that RTs in the L2 were significantly slower than in the L1, ($F$ (1, 31) = 43.33, $MSE = 99{,}682.69$, $p < .0001$, Partial eta squared = .583). There was also a significant task effect, indicating that RTs in the proximity task (1365 ms) were slower than in the verticality task

(1274) ($F$ (1, 31) = 7.43, $MSE$ = 70,882.88, $p$ = .01, Partial eta squared = .193). Crucially, however, there were no significant interaction effects between task and the other variables (all $Ps > 0.09$), indicating that although one task was performed more slowly than the other this difference did not impact on shift costs.

**Discussion**

The main hypotheses of this study were supported. First, as hypothesized, shift costs were observed in all the language-by-word type conditions, confirming that the paradigm was sensitive to the attention shift manipulation. Second, the hypothesized interaction effect was obtained. There was an L2-effect in which shift costs in the relational condition were significantly greater in the L2 than in the L1, consistent with the idea that language-based attention control is weaker in the less proficient L2 than in the more proficient L1. Moreover, also as hypothesized, this L2-effect was itself greater for conditions involving relational stimuli than non-relational stimuli (in the non-relational condition, the shift cost was slightly greater in the L1 than in L2, but not significantly so). These results are consistent with the idea that the attention control challenge in the L2 is linked to relational elements.

These conclusions were strengthened by the fact that the data ruled out two potential alternative explanations for the results. One was that relational stimulus words might somehow be more difficult to process (either in general or because of the particular stimuli selected) than non-relational stimuli, especially when encountered in the L2, and thus account for the L2-effect for relational stimuli. The analysis of the data from the repeat trials ruled out this possibility. On repeat trials, no interaction effect between word type and language was found, indicating that the original effect reported earlier, where data from shift trials had been included, is indeed associated with attention shifting demands. A second potential alternative explanation is 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 absence of an L2 versus L1 difference in shift costs in the non-relational condition.

One might also ask whether some other feature differentiating the stimuli in the word type conditions – something other than the relational/non-relational distinction – was responsible for the differential attention shift cost effects across L2 and L1. Ideally, this question might be addressed in some future study involving meaning judgment tasks and attention shifting in L1 and L2, where the very same stimulus words are presented as relational stimuli in one condition and as non-relational in another condition. This is an attractive idea, but it will be very challenging to carry out in practice, because if stimuli are going to be processed for meaning, then it may be expected that the relational or non-relational character of their meanings will be processed in all conditions. As reported earlier, Segalowitz and Frenkiel-Fishman (2005) and Chung and Segalowitz (2004) obtained strong associations between the processing of relational words in attention shifting tasks and L2 proficiency, even when the stimuli were presented in a decontextualized manner where one might have expected their relational character not to be very salient. Nevertheless, a research design contrasting two ways of processing the same stimuli might be well worth pursuing. Perhaps a more promising way to address this concern would be by convergence through other studies using a variety of different stimuli. The present study used spatial location prepositions and previous studies have used time adverbials and causal conjunctions (Segalowitz and Frenkiel-Fishman, 2005), and various prepositions (Chung and Segalowitz, 2004; Taube-Schiff and Segalowitz, 2005). It is important, of course, to broaden the range of stimuli used in future studies to test the generality of the effects linking attention shifting performance, the relational characteristics of certain words, and L2 skills.

The present results address and extend Slobin's (1996) proposal that the relational aspects of language provide an important challenge to L2 users. Slobin focused on the difficulty of mastering ACCURATE use of such elements in the L2. The present study showed, however, that even when bilinguals were able to very accurately process the relational stimuli, performance decrements with those stimuli nevertheless emerged in other ways, namely, in terms of attention shifting ability.

The present results complement and extend what is known about the role attention plays in L2 functioning. Previous work has 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 (e.g. von Studnitz and Green, 1997, 2002; Meuter and Allport, 1999; Thomas and Allport, 2000). 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.

The results here obtained are 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 and 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. An important direction for future research in this area would be to examine empirically a range of categories of linguistic construal operations, such as those listed by Croft and Cruse, thereby adding a cognitive psychological (as opposed to a purely theoretical linguistic) grounding to this approach to language. It is also important to study the conditions that promote or hinder the acquisition of language-based control of attention in the L2.

The present research proceeded from the view that L2 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 grammaticized words that connect clauses or nouns to each other in particular ways. Yet others will focus on discourse functions having to do with other aspects of how the speaker construes the information packaged into the message. 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. 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.

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

| | | |
|---|---|---|
| High 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] |
| Low Grammaticized 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] |