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Attentional Focus Affects How Events are Segmented and Updated in Narrative Reading

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Abstract

Readers generate situation models representing described events, but the nature of these representations may differ depending on reading goals. We assessed whether instructions to pay attention to different situational dimensions would affect how individuals structure their situation models (Experiment 1), and how they update them when situations change (Experiment 2). In Experiment 1, participants read and segmented narrative texts into events. Some readers were oriented to pay specific attention to characters or space. Sentences containing character or spatial location changes were perceived as event boundaries—particularly if the reader was oriented to characters or space, respectively. In Experiment 2, participants read narratives and responded to recognition probes throughout the texts. Readers who were oriented to the spatial dimension were more likely to update their situation models at spatial changes; all readers tracked the character dimension. Results from both experiments indicate that attention to individual situational dimensions influences how readers segment and update their situation models. More broadly, the results provide evidence for a *global* situation model updating mechanism that serves to set up new models at important narrative changes.

Keywords

text comprehension; event segmentation; situation model updating; incremental updating; global updating

Situation models are working memory representations constructed during narrative text comprehension. They are thought to represent information about protagonists, their goals, the objects they interact with, as well as the spatial locations in which they interact (Zwaan & Radvansky, 1998). In addition to the information stated directly in the text, situation models are elaborated by general knowledge readers have of the world (van Dijk & Kintsch, 1983; Zwaan, Langston, & Graesser, 1995). Stories naturally describe a changing set of events and situations. As the narrated situation changes in a story, readers must update their

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situation models to accommodate those changes. The experiments reported here investigated how situation model updating is affected by reader's attention to situational information during comprehension.

Situation Models are Organized Around Events

Readers build situation models centered on events (Zacks, Speer, Swallow, Braver, & Reynolds, 2007; Zwaan et al., 1995). As events change in the story, readers update their situation models, and these time points may be seen as boundaries between events. In Zacks et al. (2009), participants read extended narratives and explicitly segmented them into large (coarse) and small (fine) meaningful events. Narratives were coded separately for changes in six situational dimensions: Cause, character, goal, time, objects, and space. They found that participants were more likely to perceive event boundaries when there was a change on a situational dimension than when there was continuity, and reading time slowed down at event boundaries.

The event segmentation system likely interacts with attention control processes. Event Segmentation Theory (Zacks et al., 2007) proposes that event segmentation is a spontaneous process and may serve to direct processing to event-related features in the environment. In a think-aloud study, Kurby and Zacks (2012) found that readers were more likely to mention features of the narrative situation at event boundaries than in the middle of events. This suggests that the activation of event information may be moderated by perceived event structure. However, the direction of influence can also run the other way: goal-related attentional changes may influence perceived event structure. Consistent with this possibility, event segmentation behavior is sensitive to segmentation instructions. Participants are adept at segmenting at different grain sizes depending on instructions, and this manipulation can affect subsequent memory performance (Hanson & Hirst, 1989; Lassiter, Stone & Rogers, 1988). In this study, we asked whether focusing attention on certain dimensions of a narrative situation during reading affects how those features guide event segmentation and model updating. Focusing on spatial information, for example, may make space feature more strongly in segmentation and updating, whereas focusing on character information may make characters feature more strongly in such processes.

Reader Goals and Comprehension

To our knowledge, no study has found an effect of reader goals on the segmentation of narrative text; however, a wealth of research has evaluated the effect of goals on other measures of text encoding and comprehension. In particular, McCrudden and Schraw (2007) have put forth a model describing how reader goals influence text processing. Their Goal-Focusing model proposes that instructions will influence reader goals, which then leads readers to adopt specific strategies. Based on these strategies, readers will focus on portions of the text that are more relevant their goals. Previous work using such instructions has found that reader goals influence the inferences readers draw (Linderholm & van den Broek, 2002; Magliano, Trabasso, & Graesser, 1999; Narvaez et al., 1999; van den Broek et al., 2001). For instance, research has shown that when reading for entertainment comprehenders tend to generate different inferences than when reading for study (Linderholm & van den

Broek, 2002). People reading for study tended to produce more explanatory and predictive inferences, whereas people reading for entertainment produced more knowledge-based associative inferences. Reader goals can also influence sentence reading time (Lorch et al., 1987), global comprehension ratings (Lehman & Schraw, 2002), text recall (Bohn-Gettler & Kendeou, 2014; Linderholm & van den Broek, 2002; Narvaez et al., 1999; Pichert & Anderson, 1977), eye movements (Kaakinen & Hyönä, 2005; 2008; Kaakinen, Hyönä, & Keenan, 2002; 2003) and self-reported reading strategies (Braten & Samulstuen, 2004). Moreover, reading goals affect the extent to which comprehenders rely on situation models. Schmalhofer and Glavanov (1986) found that readers remember situational information better if they are reading to learn from a text than reading for entertainment, and Zwaan (1994) found that situational information is better remembered when people think they are reading news stories rather than literature.

Reading goals can affect how situation models are constructed and updated. The Event Indexing Model suggests that readers track at least five situational dimensions when constructing situation models –time, space, goals, causes, and characters and objects – and much research confirms that readers track these dimensions during text comprehension (Zwaan & Radvansky, 1998). A previous study asked whether readers can effectively attend to one dimension at a time and whether such focused attention has an impact on situational processing. In two experiments, Therriault, Rinck, and Zwaan (2006) manipulated whether readers attended to space, time, or characters during story comprehension and assessed situation model processing. Reading times were examined for sentences that contained changes along the spatial, time, and character dimensions. (Reading typically slows down at situational changes [see Zwaan & Radvansky, 1998], which has been taken as evidence of situation model updating [but see Radvansky & Copeland, 2010 regarding reading time and spatial changes].) Therriault et al. (2006) found that reading time slowed down for spatial shifts only when participants were instructed to attend to space whereas reading time slowed down for changes in characters and time regardless of attentional focus. Results from this study provide three key findings: 1) readers can effectively modulate their attention to separate situational dimensions, 2) attentional focus may affect how and when situation models are updated during narrative comprehension, and 3) readers robustly attend to characters and time without specific instruction.

That readers attended strongly to characters is consistent with previous work showing that readers robustly encode character information in situation models (Zwaan & Radvansky, 1998) and that readers track characters closely (e.g., Rapp, Gerrig, & Prentice, 2001; Zwaan et al., 1995). The fact that Therriault et al. (2006) found space was tracked most strongly when readers explicitly attended to space suggests that although readers *can* track spatial location during comprehension, they do not always do so (see Zwaan & Radvansky, 1998 for a review). Readers are more likely to track space if they have studied a map beforehand (e.g., Bower & Rinck, 2001; Morrow, Bower, & Greenspan, 1989), are instructed to focus on spatial information (e.g., Hakala, 1999; Therriault et al., 2006), or are reading the text a second time (Zwaan, Magliano, & Graesser, 1995).

Given that readers' tend to track characters by default, but strongly track the spatial dimension only with explicit reasons to do so, we asked whether having such a reason affects online situation model updating. Specifically, compared to normal reading or attending specifically to characters, does attending to space alter when a situation model is updated and which elements are updated? In the current study, we used instructions that are similar to what McCrudden and Schraw (2007) referred to as *general, purpose instructions*. Readers were given goals that focused attention on either the characters or the spatial locations mentioned in the story. Previous work on relevancy used gross measures of text processing such as comprehension ratings, overall reading strategies and reading times (e.g., Braten & Samulstuen, 2004; Lehman & Schraw, 2002). Here, we evaluated moment-to-moment text processing through the use of event segmentation measures (Study 1) and online recognition memory probes (Study 2). The aim of the current experiments was to assess whether instructions to pay attention to different dimensions would affect when situation models are updated and which information within these models is updated. Narrative texts were written that systematically controlled shifts along one dimension at a time. These narratives included shift sentences that contained only a change in characters or a change in spatial locations. Experiment 1 evaluated whether readers perceived these character and spatial changes as event boundaries, and whether readers' goals influenced which changes they perceived as event boundaries. Experiment 2 evaluated how situation models are updated, and whether this process is affected by readers' goals.

Experiment 1

In this experiment, participants read narrative texts and segmented them into meaningful events. Participants were instructed to pay attention to characters, pay attention to spatial locations, or read for comprehension. The purpose of this experiment was to (1) assess the points in the narratives at which readers identify boundaries that should trigger situation model updating, and (2) evaluate whether attentional instructions influence which situational changes readers identify as important event boundaries. We predicted that readers would be more likely to segment the narratives at character and spatial shift sentences than at sentences that contained no shift. We also predicted that readers would be more likely to segment at important changes that occur along the dimension to which they are attending (Therriault et al., 2006). For example, readers paying attention to space would be more likely to segment at spatial shift sentences than at other sentences and more likely to segment at spatial shifts compared to readers paying attention to characters.

Method

Participants

Participants were 62 individuals (ages 18 – 23, M = 19.65 years, SD = 1.29, 43 females) recruited from introductory psychology courses at Washington University St. Louis. Participants were randomly assigned to an attention group. Three participants were excluded from the analyses due to failure to comply with instructions. Of the remaining 59 participants, 19 were in the *character group*, 20 were in the *spatial group*, and 20 were in the *control group*. Participants either received course credit or were paid $10 per hour for their participation.

Materials

Narrative texts.—All participants were given one practice story about two children on a playground and 8 experimental texts about (1) a camping trip, (2) touring a castle, (3) a family getting ready in the morning, (4) visiting a relative in the hospital, (5) Christmas shopping, (6) visiting an aquarium, (7) employees in an office, and (8) a trip to the zoo. The practice story consisted of 23 sentences (264 words), and the 8 experimental texts ranged from 84-118 sentences (1046-1405 words) in length. All texts were presented in a single-space, single-paragraph format. They were printed on a single piece of paper in Times New Roman 12-pt font. Every sentence contained either a change in character (*character shift*), a change in spatial location (*spatial shift*), or no change (*no shift*). Each story contained 4 character shift sentences and 4 spatial shift sentences. (The stories used in this experiment can be found online at pages.wustl.edu/dcl/stimuli).

Segmentation task.—Participants were asked to use a pencil to mark off the stories into the units of activity that seemed natural and meaningful. They were instructed to place a line between two words to mark a boundary when they believed one unit of activity had ended and another had begun.

Attention instructions.—Participants in the control group were instructed to read the texts for comprehension and were asked to write a paragraph summarizing each story. Participants in the character group were instructed, before reading, to pay close attention to the characters in the story because afterwards they would be asked to write a brief description of the physical appearance, personality traits, and general impressions about a specific character. Each story contained at least two characters and the participants did not know which of these characters they would be asked to describe. Thus, they were instructed to pay attention to all of the characters in each story. Participants in the spatial group were instructed to pay close attention to all of the spatial locations described in each story. They were asked to make a "mental map" of where the characters go because they would be asked to draw this map on a piece of paper after each story.

Procedure

Participants were tested in a group setting in a large classroom. They first read and segmented the practice story. Participants in the control group were given an example of an appropriate summary of the practice story, whereas participants in the character group were given an example of an appropriate character description and participants in the spatial group were given an example of an appropriate map. Following the practice story, the experimenter answered questions and then participants completed the 8 experimental texts. For each text, participants read and segmented it and then completed a summary (control group), character description (character group), or drew a map (spatial group). Finally, participants completed a short demographics questionnaire.

Data Preparation

Most of the boundaries marked by participants were placed at sentence breaks; however, some were placed in the middle of a sentence (e.g., after a semicolon). The boundaries placed in the middle of a sentence only made up 3.5% of the segmentation data (Camping

= 3.1%; Castle = 3.5%; Family = 4.1%; Hospital = 2.1%; Shopping = 2.1%; Aquarium = 2.7%; Office = 4.8%; Zoo = 5.6%). Boundaries placed at a sentence break were coded as associated with the sentence following the break. For each sentence, the probability of segmenting was calculated as the number of participants who segmented divided by the total number of participants. Then, the probabilities were averaged separately for all of the sentences containing no shift, a character shift, or a spatial shift. The proportion of participants who segmented is plotted for each sentence in each story in Figure S1 of the Supplementary Materials.

Results and Discussion

Effects of Shifts on Segmentation

Figure 1 plots the probability of segmenting at each shift type for each attentional group. To evaluate whether participants identified our shift sentences as event boundaries and to evaluate whether this differed by attentional instructions, we conducted a 3 (Group: control vs. character vs. spatial) x 3 (Shift Type: no shift vs. character shift vs. spatial shift) mixed ANOVA. The main effect of Shift Type was significant, $F(2,112) = 276.63$, $p < .001$, $\eta^2 = 0.82$. Tukey's *b* post hoc analyses indicated that participants were more likely to segment at a sentence containing a spatial shift ($M = 0.59$) than at a sentence containing a character shift ($M = 0.52$), and they were more likely to segment at both of these sentence types than at a sentence containing no shift ($M = 0.10$). The main effect of Group was also significant, $F(2,56) = 5.66$, $p = .006$, $\eta^2 = 0.20$. Tukey's *b* post hoc analyses indicated that the spatial group ($M = 0.46$) segmented more than did the control group ($M = 0.33$), whereas the character group ($M = 0.41$) did not differ from either of the other groups.

These main effects were qualified by a significant Group x Shift Type interaction, $F(4,112) = 2.62$, $p = .039$, $\eta^2 = 0.02$, indicating that the type of shift that participants identified as event boundaries differed by group. Specifically, the spatial group was more likely to segment at a spatial shift ($M = 0.70$, $SD = 0.19$) than at a character shift ($M = 0.57$, $SD = 0.21$), $t(19) = 2.42$, $p = .026$, $d = 0.65$, whereas the control group was equally likely to segment at a character shift ($M = 0.44$, $SD = 0.21$) and a spatial shift ($M = 0.48$, $SD = 0.17$), $p = .384$, and the same was true for the character group (character shift: $M = 0.55$, $SD = 0.16$; spatial shift: $M = 0.58$, $SD = 0.18$, $p = .408$).

These results indicate that the sentences containing a shift were perceived as event boundaries more often than no shift sentences. Further, the task orientation with which participants read the stories influenced which types of shifts they perceived as event boundaries. Readers who were directed to attend to space segmented more at spatial shifts than at character shifts, whereas readers who were directed to attend to characters segmented equally often at character shifts and spatial shifts. This supports the possibility suggested by Therriault et al. (2006) that explicit instructions to direct attention to particular situational dimensions influences when readers update situation models.

Finally, despite different task orientations, the three groups did not differ in their probability of segmenting at a character shift, $F(2,59) = 2.11$, $p = .131$. The fact that readers identified character shifts as meaningful event boundaries is consistent with previous results showing that when people read narrative text for comprehension, they tend to focus on characters, their properties, and their goals (Albrecht & O' Brien, 1993; Glenberg et al., 1987; Rapp et al., 2001; Rinck & Weber, 2003).

Experiment 2

The results from Experiment 1 indicated that readers segmented at the shift sentences, and that segmentation differed by attentional group. Given that shift sentences were perceived as event boundaries, we assume that readers need to update their situation model at these sentences (Zwaan & Radvansky, 1998). One possibility is that manipulating attention through the use of relevancy instructions may affect situation model updating mechanisms. If relevancy instructions prompt readers to focus on portions of the text that are more relevant their goals, then it is possible that the instructions will influence when event boundaries are perceived (Experiment 1) and, subsequently, what information is updated within the situation model. We hypothesized that readers paying attention to spatial location would be more likely to update spatial information, and to update at spatial changes, than readers paying attention to character information, and vice versa.

If readers' attentional focus can influence situation model updating, what are the mechanisms that are affected? Theories of comprehension have proposed two distinct mechanisms by which situation models are updated. The first is an *incremental* updating mechanism in which information relevant to only the changing dimension is updated in the situation model (Bower & Rinck, 2001; Zwaan et al., 1995). The Event Indexing Model (Zwaan et al., 1995) proposes an incremental mechanism. For instance, when individuals read about a character moving from the parking lot into the store, according to the Event Indexing Model, only information related to the spatial location is updated. Information related to the parking lot is backgrounded, information related to the store is now represented, and information related to the character remains active in the situation model.

Recent work by Curiel and Radvansky (2014) has demonstrated evidence of incremental updating in the context of event indexing. They found that readers slowed down at a spatial shift even when it immediately followed a character shift (and at a character shift that immediately followed a spatial shift). This pattern of results suggests that the initial spatial shift did not lead to updating the character information (or vice versa)—that is, the spatial information was updated incrementally at the spatial shift.

The second updating mechanism is a *global* mechanism in which the entire situation model is updated (Bailey & Zacks, 2015; Kurby & Zacks, 2012; Zacks et al., 2007). When one dimension changes, not only is that dimension updated but also the unchanged dimensions. Event Segmentation Theory, which incorporates such a global mechanism, proposes that when a change occurs and an event boundary is perceived, the entire model is cleared from working memory and a completely new model is built. For example, when individuals read about the same character moving from the parking lot into the store, Event Segmentation Theory proposes that information about the parking lot as well as information related to the character will be removed from the situation model until a new model is constructed.

Reading comprehension studies have provided evidence for global updating by demonstrating that readers update not only information related to the changed dimension but also information related to the unchanged dimension. For example, readers are slower to respond to *objects* mentioned before a *spatial* shift (e.g., Glenberg, Meyer, & Lindem, 1987; Rinck & Bower, 2000), to *objects* mentioned before a *time* shift (e.g., Ditman, Holcomb, & Kuperberg, 2008), and to *spatial* information mentioned before a *time* shift (e.g., Speer & Zacks, 2005).

Incremental and global updating are different memory updating mechanisms. However, situation model updating does not necessarily have to always occur in an entirely incremental or an entirely global fashion. For instance, global updating may occur at changes that are perceived as event boundaries, whereas incremental updating may occur at changes that do not trigger the perception of event boundaries. The Structure Building framework involves both types of updating mechanisms (Gernsbacher, 1990). In this framework, readers incrementally update their situation model to represent the incoming information. However, when there is a large discrepancy between the incoming information and previous information, readers globally update and build an entirely new model.

Two recent studies have provided evidence that both global and incremental updating can occur during a single narrative comprehension experience. Kurby and Zacks (2012) used a think-aloud paradigm to measure the extent to which readers mentioned different dimensions of a narrative situation. When changes occurred along a given dimension that did not correspond to an event boundary (i.e., event middles), readers were more likely to mention just the changing dimension. At perceived event boundaries, readers were likely to mention both changed and unchanged information, from several dimensions. Kurby and Zacks (2012) argued that readers were incrementally updating their situation models at changes that occurred in the middle of an event and globally updating them at event boundaries. In another study, Bailey and Zacks (2015) used the memory updating paradigm that we used in the current study: Participants read narratives that included shifts in the spatial and character dimensions, and also included memory probes testing accessibility of information on those dimensions. They found that the likelihood of using a particular updating mechanism (incremental vs. global) varied with age: Young adults updated more incrementally whereas older adults updated more globally.

A third study used perceptual and memory tasks to attempt to distinguish between global and incremental updating during television viewing. In their first study, Huff, Meitz and Papenmeier (2014) measured long-term memory for event boundaries identified in situation comedies, as a function of the number of changing situational dimensions at each boundary (locations, actions, characters, time). They found that as the number of changing dimensions increased, recognition memory for the event boundary improved. In a second study, they found that viewers' abilities to predict what would happen after the boundary decreased with increasing numbers of situation changes. Huff et al. (2014) interpreted these results as supporting a purely incremental updating mechanism. We will return to this claim in the General Discussion.

To evaluate situation model updating in Experiment 2, the stories were presented on a computer screen one sentence at a time and we used a recognition memory probe technique. Immediately after reading a sentence that contained a shift, participants responded to a probe phrase from the previous situation that was related either to the changed or unchanged situational dimension. To discourage participants from focusing disproportionately on the shift sentence, probe phrases were also included after control sentences that contained no shift. We measured response time and accuracy to the probe phrases on the assumption that responses would be relatively fast and accurate if the information was actively represented in the situation model, whereas responses would be relatively slower and less accurate if the information had been removed from the situation model during shift-related updating. In this paradigm, slower or less accurate recognition responses are used to assess updating. If there is a change on a dimension and responses on either dimension are slowed or less accurate relative to a no-change control, this is evidence of updating.

Incremental updating should affect only the changed dimension. For example, imagine reading about a man who parked his car and then headed into a grocery store. After reading about this change in spatial location, an incremental updating mechanism should lead to slower or less accurate responses to information related to spatial locations in the parking lot. However, incremental updating of the spatial location should not influence accessibility of character information; it is an unchanged dimension. A global updating mechanism, on the other hand, should influence responses to both probes of information about the parking lot (which changed) and about the man (which did not). More generally, when responses to probes of an unchanged dimension are slower or less accurate than probe responses to a no-change control, this indicates the situation model has been updated globally. When responses to probes of a changed dimension are slower or less accurate than responses to probes of an unchanged dimension, this indicates that only the changed dimension of the situation model has been updated, which would be incremental updating.

Attention to situational dimensions may affect both *when* situation model updating happens, and also *what* is updated—whether incremental and global updating mechanisms are engaged. If a reader is attending to one dimension, changes in that dimension may be more likely to lead to global updating. For example, if a reader is tracking spatial information, then reading about a spatial shift might be especially likely to trigger updating of both character and spatial information. Further, if a reader is *not* tracking a dimension while reading, then information related to that dimension may not be updated even during a global update. For example, if a reader was failing to track spatial information, then that information likely is poorly represented in the model and will show little change in accessibility as a function of updating, global or incremental. (Note that this does not mean that a reader could not answer questions about such information; they just would need to rely on other sources such as surface information or long term memory.) Thus, it is possible for global updating to affect only one of the two dimensions if a reader does not represent the other dimension in her situation model. It is also possible for global updating to happen only at one kind of situation change if a reader segments the narrative based only on a dimension of interest.

The main goals of Experiment 2 were (1) to test whether readers update their situation model incrementally, globally, or both, and (2) to evaluate the effects of the attentional manipulation on situation model accessibility.

Method

Participants

Participants were 105 individuals (ages 18 – 29, *M* = 18.98 years, *SD* = 1.53, 90 females) recruited from introductory psychology courses at Washington University St. Louis. Participants were randomly assigned to an attention group: 37 were in the character group, 33 were in the spatial group, and 35 were in the control group. Participants either received course credit or were paid $10 per hour for their participation.

Materials

All participants read the same practice text and 8 experimental texts from Experiment 1. Each of the experimental texts contained 12 recognition memory test trials made up of a sentence containing a probe phrase (e.g., "rosy cheek", "above the sign"), 3 filler sentences, a critical sentence, and a recognition probe phrase (for an example, see Appendix A). The sentence containing the probe phrase set up the new event and included a phrase related either to the characters in the story (e.g., "rosy cheek") or to the spatial locations in the story (e.g., "above the sign"). The 3 filler sentences contained information relevant to storyline but no major changes along the dimensions represented in situation models such characters, space, goals, objects, and time. The critical sentences could contain either a change in character (*character shift*), a change in spatial location (*spatial shift*), or no change (*no shift*). The recognition probe phrases were either targets (e.g., "above the sign") or plausible foils (e.g., "on the table"). Target and foil probe phrases were matched on syllable length according to the MRC Psycholinguistic Database (Wilson, 1988). All probe phrases were either 3 or 4 syllables in length.

Design

The texts were presented one sentence at a time. Participants pressed the spacebar to advance to the next sentence. Each story contained 12 critical sentences: 4 contained no shifts, 4 contained a character shift, and 4 contained a spatial shift. After they read a critical sentence, participants were presented with a warning signal (#####) in the center of the screen for 500 ms followed by a probe phrase. The practice story contained four probe phrases and the 8 experimental texts each contained 12 probe phrases. Of the 12 probe phrases in the experimental texts, 6 were character probe phrases and 6 were spatial probe phrases. Extensive pilot testing identified probe phrases that reduced ceiling effects in response accuracy. The type of shift sentence (no shift, character shift, or spatial shift) was crossed with the type of probe phrase (character probe or spatial probe) resulting in 6 trial types. Thus, we manipulated whether the recognition probe phrase was presented prior to or after the updating process. For two probe types—no shift character probes and no shift spatial probes—phrases were presented and probed within the same event (i.e., event middles in Appendix A), with no shift intervening. These trials were assumed to measure accessibility prior to situation model updating. Other probe phrases were presented following a shift on either the probed dimension (character probes after character shifts or spatial probes after spatial shifts), or a shift on the *other* dimension (character probes after spatial shifts or spatial probes after character shifts). If incremental updating occurs, one would expect responses to be impaired following a shift on the probed dimension relative to shifts on the other dimension. If global updating occurs, one would expect responses to be impaired following a shift on any dimension compared to no shift. Appendix A illustrates this design.

Probe phrases remained onscreen until a response was recorded. Participants were instructed to press the "Y" key as quickly as possible if they had read the phrase in a recent sentence and to press the "N" as quickly as possible if they had not read the phrase. Response times were recorded and no feedback was provided. Immediately after a button was pressed, the next sentence in the story was presented onscreen. Text order (i.e., 1-8 vs. 8-1) and probe phrase type (i.e., target vs. foil) was counterbalanced, and participants were randomly assigned to these conditions.

Attention group.—The same instructions for each group were used from Experiment 1. Again, the control group summarized the stories, the character group wrote character descriptions, and the spatial group drew maps.

Procedure

Participants were seated at a desktop computer and then read the practice text. Participants in the control group were given an example of an appropriate summary of the practice story, participants in the character group were given an example of an appropriate character description, and participants in the spatial group were given an example of an appropriate map. Following the practice story, the experimenter answered questions and then participants read the 8 experimental texts. After each text, participants completed a summary (control group), character description (character group), or drew a map (spatial group) for that story. Finally, participants completed a short demographics questionnaire.

Data Preparation

Sentence reading times were z-scored within participants. Z-scores more than 3.5 standard deviations different from the participant's mean were removed from the analyses. For the sentence reading times, 29 values (0.8% of the data) for the control group, 37 values (1.1% of the data) for the character group, and 57 response time values (1.7% of the data) for the spatial group met this criterion. There were no outliers in the mean accuracy to the probe phrases. The variables were approximately normally distributed ($|\text{skewness}| < 2.0$, $|\text{kurtosis}| < 3.0$).

To control for the large effects of sentence length on reading time, we fit a linear regression for each participant (Ferreira & Clifton, 1986; Trueswell, Tanenhaus, & Garnsey, 1994). The regression predicted reading time for each sentence from the number of words in the sentence, and residuals from these regressions were used to analyze the effects of feature changes on reading time to the critical sentences.

Results and Discussion

Mixed modeling analyses were used to evaluate the effects of attention group on the outcome measures. Linear mixed-effect models were fit to the residual sentence reading times and the probe response times, whereas logistic mixed-effect models were fit to the accuracy data (i.e., responses coded as 0 or 1).

Sentence Reading Times

Mean residual reading times for the shift sentences are shown in Figure 2. A linear mixed model analysis was conducted to evaluate the effects of attention group and shift type on mean residual sentence reading time. The random effect for items was added separately to the model and a likelihood ratio test was performed to assess significance. The random effect of items was significant, $\chi^2(1) = 1498.98$, $p < .001$. The final model contained this random effect as well as the fixed effects of Attention Group (control vs. character vs. spatial) and Shift Type (no shift vs. character shift vs. spatial shift).

The Attention Group x Shift Type interaction was significant, $F(4, 9771) = 10.88$, $p < .001$, such that participants in the spatial group read sentences containing a spatial shift ($M = 0.14$, $SD = 1.31$) slower than sentences containing either a character shift [$M = -0.06$, $SD = 0.76$; $t(2156) = 4.51$, $p < .001$] or no shift [$M = -0.08$, $SD = 0.78$; $t(2185) = 4.95$, $p < .001$], whereas participants in the control group and character group showed no differences in reading times across the three types of shift sentences. Consistent with results of Experiment 1, this pattern of results indicates that instructions to pay attention to space caused readers to slow down (and perhaps update their situation model) when they encountered a change in spatial locations.

Recognition Probe Responses

Accuracy and response times to the probe phrases were compared for those that followed a *no shift* sentence, those that were related to the *unchanged dimension* – character probes following spatial shifts and spatial probes following character shifts – and those that were from the *changed dimension* – character probes following character shifts and spatial probes following spatial shifts. This variable describing the three levels of the changed dimension - probe relationship is referred to as *Updating Condition*.

Response Time.—We used an accuracy threshold of 70% as used in Bailey and Zacks (2015) to ensure that only responses from those individuals who were engaged in the task were analyzed. This resulted in excluding 1 participant in the control group, 1 participant from the character attention group and 3 from the spatial attention group from further analysis. For the remaining participants, we included all trials regardless of whether the participants responded correctly or incorrectly. The mean response times for character and spatial probes following each type of updating dimension condition is plotted separately for each attention group in Figure 3. A linear mixed model on the log-transformed response time data was conducted to assess the effects of attention group, probe type, and updating conditions while modeling the random effect of subjects and items. We also included the number of syllables in the probe phrases as a fixed effect to control for the effects of probe phrase length on response time. The final model included subjects and items as random effects and the fixed effects of Attention Group (control vs. character vs. spatial), Probe Type (character vs. spatial), Updating Condition (no shift vs. unchanged dimension vs. changed dimension), and Syllables (3 vs. 4 syllables).

Neither the fixed effect of Attention Group nor Probe Type were significant, *p*s > .49, indicating that response times were similar across groups and for character and spatial probes. However, the fixed effect of Updating Condition was significant, $F(2, 215) = 5.18$, $p = .006$. Tukey's HSD post hoc analyses indicated that participants responded to probes following no shift ($M = 1296$ ms) significantly faster than probes from the changed dimension ($M = 1355$ ms), $p = .002$. Response times in the unchanged dimension condition ($M = 1341$ ms) were marginally different from the no shift condition, $p = .066$, but not significantly different from the changed dimension conditions, $p = .370$. When there was a change along a particular dimension, recognition of probes related to that dimension was slowed significantly, whereas recognition of probes unrelated to that dimension was slowed marginally. The results are more nuanced when we examine the effects of the attention group manipulation.

The Attention Group x Probe Type x Updating Condition interaction was significant $F(4, 7454) = 2.59$, $p = .035$. Next, we break this interaction down by group. For the control group, follow-up contrasts revealed that response times were marginally slower for probes when they were presented after a narrative shift ($M = 1354$ ms) as compared to probes following no shift ($M = 1311$ ms), $p = .053$, which suggests that readers in the control group were updating their situation model at narrative shifts. Further, response times were marginally slower for spatial probes than for character probes, $p = .063$. The character group showed no significant effects of updating.

The spatial group showed the most interesting pattern of situation model updating. Follow-up contrasts revealed that participants responded to probes following no shift ($M = 1291$ ms) significantly faster than probes from the unchanged dimension ($M = 1365$ ms), $p = .038$, and from the changed dimension ($M = 1401$ ms), $p = .002$. Importantly, response times did not differ significantly for probes from the changed and unchanged dimensions, $p = .260$. This effect indicates that readers who are instructed to track spatial locations are globally updating their situation model because all – both changed and unchanged – information is temporarily less accessible following a narrative shift. Further, this effect was more apparent at spatial shifts: the spatial group responded significantly more slowly to all probes following a spatial shift (character probes: $M = 1404$ ms; spatial probes: $M = 1454$ ms) than all probes following a character shift (character probes: $M = 1347$ ms; spatial probes: $M = 1325$ ms), $p = .005$. Thus for the group attending to space, spatial shifts reduced the availability of spatial and character information, consistent with global updating of both dimensions in response to spatial shifts.

Accuracy.—The mean proportion of correctly recognized probe phrases was computed for each participant. Mean response accuracy across all conditions was 80.8%. Figure 4 presents mean accuracy for character and spatial probes following no shift, the unchanged dimension, and the changed dimension sentences separately for each attention group. A logistic mixed effects model was conducted to assess the effects of attention group, probe type, and updating condition on probe phrase accuracy given that, for each trial, accuracy was a dichotomous variable (i.e., correct vs. incorrect). Random effects for participants and items were added separately to the model and a likelihood ratio test was performed to assess significance. The random effect of participants was significant, $\chi^2(1) = 195.91$, $p < .001$, as was the random effect of items, $\chi^2(1) = 1095.0$, $p < .001$. The final model retained both the random effects of participants and items as well as the fixed effects of Attention Group (control vs. character vs. spatial), Probe Type (character vs. spatial), and Updating Condition (no shift vs. unchanged dimension vs. changed condition).

The analysis revealed no significant fixed effects or interactions, all *F*s < 1.0.

General Discussion

The main goal of the two studies was to evaluate whether manipulating readers' attentional focus influenced how narratives are segmented and how situation models are updated. The results of both experiments suggest that instructions to pay attention to characters, spatial location, or simply to read for comprehension affected the points at which situation models were updated, and which elements of those models were updated.

The results of Experiment 1 demonstrated that readers perceived the spatial and character changes in the narratives as event boundaries. Moreover, participants who attended to space were more likely than the other participants to segment at a spatial change, which suggests that intentionally tracking space increases the likelihood that event models are structured by space. Experiment 2 provided converging evidence for the idea that attending to space caused readers to read and update differently than those attending to characters or those reading for comprehension. Specifically, participants in the spatial group read sentences containing a spatial shift more slowly than those containing a character shift and those containing no shift. They also showed evidence of updating their situation models at spatial shifts, and they did so in a global manner (see Figure 3). That is, participants who attended to space responded to both spatial and character recognition probe phrases that followed a change in spatial locations slower than they responded to probe phrases that followed either a character shift or a no shift sentence.

Our account of these spatial updating results is that readers attending to space build new situation models at changes in space. This results in reduced accessibility of information from the old models, whereas information in the current situation model is highly accessible and maintained in a stable state until a new shift is encountered (Kurby & Zacks, 2012; Zwaan & Madden, 2004). In contrast, however, some have argued that the accessibility of spatial information waxes and wanes depending on memory-based resonance between the current textual input and spatial information stored in memory from the prior text (de Vega, 1995; Smith & O'Brien, 2012; O'Brien, Rizzella, Albrecht, & Halleran, 1998). According to these accounts, previously mentioned spatial information is rendered more accessible when cued by spatial information in the current text input. In fact, Smith and O'Brien (2012) found that readers did not reactivate spatial information when textual references to that spatial information were removed, but they did when specifically told to track the movements of the protagonist. Our data are somewhat consistent with these findings, but they also suggest readers are using mental models to understand these stories; when readers encountered a shift in spatial locations, the no-longer-relevant spatial information as well as information related to other situational dimensions (i.e., characters) was reduced in accessibility.

Instructions to pay attention to characters did not appear to affect participants' reading times or memory updating. One likely possibility is that readers naturally track the character dimension. Previous work has demonstrated repeatedly that protagonists are important for comprehension (Zwaan & Radvansky, 1998) and readers track them closely (e.g., Albrecht & O' Brien, 1993; Glenberg, et al., 1987; Rapp et al., 2001; Rinck & Weber, 2003; Zwaan et al., 1995). Further, Therriault et al. (2006) report that character shifts influenced situation model processing regardless of attentional instructions. They found that all readers slowed down when reading about a change in characters.

In fact, we observed striking similarities between the character and control groups across both studies. They demonstrated similar patterns of segmentation, shift sentence reading times, as well as accuracy rates and response times to probe phrases (see Figures 1-4). Thus, one possibility is that participants in the control and character groups were reading and updating their situation models in a very similar manner. Importantly though, readers may not naturally track space as closely as they do characters (Zwaan, Radvansky, Hilliard, & Curiel, 1998). Thus, when they are instructed to attend to space, their goals, reading processes, and situation model updating are affected.

Global and Incremental Mechanisms

The pattern of results from Experiment 1 suggests that attentional demands modulate *when* readers update their situation models, but the results from Experiment 2 suggest that attentional demands modulate *what* they update in their situation models. In particular, participants instructed to attend to spatial characteristics of the narratives updated both character and spatial information at narrative shifts, which was consistent with global updating.

Surprisingly, these data do not provide evidence for incremental updating. In most cases, response times to a probe were slower when they were presented after a situational change, even when the probe came from an unchanged dimension. For instance, when reading about a character Mike moving from his office into a conference room, participants' responses to information about Mike (e.g., "bushy eyebrows") was affected. Even though his bushy eyebrows presumably remained unchanged as he walked from his office to the conference room, this unchanged information was temporarily reduced, leading to slower response times. This is of course not evidence that incremental updating does *not* occur, and other studies provide evidence that it does (e.g., Curiel & Radvansky, 2014; Huff et al., 2014; Kurby & Zacks, 2012).

As we described in the Introduction, Huff et al. (2014) evaluated updating during television viewing and interpreted their results as indicating a pure incremental updating mechanism. This interpretation was based on the fact that increasing numbers of situation dimension changes were associated with graded increases in recognition memory and decreases in prediction accuracy. However, we would suggest that the long-term memory and prediction methodologies do not actually allow one to discriminate between incremental and global updating, for at least two reasons. First, because performance was averaged across participants, for any individual a particular point in time is only probabilistically associated with being an event boundary. An alternative to the interpretation of Huff et al. is that each individual updated globally when they perceived an event boundary, but the probability of experiencing an event boundary increased with the number of situation dimension changes (Magliano, Miller & Zwaan, 2001; Zacks et al., 2009). Second, to discriminate incremental from global updating, the most diagnostic information to test is information that remains unchanged from one event to the next. If global updating occurs, this information should be temporarily removed from working memory at an event boundary, whereas if incremental updating occurs, this information should remain accessible in working memory. The present experiments were designed precisely to compare changed and unchanged information (see also Bailey & Zacks, 2015). However, Huff et al. (2014) did not evaluate whether the unchanged information was updated.

To systematically evaluate the effects of change along only one dimension in the current experiments, the narratives used contained shifts along only the spatial dimension or the character dimension. Thus, a limitation was that we were unable to assess other situational dimensions (e.g., time and causality).

Conclusion

Readers slow down and update their situation models when information related to characters and spatial locations changes throughout a narrative. Most important, the process of reading and situation model updating is significantly affected when readers are instructed to attend to space. Consistent with previous work using relevancy instructions (see McCrudden & Schraw, 2007), we found that instructing readers to attend to space affected text processing. Importantly, we found that instructions to attend to space influenced readers' strategic control of moment-to-moment text processing, as measured by event segmentation and online recognition memory performance. Readers attending to space were more likely to identify spatial shifts as meaningful changes in the story and updated their entire situation model in response to these spatial shifts. These insights into strategic control of online text processing inform theories of how humans read and understand narratives, which in turn, might inform theories of how we perceive and understand our world.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Appendix A

Example of a narrative text.

SET UP SENTENCES	Jim and Kathy were preparing to take their kids on their first camping trip, and they were a little nervous. They had waited longer than their friends to have children. Most of the time they were very happy with this decision; they relished the thought of being retired by the kids' late adolescence and having the time to take long trips with them. They felt they were wiser, more patient parents than they would have been twenty years ago. Both had been workaholics in their joint law practice, and it had paid off in a level of financial security. They could afford to slow down, to take time to really enjoy the kids. But they felt a distance from the other parents, and they were at times self-conscious about being perhaps a little less active. Camping was important.	
SENTENCE WITH PROBE PHRASE	Jim picked up his keys from the basket by the front door and paused.	
FILLER SENTENCE 1	The basket was supposed to be a place for just keys, but his were always buried under everything else in there.	
FILLER SENTENCE 2	Jim hated how it became a place to keep junk.	
FILLER SENTENCE 3	From now on he would keep it clean, he vowed.	
SPATIAL SHIFT	He found his keys and walked into the garage.	**EVENT BOUNDARY**
SPATIAL PROBE	BY THE FRONT DOOR (**TARGET**); BY THE BIG TREE (**FOIL**)	
FILLER SENTENCE A	“I don’t like the look of those clouds,” Jim thought.	
FILLER SENTENCE B	He remembered that the forecast said it would be in the upper seventies and sunny the rest of the weekend, so he felt the weather would improve.	
SENTENCE WITH PROBE PHRASE	As soon as he entered the garage Jim spotted the tent he had stored in the rafters.	
FILLER SENTENCE 1	He loved getting out into nature and was excited about getting everything ready for the trip.	
FILLER SENTENCE 2	He knew he wasn’t very organized about this, but he figured he would find everything if he just looked around.	
FILLER SENTENCE 3	Unfortunately he already had a nagging feeling that he’d probably forget something.	
NO SHIFT	He looked around for other things one would need for a camping trip.	**EVENT MIDDLE**
SPATIAL PROBE	IN THE RAFTERS (**TARGET**); ABOVE THE SHELF (**FOIL**)	
FILLER SENTENCE A	“Ah ha! There it is,” he exclaimed.	
SENTENCE WITH PROBE PHRASE	On the top shelf in the corner, Jim saw the box that his wife had conveniently labeled “Camping Gear”.	
FILLER SENTENCE 1	As he pulled it down, the sleeping bags that had been piled on top fell down around him.	
FILLER SENTENCE 2	“At least I won’t forget those,” he muttered as the last one bounced off his shoulder.	
FILLER SENTENCE 3	Opening the tote, he found matches, fire starter, flashlights, camping dishes, and some random pieces of rope.	
CHARACTER SHIFT	Walking into the garage, Kathy laughed at the pile of stuff surrounding her husband.	**EVENT BOUNDARY**
SPATIAL PROBE	IN THE CORNER (**TARGET**); IN THE DOORWAY (**FOIL**)	
FILLER SENTENCE A	He was sitting on the floor, digging through the tote.	
FILLER SENTENCE B	“Jackpot,” he thought to himself.	
FILLER SENTENCE C	Kathy looked up at the rafters.	

SENTENCE WITH PROBE PHRASE	Pulling back her short black hair, she asked, “Need some help?”	
FILLER SENTENCE 1	Taking a step stool, she pulled the tent down from the rafters and handed it to her husband to load into the car.	
FILLER SENTENCE 2	Putting the stool back, she walked over to the shelves in the corner.	
FILLER SENTENCE 3	She pulled out the other box of camping gear that she herself had packed and labeled.	
NO SHIFT	Inside the box, on top of everything else, was a packing list for camping trips that she had made.	**EVENT MIDDLE**
CHARACTER PROBE	SHORT BLACK HAIR (**TARGET**); OUTSTRETCHED ARMS (**FOIL**)	
FILLER SENTENCE A	The list was neatly arranged by category.	
SENTENCE WITH PROBE PHRASE	Kathy was glad she was so much more organized than her husband.	
FILLER SENTENCE 1	She pulled out the list and passed the box to her husband to put in the car.	
FILLER SENTENCE 2	She quickly scanned the list and, satisfied, put it into her pocket.	
FILLER SENTENCE 3	“That’s everything from out here—I’ll go get the kids,” Kathy said.	
CHARACTER SHIFT	Jim leaned against his workbench to wait.	**EVENT BOUNDARY**
CHARACTER PROBE	ORGANIZED (**TARGET**); EFFICIENT (**FOIL**)	
FILLER SENTENCE A	Kathy thought the boys were probably downstairs playing.	
FILLER SENTENCE B	Jim heard her call to them as the screen door closed behind her.	
SENTENCE WITH PROBE PHRASE	Jim scratched his graying beard as he waited.	
FILLER SENTENCE 1	He was excited about taking the kids on this trip.	
FILLER SENTENCE 2	They were going to the same place he had gone camping as a kid.	
FILLER SENTENCE 3	It was halfway up the mountain that their town was named for.	
NO SHIFT	The drive would take them about two hours today because it was Memorial Day weekend and Jim knew traffic would be bad.	**EVENT MIDDLE**
CHARACTER PROBE	GRAYING BEARD (**TARGET**); SHORT MUSTACHE (**FOIL**)	
FILLER SENTENCE A	He wondered what time it was.	
SENTENCE WITH PROBE PHRASE	Jim drummed his fingers on the workbench as he began to become impatient.	
FILLER SENTENCE 1	They still had to stop for gas, groceries, and breakfast at McDonald’s before they could even leave town!	
FILLER SENTENCE 2	He was glad when his family came out, and he began loading their camping supplies into the car.	
FILLER SENTENCE 3	”Let’s go!” he said	
SPATIAL SHIFT	They pulled out of the driveway and, five minutes later, pulled up to a gas pump.	**EVENT BOUNDARY**
SPATIAL PROBE	ON THE WORKBENCH (**TARGET**); ON THE BOOKSHELF (**FOIL**)	
FILLER SENTENCE A	Jim ran his credit card at the pump and took the nozzle to start filling the car.	
FILLER SENTENCE B	As the gas pumped, Jim watched the numbers whizzing higher.	
FILLER SENTENCE C	He was a little worried about sleeping on the ground tonight.	
SENTENCE WITH PROBE PHRASE	He had been standing for five minutes and already his achy back was bothering him.	
FILLER SENTENCE 1	He mentally added aspirin to the grocery list.	

FILLER SENTENCE 2	The list was getting longer, and he hoped it wouldn't take too long at the store.	
FILLER SENTENCE 3	Fortunately, the gas had just finished pumping.	
SPATIAL SHIFT	Jim took his receipt and they drove to the grocery store.	**EVENT BOUNDARY**
CHARACTER PROBE	ACHY BACK (**TARGET**); STIFF ANKLES (**FOIL**)	
FILLER SENTENCE A	Jim grabbed a cart as he and Kathy walked into the store.	
FILLER SENTENCE B	He followed behind with it as they walked through the store.	
SENTENCE WITH PROBE PHRASE	He paused to clean his bifocals.	
FILLER SENTENCE 1	He was embarrassed that his eyesight was so bad already.	
FILLER SENTENCE 2	Looking at the groceries on the shelf, he sometimes had to squint to read the brand names.	
FILLER SENTENCE 3	"I hope the kids don't inherit my terrible eyesight," he thought as he grabbed the aspirin for his back.	
CHARACTER SHIFT	Kathy expertly led the way through the store, taking the things they needed from the shelves.	**EVENT BOUNDARY**
CHARACTER PROBE	BIFOCALS (**TARGET**); OLD GLASSES (**FOIL**)	
FILLER SENTENCE A	She had her list organized by type of food and section of the store.	
SENTENCE WITH PROBE PHRASE	It helped that it was summer and all the standard camping food was at the front of the store.	
FILLER SENTENCE 1	Kathy was very proud of what an efficient shopper she was.	
FILLER SENTENCE 2	In addition to the hot dogs and hamburgers, Kathy picked up a bunch of snacks.	
FILLER SENTENCE 3	She chose granola bars and trail mix, because she tried hard to keep her family healthy.	
CHARACTER SHIFT	Jim didn't like that there wasn't any candy going into the cart.	**EVENT BOUNDARY**
SPATIAL PROBE	AT THE FRONT (**TARGET**); ON THE GROUND (**FOIL**)	
FILLER SENTENCE A	Jim appreciated Kathy's attempts to make them eat well, but he was on vacation now and really just wanted some sugar.	
FILLER SENTENCE B	He knew the kids would agree.	
FILLER SENTENCE C	He liked to spoil them.	
SENTENCE WITH PROBE PHRASE	They passed the candy aisle, and Jim took advantage of the opportunity.	
FILLER SENTENCE 1	He grabbed a giant bag of M&Ms, plus a few other treats.	
FILLER SENTENCE 2	He buried them in the cart beneath Kathy's bag of carrots.	
FILLER SENTENCE 3	"We're getting stuff for s'mores, right?" he asked.	
NO SHIFT	Jim knew you couldn't have a camping trip without s'mores.	**EVENT MIDDLE**
SPATIAL PROBE	CANDY AISLE (**TARGET**); CHECKOUT LINE (**FOIL**)	
FILLER SENTENCE A	"I guess we can," Kathy conceded.	
FILLER SENTENCE B	Jim grinned and threw the ingredients into the cart: marshmallows, chocolate bars, and graham crackers.	
SENTENCE WITH PROBE PHRASE	He considered himself a devoted father, and was determined to give his kids the full childhood camping experience.	
FILLER SENTENCE 1	He checked the cart; it seemed that they had everything they needed.	
FILLER SENTENCE 2	"Let's check out and get out of here," Jim said.	
FILLER SENTENCE 3	He paid for the groceries in the self-checkout to save time.	

SPATIAL SHIFT	He grabbed the bags, took them out and loaded them in the car, and they drove away.	**EVENT BOUNDARY**
CHARACTER PROBE	DEVOTED (**TARGET**); CHILDISH GRIN (**FOIL**)	
CONCLUDING SENTENCES	The drive up the mountainside towards the campgrounds was beautiful. The kids really seemed to enjoy the idea of camping on the mountain. They pulled up to their camp spot and began to unpack. Jim told the boys that if they helped him put the tent up that he would take them to check out the nearby stream. The tent went up easier than Jim and Kathy thought it would. "Just in time," they thought, because they were getting hungry again. Kathy set up the grill and started getting some burgers ready. She told Jim to take the kids to the stream and that the food would probably ready in half an hour or so. As she watched them walk off, she happily thought to herself that this was going to be a rewarding trip. She began cooking and soaked in every second of being outside and on vacation.	

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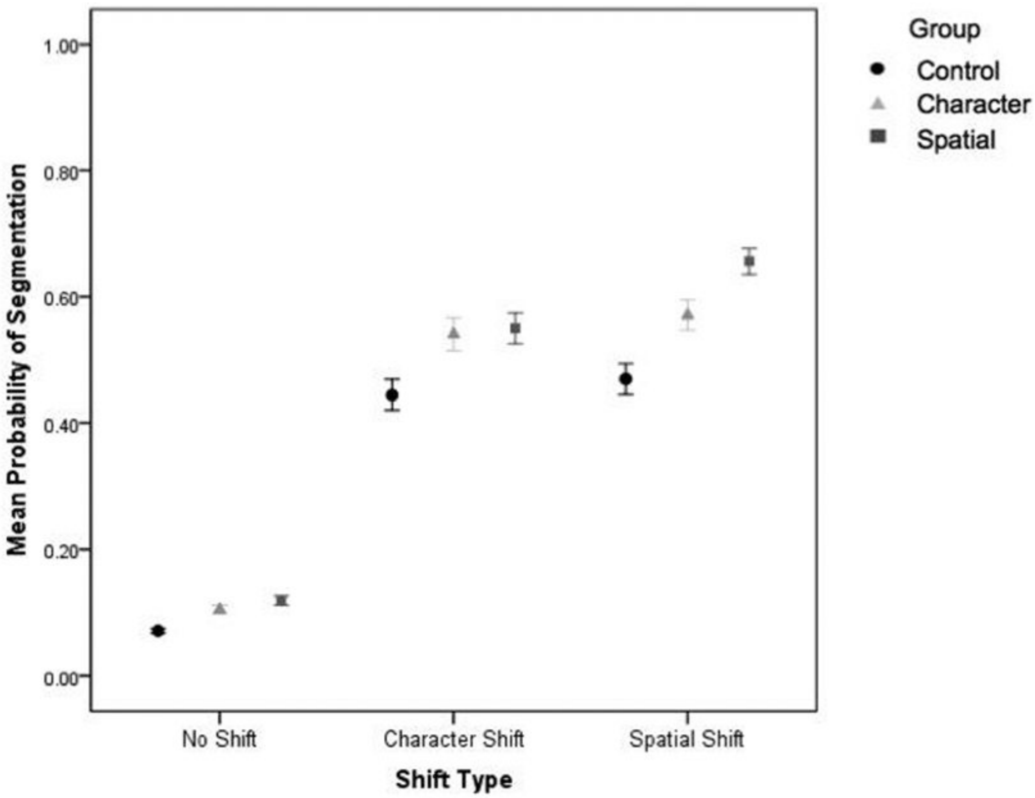

Figure 1.

Mean probability that each attention group segmented at a no shift, character shift, and spatial shift sentence in Experiment 1. Error bars are standard errors of the mean.

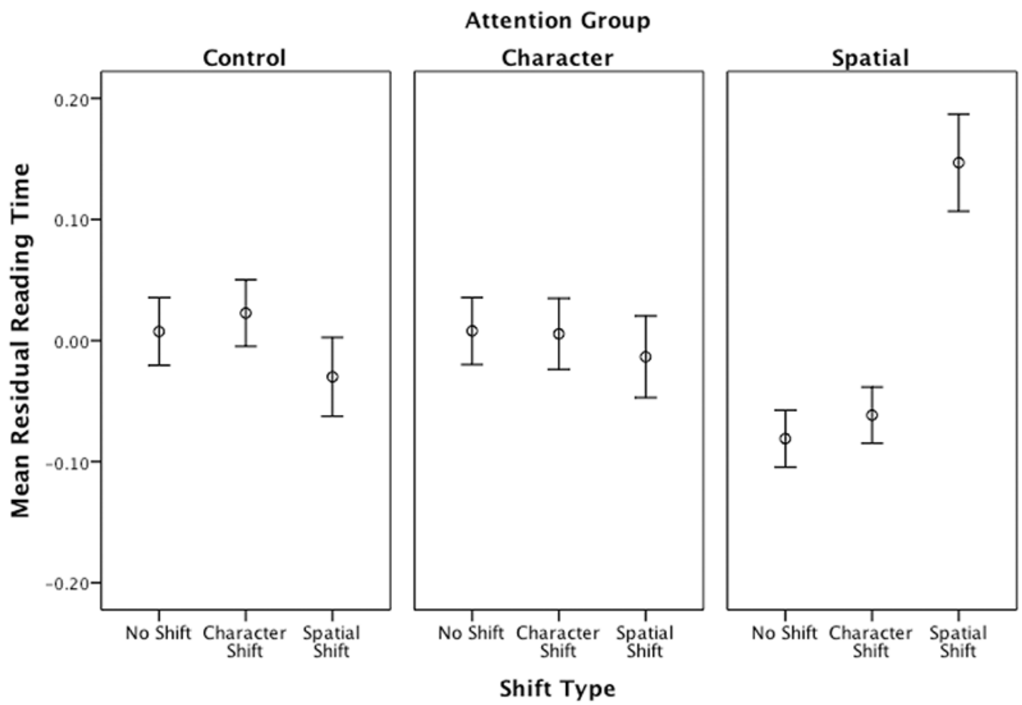

Figure 2.
Mean residual sentence reading time each attention group on the no shift, character shift, and spatial shift sentences in Experiment 2. Error bars are standard errors of the mean.

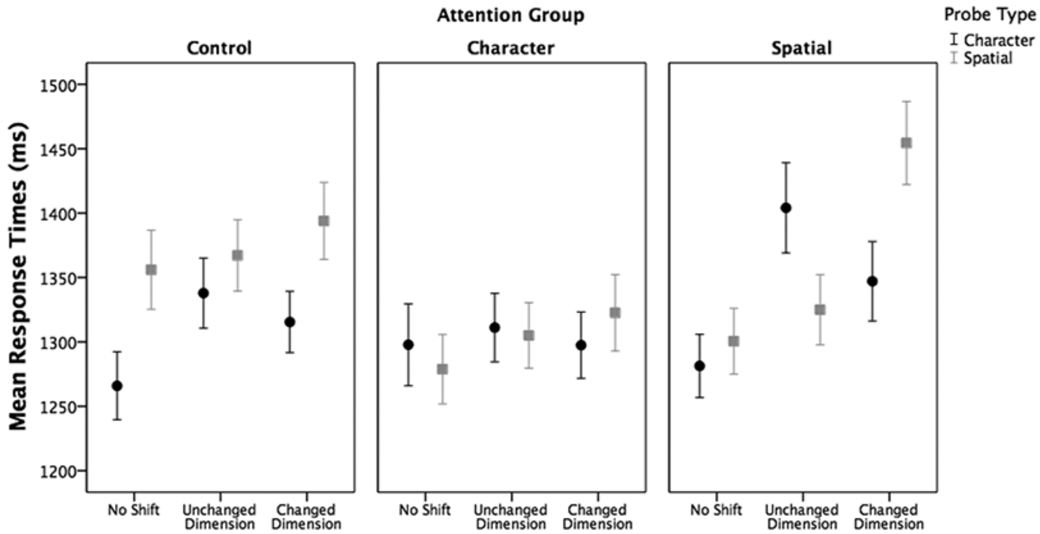

Figure 3.

Mean response time to the probe phrases presented after no shift, probe phrases related to unchanged information, and probe phrases related to the changed information for each attention group in Experiment 2. Error bars are standard errors of the mean.

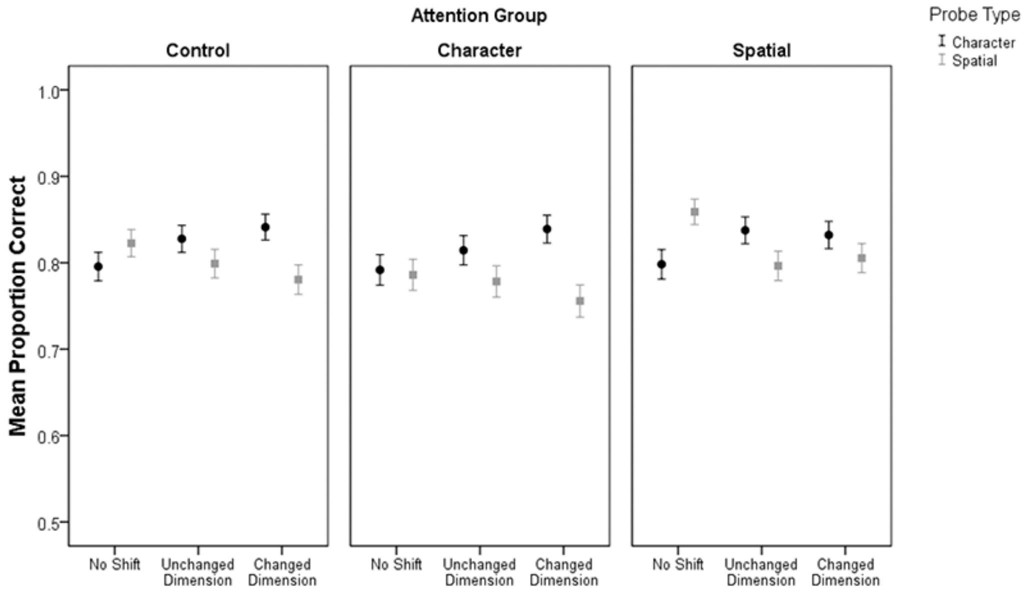

Figure 4.
Mean accuracy to the probe phrases presented after no shift, probe phrases related to unchanged information, and probe phrases related to the changed information for each attention group in Experiment 2. Error bars are standard errors of the mean.