On-line Interactions of Context and Grammatical Aspect

Sarah E. Anderson (sec57@cornell.edu)[a],
Teenie Matlock (tmatlock@ucmerced.edu)[b],
Michael J. Spivey (spivey@ucmerced.edu)[b]
[a] Department of Psychology, Cornell University, Uris Hall, Ithaca, NY 14853 USA
[b] Cognitive and Information Sciences, University of California, Merced, Merced, CA 95344 USA

Abstract

What role does *grammatical aspect* play in the time course of understanding motion events? Although processing differences between past progressive (*was walking*) and simple past (*walked*) aspect suggest differences in prominence of certain semantic properties, details about the temporal dynamics of aspect processing have been largely ignored. The current work uses mouse-tracking (Spivey, Grosjean, & Knoblich, 2005) to explore motor output in response to contextual descriptions and aspectual forms. Participants heard descriptions of terrain (difficult or easy) and motion events described with either the past progressive or simple past while placing a character into a scene to match this description. Overall, terrain descriptions modulated responses to past progressive more than to simple past in the region of the screen corresponding to the path. These results, which suggest that perceptual simulation plays a role in the interpretation of grammatical form, provide new insights into the understanding of event descriptions.

Keywords: Language Processing; Event Understanding; Mouse-Tracking; Embodied Cognition; Motion Verbs

The emerging consensus is that language influences thought (see Boroditsky, 2000; Lucy, 1992; Matlock, Ramscar, & Boroditsky, 2005), but the extent to which this generalizes is uncertain. *How* does language influence the way people think about everyday events? Can grammar influence the way events are conceptualized, and if so, how? Does hearing just "-ed" versus "-ing" on a motion verb influence listeners' cognitive processing and motor response, and if so, how? The goal here is to explore the influence of grammatical aspect on the conceptualization of motion events. The main question is how grammar and contextual descriptions differentially influence motor output as people understand language.

Many language theorists have observed that grammatical aspect provides temporal information about the internal structure of a verb, specifically providing information about the completion, duration, or repetition of the action (Comrie, 1976; Frawley, 1992). This temporal information, though subtle, can exert a substantial influence on the way a sentence is understood. Take, for example, the following sentences: "David ran to the university," and "David was running to the university." Both convey information about an event that occurred in the past, although they use different aspectual forms. The first sentence uses the simple past form of the verb "ran," emphasizing the completion of the action. In contrast, the second uses the past progressive form, emphasizing the ongoing nature of the action. Despite agreement that aspect provides such temporal "coloring" of a verb's information, potential processing differences between these aspectual forms have received little attention in psycholinguistic research.

More recently, however, aspect was explored in a series of offline studies that examined spatial outcome differences in response to simple past and past progressive verbs (Matlock, Fausey, Cargill, & Spivey, 2007). Participants read a sentence like "This morning David walked to the university" (simple past) or "This morning David was walking to the university" (past progressive), and looked at a schematic drawing that showed a path leading to the destination described in the sentence and ten unevenly spaced identical silhouette characters on the path (e.g., pedestrian with leg extended forward and arms bent as if in motion). Participants were instructed to "circle the man that the sentence is most naturally referring to." In brief, participants were more likely to circle a character in the middle region of the path with sentences containing past progressive verbs (*was walking*), and more likely to circle a character in the latter region of the path in response to sentences containing a simple past verb (*walked*). A similar pattern emerged in a subsequent experiment in which participants were asked to indicate where along the path an object had been dropped after reading simple past or past progressive sentences. These and other results suggest that when participants read simple past sentences, they focus on the end of the path, or the location of the completed action in the scene. In contrast, when participants read past progressive sentences, they focus on the middle section of the path, where the ongoing action would be taking place. These data suggest that different aspectual forms have consequences for thinking about motion events, but questions about the time course of processing remain.

On-line processing differences were initially addressed in a series of experiments by Madden and Zwaan (2003), in which the authors demonstrated different aspectual forms produce reaction time differences in narrative reading. Their participants were quicker to respond to pictures showing a completed action after they had read a sentence containing a simple past verb (e.g., The car sped through the intersection) versus a sentence containing a past progressive verb (e.g., The car was speeding through the intersection). However, no such latency differences were found when participants read sentences containing past progressive verbs and saw pictures of intermediate action. The authors suggest that the effect was missing in the past progressive condition because readers represented the ongoing action at different stages of completion. In other words, past progressive verbs could potentially correspond to any of a number of intermediate actions, and this could be un-captured by picture verification and reaction time tasks. Therefore, their results suggest that different aspectual forms lead to processing differences in real time. (For other work on aspect and spatial representation, see Ferretti, Kutas, & McRae, 2007; Magliano & Schleich, 2000; Morrow, 1985).

Such reaction time data have revealed valuable insights into the processing of aspect. However, as suggested by the work of Madden and Zwaan (2003), they are somewhat limited when investigating diffuse representations. In addition to such offline and reaction time experiments, there is a great deal of information about real-time cognitive processing in the dynamics of the response. For example, evidence suggests that factors influencing latency to respond also influence later aspects of response dynamics meaning that the temporal dynamics of the motor movement that executes a response contain volumes of virtually untapped data. As a simple example, Abrams and Balota (1991) asked participants to perform a lexical decision task by making rapid limb movements in opposite directions to indicate whether a string of letters was a word or not. As expected, they found that the frequency of the word influenced reaction time, with high frequency words eliciting faster responses than low frequency words. Also, they found that word frequency influenced response kinematics after the response was initiated. Responses to high frequency words were executed with greater force than responses to low frequency words (Abrams & Balota, 1991). These findings suggest that word frequency not only influences the time required to recognize a word, but also influences response dynamics, implying that the response system is not slavishly executing a completed command regarding the categorical status of the word. This makes a compelling case for looking not only at reaction time differences, but also at variables of the motor movements themselves initiated in response to a stimulus.

To better understand the potential differences in the on-line processing of different aspectual forms, we have employed the methodology of *computer-mouse tracking*. Monitoring the streaming x- and y-coordinates of goal-directed mouse movements in response to spoken language is a useful indicator of underlying cognitive processes. In contrast to ballistic saccades, arm movements allow for a continuous, smooth motor output within a single trial to complement eye-tracking research. Spivey, Grosjean, and Knoblich (2005) demonstrated that these mouse movements can be used to index the continuous activation of lexical alternatives. By recording the x,y coordinates of the mouse as it moved with the goal-directed hand motion to click on the appropriate object, competition between the partially activate lexical representations was revealed in the shape and curvature of the hand-movement trajectories.

Further, some of our own data indicates that mouse-tracking is useful and informative for exploring research questions on the on-line processing of grammatical aspect (Anderson, Fausey, Matlock, & Spivey, 2008). In one experiment, participants listened to sentences like, "Tom jogged to the woods and then stretched when he got there," or "Tom was jogging to the woods and then stretched when he got there." While participants heard these sentences, they saw scenes consisting of a path curving upwards from left to right, and terminating at the destination described in the sentence. A character was located to the right of the beginning of the path and under the destination, separated from the scene by a black box framing the destination and path. Similar to our earlier offline results, participants dropped the character closer to the center of the path with past progressive verbs and closer to the destination with simple past verbs. Further, the two aspectual forms elicited significantly different movement durations: Participants moved the character into the scene for a longer duration of time with past progressive verbs than when they heard sentences containing simple past verbs. These drop location and movement duration results converge with and further inform earlier research, supporting that past progressive aspect focuses attention on the on-going nature of the action while simple past aspect focuses attention on the end state of that action, even during real time processing.

In the current experiment, we sought to extend these findings by investigating the way verbal aspect may interact with terrain descriptions. Research has shown that context descriptions interact with fictive motion verbs to produce both differences in patterns of eye movements and in reaction times (Matlock, 2004; Richardson & Matlock, 2007). However, the impact of such descriptions on grammatical aspect has not been explored. Here we use mouse-tracking methodology to investigate how different aspectual forms interact with similar context descriptions. Participants heard two sentences. The first provided a contextual description of the path and the second manipulated grammatical aspect. For example, on target trials participants heard a context sentence describing the path as either difficult (i.e., "The road to the university was rocky and bumpy") or easy ("i.e., "The road to the university was level and clear"), before a target sentence containing either a simple past verb (i.e., "David walked to the university where he sat in class") or a past progressive verb (i.e., "David was walking to the university where he sat in class"). While hearing these sentences, participants saw scenes containing a diagonal path that originated halfway up the screen and extended from the extreme left to the top and center of the screen (corresponding to the destination in the sentence). The orientation of the path was changed to this short, diagonal path from the long, curvy path of earlier research (Matlock, et al., 2007; Anderson, et al., 2008) to allow for more thorough and precise investigations of potential spatial and movement duration differences. A character was located to the right of the beginning of the path and under the destination. It was separated from the scene by a black box framing the destination and path.

We explored several hypotheses. If past progressive verbs sentences elicit more attention to the path, then the effect of context description was expected to be greater with past progressive verbs than when they contained simple past verbs. Specifically, we predicted that context would modulate movement durations and spatial attraction to the path more in the past progressive sentences than in the simple past verb sentences. Further, we wanted to explore the influence of the visual scene's path on movement durations.

The visual scene---with a path starting halfway up the screen---would enable us to examine if the trajectories produced in response to each aspectual form would reliably differ for the entire trajectory of the hand or only in the region of the screen corresponding to the path. If differences emerged across the entire trajectory, then the effect of grammatical aspect would appear to be more global, and to exert influence across the entire event description. However, if differences emerged only in the region of the screen corresponding to the path, then the effect of grammatical aspect would appear to be specific to the parts of the event it describes.

Method

Participants. A total of 64 undergraduates at Cornell University participated in the experiment for extra credit in psychology courses. All participants were right handed and native speakers of American English.

Materials. Twelve sentences were created from adapting the stimuli used in the offline studies of Matlock et al. (2007). As we hoped to elicit movements across the extent of the scene, from which we could extract differences in motor dynamics between the two conditions, a final clause that described an event at the destination was added, encouraging movement all the way to the destination. Similarly, two contexts for each stimulus were created. Hence, four versions of each of the 12 experimental items were created, as shown in (1) below: (1a) rough context description, simple past verb, (1b) rough context description, past progressive verb, (1c) smooth path description, simple past verb, (1d), smooth path description, past progressive verb.

1a) *The road to the university was rocky and bumpy*. / David walked to the university where he sat in class.
1b) *The road to the university was rocky and bumpy*. / David was walking to the university where he sat in class.
1c) *The road to the university was level and clear*. / David walked to the university where he sat in class.
1d) *The road to the university was level and clear*. / David was walking to the university where he sat in class.

Sentences were recorded using a Mac-based speech synthesizer program. Each of the 12 experimental items was spliced in order to produce both a past progressive and a simple past version, ensuring that the prosody of both of the targets were otherwise identical. Similarly, the context description was spliced onto the beginning of each of these target sentences. A pause of one second separated the offset of each context sentence from the onset of the target sentence. The experimental items were counterbalanced across four presentation lists. Each list contained three instances of each condition, so that all participants heard all twelve target sentences, but only heard one version of each.

Corresponding visual scenes were created for each target sentence pair. Each target visual scene consisted of a diagonal path starting halfway up and on the extreme left side of the screen. The path slanted to the right, terminating in the middle at the top of the screen. A character was located to the right of the beginning of the path and under the destination, separated from the scene by a black box framing the destination and path. See Figure 1. The depicted items in the scene were taken from clipart and edited in Adobe Photoshop. The only moveable item in the scene was the character, which subtended an average of 1.53 degrees of visual angle in width by 2.05 degrees in height. The destinations were an average of 11.22 degrees of visual angle in width by 4.09 degrees in height, and the path itself occupied a square of 8.42 degrees of visual angle in width by 6.11 degrees of visual angle in height. The character was located 14.25 degrees of visual angle from the destination. The stimuli were presented using Macromedia Director MX, and mouse movements were recorded at an average sampling rate of 40 Hz. The display resolution was set to 1024 x 768.

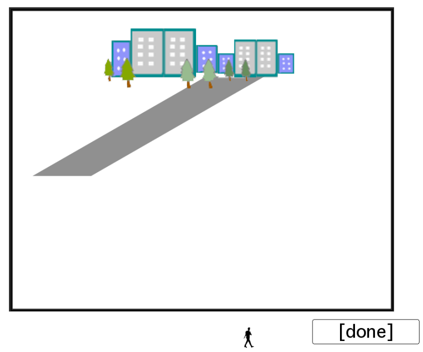

Figure 1: Example target visual scene accompanied by target sentences (1a, 1b, 1c, or 1d).

Additionally, to keep participants from developing strategies specific to the experimental sentences, 12 filler items were created. The fillers were of the same form as the target sentences: each contained a context description and either a past progressive or simple past verb. These filler trials varied from the target trials such that the context description provided no information about the path (i.e., "The weather in the valley was warm and humid") and such that they described no movement along the path (i.e., "Janet swam in the pool and then dried in the sun,"). These filler items were accompanied by 12 filler scenes, created using a short path beginning on the right side of the screen and slanting to the top, center of the screen. Besides the direction of the path, each filler scene was quite similar to the target scenes, for instance, character outside of a scene that contained the path and destination mentioned in the filler sentence.

Procedure. Participants were asked to make themselves comfortable in front of the computer, and allowed to adjust the mouse and mouse-pad to a location that suited them. First, participants read instructions to place the character in the scene to make the scene match the sentences they heard. Upon signaling to the experimenter that they understood the task, they were next presented with two practice trials (similar in form to the filler trials), followed by the experimental task. At the onset of each trail, participants were presented with the entire visual scene. After a 500 ms preview, the sound file began. After the participant had moved the character (though not to any particular location), a "Done" button appeared in the bottom left corner of the screen. Participants clicked this button to move to the next trial. A blank screen with a button in the center labeled "Click here to go on" separated trials from each other. The entire experiment lasted approximately 20 minutes.

Results

Mouse movements were recorded during the grab-click, transferal, and drop-click of the character in the experimental trials. Prior to the analyses, the data were screened to remove extremely long trials. Movement durations 20 seconds or more were removed because they constituted an unusually long time for a mouse-movement. Using this criteria, only three trials(less than 0.4%) of trajectories, were excluded.

Drop Locations. Previous offline results revealed that participants chose a location closer to the middle of the path as the best representative of a sentence containing a past progressive verb, while selecting a location closer to the destination as the best representative of a sentence containing a simple past verb (Anderson, et al., 2008, Matlock, et al., 2007). By plotting the drop point (location along the path where each participant let go of the mouse to "drop" the character) in each of the four conditions, the current results demonstrate a similar trend. See Figure 2. There was not a significant interaction of terrain description and verb aspect (p's > .5). However, there was a main effect of verb aspect when comparing the average drop x-coordinate, $F(1,62) = 8.462$, $p < 0.05$, with the average drop x-coordinate being further left (closer to the path) when participants heard past progressive verbs ($M = 476.71$, $SD = 68.81$) than when they heard simple past verbs ($M = 494.82$, $SD = 61.74$). Similarly, there was a main effect of aspect when comparing the average drop y-coordinate, $F(1,62) = 6.048$, $p < 0.05$, with the average drop y-coordinate being lower (further from the destination) when participants heard past progressive verbs ($M = 219.04$, $SD = 37.02$) than when they heard simple past verbs ($M = 210.65$, $SD = 41.01$). This tendency to drop a character closer to the path in the past progressive condition, and close to the destination in the simple past condition, replicates previous evidence that the ongoing nature implied by a past progressive verb draws attention to the middle portion of the path, whereas there is a tendency to focus attention on the destination in response to simple past verbs.

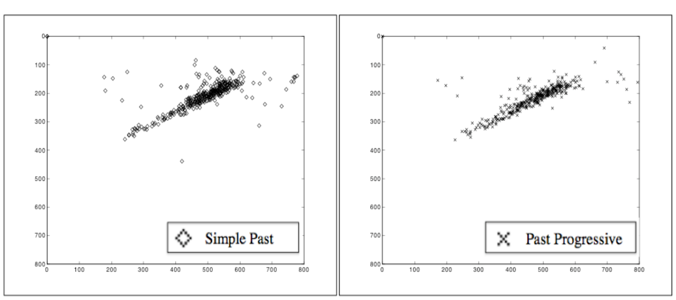

Figure 2: Drop locations in response to simple past verbs (left panel) and past progressive verbs (right panel).

Movement Durations. We began our investigation of online processing by looking at the temporal dynamics of the movement of the character. There was no significant interaction of context and aspect when comparing overall movement durations (i.e., the length of time from the initial grab of the character to the final drop of the character into the scene), p's> .2. There was a significant interaction of context and aspect on movement durations specifically *within in the region of the screen corresponding to the depicted path*, $F(1, 63) = 4.6$, $p < .05$. See Figure 3. In the region of the path, the average movement duration for simple past verbs was not substantially different when the context was first described as rough (M= 2448.33, SD=1848.88) or smooth (M=2478.72, SD= 1527.17). On the other hand, the average movement duration in the region of the path for the past progressive verbs was slower when the context was first described as rough (M = 2667.70, SD=1679.86) than when it was described as smooth (M=2121.88, SD=1240.13). Because simple past verbs focus attention on completed action, context descriptions do not significantly impact the movement dynamics. On the other hand, because past progressive verbs encourage attention to the ongoing-ness of the action, context descriptions of the location of that ongoing action do influence processing. These data extend previous research significantly, suggesting that aspect influences the real-time movement dynamics of the event being matched and that these dynamics are sensitive to visual information. Also, as predicted, the context descriptions modulate this on-line measure when aspect focuses attention to the ongoing action of the verb.

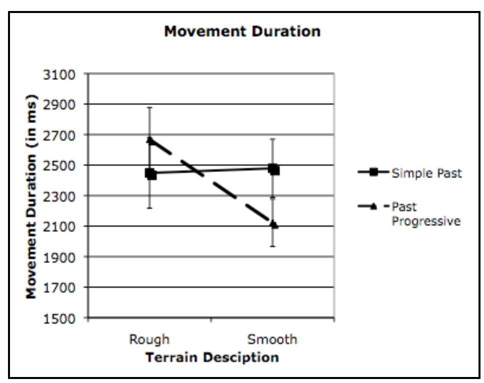

Figure 3: Movement duration differences in the region of the visual scene corresponding to the path.

Raw Time Analyses: To begin looking at the differences in spatial attraction to the visual scene's path across conditions, we first looked at average x- and y-coordinates within eight 500ms time-bins of the movement duration. There was no significant interaction between aspect and terrain, p's>.1, or main effect of either variable, p's>2. However, breaking the movement into time bins serves only as an approximation of actual attraction over raw time. These 500ms time-bins were not time locked to the sound files, and hence did not have a fixed starting time. Because the offset of verb occurred late within the sound files and because many participants did not begin to move the character until after the end of the sound file (with an average 1400 ms lag between offset of verb and end of sentence), these data are not synchronized to a fixed point. Future work will address potential raw time spatial differences more fully.

Spatial Attraction. Figure 4 shows the average time-normalized trajectories in each of the four conditions. The mean simple past and past progressive trajectories at each of the 101 time-steps in the top panel of Figure 4 illustrate that in the rough terrain context, the average past progressive trajectory curved more toward the path than the average trajectory elicited by the simple past sentences, but only near the end of the trajectory. However, in the smooth terrain description, (Figure 2, bottom), there appears to be greater attraction toward the path across a greater portion of the trajectory for the past progressive verbs.

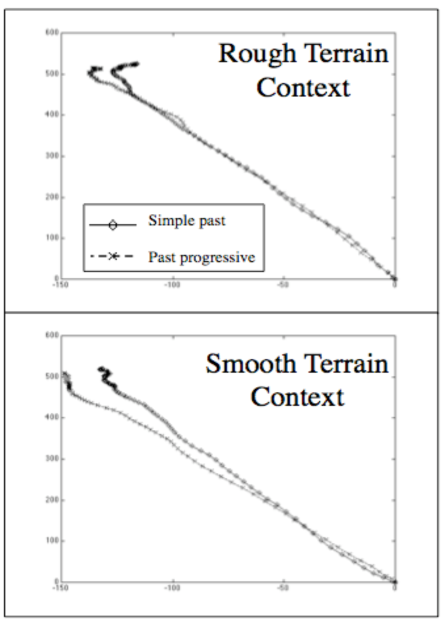

Figure 4: Average time-normalized simple past and past progressive trajectories in rough and smooth terrain contexts.

To determine whether the divergences observed across the simple past and past progressive sentence trajectories in the rough and smooth terrain descriptions were statistically reliable, we conducted a series of t-tests. These analyses were conducted separately on the x- and the y-coordinates at each of the 101 time-steps. In order to avoid the increased probability of a Type-1 error associated with multiple t-tests, and in keeping with Bootstrap simulations of such multiple t-tests on mouse trajectories (Dale, Kehoe, & Spivey, 2007), an observed divergence was not considered significant unless the coordinates between the simple past- and past progressive-sentence trajectories elicited p-values $< .05$ for at least eight consecutive time-steps.

In the rough context description condition, there was significant divergence of the past progressive x-coordinates away from the simple past x-coordinates and toward the path between time-steps 89 and 101, *p*'s $<.05$, and no significant divergence in the y-coordinates. This difference is commensurate with the observed differences in drop locations for past progressive and simple past verbs described earlier. Even though there was no significant interaction between aspect and context description on drop location, this significant divergence so late in the time-normalized trajectories may simply be an artifact of drop locations.

On the other hand, in the smooth context description, there were significant divergences of the past progressive x-coordinates away from the simple past x-coordinates towards the path between time steps 48 and 60, *p*'s $<.05$, and again between time steps 65 and 89, *p*'s $< .05$. There was also significant divergence of the average past progressive y-coordinates away from the average simple past y-coordinates and towards the path between time steps 89 and 101. Again, this divergence late in the trajectory may be an artifact of the drop locations in each condition.

While these results are encouraging, they are not as convincing as the path-movement duration results (Figure 3). It is curious that the spatial attraction differences were detected in the smooth context description but not as robustly in the rough context description. Perhaps the visual stimuli used to depict the path simply did not appear to afford difficult or uneven travel, and the incongruence in the linguistic description and the visual appearance of the path hindered the emergence of full spatial differences in this context description. Future work is slated to investigate this possibility.

General Discussion

The results reported here are consistent with previous research using mouse-tracking (Anderson, et al., 2008), narrative reading (Madden & Zwaan, 2003), and offline judgment tasks (Matlock, et al., 2007). They also provide new evidence that different grammatical forms influence the processing of event descriptions, with the simple past (e.g., *walked*) focusing attention on the end of the path and the location of the completed action, and past progressive (e.g., *was walking*) focusing attention to the "middle" of the event and the spatial region of that ongoing action. In addition to corroborating previous work on grammatical aspect, these data also reveal new insights about processing through the examination of continuous motor output in response to aspectual and contextual differences.

First, drop locations reliably differed between aspectual forms, with the past progressive condition eliciting drop locations closer to the path, and the simple past condition eliciting drop locations closer to the destination. These data are in line with earlier research, and were not significantly altered by terrain description. Contextual descriptions did interact significantly with verbal aspect in movement durations, specifically within the region of the screen depicting the path. Contextual descriptions did not significantly modulate simple past movement durations, because of the simple past's emphasis on the completed action. However past progressive movement durations were significantly faster when preceded by an easy terrain description than when preceded by a rough terrain description. Because these differences emerge only in the region of the path in the visual scene, but not in the overall trajectory, these data suggest that grammatical aspect exerts processing influences specific to the parts of the event it describes.

Similarly, while the coarse measure of raw-time spatial attraction to the path did not reveal statistically significant results, there was a significant spatial divergence of the past progressive trajectory away from the simple past trajectory and toward the destination in both contextual descriptions. Divergences late in the trajectory may be a result of differences in drop location, but divergences across the trajectories after the smooth context description provide further evidence for processing differences between these two aspectual forms. More specifically, our results may suggest that differences in underlying perceptual simulations, resulting in these differences in the dynamics of the motor response, may account for observed processing differences.

The current research has notable implications for several areas of research. Although grammatical aspect has been considered to provide minimal semantic information by providing subtle temporal nuance, our results indicate that aspect can significantly influence on-line processing. This work also investigates grammatical aspect using a novel approach, allowing for the examination of more fine-grained temporal information, which complements the existing reaction time data. In addition, our results provide evidence to support cognitive linguists' claims regarding meaning as a conceptualization of linguistic descriptions, and the idea that aspect, like many domains of language, involves dynamic conceptualization (Langacker, 1987: Talmy, 2000).

More broadly, this work resonates with embodied cognition work on perceptual simulation and language understanding (Barsalou, 1999). It also dovetails with the methodological advances of Balota and Abrams (1995) by providing new evidence from the temporal dynamics of a response after the response has been initiated, and demonstrating that the motor system is not a robot-like automaton triggered by completed cognitive processes. Rather, motor processes are co-extensive with cognitive processes during perceptual/cognitive tasks (e.g., Balota & Abrams, 1995; Gold & Shadlen, 2000; Spivey et al., 2005; This work also comports with our understanding of how mental models and visual information are coordinated in motor output. Similarly to the way understanding of spatial events is created and observed through tracking eye movements (Richardson & Matlock, 2007; Spivey & Geng, 2001), this work demonstrates that event understanding takes place differently as a function of changes in context descriptions and grammatical aspect. Finally, the work explores a new way that language may influence thought.

References

Abrams, R.A. & Balota, D.A. (1991). Mental chronometry: Beyond reaction time. *Psychological Science, 2*, 153-157.

Anderson, S. E. . Matlock, T., Fausey, C., & Spivey, M.J. (2008). On the path to understanding on-line processing of grammatical aspect. *Proceedings of the 30th Annual Conference of the Cognitive Science Society* (pp. 143-148), Mahwah, NJ: Lawrence Erlbaum Associates.

Barsalou, L. (1999). Language comprehension: Archival memory or preparation for situated action? *Discourse Processes*, *28*, 61-80.

Balota, A. D. & Abrams, R. A. (1995). Mental chronometry: Beyond onset latencies in the lexical decision task. *Journal of Experimental Psychology: Learning, Memory, & Cognition, 21*, 1289-1302.

Boroditsky, L. (2000). Metaphoric structuring: Understanding time through spatial metaphors. *Cognition, 75*, 1-28.

Comrie, B. (1976) *Aspect*. Cambridge: Cambridge University Press.

Dale, R., Kehoe, C., & Spivey, M. (2007). Graded motor responses in the time course of categorizing atypical exemplars. *Memory and Cognition, 35*, 15-28.

Ferretti, T. R., Kutas, M., McRae, K. (2007). Verb aspect and the activation of event knowledge in semantic memory. *Journal of Experimental Psychology: Learning, Memory, & Cognition, 33*, 182-196.

Frawley, W. (1992). *Linguistic semantics.* Hillsdale, NJ: Lawrence Erlbaum Associates.

Gold, J. I. & Shadlen, M. N. (2000). Representation of perceptual decision in oculomotor commands, Nature, 404, 390-394.

Langacker, R. W. (1987). *Foundations of cognitive grammar: Theoretical prerequisites*. Stanford, CA: Stanford University Press.

Lucy, J.A. (1992). Grammatical Categories and Cognition: A Case Study of the Linguistic Relativity Hypothesis. Cambridge: Cambridge University Press.

Madden, C.J. & Zwann, R.A. (2003). How does verb aspect constrain event representations? *Memory & Cognition, 31*, 663-672.

Magliano, J.P. & Schleich, M.C. (2000). Verb aspect and situation models. *Discourse Processes, 29*, 83-112.

Matlock, T. (2004). Fictive motion as cognitive simulation. *Memory & Cognition, 32*, 1389-1400.

Matlock, T., Ramscar, M., & Boroditsky, L. (2005). On the experiential link between spatial and temporal language. *Cognitive Science, 29*, 655-664.

Matlock, T., Fausey, C., Cargill, S., & Spivey, M. (2007, November). On the path toward understanding the dynamics of aspect descriptions in motion events. Paper presented at 48th Annual Meeting of the Psychonomic Society, Long Beach, California.

Morrow, D.G. (1985). Prominent characters and events organize narrative understanding. *Journal of Memory and Language, 24*, 304-319.

Richardson, D. C., & Matlock, T. (2007). The integration of figurative language and static depictions: An eye movement study of fictive motion. *Cognition, 102*, 129-138.

Spivey, M. & Geng, J. (2001). Oculomotor mechanisms activated by imagery and memory: Eye movements to absent objects. *Psychological Research, 65*, 235-241.

Spivey, M.J., Grosjean, M. & Knoblich, G. (2005). Continuous attraction toward phonological competitors. *Proceedings of the National Academy of Sciences, 102*, 10393-10398.

Talmy, L. (2000). *Toward a cognitive semantics*. Cambridge, MA: MIT Press.