Perceiving and Describing Event Temporal Dynamics

Shulan Lu (Shulan_Lu@tamu-commerce.edu)
Devin Pierce (dpierce@cp.tamu-commerce.edu)
Department of Psychology and Special Education
Texas A & M University-Commerce
Commerce, TX 75429-3011, USA

Abstract

This paper investigates how people coordinate perceiving and describing event temporal dynamics. Participants viewed animations of fish swimming events and described how the events are related in time. We examined the timing when linguistic descriptions were launched, the linguistic characteristics, and the eye movement properties of participants viewing the fish swimming events. The results showed that there are three modes of launching descriptions: (a) some people always launch their descriptions while events are unfolding, (b) some people always launch descriptions after events unfold, and (c) some people switch between launching during and after the events depending on the context. When two events have a higher degree of simultaneity in time, people tend to launch their spontaneous descriptions *after* the events unfold. The linguistic characteristics of the descriptions, for example, the number of clauses and the number of verbs, reflect some of the interactions between description modes and event temporal properties. People tend to fixate on the end points of the events when they are ready to utter the words "stop" and "start".

Introduction

We often need to describe events and their temporal dynamics. For example, situations where we need to represent temporal relations might include explaining to someone how to make a particular dish by following a recipe, remembering the temporal dynamics between events of a traffic accident we witnessed, or talking to someone over the phone about how to troubleshoot a computer problem. When we think about event temporal dynamics, we often need to know how long each event takes place (i.e., event duration) and how each event is related to other events (i.e., event temporal relations).

Events can unpack seamlessly, co-occur with one another in time and space, and unfold simultaneously. The temporal dynamics between events are abstract and subtle at times. How do we encode the event temporal dynamics, and in particular, event temporal relations when events are unfolding? Hunt and Agnoli (1991) suggested that people think more efficiently about a topic if their language provides an efficient code. Gentner and Boroditsky (2001) suggested that language plays a more important role in representing abstract domains than concrete domains. Boroditsky and her colleagues provide some evidence that language plays a role in how people think about the temporal aspects of an event (Boroditsky, 2001; Boroditsky, Ham, & Ramscar, 2002). For example, Mandarin speakers talk about time as if it flows vertically and think of time vertically even when they were tested in English. Such proposals suggest that there might be a close relationship between describing and conceptualizing event temporal dynamics.

In the current study, people viewed animations that systematically varied the event temporal relations, and described the temporal relations when they were ready. To understand the relationship between perceiving and describing the event temporal dynamics, we examined the following four indicators: (a) do people tend to launch their spontaneous descriptions when the events are unfolding or afterwards? (b) what linguistic properties do online descriptions have? (c) how well could the online descriptions depict the event temporal dynamics? and (d) where do people tend to look when they mark off the event onsets and offsets? In the paragraphs below, we will discuss each indicator and make some predictions accordingly.

Whether people describe events in a tight coupling with their comprehension of events has long been a debate. Wundt (1900/1970) suggested that describing events occurs after people comprehend events, whereas Paul (1886/1970) suggested that describing events and comprehending events may interleave. There has been some evidence supporting Wundt's position. Griffin and Bock (2000) presented participants events that were depicted in pictures and participants described the events. Participants typically initiated their corresponding linguistic descriptions after they comprehended the events. Graesser, Lu, Olde, Cooper-Pye, and Whitten (in press) presented participants an illustrated text about an everyday device along with a hypothetical breakdown scenario and participants generated questions that could troubleshoot the device. Comprehenders performed causal analysis of the device mechanism and fixated on the problem component of the device before they launched their questions. The events used in these studies were simple events depicted in static pictures. There might be differences when events are dynamically unfolding. Zacks, Tversky, and Iyre (2001) asked participants to segment an ongoing everyday event at both coarse grained level and fine grained level. Participants tended to show a stronger alignment between coarse grained and fine grained segmentation if they described events while performing segmentation. Such evidence suggests that people may launch their descriptions while the event temporal dynamics are unfolding.

What linguistic properties do online descriptions exhibit? Slobin's (1996) thinking-for-speaking hypothesis suggests that people tend to constrain their descriptions based on the temporal parameters available in language. Wierzbicka (1994) proposed that BEFORE, AFTER, and WHEN are three semantic primitives in temporal language. These three primitives together with other temporal adjuncts can be used to paraphrase complex temporal relational terms. Similarly, Graesser, Wiemer-Hastings, and Wiemer-Hastings (2001) proposed a common representational system for representing text, episodic experiences, and world knowledge, in which BEFORE, AFTER, and DURING are primitives for encoding temporal descriptions. Lu and Graesser (2004) asked participants to view, remember, and subsequently judge the event temporal relations, and also asked participants to sort temporal relational words into semantic clusters. The results consistently showed support for Wierzbicka and Graesser et al. proposals, in that, people tend to think of temporal relations consisting of BEFORE, AFTER, and some degree of co-occurrence that is manifested by WHEN or DURING. Taken together, the linguistic space of the online descriptions may be carved out by these temporal primitives.

One may ask such a question as whether and how well the online descriptions depict the temporal relations. For example, some events start at the same time but end at different times, whereas other events start at different times but end at the same time. Do people tend to differentiate the subtle distinctions by judiciously combining the temporal primitives together with adjuncts? Or do people tend to blur these distinctions? Studies showed that people frequently simplify complex temporal relations between events, and misconstrue them as simpler temporal relational primitives (Lu, 2004; Lu & Graesser, 2004; Lu, Harter, & Graesser, 2005). For example, people often perceive events that partially overlap in time as events that follow each other immediately. Such evidence suggests that people are likely to blur the distinctions when they are engaged in spontaneous descriptions.

People typically fixate on an object in a picture while they are thinking about it (Graesser et al., in press; Grant & Spivey, 2003; Tanenhaus, Spivey-Knowlton, Eberhard, & Sedivy, 1995). For example, Tanenhaus et al. (1995) asked participants to manipulate objects in a toy environment under audio command. Participants fixated on the objects in pictures before they heard the end of the spoken word. One question arises to where people fixate when they talk about temporal concepts? To begin our understanding of this question, we analyzed the eye movements before people linguistically marked off the beginnings and ends of events. Following the same reasoning that people look at an object before they describe a concept, it is possible that people may fixate on the relevant temporal markers of events before they describe the markers. Research on events and actions suggested that people pay closer attention to the culmination of the plans and goals. This suggests an alternative that people may tend to focus on the end points of events (Graesser, 1978; Lichtenstein & Brewer, 1980; Lu, 2004; Miller, Galanter, & Pribram, 1960; Rieger & Zheng, 2003).

In this paper, we are trying to dissect the dynamic couplings between perceiving and describing abstract event temporal relations. We investigated the four indicators discussed above and provided some preliminary answers. In the sections below, we will report the details of the study and the results.

Methods

Participants

There were 19 college students at the University of Memphis who participated for course credit.

Materials

Animated Events A set of 42 animations depicting fish swimming events were used in this experiment. Each animation depicts one of Allen's (1984; 1991) seven temporal relations as described below (following Allen's naming system):

1. BEFORE: Event 1 occurs before Event 2 with some temporal space in between.
2. MEET: Event 2 follows Event 1 immediately.
3. OVERLAP: Event 1 and Event 2 do not start and end at the same times, but overlap over some time in between.
4. START: Event 1 and Event 2 start at the same time.
5. DURING: Event 2 occurs in between the beginning and end of Event 1.
6. FINISH: Event 1 and Event 2 end at the same time.
7. EQUAL: Event 1 and Event 2 share the same time course.

For each temporal relation, there were six different animations. The animations varied the event spatial trajectory, the spatial perspective, and the fish swimming speed. The animations were created in 3d Studio Max release 5. The animation quality is near photorealistic. Each animation is about 25 seconds and runs at approximately 30 frames per second. The presentation order of the animations was randomized. There were seven randomized orders for the experiment. Each participant received one of the seven orders.

Temporal Word List A list of words and phrases that encode the temporal relations were selected from Lu and Graesser (2004) study, where participants sorted temporal words into semantic groups. The purpose of the selection was to expose participants to various ways in which temporal relations are described in language. There were verbs, adverbs, prepositions and conjunctions. The following are some example words: (a) anticipate, precede, follow after, succeed, go with, overlap, (b) before, earlier, previously, in advance, after, later, next, subsequently, at the same time, simultaneously, for now, and (c) prior to, soon

after, until, when, while, during, in the course of. The complete word list was presented on a computer screen during the exposure and training phase only.

Apparatus

An Applied Science Laboratory Model 501 eye tracker was used in the study. Eye movements were recorded 60 times per second (once every 17 ms). The experimental session was videotaped and audio recorded through a VCR. The VCR recorded a TV screen that displayed the ongoing events in each animation and a superimposed image of what the left eye was fixating on. The superimposed image was generated by the eye tracking equipment. Each participant wore a small microphone, which was connected to the VCR, so their verbal descriptions were recorded.

Procedure

Participants were told that they will be viewing animations of fish swimming events. Participants received the following instructions, "While you view the animation, try to describe the time relations between the fish swimming events using one or two succinct sentences. For example, the light fish swims before the dark fish, but stopped after the dark fish. Or another example, the light fish and the dark fish swim simultaneously. The words or phrases underlined in these examples tell us the time relations between the two fish swimming events. Of course, these are just *arbitrary* examples. Describe the events and time relations in a way, which is most natural to you and which is understandable to others who do not see the animations. Before you speak, please hit S on the keyboard".

Participants were presented with the word list described earlier on the computer screen. Participants were told that these words are example words that describe the time relations between events. Experimenter read each word to participants and pointed to the word on the screen. Upon completion, the word list screen was removed. Then participants received trial animations and practiced to perform the task by following the instructions. Participants also positioned their finger next to the S key on the keyboard.

When participants felt ready for the experiment task, they went through an eye tracker calibration procedure. Upon completing the calibration, participants viewed one animation at a time and described event temporal dynamics when they were ready. Calibration was checked periodically throughout the experiment session.

Results

Modes of Launching Descriptions

There were three different modes of launching online descriptions: (a) the after mode: participants always launched their descriptions after the events unfolded throughout the experiment; (b) the during mode: participants always launched their descriptions while events were unfolding; and (c) the mixed mode: participants some times launched their descriptions after the events unfolded, and sometimes while the events were unfolding. 37% of the participants were after mode speakers, whereas 26% of the participants were the during mode speakers. The rest 37% of the participants were mixed mode speakers.

Interestingly, there was some trend that participants were more likely to launch their descriptions *after* the events completely unfolded with respect to some event temporal relations. Figure 1 shows the proportions of descriptions that were described *during* versus *after* events unfolded. For START, DURING, FINISH, and EQUAL events, the proportions of participants who launched their descriptions after animated events finished were .61, .62, .62, and .67 respectively. However, there was not such a trend for other event temporal relations. For BEFORE, MEET, and OVERLAP events, the proportions of participants who described after the animated events came to stop were .53, .54, and .50 respectively. These two groups of event temporal relations differed significantly on the proportions of descriptions launched after events unfolded, t (18) = 2.02, $p < .05$.

Linguistic Properties

Participants used a wide range of temporal words. There were 11 different temporal verbs in all of the descriptions. *Start* (M = 44.68) and *stop* (M = 48.21) were routinely used, whereas other temporal verbs were used but not consistently. *Precede*, *lead*, and *continue* are some examples. Note that the mean value refers to the number of times used per participant. There were 22 different temporal adverbs in the descriptions, and 8 different temporal conjunctions / prepositions. *Before* (M = 14.84) was the most frequently used semantic primitive, whereas *after* (M = 3.89) was infrequently used. *During* and *when* were rarely used. *At the same time* (M = 14.89) and *simultaneously* (M = 5.58) were accessed fairly frequently as well. In addition, participants used *and*, *then*, *first*, and *later* on many occasions.

We examined a number of linguistic properties, and computed the index of each linguistic property as a function of (a) 7 event temporal relations; and (b) 3 modes of launching descriptions. With respect to the number of temporal conjunctions in describing an animation (M = 1.40), there were significant main effects of temporal relations, F (6, 96) = 14.56, MSE = .25, $p < .05$, there were significant main effects of launching modes, F (2, 16) = 8.50, MSE = 2.03, $p < .05$, there were significant interactions between temporal relations and launching modes, F (12, 96) = 2.63, MSE = .25, $p < .05$. Participants in the after mode tended to use more temporal conjunctions (e.g., and, then) than those in the during mode (M = 2.10 versus 1.01). Participants, who waited till the animated events finished, used 2 conjunctions, whereas those, who did not wait, used 1 conjunction on average. With respect to the number of temporal verbs in describing an animation (M = 2.32), there were significant main effects of temporal relations, F (6, 96) = 9.56, MSE = .25, $p < .05$, there were significant main effects of launching modes, F (2, 16) = 8.50, MSE = 2.03, $p < .05$, there were significant interactions between temporal relations and launching

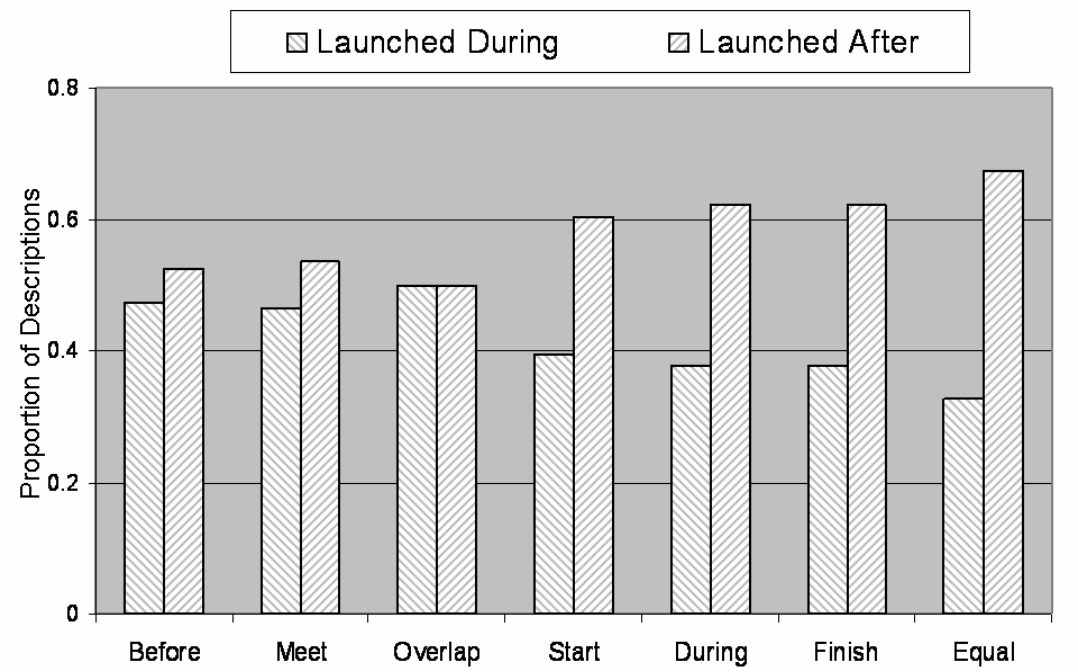

Figure 1: Proportions of trials launched description during versus after animated events.

modes, F (12, 96) = 2.63, MSE = .25, p < .05. Participants in the during mode tended to use more temporal verbs (e.g. start, stop) than those in the mixed mode (M = 2.71 versus 1.80). Participants, who launched descriptions while events were unfolding, tended to mark the onset and offset of events more precisely by using .9 verbs such as start and finish. With respect to the number of temporal adverbs in describing an animation (M = 1.10), there were significant main effects of temporal relations, F (6, 96) = 11.28, MSE = .24, p < .05, there were significant main effects of launching modes, F (2, 16) = 3.81, MSE = .87, p < .05, there were no significant interactions between temporal relations and launching modes. Participants used at least 1 temporal adverb such as simultaneously in each trial.

With respect to the number of clauses in describing an animation (M = 3.00), there were significant main effects of temporal relations, F (6, 96) = 23.39, MSE = .18, p < .05, there were significant main effects of launching modes, F (2, 16) = 4.69, MSE = 2.54, p < .05, there were significant interactions between temporal relations and launching modes, F (12, 96) = 1.85, MSE = .18, p < .05. Participants in the during mode tended to have longer descriptions than those in the mixed mode (M = 3.46 versus 2.42). On average, the during mode participants used 1 more clause than the mixed mode participants. Mainly present tense and past tense were used in the descriptions, whereas other tenses were rarely used. With respect to the number of past tense in describing an animation (M = 1.37), there were significant main effects of temporal relations, F (6, 96) = 6.00, MSE = .23, p < .05, there were marginally significant main effects of launching modes, F (2, 16) = 3.31, MSE = 9.08, p = .06, there were significant interactions between temporal relations and launching modes, F (12, 96) = 2.57, MSE = .23, p < .005. Participants in the after mode tended to use past tense than those in the mixed mode (M = 2.27 versus .79). With respect to the number of present tense in describing an animation (M = 1.40), there were only significant main effects of temporal relations, F (6, 96) = 2.63, MSE = .21, p < .05. Participants in the during mode were most likely to use present tense (M = 1.88), whereas participants in the after mode were least likely to use present tense (M = .83).

Description and Communication

We also coded whether a reader can reconstruct the event temporal relations from the verbal descriptions alone. A description received a score of 1, if it was considered as depicting the animation correctly. A description received a score of 0, if it was considered as not depicting the animation at all. A description received a score of .5, if was considered as depicting the animation in general but not making subtle distinctions among temporal relations (e.g., BEFORE versus MEET confusion). We added up scores for all six descriptions of each temporal relation and then divided the scores by 6. Thus we computed a communication indexing score for descriptions of each event temporal relation. The means of the communication indexing score were the following: BEFORE (.58), MEET (.54), OVERLAP (.82), START (.85), DURING (.77), FINISH (.82), and EQUAL (.87). The results suggested that the distinctions between BEFORE and MEET were frequently not linguistically marked, whereas EQUAL events were more frequently marked. There were not significant differences between the *during* mode and the *mixed* mode describers on the communication indexing score. Below provides one sample description for each temporal relation that received a score of 1. The pauses and the hesitations in between were not coded, however, they were not infrequent.

- BEFORE: The larger fish swims across and finishes. And a few moments later, the smaller fish swims across.
- MEET: The light fish swam all the way across and stopped. And then immediately, the dark fish swam across and stopped.
- OVERLAP: The red fish moves forward, and then the pink fish moves forward shortly afterwards. The red fish stops and then the pink fish stops.
- START: The big red fish and the brown fish started swimming simultaneously, and then the brown fish stopped before the big red fish stopped.
- DURING: The brown fish started swimming just before the orange fish, but the orange fish stopped swimming before the brown fish.
- FINISH: The orange fish starts swimming before the brown fish. And then the brown fish and the orange fish stop simultaneously.
- EQUAL: Both fish started swimming at the same time and stopped at the same time.

Eye Movement Properties

The sample descriptions suggested that participants tend to linguistically mark the beginning and ends of events. Did participants fixate on the beginning points of an event when they described the onset of an event? Did participants fixate on the end points of an event when they described the offset of an event? We performed some preliminary analysis of the eye movements. The eye movements showed that participants tend to switch back and forth between two fish and keep track their motion trajectories. Almost all the time, the end point of an event was fixated before participants uttered the word such as "stop". The end point of an event was also frequently fixated before participants uttered the word such as "start". Interestingly, out of six animations depicting each temporal relation, there were 1.48 occurrences of eye fixations tracing back to the starting point of an event before participants delivered the word "start".

Discussion

The current study dissected a number of online cognitive processes when people perceive and describe event temporal dynamics. The results suggested that perceiving events and describing events serve as online repository for each other, exert constraints at times on each other, and scaffold each other toward constructing abstract event structures.

The current study indicated that people do not always wait to launch their descriptions until the events completely unpack. For some event temporal relations (e.g., EQUAL), people tend to wait till the end of events. One possibility is that people have to wait till the end of animations to find out temporal relations such as EQUAL. However, this possibility is not entirely adequate in explaining why people tend to wait till the end of START and DURING events. Perceiving and comprehending events that have higher degrees of simultaneity may be taxing working memory capacity. Describing the events as the events unfold takes away cognitive resources from comprehending events. Subsequently, people prefer not to describe until they see the full range of the events.

There appear to have been individual differences in describing temporal relations. The *during* mode describers tended to follow the event trajectory and take detailed notes (story-teller type of describer), whereas the *mixed* mode describers tended to use language as a strategy for capturing the event relations and tried to economize their descriptions. Compared with the *mixed* mode describers, the *during* mode describers used longer descriptions, tended to use temporal conjunctions linking clauses, usually marked off the onset and offset of events, and used the present tense. The *after* mode describers tended to be in between on some of the linguistic measures.

People could choose different words while encoding the temporal relations, but they show a proclivity toward some words. Among the three semantic primitives, BEFORE was accessed disproportionately more often the other two primitives. One potential explanation is the iconicity principle, where narrators tend to describe events in alignment with the order in which the real world events unfold (Ohtsuka & Brewer, 1992; Zwaan & Radvansky, 1998). The results suggested an interesting choice made by describers when facing the linearity of language and the simultaneity of events. Describers followed along the event trajectory naturally, but varied the use of *start* and *stop,* and constructed a sentential matrix of *start* and *stop,* indicating the asynchrony between events. One potential challenge to this conjecture is that people may not mark off the beginnings and ends when the events are more complex and embedded in a higher order event structure such as schema.

In the current study, not only event temporal relations were varied, but also spatial perspectives where events unpack were varied. To what extent did participants describe the spatial properties of events? The occurrences of spatial words and phrases are not frequent in the descriptions. For example, the number of spatial prepositions and prepositional phrases (e.g., in the middle) were below 1 on average for each trial.

The descriptions did not always depict the temporal relations accurately and appeared to be differential among different relations. For example, participants frequently failed to distinguish MEET from BEFORE. The communication indexing scores are relatively high with respect to START, DURING, FINISH, and EQUAL. The verbal protocols suggested that participants efficiently used the *start* and *stop* matrix in conjunction with temporal adverbs. Interestingly, the *during* mode describers did not score higher than the *mixed* mode describers.

The eye movements showed an interesting asymmetry. Participants were equally likely to mark off the beginnings and endings of events in descriptions; however, they frequently fixated on the end points even when they were describing the "start". The eye movements hinted that participants may regress to the beginning points of events when two events overlap in some degree. There is also some hint that participants in the *after* mode may be more likely to performing the regression eye movements (M = 1.74), whereas participants in the mixed mode may be less likely to perform the regression (M = 1.02). Participants

may tend to regress more with some temporal relations (OVERLAP, M = 1.81) than others (BEFORE, M = .81). Further work is needed to examine the conditions under which people perform regressive eye movements toward the beginning of an event.

In closing, the current study investigated a few indicators of the online cognitive processes when people are engaged in perceiving, describing events, and constructing abstract event temporal relations. The results showed the dynamic coupling between the perceptions of ongoing events, the nature of the event temporal relations, and the linguistic properties that get activated online. Future research is underway to systematically unpack the relationships.

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References

Allen, J. F. (1984). Towards a general theory of action and time. *Artificial Intelligence, 23*, 123-154.

Allen, J. F. (1991). Time and time again: The many ways to represent time. *International Journal of Intelligent Systems, 6*, 341-355.

Boroditsky, L. (2001). Does language shape thought? Mandarin and English speakers' conceptions of time. *Cognitive Psychology, 43*, 1-22.

Boroditsky, L., Ham, W., & Ramscar, M. (2002). What is universal in event perception? Comparing English and Indonesian speakers. In W. D. Gray, & C. D. Schunn (Eds.), *Proceedings of the 24th Annual Meeting of the Cognitive Science Society*. Mahwah, NJ: Erlbaum.

Gentner, D., & Boroditsky, L. (2001). Individuation, relativity, and early word learning. In M. Bowerman, & S. Levinson (Eds.), *Language acquisition and conceptual development*. Cambridge, England: Cambridge University Press.

Graesser, A. C. (1978). How to catch a fish: The memory and representation of common procedures. *Discourse Processes, 1*, 72-89.

Graesser, A. C., Lu, S., Olde, B., Cooper-Pye, E., & Whitten, S. N. (in press). Question asking and eye tracking during cognitive disequilibrium: Comprehending illustrated texts when the devices breakdown. *Memory and Cognition.*

Graesser, A. C., Wiemer-Hastings, P., & Wiemer-Hastings, K. (2001). Constructing inferences and relations during text comprehension. In T. Sanders, J. Schilperoord, & W. Spooren (Eds.), *Text representation: Linguistic and psycholinguistic aspects*. Amsterdam: Benjamins.

Grant, E. R., & Spivey, M. J. (2003). Eye movements and problem solving: Guiding attention guides thought. *Psychological Science, 14*, 462-466.

Griffin, Z. M., & Bock, K. (2000). What the eye says about speaking. *Psychological Science, 11*, 273-279.

Hunt, E., & Agnoli, F. (1991). The Whorfian hypothesis: A cognitive psychology perspective. *Psychological Review, 98*, 377-389.

Lichtenstein, E. D., & Brewer, W. F. (1980). Memory for goal-directed events. *Cognitive Psychology, 12*, 412-445.

Lu, S. (2004). Perceiving, remembering, and describing event temporal relations. *Dissertation Abstracts International*, 65 (06), 3191. (UMI No. 3137799)

Lu, S., & Graesser, A. C. (2004). What is universal in perceiving, remembering, and describing event temporal relations? In K. D. Forbus, D. Gentner, & T. Regier (Eds.), *Proceedings of the 26th Annual Meeting of the Cognitive Science Society*. Mahwah, NJ: Erlbaum.

Lu, S., & Harter, D., & Graesser, A. C. (2005). *Do events have fuzzy psychological temporal frames? A computational and empirical investigation of event temporal relations.* Manuscript submitted for publication.

Miller, G. A., Galanter, E., & Pribram, K. H. (1960). *Plans and the structure of behavior*. New York: Holt, Rinehart & Winston.

Ohtsuka, K., & Brewer, W. F. (1992). Discourse organization in the comprehension of temporal order in narrative texts. *Discourse Processes, 15*, 317-336.

Paul, H. (1970). The sentence as the expression of the combination of several ideas. In A. L. Blumenthal (Ed. And Trans.), *Language and psychology: Historical aspects of psycholinguistics*. New York: Wiley. (Original work published 1900).

Rieger, T., & Zheng, M. (2003). An attentional constraint on spatial meaning. In R. Alterman & D. Kirsch (Eds.), *Proceedings of the 25th Annual Meeting of the Cognitive Science Society*. Mahwah, NJ: Erlbaum.

Slobin, D. (1996). From "thought and language" to "thinking for speaking". In J. Gumperz & S. Levinson (Eds.), *Rethinking linguistic relativity*. Cambridge, UK: Cambridge University Press.

Tanenhaus, M. K., Spivey-Knowlton, M. J., Eberhard, K. M., & Sedivy, J. C. (1995). Integration of visual and linguistic information during spoken language comprehension. *Science, 268*, 1632-1634.

Wierzbicka, A. (1994). Semantic primitives across languages: A critical review. In C. Goddard, & A. Wierzbicka (Eds.), *Semantic and Lexical Universals: Theory and Empirical Findings.* Amsterdam: Benjamins.

Wundt, W. (1970). The psychology of the sentence. In A. L. Blumenthal (Ed. and Trans.), *Language and psychology: Historical aspects of psycholinguistics*. New York: Wiley. (Original work published 1900).

Zacks, J. M., Tversky, B., & Iyer, G. (2001). Perceiving, remembering, and communicating structure in events. *Journal of Experimental Psychology: General, 130*, 29-58.

Zwaan, R. A., & Radvansky, G. A. (1998). Situation model in language comprehension and memory. *Psychological Bulletin, 123*, 162-185.