Does language guide event perception?

Evidence from eye movements

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Abstract
Languages differ in how they encode motion. When describing bounded motion, English speakers typically use verbs that convey information about manner (e.g., slide, skip, walk) rather than path (e.g., approach, ascend), whereas Greek speakers do the opposite. We investigated whether this strong cross-language difference influences how people allocate attention during motion perception. We compared eye movements from Greek and English speakers as they viewed motion events while (a) preparing verbal descriptions, or (b) memorizing the events. We found that in the verbal description task, speakers’ eyes rapidly focus on the event components typically encoded in their native language, generating significant cross-language differences even during the first second of motion onset. However, when freely inspecting ongoing events, as in the memorization task, people allocate attention similarly regardless of the language they speak. Differences between language groups arose only after the motion stopped, such that participants spontaneously studied those aspects of the scene that their language does not routinely encode. The findings offer a novel perspective on the relation between language and perceptual/cognitive processes. Specifically, they indicate that attention allocation during event perception depends on the goals of the perceiver; effects of one’s native language arise only when linguistic forms are recruited to achieve the task.

Keywords: spatial language; language and thought; visual world; eyetracking; motion
Most commentators in the cognitive sciences agree that core aspects of the human perceptual and cognitive machinery that guide our interactions with the external world are universal. However, some researchers have recently proposed that our interactions with the world may be substantially shaped by the properties of our native language (see the reviews in Bowerman & Levinson, 2001; Gentner & Goldin-Meadow, 2003). According to this position, since human beings need to share information about the world through the use of language, attention during perceptual and cognitive tasks needs to focus on those dimensions of experience that are typically encoded in one’s native language. And since languages differ considerably in their encoding of the spatial, temporal, and causal properties of events, speakers of different languages will end up paying attention to different event components as they experience events.

Even though this position has generated much controversy, its core claim has proven hard to evaluate since the interface between perception and language has remained inaccessible to standard methods of psychological research. Here we used a novel technique to investigate the language-thought relationship by monitoring eye movements to event components by speakers of different languages. Since eye fixations approximate the allocation of attention under normal viewing conditions, they allow us to test whether dimensions of experience that can most naturally find their way into one’s native language become cognitively more salient.

We chose motion events as our empirical focus for two main reasons. First, motion scenes are concrete, readily observable and easily manipulated and tested; second, the expression of motion is characterized by considerable cross-linguistic variability. All languages typically encode the path, or trajectory (e.g., \textit{arrive}, \textit{ascend}), and the manner of motion (e.g., \textit{skate}, \textit{fly}), but differ systematically in the way path and manner are conflated inside sentences. In English, when describing a bounded event, one can say ‘A man is skating over to a snowman’ (a manner verb plus a phrase describing a bounded, completed path) but in Greek the same sentence is ungrammatical: instead one must say ‘A man is arriving at a snowman (by skating)’ (i.e., a path verb plus a path phrase with an additional, optional manner modifier).

It is important to highlight that both languages have manner of motion verbs and use them similarly for simpler, unbounded events (‘A man is skating’). The languages differ in whether manner verbs can additionally compose with a bounded path modifier to refer to culminated, bounded events. As a result, English encodes manner of motion in verbs much more frequently than Greek, while Greek encodes path, or trajectory, of motion in verbs more frequently than English. This manner-path asymmetry is diagnostic of a broad typological split across most of the world’s languages (Talmy, 1985), and has been confirmed by psycholinguistic experiments on motion with both adults and children (Choi & Bowerman, 1991; Gennari, Sloman, Malt &

To test whether these cross-linguistic differences affect the way language users direct attention to manner of motion, we recorded eye movements from native Greek and English speakers as they watched unfolding motion events (both bounded and unbounded) while performing either a linguistic or a nonlinguistic task. It is well known that the allocation of attention during scene perception depends upon which aspects of the scene are deemed important to achieve the task (e.g., Triesch, Ballard, Hayhoe & Sullivan, 2003). Given this, we carefully constructed our animated visual stimuli so that linguistically relevant manner and path information could be easily defined as distinct regions spatially separated from each other. If cross-linguistic differences affect the allocation of attention during event perception generally, we would expect English speakers to be more likely than Greek speakers to focus on manner information early and consistently in both the linguistic and nonlinguistic task. But if event perception is independent of language, we should see differences between English and Greek speakers only in the linguistic task (and only in bounded events, where the two languages differ in which information is prioritized); During tasks that do not require description of the event (as in the nonlinguistic task), Greek and English speakers should behave similarly in their allocation of attention.

METHOD

Subjects

Seventeen native English speakers and seventeen native Greek speakers participated in the experiment. The English speakers were Psychology undergraduates at the University of Pennsylvania and received course credit for participation. The Greek speakers were students or junior faculty at various Universities in the Philadelphia area and were paid $8 for participation.

Stimuli

Test items consisted of 12 short clip art animations depicting motion events. Each event had two variants, one bounded (e.g., Fig. 1a, a man skating to a snowman), the other unbounded (e.g., Fig 1b, a man skating). We also created 12 filler events that did not involve pure motion (e.g., a woman knitting). Each animation lasted three seconds ending with a beep. The final frame of the animation then remained on the screen for two additional seconds. A presentation list was generated such that six of the critical items depicted bounded events and six depicted unbounded events. These trials were randomly intermixed with filler trials. A second list was
generated from the first list by swapping the conditions of the critical trials (bounded / unbounded). Two additional reverse-order lists were also generated.

-- insert Fig. 1 here --

All target stimuli involved instrumental motions (e.g., skating, sailing, skiing), which allowed us to easily define a spatial region associated with the manner of motion (i.e., the instruments themselves, e.g., the skates, the sail, the skis). Eye movements to these instruments were therefore coded as Manner looks. The moving character (e.g., the skier) always followed a predictable path, such that the initial heading of this character was toward the spatial region occupied by the goal (e.g., the snowman in the skating example). Pilot work revealed that one common eye movement around the start of animation was to ‘project the path’ of motion to the goal (where the moving character was heading). Thus, Path looks were defined as looks to this path-endpoint region. Unbounded motion videos were identical to bounded videos except that the goal object was removed; Path looks in this condition were defined the same way: as path-projecting looks to where the goal would have been if present.

Procedure

Subjects were randomly assigned to either the Linguistic or the Nonlinguistic condition and to one of the four presentation lists. In both conditions, subjects were informed that they would watch a set of animated clips on a computer screen showing a person or an animal do something. They would hear a beep at the end of each animation followed by two seconds in which the last frame remained on the screen. In the Linguistic condition, subjects were asked to describe the clips freely after they heard the beep. In the Nonlinguistic condition, they were told to watch each video and further inspect the image after the beep. Nonlinguistic subjects were also told that, after viewing all the clips, they would see a series of still images corresponding to each clip, and they would have to indicate whether the image was the same or different from the clip they had seen earlier.

All subjects received the memory test at the end of the experiment (i.e., it was a surprise task for the Linguistic subjects). During the memory test, participants saw a set of still images each of which was extracted from the mid-point of each of the original events. For filler events, the images were the same as the prior events. For test items, half of the bounded and half of the unbounded trials were altered and half remained the same. Altered bounded trials consisted of the still image from its unbounded variant, and vice versa. In practice, this meant removing the goal from the bounded motion events (e.g., for the scene where a man was skating to a
snowman, people were shown an image of a man simply skating), or introducing the goal (e.g., the snowman) when the original event was unbounded. Accuracy of responses was recorded.

In preparation for the memory task, subjects in the Nonlinguistic condition went through two practice trials with non-motion events, one of which was the same and the other different from the original, before they viewed the set of 24 events.

Experiments were conducted in the participants’ native language. For the Greek participants, the experimenter was a native Greek speaker (the first author) and instructions etc. were in Greek throughout. The experiment was preceded by greetings and casual conversation in Greek between experimenter and participants.

Eye movements were recorded using an ISCAN ETL-500 remote table-top eyetracker trained on the participant’s right eye. Stimuli were displayed on a 15-inch monitor at a 22-inch viewing distance. A computer analyzed the eye image in real-time, superimposing the horizontal and vertical eye position of the direction of gaze onto the video image of the stimuli. The stimuli video and the superimposed eye position, along with all auditory events, were recorded to tape using a frame-accurate digital video recorder (a SONY DSR-30). The videotape was later examined frame-by-frame by a trained coder, who coded looks to pre-determined critical components of each event. For coding purposes, we defined path regions on the basis of path endpoints (e.g., the snowman), since that gave an especially clear and linguistically relevant criterion for paths. We also classified instrument regions as depicting manner, since they were spatially separated from path endpoint objects and (to a certain extent) from the agents in the events. Utterances were transcribed by the first author, a bilingual Greek-English speaker.

RESULTS AND DISCUSSION

Linguistic (production) data

Verbal descriptions in the Linguistic task confirmed what is already known about English and Greek verb usage. For bounded motion events, English speakers were much more likely to produce manner verbs than Greek speakers (78% vs. 36% of responses respectively) while, for unbounded events, the two languages did not differ widely (74% of all responses contained manner verbs in English vs. 56% in Greek).

Eye movement data

Given the theories sketched above, we were especially interested in whether Greek and English participants differed in how they prioritized the collection of manner- and path-relevant visual information during the perception of unfolding motion events. In particular, how did participants prioritize looks to the path endpoint
region vs. the manner region? As we show below, our results indicate that Greek and English speakers do indeed allocate attention to these regions differently in accordance with their language, but only in the Linguistic task and only when the languages differ in which information is prioritized (bounded motion events).

**Attending to Manner vs. Path over time.** Figures 2 and 3 plot the difference in Manner and Path-Endpoint looks on a frame-by-frame basis from motion onset for both bounded and unbounded events. Beginning with bounded events (Fig. 2), the strong asymmetry in motion verb content was reflected in attention allocation during both event perception and speech planning: As motion began, participants in the Linguistic condition looked to the regions that their language routinely encodes in verbs: Greeks projected the path, looking first to the endpoint of the path (e.g., the snowman) whereas English speakers looked to the manner (e.g., the skates). These eye movement patterns were repeated after the beep while people were describing aloud bounded events.

--- insert Fig.2 here ---

Remarkably, in the Nonlinguistic task (Figure 2b), eye movements were nearly identical for both language groups as bounded events unfolded over time. As the figure shows, interrogation of these events generated nearly identical shifts in attention. Differences did emerge late though, at the end of each trial after the event had finished and participants began studying the last frame for later recollection. Greek speakers focused their attention on manner whereas English speakers were concerned about studying the path endpoint – exactly those components of motion which are not typically encoded in the main verb in the two languages. The most plausible interpretation of this finding is that individuals constructed linguistic representations of the scenes before committing perceptions to memory -- hence they concentrated on those aspects of the events that they could not easily map onto accessible linguistic structures.

Analyses of Variance (ANOVAs) were conducted on looking times to the critical components of the event during each of five separate 1-second intervals beginning from video onset for both the Linguistic and NonLinguistic tasks. ANOVAs had two factors: Language Group (Greek vs. English) and Region-Fixated (Path-endpoint vs. Manner). For the Linguistic task, a significant interaction emerged between Language Group and the Region-Fixated emerged during the first second of animation (F1(1,16)=4.01, p-rep = 0.91, $\hat{\eta}^2_p = 0.20$; F2(1,11)=10.14, p-rep = 0.97, $\hat{\eta}^2_p = 0.48$), such that Greek speakers fixated the path-endpoint (e.g., the

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1 All ANOVAs were conducted on arcsin transformations of looking time because the untransformed measure is bounded between 0 and 1 sec (see Trueswell, Sekerina, Hill & Logrip, 1999).
snowman) more than English speakers (F1(1,16)=4.59, p-rep = 0.92, □p^2 = 0.22; F2(1,11)=9.36, p-rep = 0.96, □p^2 = 0.46). During the third second, a similar interaction obtained (F1(1,16)=3.43, p-rep = 0.89, □p^2 = 0.18; F2(1,11)=7.40, p-rep = 0.95, □p^2 = 0.40), such that English speakers fixated the path-endpoint region more than Greek speakers (F1(1,16)=5.30, p-rep = 0.93, □p^2 = 0.25; F2(1,11)=4.86, p-rep = 0.92, □p^2 = 0.44).²

For the NonLinguistic task, Region-Fixated (Path vs. Manner) did not reliably interact with Language Group until the fourth second, i.e., immediately after the animation froze (F1(1,14)=6.31, p-rep = 0.94, □p^2 = 0.31; F2(1,11)=5.86, p-rep = 0.93, □p^2 = 0.35), such that English speakers studied path-endpoints more than the Greek speakers (F1(1,14)=4.45, p-rep = 0.92, □p^2 = 0.24; F2(1,11)=6.92, p-rep = 0.95, □p^2 = 0.39). The same statistical pattern held for the fifth second: a reliable interaction (F1(1,14)=9.66, p-rep = 0.97, □p^2 = 0.41; F2(1,11)=15.59, p-rep = 0.99, □p^2 = 0.59) again with English speakers studying path-endpoints reliably more than Greek speakers (F1(1,14)=9.20, p-rep = 0.97, □p^2 = 0.40; F2(1,11)=8.28, p-rep = 0.96, □p^2 = 0.43).

As discussed already, unbounded events did not yield wide differences in linguistic descriptions. Accordingly, for these events, there were no major differences in eye movements between English and Greek speakers in either the Linguistic or the Nonlinguistic task (Fig. 3). ANOVAs identical to those described for bounded events were also conducted here. Region-Fixated did not interact significantly with Language Group during any of the five 1-second intervals.³

² The eye movement patterns could be taken to reflect either a deep semantic difference in how verb systems of different languages encode events or simply the order in which semantic information is called upon when formulating appropriate descriptions in English or Greek. Our findings offer a way of teasing these two possibilities apart. We classified manner information, regardless of its lexical/syntactic realization, as being encoded early in the sentence if it appeared either before the V (in the NP-subject such as “the skater” or a postnominal modifier, e.g., “the man with the skates”), or in the verb itself (“is skating”). Post-verbal manner information (in an instrument/locative PP, e.g. “with/on skates”, or a gerund, e.g., “skating”) was considered late encoding. We found that manner modifiers were inserted early in approximately 65% of the Greek descriptions and 87% of the English descriptions of bounded events. But despite this similarity, the fact that manner resides in different grammatical objects in the two languages (the subject in Greek, the verb in English) leads to distinct eye movement patterns: thus the eye movement patterns seem to be determined not by a general preference to look to whatever information speakers need to describe the scenes in the order in which they need the information but by deeper sentence planning processes driven by the sentential verb.

³ In a separate analysis, we considered the possibility that the differences in eye movements between bounded and unbounded events might be due to a difference in ease of naming of the Goal object in the two languages (since the scenes differed from each other in just this respect). We obtained an indirect measure of ease of lexicalization for the Path-endpoint objects by looking at how consistent speakers within each language were in naming these objects. Goal objects in bounded events were named in 67% of the English responses and 77% of the Greek responses. Within this group of responses, we assigned a consistency score to each bounded event in the two languages; the score corresponded to the maximal proportion of responses that used the exact same word (e.g., “snowman”) for the Goal object in that event. (We excluded one event for which no data points from English were available). The mean consistency score for English was 97.7 and for Greek 93.1. This inter-speaker convergence also held for Agents who were
Early vs. global effects on attention in bounded events. Given the cross-linguistic differences observed above for bounded events, we were interested in whether these differences reflected differences in how manner vs. path information uptake was initially prioritized. To investigate this, we analyzed for each trial whether participants looked first to path-endpoint or manner region, ignoring all other regions (e.g., the agent, the background, etc.). For example, a sequence of looks to the agent, the path-endpoint and then the manner (instrument) would be coded as a ‘Path First’ look. Results are plotted separately for the Linguistic and Nonlinguistic condition in Figure 4. As shown in the figure, there was a general bias to inspect paths first, presumably because they are larger scoring regions, in both the Linguistic (F1(1,16)=33.92, p-rep =0.99, $\eta^2_p=0.68$; F2(1,11)=11.14, p-rep = 0.96, $\eta^2_p=0.50$) and the Nonlinguistic condition F1(1,14)=9.45, p-rep = 0.96, $\eta^2_p=0.40$; F2(1,11)=11.61, p-rep = 0.96, $\eta^2_p=0.51$). However, there was an interaction between First Look Type (Path/Manner) and Language in the Linguistic condition, significant by subjects marginal by items (F1(1,16)=5.50, p-rep = 0.91, $\eta^2_p=0.26$; F2(1,11)=3.61, p-rep = 0.84, $\eta^2_p=0.25$), such that Greek speakers were more likely than English speakers to arrive first at the path-endpoint by subjects but not by items (F1(1,16)=7.18, p-rep = 0.94 , $\eta^2_p=0.31$; F2(1,11)=2.56, p-rep = 0.78, $\eta^2_p=0.19$), and English speakers were more likely than Greek speakers to arrive first at the manner region, though only marginally so (F1(1,16)=3.73, p-rep = 0.85 , $\eta^2_p=0.19$; F2(1,11)=4.55, p-rep = 0.87, $\eta^2_p=0.29$). No such interaction emerged in the Nonlinguistic condition. This pattern is consistent with the hypothesis that attention allocation at the earliest stages of event apprehension is affected by linguistic encoding preferences but only when language is needed to complete the task.

-- insert Fig.4 here --

Interestingly however, it is not the case that Greek and English speakers differ in how much time they spend overall inspecting path or manner information during the three second animation. This is illustrated by calculating the proportion of time spent looking at these two regions of interest (see Figure 5). As the figure shows, participants spent more time looking at paths than manners in both the Linguistic (F1(1,16)=19.71, p-rep = 0.99, $\eta^2_p=0.55$; F2(1,11)=4.47, p-rep = 0.87, $\eta^2_p=0.29$) and the Nonlinguistic condition (F1(1,14)=28.45, p-rep = 0.99, $\eta^2_p=0.67$; F2(1,11)=23.35, p-rep = 0.99, $\eta^2_p=0.68$). Looking time however did not interact with Language for either task (see Fig.6).

overwhelmingly encoded in subjects’ responses: whatever variation was found here was due to different perspectives (e.g., ‘the skier’ vs ‘the man’) rather than differences in ease of encoding.
Taken together, these results show that overall attention allocation in event perception does not differ across languages, even when participants are engaged in a linguistic task: what does differ is when people look to particular regions, i.e., which information is prioritized, during sentence planning. Specifically, as motion events are apprehended, the regions which attract participants’ attention early reflect language-dependent preferences for encoding motion information in the verb (e.g., the where vs. how of motion in Greek and English verbs respectively).

--- insert Fig.5 here ---

Memory data

The results from the memory test are presented in Table 1. Decreases in accuracy indicate that participants had trouble remembering if a path-endpoint had been present or absent in the original video. As seen in the table, participants were generally quite accurate at judging path information, with the exception of the Greek speakers in the Nonlinguistic condition. Indeed, ANOVAs revealed that the Greek speakers’ poorer performance resulted in a significant effect of Language Group overall (F1(1,25)=3.76, p-rep = 0.91, $\eta^2_p = 0.13$; F2(1,11)=11.95, p-rep = 0.98, $\eta^2_p = 0.52$) but that this effect interacted with task, i.e., Linguistic vs. Nonlinguistic (F1(1, 25)=4.95; p-rep = 0.93, $\eta^2_p = 0.17$; F2(1,11)=10.69, p-rep = 0.97, $\eta^2_p = 0.49$). Simple effects revealed that the effect of Language group was significant in the Nonlinguistic condition (F1(1,10)=4.53, p-rep = 0.91, $\eta^2_p = 0.31$; F2(1,11)=12.90, p-rep = 0.98, $\eta^2_p = 0.54$) but not significant in the Linguistic condition (Fs<1).

This pattern of memory errors in the Nonlinguistic condition suggests that Greek speakers’ efforts to attend to the manner during encoding came at a cost, resulting in decreased recognition performance for the path-endpoint. That is, studying the manner area during when the video froze in the Nonlinguistic condition (Fig. 2b) made it less likely for Greek speakers to later recall information about the path-endpoint object.

--- insert Table 1 here ---

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5 Five participants (2 English, 3 Greek) were dropped from this analysis because of a strong ‘same’ bias (i.e., they incorrectly judged 60% or more of the changed items as unchanged from the original video).
CONCLUSIONS

The experiment reported in this paper introduced and explored a novel tool for investigating the language-thought interface by cross-linguistically analyzing participants’ eye movements as they inspected ongoing dynamic events. Our findings support the conclusion that preparing for language production has rapid differential effects on how people allocate visual attention to components of a scene: if people need to talk about what they see, they immediately focus on aspects of scenes which are relevant for purposes of sentence planning. This supports and extends similar results from prior studies examining the rapid mobilization of linguistic resources for language production (Griffin & Bock, 2000; Levelt, 1989; Meyer, Sleiderink & Levelt, 1998), otherwise known as ‘thinking for speaking’ (Slobin, 1996). Additionally, for the first time, our study reveals how cross-linguistic differences in event encoding impact the process of segmenting and attending to different event components during the formulation of linguistic messages: where languages differ from each other in how they encode event structure, this difference shows up in how speakers interrogate scenes during speech planning.

Perhaps most importantly, our findings show that the linguistic encoding of events does not affect the moment-by-moment processes underlying event perception in situations where there is no need for linguistic communication. As our nonlinguistic task shows, when inspecting the world freely, people are alike in how they perceive events, regardless of the language they speak. This result is hard to reconcile with recent claims according to which framing events in language affects the way events are perceptually experienced (e.g., Levinson, 1996) but is consistent with accounts emphasizing universal aspects of event perception and cognition.

Overall, our data point to the conclusion that the way events are inspected in the visual world depends on the perceivers’ goals: if perceivers are preparing to speak, then their attention is directed to linguistically relevant event components; otherwise, language-specific preferences for event encoding do not intrude into the ordinary processes of event apprehension. When they do surface, language-driven effects on attention seem to be quite specific: at least in the domain of motion events, which is characterized by differences in (path/manner) verb typology, typological choices do not affect the global allocation of attention to event components, but simply the order in which these components are attended to by observers when they prepare to speak. This empirical outcome goes against recent proposals which have raised the possibility that semantic distinctions typically encoded in the verbal predicates of a language can become more salient/accessible in the mental life of the speakers of that language (Bowerman & Levinson, 2001; Gentner & Boroditsky, 2001; Slobin, 1996).
Nevertheless, our data also reveal linguistic effects in tasks that do not overly involve linguistic communication. Recall that in our nonlinguistic task, linguistic representations were used to support rapid encoding in declarative memory after a motion event unfolded; furthermore, this rapid translation had implications for memory accuracy later on in our task. Although this process points to a role for language-specific categories in situations where people do not speak, its nature does not easily fit with relativistic views: in preparation for a memory task, speakers seem to shift their attention to categories typically not encoded in their language (at least in the main verb). The fact that people rely on language resources for rapid, post-perceptual processing and storage of event representations is consistent with previous reports of linguistic mediation in memory tasks (Baddeley, 2003; Conrad, 1964; Paivio, 1990). Even though the scope of such mediation is still a matter of active investigation, we expect that in situations where rapid translation of motion stimuli into linguistic utterances is blocked (e.g., through linguistic shadowing, or in speeded judgment tasks), both on-line attention allocation and memory for path/manner of motion would be comparable across speakers of different languages, regardless of verb encoding preferences.

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Table 1. Percentage of Correct Responses in Memory Task

<table>
<thead>
<tr>
<th>Type of Event</th>
<th>Bounded</th>
<th>Unbounded</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Linguistic Condition</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Native English Speakers</td>
<td>92</td>
<td>91</td>
</tr>
<tr>
<td>Native Greek Speakers</td>
<td>92</td>
<td>92</td>
</tr>
<tr>
<td><strong>Nonlinguistic Condition</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Native English Speakers</td>
<td>90</td>
<td>88</td>
</tr>
<tr>
<td>Native Greek Speakers</td>
<td>73</td>
<td>71</td>
</tr>
</tbody>
</table>
Animation Unfolds (3 s)  
BEEP  
Animation Freezes (2 s)

1a. Bounded variant

1b. Unbounded variant

Figure 1. Sample stimulus event: (a) bounded variant and (b) unbounded variant.
Figure 2. Eye movement results for Bounded Events: (A) Linguistic Task, (B) Non-Linguistic Task. Plotted over time from video onset, on a frame-by-frame basis, is the proportion of trials for which participants fixated the path-endpoint component of the event (e.g., the snowman) minus the proportion of trials participants fixated the manner component (e.g., the skates). Positive values reflect a preference to look at the path-endpoint, negative values reflect a preference to look at the manner.
Figure 3. Eye movement results for Unbounded Events: (A) Linguistic Task, (B) Non-Linguistic Task. Plotted over time from video onset, on a frame-by-frame basis, is the proportion of trials for which participants fixated the path-endpoint component of the event minus the proportion of trials participants fixated the manner component. Results are largely negative (biased toward Manner looks) because looks to the Path-endpoint constituted looks to the empty region where the endpoint object would have been if it had been present (e.g., where the snowman had been in the Bounded Event condition).
Figure 4. **First Look Analysis for Bounded Events:** (A) **Linguistic Task**, (B) **Nonlinguistic Task**. Average proportion of trials that participants looked first to the Path Endpoint Region (e.g., the Snowman) or the Manner Region (e.g., the skates) at video onset. Error bars indicate standard errors.
Figure 5. Looking Time for Bounded Events: (A) Linguistic Task, (B) NonLinguistic Task. Average proportion of time that participants spent looking at the Path Endpoint Region (e.g., the Snowman) or the Manner Region (e.g., the skates) during the 3 seconds of animation. Error bars indicate standard errors.