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Manners and Goals in Pre-Linguistic Thought: The Origins of Aspectual Construal

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There are a handful of semantic concepts that serve an organizing function within the grammar. The over-arching goal of this research program is to examine the conceptual origins of these concepts (cf. Wagner & Lakusta, in press): To what extent is the infant mind specially prepared to acquire the natural semantics of language? One of these core concepts is Aspect, and the specific goal of this study is to examine the pre-linguistic representations that might support aspect semantics.

More specifically, the particular dimension of aspect being investigated is that of TELICITY. Telicity is a feature of predicates: Telic predicates describe events with inherent endings (*I ran to the store)*; Atelic predicates describe events without such endings (*I ran)*. Across languages, there are a variety of syntactic reflexes that follow from a predicate's aspectual value (telic or atelic), including argument structure, auxiliary and adverb selection, and case marking (see Dowty 1979, Smith 1991, and Klein 1994 for further discussion). However, no languages have a morpheme that directly signals the telicity of a predicate.

In their early language use, children seem to use telicity to guide their choice of morphology. In particular, children tend to restrict their use of tense and grammatical aspect markers as a function of the telicity of the predicate, preferentially applying past and perfective markers to telic predicates and applying present and imperfective markers to atelic predicates (see Li & Shirai 2000 and Wagner in press for an overview of this phenomenon). Thus, telicity appears to be a semantic distinction that children expect will be important in their linguistic system.

Putting it more strongly, telicity appears to be a natural linguistic category for children, and further, may also be a natural category in children's cognition. It might be the case, therefore, that even before infants can command the linguistic tools of aspect, they may still nonetheless analyze events in the same

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sorts of terms – that is, as having or not having an inherent end-point. The study reported here directly addresses this question: Do pre-linguistic infants analyze events as having (or not-having) an inherent end-point? If so, what are the factors that influence that representation, and make an event more likely to be construed in a way consistent with a telic (or atelic) description?

It should be noted that events in the world do not actually specify an aspectual value. The very same event can be described as being either telic or atelic. The particular choice of predicate that a speaker uses forces one to construe the event in a consistent way: if a telic predicate is used, it leads to a construal that contains a designated end-point. If an atelic predicate is used, it leads to a construal that does not contain the ending. The study reported here does not use language, and so is not concerned with whether infants can use language to guide their construal process. Instead, it investigated the event-construal abilities of infants without language.

In particular, the current experiment examined infants' representation of telicity with DIRECTED MOTION events. Directed motion events are internally complex, consisting of several component parts: a FIGURE moves from one point (the SOURCE) to another (the GOAL) in a particular MANNER of motion. They are one of the core event-types in language, and are deeply integrated into grammatical processes, including things as fundamental as the verb phrase (cf. Talmy 1985, Jackendoff 1990). The goal of a directed motion event is the designated ending of the motion; what distinguishes directed motion events from simple motion events is the specificity of the ending – it is what the motion is directed towards. In principle, empty space could be the goal of a directed motion event (The bunny hopped *there*) but in practice, it is difficult to make an ending sufficiently specific without there being something in particular present, such as an object. The manner component of a directed motion is the means by which the motion achieves its goal[1].

Directed motion events have two critical advantages for studying early representations of telicity. First, both the manner and goal components are integral elements, and can be manipulated independently. Thus, if one's goal is to go to a coffee shop, one can get there using a variety of manners including hopping, skipping, jumping, etc. Moreover, there isn't an inherent bias in these events that would likely skew early representations; both manner and goal components are integral to these events. Second, manner and goal oriented construals of directed motion events correspond directly to a difference in telicity. Predicates describing the manner of motion of an event are atelic: *The bunny hopped.* Similarly, predicates describing the goal of a directed motion event are telic: *The bunny hopped into the bowl.* If infants distinguish between these two construals of directed motion events, then they have made a distinction that will indeed be relevant for the linguistic notion of telicity.

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[1] An additional component, PATH, also contributes to prior history. The path of a Directed Motion event is the trajectory the motion takes towards the goal.

Previous work in infant cognition has found that infants can track the goal of various kinds of events. For example, in Woodward (1998), 5-month-old infants understood that the goal of a reaching event is a particular object, not a particular location in space. This understanding seems to depend on infants' knowledge of people's general intentions when reaching, and it may be linked to their own experiences with reaching and related actions (Somerville, Woodward & Needham 2005, Woodward & Gujardo 2002) as well as their ability to perceive the reacher as being an intentional agent (Gujardo & Woodward 2004). Other researchers have found that infants may identify goals by considering the structure of the events leading up to the end-point (Gergely & Csibra 2003). For example, in Csibra Biro, Koos & Gergely (2003), 12-month-old infants were habituated to a small ball fleeing a large one, and then escaping off screen through a small gap in a barrier. Unable to get through the gap, the large ball moved around the barrier and off screen. At test, the remainder of the screen was revealed and infants expected the large ball to catch the small one. Based on the structure of the event and the principle of rational action, the only logical goal of the chasing history was a catching ending, a fact which infants seem to appreciate. Collectively, these studies suggest that infants can construe an event in terms of its goal, or end-point.

Infants also seem able to connect manner information to an event's goal. Wagner & Carey (2005) replicated the Csibra et al. (2003) result just noted, but also found that changing the motion pattern into a non-chasing event kept infants from inferring a catching ending. Moreover, some recent studies have examined infants' ability to track changes in the manner of motion of an event in contrast to the direction of motion (the PATH). Pulverman, Sootsman, Golinkoff & Hirsh-Pasek (2002) found that 14- and 17-month-old infants could notice changes to both components, as did Casasola, Hohenstein & Naigles (2003) with 10-month-olds. However, neither of these studies looked at the link between manner and goal information. Pulverman et al. did not have any specific goals present in their study; Casasola et al. did have goals present, but their conditions contrasted goal and source information and not how different manners connected to the goals.

The current study examined how infants represent directed motion events. It asked if infants can track the goals of these events, showing that they can adopt the equivalent of a telic construal. Moreover, three different manners of motion were used to explore how differences in manner might lead infants to omit the ending of the event in their representation, as in an atelic construal.

1. Experiment

The method used in this study is an adaptation of Woodward's switch paradigm (Woodward 1998), as laid out in Lakusta, Wagner, Landau & O'Hearn (2007). As in those studies, successful goal-tracking is operationalized as longer looking-times to test trials with new goals. The three manners of motion events tested were Hopping, Gliding, and Scooting. All three manners were minimally intentional: they all involved an animate-like figure (a toy bunny rabbit) facing towards the goal object throughout the motion part of the event. The manners differed along several other dimensions, most notably: the naturalness of the manner for the agent, the complexity of the motion, and the efficiency of the link between manner and goal. Hopping was the most natural manner for the agent (bunnies hop), although it is unclear whether infants would makes this connection given the humanoid nature of the particular bunny used (see Figure 1). Scooting was the most complex manner as it involved two posture changes (getting into the seated position and getting out of it) while the other two manners involved no posture changes. Finally, both Hopping and Gliding were rated by adults as being significantly more efficient means to the goal than Scooting. Seventy-four adults (OSU undergraduates who participated for research credit) each watched a single DM event and rated it for interest and efficiency on a 5 point scale: "How efficient was the bunny's action as a way of getting to the ending?". A one-way ANOVA showed a difference across the manners ($F(2, 72) = 3.6$, $p < .033$). Post-hoc comparisons showed that Scooting was significantly less efficient than both Gliding and Hopping (Gliding average rating = 3.76, Hopping = 3.72, Scooting = 3.0).

No attempt was made to isolate the particular property of the manners that might influence goal-tracking; indeed, since the purpose was to find manners that led to different behavior, properties were confounded as a way of making them maximally different. It was hypothesized that in general, properties which made the manner easier to process would facilitate goal-tracking as fewer mental resources would need to be devoted to manner; in addition, properties which highlighted the link between manner and goal should also facilitate goal-tracking. Thus, it was predicted that infants would succeed at tracking the goal through Hopping: Hopping was naturally associated with the agent and comparatively non-complex – both factors which should make it relatively easier to process the manner information; moreover, Hopping was rated as a more efficient means to the goal, which should help highlight the importance of the goal in the event. By contrast, infants were predicted to fail at tracking the goal through Scooting: Scooting is not naturally associated with the agent and is comparatively complex – both factors which should make it relatively harder to process the manner information; moreover, Scooting was rated as a less efficient means to the goal, so no special emphasis on the goal is placed in this event. Finally, the Gliding event is intermediate between the other two: it was rated as efficient and it is less complex; but, it is not naturally associated with the agent. This condition is virtually identical to a condition in Lakusta et al. (2007) (the no-source, simple-goal condition) and infants were able to track the goals in that experiment. It was therefore predicted that the infants would be able to track the goal through Gliding.

1.1 Participants

Participants were 48 infants with a mean age of 11 months, 11 days (range: 10 mo. 19 days to 12 mo. 6 days). Twenty-two participants were girls. All were from a greater east-coast metropolitan area and came into a lab to participate. The data from an additional nineteen infants were excluded from analysis: eleven for fussiness (and failure to attend through familiarization and at least 4 balanced test trials), two because of parental interference, four due to experimenter error and/or equipment failure, one because the parents reported the child was premature, and one for being a statistical outlier on familiarization[2]. Infants were randomly assigned to one of the three manner of motion conditions and there was no difference in the mean age of infants in each condition (Gliding mean = 11 months 11 days; Hopping mean = 11 months 9 days; Scooting mean = 11 months, 12 days).

1.2 Stimuli

The events were acted on a stage that was 13" high, 33.5" wide, and 14" deep. A curtain could be raised to occlude the stage and lowered to reveal it. On opposite front corners of the stage were two goal objects (each 6" wide): a yellow octagonal tub and a purple box. The agent of the action was a 9" high bunny (the "Good Night Moon" bunny). The bunny had solid eyes and articulated arms and legs. It was attached to a dowel-rod and its movements were controlled from above via this rod.

For familiarization trials, the curtain was lowered to reveal the bunny at the back center of the stage. An experimenter waggled the bunny to attract the infant's attention, saying "Look <baby's name> Look!" The experimenter then made the bunny move to one of the two goals using the designated manner of motion. A metronome light was used to insure consistent motion timings. At the goal, the bunny was made to either get on top of the box or into the tub. At this point, the experimenter again waggled the bunny and said "Look <baby's name> Look!" The bunny then remained still at the goal until the infant looked away for two consecutive seconds. The occluding curtain was then raised and the bunny returned to its starting position.

After seven identical familiarization trials, the positions of the two goal objects were switched. Infants then viewed the objects in the new positions, but the bunny was not present and no motion event took place.

The test trials proceeded in the same way as familiarization, except that the bunny switched goals on alternating trials. Infants saw the bunny move to the

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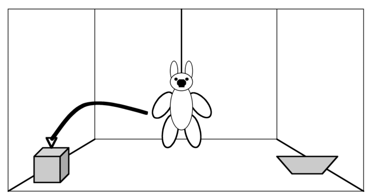
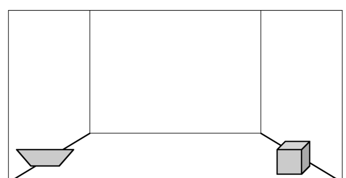
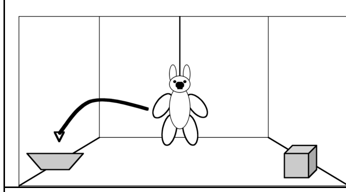
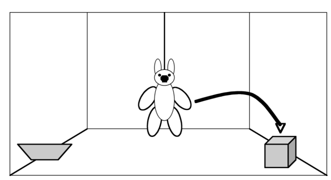
[2] The infant removed as an outlier had looking times that were more than 2.5 standard deviations higher than the mean times on the final 3 familiarization trials.

new goal (in the old location) on three trials and to the old goal (in the new location) on three trials. Across participants, counterbalancing was done for the side of the stage each goal started on, the goal of familiarization trials, and which goal the bunny moved to first at test. A schematic depiction of the experiment is shown in Figure 1.

In the Gliding condition, the bunny leaned slightly forward and moved smoothly to the goal without breaking contact with the stage. In the Hopping condition, the bunny made three hops towards the goal and then hopped into/onto it. In the Scooting condition, the bunny sat down on its bottom and was Scooted to the goal where it popped up and got into/onto.

Figure 1: Schematic overview of the experiments. The specific manner of motion varied by condition.

7 Familiarization Trials		
1 Inter-Trial Display		
Test Trials (show in alternation)		
	New-Goal/Old-Location	Old-Goal/New-Location

1.3 Procedures

Infants sat in a high-chair approximately one meter from the stage. A parent sat next to the infant facing away from the stage. Parents were instructed not to interact with their child during the study unless necessary. As the infants were getting seated, they were able to see the goal objects in their initial positions. The bunny was hidden at this time. Once the infant was settled, her looking space was calibrated by drawing attention to a toy rattled at the edges of the stage. Following calibration, the occluding curtain was raised and familiarization began.

One camera was trained on the stage, and was used to double-check conditions and to insure consistent presentation of the events. A second camera was immediately above the stage and was trained on the infant's face. The presentation experimenter conducted calibration and presented the events. A coding experimenter watched the infant from a separate room and coded looking using the Xhab program (Pinto 1985). The coding Experimenter was blind to the condition being run and the presentation Experimenter was blind to the infant's looking behavior.

1.4 Coding

All infants were coded on-line by a coding experimenter. In addition, 75% of the infants in each condition were coded off-line by a blind coder. Coders' timings for Gliding were correlated at .987 (Pearson Correlation, $p < .01$), for Hopping at .993 (Pearson's correlation, $p < .01$), and for Scooting at .974 (Pearson's correlation, $p < .01$). Coding included both the action and the goal of the event[3]. The timing of the action was done via metronome (a blinking light), but to insure that the timing was consistent, the trials of 8 infants in each manner condition were coded for how long the action took. The mean time for the Gliding action was 5.1 seconds, std. = 0.64 seconds; for the Hopping action it was 4.9 seconds, std =.51 seconds; and for the Scooting action it was 5.0 seconds, std = .44 seconds. Finally, to insure that the presentation experimenter did not cue the infants to look longer at some test trials, one third of all test trial pairs were subjected to further analysis. Two raters were shown the motion parts for pairs of trials without the familiarization context, and guessed which trial showed the New Goal (and by hypothesis, received the longer looks). Raters correctly guessed the right answer 39% of the time, which is not different from chance.

2. Results

The mean looking-time to all 7 familiarization trials was 101.0 seconds for Gliding, 100.85 seconds for Hopping, and 106.07 seconds for Scooting. These times were not significantly different from each other. There was a significant decline in looking from the first two familiarization trials to the last two

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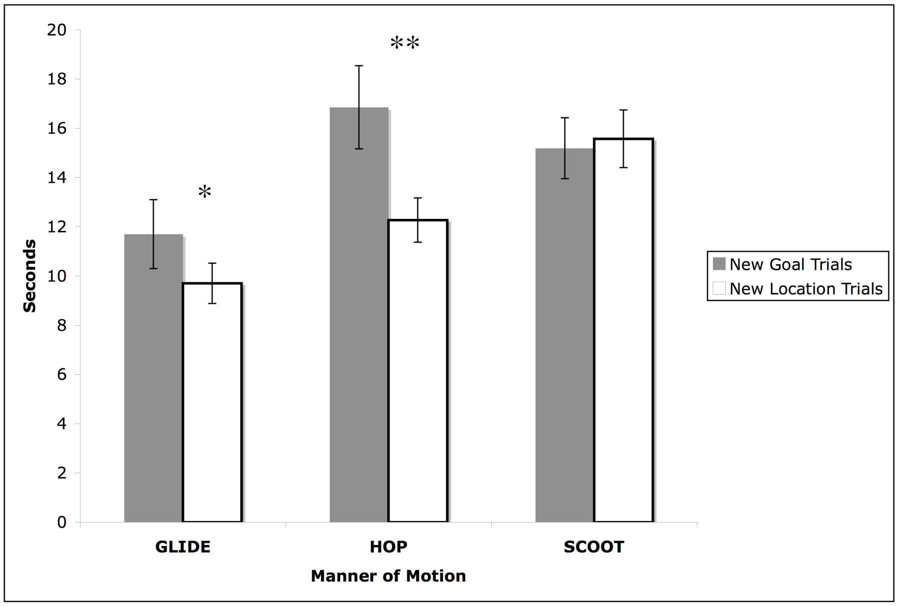
[3] In Lakusta et al. (2007) it was necessary to include the action as part of the looking times for some conditions, particularly those looking at changes to the source object. The same coding procedures were used here to allow for direct comparisons with that work. The results, however, do not depend on including the looking times to the actions. On over 90% of trials, infants looked at the entire action and so the variation in looking times comes from how long infants look at the end-point of the event.

familiarization trials in all three conditions: Gliding ($M1 = 18.27$ seconds, $M2 = 12.13$ seconds, $t (1, 15) = 2.842$, $p<.012$); Hopping ($M1 = 17.11$ seconds, $M2 = 11.87$ seconds, $t (1, 15) = 2.79$, $p<.014$); Scooting ($M1 = 16.69$ seconds, $M2 = 12.54$ seconds, $t (1, 15) = 3.23$, $p<.006$). The amount of recovery to the test trials from the last familiarization trials depended on the particular condition. There was no significant recovery in the Gliding condition; for Hopping there was significant recovery only to the New Goal test trials ($t (1, 15) = 3.05$, $p < .01$); and for Scooting there was significant recovery found to the New Location test trials ($t (1,15) = 2.72$, $p < .016$) and almost to New Goal test trials ($t (1, 15) = 2.03$, $p < .06$).

To examine the test trials, an ANOVA was conducted with looking time as the dependent measure and the independent measures of Test trial type (new goal vs. new location) and Motion type (Gliding vs. Hopping vs. Scooting). A main effect was found for test trial type ($F (1,45) = 7.17$, $p < .01$, effect eta = .14): across conditions, there was longer looking to the New Goal trials, $M = 14.6$ seconds than to the New Location trials, $M = 12.5$ seconds. A main effect was also found for Motion type ($F (2, 45) = 5.6$, $p < .007$, effect eta = .20). A Tukey's post-hoc test showed that this effect resulted from there being significantly shorter looking times across the board for Gliding (across all test trials, $M = 10.7$ seconds) compared to both Hopping and Scooting ($M = 14.56$ seconds and $M = 15.38$ seconds, respectively). Most importantly, there was also an interaction between test trial type and motion type ($F (2, 45) = 3.5$, $p < .04$, effect eta = .13). A Post-hoc Tukey's tests conducted on the difference between looking times to the New Location test trials and the New Goal test trials found that the looking pattern to Hopping was significantly different from Scooting, with Gliding being intermediate between the two and significantly different from neither. Figure 2 shows these results.

Because of the interaction between Motion type and Test trial type, separate analyses were conducted on each Motion type. Paired t-tests were conducted comparing mean looking to the New Goal trials and New Location trials. For Gliding, infants looked longer at the New Goal Trials (11.7 seconds) than the New Location trials (9.7 seconds) which was a marginally significant difference, ($t (15) = 1.94$, $p < .072$). A trial-by-trial comparison across the three test trial pairs showed that infants looked longer at the New Goal trials in each pair, and in fact, this difference was significant on the third pair ($t (15) = 3.3$, $p < .005$). Moreover, twelve of the sixteen infants looked longer at the new goal trials overall. For Hopping, infants looked longer at the New Goal trials ($M = 16.85$ seconds) than the New Location trials (12.27 seconds) which was significantly different with a 2-tailed test ($t (1, 15) = 2.87$, $p < 0.012$). The trial-by-trial comparison showed that infants looked longer at the New Goal trials in each pair, and this difference was significant for the first pair ($t(15) = 3.1$, $p < .008$). As with the previous condition, 12 of the 16 infants looked longer at the New Goal trials overall. For Scooting, there was no significant difference between the looking to the New Goal trials (15.19 seconds) and the New Location trials (15.57 seconds). The trial-by-trial comparison showed that infants looked longer at the New Location trials for two of the three pairs, but did not look significantly longer at any half of any pair. Moreover, only 7 of the 16 infants looked longer at the New Goal trials overall.

Figure 2: Mean Looking times to New Goal and New Location test trials for Glide, Hop, and Scoot. * p < .05, 1-tailed, ** p < .05, 2-tailed



3. Discussion

Overall, these results show that 11-month-old infants can track the goal of a directed motion event robustly through a Hopping manner of motion, marginally through a Gliding manner of motion, and not at all through a Scooting manner of motion. Further, the fact that the particular manner of motion used influences infants' interpretation of the end-point provides evidence that they are treating these as actual events; the endings (when they are tracked) are connected to what came before them.

The results are also consistent with the idea that infants have analyzed some of these events, namely the hop-to-goal and glide-to-goal events, as being telic. A telic construal requires one to include the end-point in one's representation; by tracking the ending of these events, infants are doing just that. The results are also consistent with the possibility that infants can analyze some events, namely scooting events, as being not telic. For this event, infants did not include the event's end-point in their representation

These data also suggest some possible event elements that lead an infant to adopt a particular construal. Consider first what makes an event telic for the infant. Certainly, the infants were not guided by language. At no time in this study were the events described for the infants, and it is not even clear that they would understand the relevant syntax even if they had been. Instead, it appears that features of the events themselves suggest a telic construal for the infant. What are these features? The three manners used differed in two critical ways. The first difference was discussed previously: Hopping and Gliding were notably more efficient ways to get to the goal object than Scooting was. Within the literature on infant cognition, the theory of rational action (cf. Csibra et al. 1993, Gergely & Csibra 1993, Gergeley et al. 2005) argues that infants are better able to infer an event's ending when the means to the end is rational. Since Hopping and Gliding were seen by adults as a more efficient means to the ending than Scooting is, infants might also have seen them as more rational means, which would facilitate their ability to link them to the events' endings. It is unclear whether having a more rational manner of motion is actually leading the infants to include the goal in their representation or whether it merely facilitates their ability to process (and therefore remember) the goal information.

If the latter is true, a second important difference between Scooting and the other manners may also be at play. Scooting was prima facie more complex than the other manners. Scooting required two changes in posture while Hopping and Gliding required none; moreover, there was more wiggling during Scooting in general. Infants may have found it easier to represent and integrate the less complex actions with the goal information than the more complex one. Previous research with infant cognition has suggested that infants are quite limited in their processing abilities and may not be able to focus on more than a single dimension of a complex event or object (Feigenson, Carey & Spelke 2002; Baillargeon & Wang 2002). Infants may simply not have had the processing resources to spare for the goal after watching the more visually complex manner of Scooting.

An alternative way of thinking about these facts is that the visually exciting manner of Scooting may have encouraged the infants to adopt an atelic construal of the event. Such a construal would naturally leave off information about the event's ending. This claim, however, goes somewhat beyond the current data. The current experiment showed that Scooting can block a telic construal but to really demonstrate an atelic construal would require some sort of positive evidence: for example we might predict that an atelic construal would lead to enhanced understanding and memory for the manner component of the event.

A variety of outstanding questions remain about infants representations of directed motion events. At the most local level, what exactly do infants think the goal of such an event is? The goals in the current experiments were defined by several dependent features: most notably, the properties that defined the objects themselves (their shape, color, etc.), and the actions undertaken at each object (getting in/on). Since these features were always confounded – the bunny always went on top of the purple box and inside of the yellow tub – there is no way to know whether infants considered the goal to be the object per se, or just the action done at the object.

More globally, is it fair to say that infants have adopted a general telic construal for these events, or have they simply understood that some motion events include their goals? Telicity is a linguistic notion and as such is an extremely abstract concept that applies to events across the board. If infants' understanding of event endings is restricted to directed motion events, then their concept is different, and lesser, than the linguistic concept of telicity. Further experimentation is needed to see if infants have a general concept that applies to a range of event types, as telicity does in natural languages. The results presented here are only one piece in this puzzle, but they are a piece that suggests that the linguistic category of telicity has a reasonably close parallel in infants' pre-linguistic cognition.

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