An Asymmetry between Goal and Source in Infants’ Representations of Motion Events

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AN ASYMMETRY BETWEEN GOAL AND SOURCE IN INFANTS' REPRESENTATIONS OF MOTION EVENTS

A THESIS

Submitted in partial fulfillment of the requirements

For the degree of Master of Arts

by

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Montclair State University

Montclair, NJ

2012
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Abstract

In this paper, the asymmetry between source and goal was explored in the context of motion events involving inanimate figures (e.g. balloon, tissue). Past research with infants has indicated a preference for goal paths in animate events, such as a duck walking into a box, over source paths, such as a duck walking out of a box (Lakusta, et al., 2007). The difference between a goal bias for animate and inanimate events has not been thoroughly researched in infants (e.g., a balloon, rather than a duck, moving out of a box). In order to explore this, the current study measures the looking times as 14- and 18-month old infants view goal and source events presented on a screen. Results (N=26) indicate a statistically significant preference for goal events over source events. If infants show a goal bias for inanimate events, then these pre-linguistic representations may be the basis for learning language, since language also shows a goal bias for both animate and inanimate events. Further research is needed to test the strength of this bias in inanimate events versus animate events.
An Asymmetry between Goal and Source in Infants’ Representations of Motion Events

How does language relate to pre-linguistic thought? Past research has indicated a preference for goal paths (endpoints; e.g. a duck walking to a tree) over source paths (starting points; e.g. a duck jumping out of a box) (Clancy, 1985; Freeman, Sinha & Stedmon, 1980; Ihara & Fujita, 2000; Lakusta & Landau, 2005; Lakusta & Landau, 2012; Lakusta, Yoshida, Landau & Smith, 2006; Landau & Zukowski, 2003; Papafragou, 2010; Pléh, 1998). This asymmetry has also appeared non-linguistically (that is, the way people think of an event or a memory of an event) (Lakusta & Landau, 2012; Papafragou, 2010; Regier & Zheng, 2007) and pre-linguistically (that is, prior to the development of language) (Lakusta, Wagner, O’Hearn, & Landau, 2007). Much research has delved into the encoding of source and goal in language and non-linguistically across many types of events. As discussed at greater length below, research has shown a goal bias for animate and inanimate events in language but more strongly for animate events non-linguistically (Lakusta & Landau, 2012). The difference between a goal bias for animate and inanimate has not been thoroughly researched in infants. The possibility of the goal bias extending to inanimate events (e.g. a balloon floating out of a box) in infants is the main focus of this paper.

I. Motion Events

Although there are various event types (such as change of state events or change of possession events), this paper specifically explores the motion event. Leonard Talmy (1985) identified a motion event as a situation containing movement or the maintenance of a stationary location. His basic event includes one object, namely the Figure, which
moves or is located in relation to a reference object, or Ground (as coined by Talmy). A motion event, as described by Talmy, has four components: Figure, Ground, Path, and Motion. Figure and Ground have already been described above. The Path is the course of the Figure in relation to the Ground, and the Motion simply refers to the existence of motion or location in an event (Talmy, 1985). A Motion event can have internal components as well as external components; internal components are ‘move’ and ‘location’ and external components are ‘Manner’ and ‘Cause’. To integrate all of these terms in a more concise way, Talmy presented the following example:

<table>
<thead>
<tr>
<th></th>
<th>Manner</th>
<th>Cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>motion</td>
<td>The pencil rolled off the table</td>
<td>The pencil blew off the table</td>
</tr>
<tr>
<td>location</td>
<td>The pencil lay on the table</td>
<td>The pencil stuck on (to) the table (after I glued it)</td>
</tr>
</tbody>
</table>

Table 1. The pencil is the Figure and the table is the Ground. The Paths are ‘off’ and ‘on’. ‘Rolled’ and ‘blew’ express motion, and ‘lay’ and ‘stuck’ express location. ‘Rolled’ and ‘lay’ express Manner and ‘blew’ and ‘stuck’ express Cause (Talmy, 1985).

What exactly are goal paths and source paths? What are the components? Jackendoff (1983) described the structure of sentences and what role a path plays in that structure. A path is often the prepositional phrase in the English language which describes the event (e.g., ‘to’, ‘from’, ‘onto’, ‘into’). In the case of motion events (which are the focus of this paper), the Figure follows a path. For example, the types of path which are discussed in this paper include source paths and goal paths (motion events may also include VIA paths, but source and goal paths are the focus of this paper). A goal path is the movement of a figure TO a goal object, and a source path is the movement of a
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figure FROM a source object. In English, a source path includes prepositions such as 'off', 'out', or 'from' (e.g. 'from the house') and a goal path includes prepositions such as 'to', 'onto', and 'into' (e.g. 'to the yard'). The reference object of a path is an object that the figure begins or ends at. This reference object is at the beginning of a source path and at the end of a goal path (Jackendoff, 1983).

II. Asymmetry in Language

There is an apparent asymmetry in language between goal paths and source paths. Evidence for an asymmetry between goal paths and source paths has been brought to light by studies which suggest that this asymmetry exists when encoding goal paths versus source paths (e.g. describing events using goal prepositional phrases vs. source prepositional phrases). Lakusta and Landau (2005) revealed a goal bias (preference for goal events over source events) for motion events in language. They studied the linguistic encoding of goal and source paths in children aged three to seven and also in adults, both groups who have developed language (monolingual). The first experiment showed children and adults 18 manner of motion events, 16 non-manner of motion events, including 6 change of possession events, 4 change of state events, and 6 attachment/detachment events (Lakusta & Landau, 2005). Children and adults were asked to describe the events that they saw, and results showed that across all the event types, the participants regularly included the goal path in their description but not the source path (for example, saying 'into the pitcher' rather than 'out of the bucket'). This study also demonstrated that the goal bias is not limited to motion events in language, but rather it extends to other event types, as shown in Lakusta and Landau (2005). For example, the goal bias persisted for non-manner of motion events such as change of possession (e.g.,
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“He gave the flowers to the woman”), change of state (e.g., “The bear’s nose changed from blue to yellow”), and attachment/detachment events (e.g., “unhook from the dock”). For the change of possession events, all groups used predominantly Goal Path verbs, such as ‘give’ and ‘throw’ rather than Source Path verbs such as ‘get’ and ‘catch’. The participants rarely used Source Path verbs to describe these events, and if they did, they rarely included the actual Source Path (Lakusta & Landau, 2005). For the change of state events, verbs such as ‘turn’ and ‘change’ could be used, which can take both a Goal and a Source Path. When participants used verbs which could take either path, they included Goal Paths more than the Source Paths. As for the attachment/detachment events, when participants used a Goal Path verb in Attach events, they often included the Goal Path, whereas when they used a Source Path verb in the Detach events, they included the Source Path less often (Lakusta & Landau, 2005).

For the next experiment, the same participants were used, but they were supplied with a target verb (the ‘hint’) that they were to use when they described the event they saw. For example, if the event they saw was a girl pulling a pen out of a shoe, the experimenter told the participant that the hint is ‘pulled’ (Lakusta & Landau, 2005). The hint which was given was always the conjugated past tense form of the target verb. For this experiment, results suggested that the goal bias is persistent: even when the participants were presented with a biased verb, they would continue to encode the goal path more than the source path (Lakusta & Landau, 2005). For the change of possession events, participants regularly included the Goal Path verb when this was what was supplied, and mostly included the Source Path verb when this was what was supplied. When the supplied Source Path verb was not used, the participants used a Goal Path verb
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instead (e.g. ‘throw’ instead of ‘catch’) (Lakusta & Landau, 2005). Also, the Goal Path was included more often than the Source Path whether the ‘hint’ verb was a Goal verb or a Source verb. For the attachment/detachment events, participants once again used the ‘hint’ verbs almost all of the time, whereas they included the Goal Path more often than the Source Path. This suggests that a goal bias may be ingrained in us even prior to learning language. It may be that our non-linguistic representations of goal and source drive this asymmetry as we learn language and include goal paths in descriptions rather than source paths. The persistence of this asymmetry is greatly intriguing.

Papafragou (2010) asked whether a linguistic asymmetry exists between Source and Goal objects. Specifically, she asked whether Source objects would be mentioned less frequently compared to Goal objects. Adults and children were presented with a set of animated motion clips involving an animate agent moving from a Source object to a Goal object (Papafragou, 2010). They were then asked to describe the clips they saw. Results showed that Goal objects have an advantage over Source objects during linguistic communication in both adults and children (e.g. subjects offered additional information in their description of the event more often with Goal paths than with Source paths). These results extend Lakusta & Landau’s results (2005) by examining whether adults and children showed a bias for goal or source objects rather than the actual path as in Lakusta & Landau. Papafragou’s study shows that landmark objects are less likely to be mentioned linguistically if they appear as Sources compared to Goals; also, Source objects were described in less detail compared to Goal objects (Papafragou, 2010).

Lakusta and Landau (2012) found further evidence that a linguistic goal bias exists for children and adults. Participants were shown 37 videotaped motion events with
animate actors, and 32 videotaped motion events with inanimate actors; participants were asked to describe what happened in each event. Adults included the goal path more often than the source path in their description of the events (e.g. to the desk vs. from the pillows). Both adults and children showed a goal bias for the animate and inanimate events (Lakusta & Landau, 2012). These results are consistent with the results in Lakusta & Landau (2005), described earlier. Both studies indicate that there is a strong bias to linguistically code the goal over the source (as well as the goal path over the source path).

Regier & Zheng (2007) also delved into the question of whether goal events are emphasized in language. It has been proposed that people attend preferentially to the endpoints of spatial motion events, and that languages may therefore make finer semantic distinctions at event endpoints than at event beginnings. This experiment tested whether a linguistic endpoint bias exists across languages which have different spatial systems (Arabic, Chinese and English) (Regier & Zheng, 2007). To test this, they presented participants (native speakers of English, Arabic or Chinese) with video clips of joining events and their corresponding separating events. For example, a joining event would be a hand putting a hat on a doll’s head, and the corresponding separating event would be a hand taking the hat off the doll’s head (Regier & Zheng, 2007). Each participant was asked to write down a description of each event, in their native language. English and Chinese are satellite-framed (the path information is carried in a verbal satellite—for example, a preposition) while Arabic is verb-framed (the path is conveyed in the verb itself); mean number of events named for joining and separating events for both verbs and satellites were calculated to compare the three languages (Regier & Zheng, 2007). Across three languages, terms of joining (such as putting a watch on a wrist) were shown
to be semantically narrower than terms of separating were (such as taking a watch off a wrist) (Regier & Zheng, 2007). For each description, the researchers examined the primary verb describing the motion and any preposition. So, for ‘taking the doll off the towel’, the verb would be ‘take’ and the preposition is ‘off’. The findings supported the prediction that languages will make more distinctions at event endpoints (goals) than at event beginnings (sources). The results suggest that finer attention to endpoints may be a universal tendency in spatial language (e.g., across various languages, endpoints tend to be more differentiated than event beginnings). In other words, people pay more attention to endpoints of an event despite the native language of the speaker, and are able to notice changes in the endpoint more than changes in the beginning of an event (Regier & Zheng, 2007).

III. Non-linguistic representations in children and adults

In addition to a goal-source asymmetry in language, there has also been evidence for a similar asymmetry in non-linguistic representations in children and adults.

Regier & Zheng (2007) also investigated a non-linguistic goal bias (as well as a linguistic one discussed in the previous section); they tested whether there is a non-linguistic attentional bias in favor of event endpoints. A visual discrimination task was utilized for this purpose (Regier & Zheng, 2007). In this experiment, participants were shown pairs of motion events and were asked whether the events were the same or different. It was predicted that people would be better at detecting differences occurring at the end of the events (as opposed to the beginning) because people may pay greater attention to the endpoints. The video clips showed a hand manipulating objects on a
tabletop; four of the clips included: (1) placing a lid on a container, (2) taking the lid off the container, (3) placing a lid in the container, and (4) taking the lid out of the container (Regier & Zheng, 2007). Video clips 1 and 3 (joining events) differed in the endpoint spatial configuration (in vs. on), while video clips 2 and 4 (separating events) differed in the beginning of the event (in vs. on). Discriminating two joining events would require attention to endpoints, while discriminating two separating events required attention to the beginning (Regier & Zheng, 2007). Results indicated that participants made fewer errors in discriminating the joining events than the separating events; therefore participants were able to discriminate joining events more accurately than separating events.

Papafragou (2010) offered evidence for a goal bias in adults and young children for remembering objects and relations in motion events. As stated previously, adults and children were presented with a set of animated motion clips involving an animate agent moving from a source object to a goal object. A second set of clips showed the reverse of the first set of clips; and a memory task was administered after the participants viewed all of the video clips. They had to decide whether a video clip was the same or different as the previous clip. Both adults and children had a better recollection of the objects and relations if they were at the endpoint (goal) rather than the starting point (source) of the motion event (Papafragou, 2010). Spatial configurations at the endpoints of a motion were remembered better compared to spatial configurations at starting points; adults and children were able to detect changes in the Goal object more than changes in the Source object (Papafragou, 2010). For example, in one event, a fairy is flying from a tree to a flower; a Goal change occurred when the flower was substituted by another flower. The
corresponding Source version of the event includes the fairy flying from the flower to the
tree, and for the Source change, the flower is changed to a different flower (as in the Goal
change). For the memory task, participants were told they would have to remember the
clips they were shown because they would be given a memory task later, and they would
have to say whether a second set of clips was the same or different from the first set; the
memory task was administered after the participants viewed all of the clips (Papafragou,
2010). The results showed that the goal objects have an advantage over source objects in
language for adults and children, and subjects offered more detailed additional
information for goal paths than source paths (Papafragou, 2010). This demonstrates a bias
in spatial representation as well as in memory, which in turn affects the spoken
description of the motion events (Papafragou, 2010). Therefore, these results also
demonstrated a goal bias for motion events in memory (non-linguistic representations) as
well as in spoken language (linguistic representations) in children and adults.

Lakusta and Landau (2012) examined non-linguistic representations of events in
children and adults, compared to linguistic representations. They aimed to reveal whether
the goal bias in language also extends to non-linguistic representations of events. For the
first part of the study, adults and children were shown videotaped motion events which
included an actor moving from a source object to a goal object (these events included
animate actors). Each video had a matching video which included a changed aspect of the
scene (a change in the goal or the source object). Participants were required to repeat a
sequence of numbers and words that a computer was playing during the viewing of the
event (this was to interfere with linguistic encoding). The purpose of this experiment was
to assess which type of change in the scene would be noticed more (Lakusta & Landau,
2012). Results suggested that participants were able to detect goal changes better than source changes; ten of the 14 adults and 9 of the 14 children showed this pattern; one adult and four children showed no asymmetry. Their findings provide support for the hypothesis that the goal bias previously seen in language has its origins in non-linguistic representations of events in children and adults (children and adults tend to remember goals over sources). This tendency to detect changes of goals in motion events better than changes in sources is consistent with previous studies.

In another experiment in this study, the events that were used involved inanimate motion rather than animate motion (this removes the animate intention of the actor). The moving objects were inanimate objects such as a tissue or a leaf, rather than the previous experiment which used an animate actor (Lakusta & Landau, 2012). Participants (adults and children) were shown 32 videotaped motion events which included an inanimate object rolling or blowing from one object to another. Each of these events had a match that was identical to the target event, had a different source, or a different figure. The major difference between this experiment and the one with the animate actors is that participants did not show any significant differences for events that had a change versus events that had no change, although both groups showed a goal bias when asked to describe animate and inanimate motion events (Lakusta & Landau, 2012). Only 11 of the 24 adults, and eight of the 14 children detected goal changes better than source changes; seven adults and 2 children showed no asymmetry at all. Participants in this experiment did not show a significant goal bias in memory when they were encoding events which included an inanimate object moving from a source to a goal. This suggests that a goal bias is not robust for physical events in non-linguistic cognition (yet it is robust for
animate events in non-linguistic cognition) (Lakusta & Landau, 2012). This finding is the motivation for the current study to be addressed in this paper (discussed below).

**Summary**

In children and adults, a goal bias has been demonstrated in language for both animate and inanimate events. A goal bias has also been seen in non-linguistic memory of animate events, yet this bias is not apparent non-linguistically for inanimate events (Lakusta & Landau, 2012).

**IV. Pre-linguistic representations**

The main aim of this paper is to discover the basis for the asymmetry found between goal and source in language. Does this asymmetry between goal and source begin in infants? Or does it become prevalent after the introduction of language? So, is the way that infants form goal and source representations a platform which serves as the basis for this asymmetry in language, or do the representations in language occur independently of pre-linguistic representations?

One possibility is that the pre-linguistic representations of goal and source are the basis of language. If this is the case, then studies with infants should reveal a goal bias to mirror the results found in language (for animate and inanimate events).

The question of pre-linguistic representations was explored by Lakusta, Wagner, O’Hearn and Landau (2007). They took an interest in testing how 12-month-old infants represent goals and sources. As with the current study topic of this paper, they looked at these representations in Motion events involving an animate-like duck (e.g., a duck
moving out of a bowl and onto a block). First they asked whether infants are able to encode goals and sources as separate components of Motion events. Infants were familiarized to an event which a figure moved to one of two goals. During test, the figure moved to a different goal as in familiarization, but in the same location; OR: the figure moved to the same goal, but in a different location. Infants looked longer at a change in the goal than a change in the location during test, which shows that infants encode the goal in Motion events (Lakusta et al., 2007). Next, the Motion events included sources rather than goals. Results indicated that infants do not show evidence of source encoding. Then, they increased the salience of the source objects; in this instance, infants did show evidence of source encoding. Lakusta et al. (2007) then asked whether infants will show asymmetric encoding of source and goal when part of the same Motion event. To test this, they presented infants with Motion events that included the two salient source objects and the two ordinary goal objects as used previously. The infants were familiarized to the figure moving from one of two salient source objects to one of two ordinary goal objects. This experiment directly tested whether there is an asymmetry between source and goal. Results did in fact indicate a goal bias, which indicates that infants represent sources and goals asymmetrically. So, infants have the ability to encode both goals and sources in separate events, and they encode goals in preference to sources when both goal and source are present (Lakusta et al., 2007).

Previous research has indicated a Goal bias in language with children and adults, and now this same bias seems to extend to pre-linguistic event representations. However, Lakusta, et al. (2007) discovered these findings using animate events. What about
inanimate events? Will this evidence for a goal bias also extend to motion events with an inanimate figure?

If a goal bias exists pre-linguistically for inanimate events, then this would reflect the pattern of adult language. This would suggest that pre-linguistic representations of events are the basis for representations in language. In other words, the relationship between goal and source pre-linguistically (the asymmetry) may later be mapped into language, which would account for the goal bias shown to be present in language. If there is no goal bias pre-linguistically for inanimate events, then this would reflect the non-linguistic pattern for children and adults, but it would not reflect the pattern observed in language. This would suggest that language and cognition are not completely reliant upon each other; perhaps other factors influence the linguistic asymmetry between sources and goals. The pre-linguistic representations of inanimate motion events are the topic of the following study.

Method

Participants

Twenty-six infants between the ages of 14 months and 18 months participated in the study. There were two age groups in this study: 14 months (N=13, Mean = 14 months, 14 days; Range: 13 months, 30 days to 14 months, 29 days), and 18 months (N=13, Mean = 18 months, 0 days; Range: 17 months, 15 days to 18 months, 13 days). The 14 month olds included 7 females and 6 males, and the 18 month olds included 8 females and 5 males. The infants were recruited from various sources including Mom’s groups and daycares, in addition to acquaintances of Montclair State University students.
and employees. A parent of every participating infant signed a consent form for their child to participate in the study, and all infants received a prize for participating (small toy or t-shirt). All studies performed received IRB approval prior to data collection.

**Materials and Procedure**

Participants were shown a series of 10 motion events (flash animations) on a projector screen. Each event included four pre-familiarization trials (See Figure 1) and six test trials (See Figure 2). In the four pre-familiarization trials, infants were shown four separate animations (bowl, box, tissue and balloon); the purpose of these animations was to expose the participants to the objects and figures prior to the test trials so that infants’ looking times would not be based only on the object(s) in an event but rather on the entire event (an object moving away/to another object). The six test trials were presented as three trial pairs; three of the trials included a source event, and three of them included a goal event. The figure was either a tissue or a balloon floating into or out of a box or a bowl. For example, a balloon would float from one side of the screen to the other (where the object is located, in a goal event) in a span of about 2 seconds, when the balloon would then land in the box. A red curtain in the animation would close after this event occurred, and the event would then repeat until the infant looked away for 2 seconds or more, or when the infant looked at the event for 60 seconds. Events were presented sequentially to the infants. The order that the test trials and pre-familiarization trials were presented, as well as the side of the screen the object was on (during the test trials), was counterbalanced across conditions.
Participants sat on their parent’s lap as they watched the motion event sequences on the screen. The presenter of the study cued the infant to look at the screen when a new trial began by saying “Look, (baby’s name), Look!”. The balloon or tissue then floated into or out of a box or a bowl (about 2 seconds). Throughout the experiment, a trained observer recorded how long the infant looked at the event using a computer program called Xhab. The computer signaled when the infant looked away from the screen for 2 continuous seconds, or when the infant looked at the same event for 60 total seconds. At this time, the presenter would prompt the next event by moving on to the next PowerPoint slide. Two video cameras recorded the study; one recorded the screen where the events were being presented, while the other recorded the infant as he/she watched the events. The recordings of the infants were imported into iMovie and were then saved as Quicktime movies to view in the future. Looking times (the dependent variable) were coded as the infant watched each event on the screen, so that the events could be compared to each other in terms of this looking time. The parent was asked not to speak or point during the presentation, and was asked to close their eyes when the test trials appeared, so that there was no outside influence on the infant’s looking patterns. The data were coded by two research assistants for reliability. The average percent agreement between the two coders was calculated by Xhab based on the percent of time the coders were both coding the infant as looking at or away from the screen. The average observer agreement for all combined data was 96.0%. The 14-month age group had an average observer agreement of 96.2%, while the 18-month age group had an average observer agreement of 95.8%. For every infant in the study, 100% of the test trial data were coded
and subsequently analyzed for any evidence of a preference of source or goal (see Results section below).

Figure 1. Four pre-familiarization trials. The box and the bowl appeared stationary on the screen, while the balloon and the tissue appeared in motion (floating back and forth across the screen).

Trial Pair A

Source event: Balloon out of box
Goal event: Balloon into box

Trial Pair B
The main research question was whether infants show a preference for goal events over source events. First, the data from both age groups were combined and analyzed. Then, the results were analyzed for each age group separately to confirm the results.

**Combined**

The first analysis performed was a paired t-test to compare the overall mean looking times for goal events versus source events. Looking times were averaged across
test trials and showed that infants looked significantly longer at the goal events (M = 25.05, SE = 2.22) compared to source events (M = 19.42, SE = 1.70); paired, two-tailed, $t(25) = , p < .01$. The difference in looking times between average goal and average source was statistically significant (See Figure 3 below). Next, a 2 (Age: 14 vs. 18 months) x 2 (Test Trial Type: Goal vs. Source) ANOVA was performed to determine if there was an interaction between age group and the main variable. Results indicated a significant main effect of Test Trial Type ($p = .01$), but not a significant interaction, $F(1, 24) = .036, p > .10$; suggesting that 14- and 18-month old infants show a similar degree of goal preference.

Figure 3. Average goal vs. average source looking times overall. Infants spent significantly more time looking at the goal events as opposed to the source events.
Next, analyses were performed on the 14-month-olds and the 18-month-olds separately to confirm the significant result found with the combined data.

14 months

The first analysis for this age group was a paired t-test to compare the overall mean looking times for goal events versus source events. Looking times were averaged across test trials and showed that infants looked longer at the goal events ($M = 21.11$, $SE = 2.84$) compared to source events ($M = 15.86$, $SE = 1.70$); paired, two-tailed, $t(12) = 2.094$, $p = .058$. The difference in looking times between average goal event looking times and average source event looking times was marginally significant (See Figure 4).

Figure 4. Average goal vs. average source looking times for 14-month-old infants. Infants spent more time looking at the goal events as opposed to the source events, which is marginally significant.

Further analyses examined whether the main variable of interest, test trial type (goal, source) significantly interacted with the following counterbalancing variables: Trial Pair Type (A, B, C), Trial Pair Presentation Order (A, B or C presented first), Trial
Side (source or goal reference objects located on left or right side of screen), and Gender (male, female). Separate ANOVA's were performed for each of these variables, to examine whether any of these significantly interacted with the main variable of interest, Test Trial Type.

First, a 3 (Trial Pair Type: A vs. B vs. C) x 2 (Test Trial Type: Goal vs. Source) ANOVA was performed. There was a statistically significant interaction between trial pair type and test trial type, $F(2, 24) = 6.073, p = .007$. To explore this effect further, a paired t-test was performed for each Trial Pair Type individually. Trial Pair A showed no significant difference between goal ($M = 18.46, SD = 8.24$) and source ($M = 17.90, SD = 10.01$) test trial types; $t(12) = .253, p > .10$. Trial Pair C also showed no significant difference between goal ($M = 16.78, SD = 12.90$) and source ($M = 17.93, SD = 10.68$) test trial types; $t(12) = .289, p > .10$. So where is this interaction between trial pair type and test trial type coming from? It seems to be coming from Trial Pair B, which revealed a highly significant difference between goal ($M = 28.08, SD = 19.88$) and source ($M = 11.76, SD = 3.86$) test trial types; $t(12) = 3.048, p = .010$. This reveals that the difference in looking times between goal events and source events for Trial Pair B (Balloon out of bowl/into bowl) was statistically significant, showing a strong goal bias, but these differences for Trial Pair A and C (Balloon out of box/into box; Tissue out of bowl/into bowl) were not significant. It is unclear why this effect occurred in Trial Pair B, and not in Trial Pairs A and C.

Next, a 3 (Trial Pair Order: Pair A, B, C presented first) x 2 (Test Trial Type: Goal vs. Source) ANOVA was performed, which did not reveal a significant interaction, $F(2, 10) = 1.149, p > .10$. Then, a 2 (Trial Side: Left vs. Right) x 2 (Test Trial Type:...
Goal vs. Source) ANOVA revealed a marginally significant interaction, $F(1, 11) = 4.244, p = .064$. To analyze this result further, a paired t-test was performed for each trial side individually, which revealed that when the reference objects were on the right in test, there was a significant difference between looking times for goal events ($M = 22.31, SD = 11.35$) versus source events ($M = 12.83, SD = 5.27$); $t(6) = 3.763, p = .009$. There was no significance found between goal ($M = 19.70, SD = 9.65$) and source ($M = 19.40, SD = 5.42$) when objects were located on the left side of the screen, $t(5) = .078, p > .10$. This result may be explained by the fact that the objects in pre-familiarization (bowl, box) were always presented on the right side of the screen. Therefore, if the objects were on the right during test, the infants were probably more interested in the motion/path of the figure (balloon, tissue) rather than the location of the object. Further, if the objects were on the left during test, the infants may have been more interested in this change in object location rather than the path taken by the figure.

Finally, a 2 (Gender: Male vs. Female) x 2 (Test Trial Type: Goal vs. Source) ANOVA revealed no significant interaction, $F(1, 11) = 1.298, p > .10$. Therefore, the counterbalancing variables which had a significant interaction with the main variable were trial pair type and trial side.

18 months

For the 18-month-old infants, data analysis performed was the same as in the 14-month-old infants. The first analysis was a paired t-test to compare the overall mean looking times for goal events versus source events. Looking times were averaged across test trials and showed that infants looked longer at the goal events ($M = 28.99, SE = 3.13$)
compared to source events (M = 22.98, SE = 2.65); paired, two-tailed, $t(12) = 1.920$, $p = .079$. The difference in looking times between average goal event looking times and average source event looking times was marginally significant (See Figure 5).

**Figure 5.** Average goal vs. average source looking times for 18-month-old infants. Infants spent more time looking at the goal events as opposed to the source events, which is marginally significant.

Further analyses examined whether the main variable of interest, test trial type (goal, source) significantly interacted with the following counterbalancing variables: Trial Pair Type (A vs. B vs. C), Trial Pair Order (Pair A, B or C presented first), Trial Side (source or goal reference objects located on left or right side of screen), and Gender (male, female). Separate ANOVA's were performed for each of these variables, to examine whether any of these significantly interacted with the main variable of interest, Test Trial Type (goal, source).

First, a 3 (Trial Pair Type: A vs. B vs. C) x 2 (Test Trial Type: Goal vs. Source) ANOVA was performed; no significant interaction was found, $F(2, 24) = 1.126$, $p > .10$. 
Next, a 3 (Trial Pair Order: Pair A vs. B vs. C presented first) x 2 (Test Trial Type: Goal vs. Source) ANOVA was performed, which also did not show a significant interaction, $F(2, 10) = 1.549, p > .10$. Then, a 2 (Trial Side: Left vs. Right) x 2 (Test Trial Type: Goal vs. Source) ANOVA also revealed no significance, $F(1, 11) = .814, p > .10$.

Finally, a 2 (Gender: Male vs. Female) x 2 (Test Trial Type: Goal vs. Source) ANOVA revealed a significant interaction, $F(1, 11) = 7.838, p = .017$. To explore this result, a paired t-test was performed for each gender separately. It was revealed that males showed a significant difference between goal ($M = 32.54, SD = 11.55$) and source ($M = 17.69, SD = 8.32$); $t(4) = 3.689, p = .021$. The females did not show a significant difference between goal ($M = 26.78, SD = 11.30$) and source ($M = 26.30, SD = 9.20$); $t(7) = .150, p > .10$. Therefore, the only counterbalancing variable that had a significant interaction with the main variable of interest was gender, where males showed a very strong goal bias. One possibility is that this age group (18 months) included 8 females and 5 males, whereas the 14 month age group included 7 females and 6 male. This could have caused a large effect in the males (since there were only 5 males versus 8 females). The 14 month age group did not show this effect, possibly because the male to female ratio was much more equal.

**Discussion**

When the 14- and 18-month data were combined, results indicated a significant goal preference. When the age groups were separated, the significance was marginal for both age groups. All infants in this study, on average, spent more time looking at goal events in comparison to source events during test.
To truly evaluate the strength of this goal bias, it is critical to directly compare these results with an identical design, except replacing the inanimate figure with an animate figure. This would give an indication of the strength of the goal bias between animate and inanimate events. If there is no significant interaction, this would mean the goal bias extends similarly to animate and inanimate events. This suggests that a goal bias is broad and therefore similar to language. It may turn out to be the basis for language. If an interaction is shown between the animate and inanimate events, then there are different strengths of the goal bias when comparing animate to inanimate. This would suggest that the goal bias only characterizes representations strongly for a certain type of event, which would resemble the non-linguistic pattern of event representations, as in Lakusta and Landau (2012). This leaves open the question of how children learn about the goal bias. It suggests that there is something more in language that we need to learn about (arguments/adjuncts) in order to form a goal bias. Research in linguistic theory suggests that goals may be arguments and sources may be adjuncts. Nam (2004) suggested that goal prepositional phrases compose a core event, while source prepositional phrases do not. Sources modify the processes instead. According to Nam (2004), goals are the arguments of the verb, while sources are the adjuncts. This could be a possible solution to the question of how children learn about the goal bias. So, goals and their paths may be more prominent semantically than sources and their paths.

Gordon (2003) suggests that we construct event representations that possess argument-like structures regardless of linguistic input; for example, deaf children can understand argument structure without being exposed to language. They know that the action of giving entails three arguments: a giver, a recipient, and an object being given.
Studies of infant linguistic knowledge have suggested that infants are actually using language in some way, which suggests that infants are able to comprehend linguistic structure (Gordon, 2003). Gordon considered whether infants are able to distinguish between objects that are candidate arguments (relevance to the event) in an event structure and those that are not candidate arguments (irrelevance to an event) (2003). Results showed that infants are indeed able to distinguish between elements that are relevant to the event structure and elements that are irrelevant; this suggests that event representations can be later mapped onto verb-argument structures when the infant learns language (Gordon, 2003).

Given the statistically significant result of a goal bias in this study, these results fill in the gap in research that has been done with infants. Previous research has not thoroughly examined infants' representation of inanimate events, yet the results of this study do suggest that this bias exists; however, further research is required to confirm these results.

Younger Infants

What about infants younger than 14 months old? Testing infants younger than 14 months would reveal whether this goal bias truly does exist before we learn language. For example, 14- and 18-month-olds are actually comprehending and producing some goal and source prepositions, according to data collected from the MacArthur Communication Development Inventory (see below). If infant thought reflects language (if there is a broad goal bias) then language may be affecting infants’ thought processes. In order to
test this, younger infants need to be tested to determine whether the goal bias appears non-linguistically first.

*Early Language Development*

Another idea for future research is studying early language production and comprehension. Data is currently being collected to address the question of an asymmetry between the production and acquisition of goal and source prepositions. As discussed at the beginning of this paper, Lakusta and Landau (2005) examined this idea in three and four-year-olds. Do infants acquire goal prepositions before source prepositions, so that there is a goal bias in the acquisition of prepositions? Along with this study, the MacArthur Communication Development Inventory was filled out by parents of participating infants (ages 10 months to 18 months), which gives an indication of words and phrases infants are able to comprehend and what they are able to produce. Of special interest in the inventory is the section including goal prepositions (to, on, in, onto, into) and source prepositions (off, out, from). Results indicate that infants actually tend to produce and comprehend source prepositions before they produce and comprehend goal prepositions. This result is the opposite of what would be expected if the goal bias appears in the acquisition of prepositions.

In conclusion, this study resulted in a promising insight into infants’ event representations and their possible link to language development. The differences in source and goal looking times were statistically significant, displaying a pre-linguistic goal bias for inanimate motion events. This would suggest that pre-linguistic
AN ASYMMETRY BETWEEN GOAL AND SOURCE

representations may indeed serve as the basis for language, although further research may be needed.
References


