Infants' Categorization of Goal Events

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Abstract

Infants can discriminate the difference between goal (endpoint; e.g., duck walking to a tree) and source events (starting point; e.g., duck walking away from tree), and they show a preference for the goals over the source events (Lakusta et al., 2007; Lakusta & Carey, 2015). The current experiment explored to what extent 10-18 month old infants categorically represent goal spatial relations. The present experiment is an extension of Lakusta, Yuschak, & Batinjane (2014) which found that 14-month old infants show evidence for goal and, sometimes, source categorization. Because there is evidence for 14-month old categorization the current experiment tested younger (10-month) and older (18-month) infants to explore the interaction between categorization and language. The current experiment looked at infants’ categorical representations of goal spatial relations by familiarizing infants to goal spatial relations (e.g., onto or next to) and testing them on novel goal spatial relations (e.g., into). There were three block conditions in the experiment, which all tested a novel spatial relation however, each block was increasingly different by changing the reference objects and figures to novel objects and figures. The current experiment suggests that infants between 10-18 months old can form categorizations for goal-oriented events across varying events but differ in how novel the event can be depending upon their age.
INFANTS’ CATEGORIZATION OF GOAL EVENTS

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Introduction

Do infants represent endpoints in varying events as belonging to one unitary concept of ‘goal,’ such that a duck walking to a tree and a duck going onto a block would both fall under the category ‘goal path’ since they both have end points? What about starting points? Do infants represent starting points as belonging to one concept of ‘source’ such that a duck walking away from a tree and a duck going off of a box use the same concept of ‘source,’ since they both have starting points? Infants can distinguish the difference between goal (endpoint; e.g., duck walking to tree) and source events (starting point e.g., ducking walk away from tree) and they prefer to look at goal over source events (Lakusta et al., 2007).

However, the question of how infants categorize these goal and source events is yet to be explored. This thesis examined goal categorization in infants 10 -18 months of age. Exploring goal and source categorization is important for understanding how children cognitively represent and acquire language. As will be reviewed below, linguists have also studied goal and source paths and the semantic structure of these paths is well understood. By studying how infants categorize such paths we can also ask, do infants categorize differing spatial relationships of motion events that reflect semantic structure? In what follows, previous findings and the motivations for the current investigation are reviewed.

Representation of Events

Motion Events

Imagine an event of a man walking out of his house and onto his porch. One may encode different aspects of the event such as, how many steps the man took, the cadence of his walk, the path the man took to the porch, or what door he exited to reach his porch. Considering this event, the main components that are encoded by language are: 1) the figure
(the man) which is mapped into the noun phrase in English, 2) the manner of motion (walking), which is typically mapped into the verb phrase in English 3) the pathway (from the house and to the porch), which are typically mapped into prepositional phrases in English (from- and to-), and 4) the reference object noun (porch) which is mapped into the noun phrase in English (Talmy, 1985). Notice that language encodes the main components and, many details of the perceptual representation are omitted, such as the man leaving his house (the source or starting point) can also be described but research has found that they are often not considered core elements to our organization of language, and hence are often omitted (Lakusta & Landau, 2005).

Focusing on the pathway component of language, according to Jackendoff (1983) path events can be understood as: to, from, or via paths. A To pathway (Figure 1a.) would be when a figure moves towards an endpoint object. Conversely a from pathway (Figure 1b.) is a figure moving away from a starting point object. A via event is moving past a reference point. There are different prepositions that can be used for to, from, and via. In English, to path events can be encoded with prepositions such as ‘to’, ‘into’, ‘onto’, etc., from paths use, ‘from’, ‘out of’, ‘off of’, etc., and via uses, ‘via’, ‘past’, ‘through’, etc. (Jackendoff, 1983). In this paper, following Jackendoff’s linguistic theory, to pathway events will be referred to as goal events and from pathways will be referred to as source events.

**Figure 1**

**Figure 1a.**

**Figure 1b.**

**Figure 1.** is an example of the two main pathway events in this paper. Figure 1a is a from pathway, also to be referred to as a source event. Figure 1b is a to pathway, also to be referred to as a goal event.
Jackendoff's (1983) Thematic Relations Hypothesis proposes that spatial paths can have parallel syntactic structures in events across different semantic domains. For example, "Bill passed the book to Jane" is a parallel structure to "Bill went to the store". This means that spatial prepositions that are encoded as possessions are parallel to locations of a motion event. In this case the book's possession is changed from Bill to Jane and in the later sentence Bill's location is changed. In the first sentence Jane is the 'goal' and in the second sentence the store is the 'goal.' The same parallel can also be said about state changing. For example, "Jane went from angry to sad" is a parallel structure to "Jane went from the library to her car." Jane's emotional state is moving from one to another similarly to Jane's location moving through a motion event. In this example angry is the 'source' event in the first sentence and in the second sentence the library is the 'source' event. Because parallels are seen in these different syntactic structures, this suggests that the ways we encode and represent these events may be abstract.

**Goal and Source Asymmetry**

In linguistic representations as well as non-linguistic representations of goal and source events there is an overall bias for the goal event (Lakusta & Landau, 2012). For example, children and adults prefer to talk about the goal paths over the source paths (Lakusta & Landau, 2005). Research that looked at English, Dutch, Korean, and Tzotzil languages in children found that regardless of the language, semantically children prefer the endpoint, forming a preference for endpoints over starting points across English, Dutch, Korean, and Tzotzil languages (Bowerman, 1996). Zheng and Goldin-Meadow (2002) found the same goal bias through communicative gestures in deaf children in both Chinese and English speaking cultures. Their findings showed that the deaf American and Chinese
children expressed motion events the same way even when they had never been exposed to any language model before. Additionally, these children were more likely to sign gestures of pathway events rather than manner or motion events and were more likely to sign for figures and endpoints (goals) over agents, recipients, places and origins (sources).

Additionally, in infants’ non-linguistic representations as well as adult and children’s non-linguistic memory goal paths are preferred to source paths. The author’s suggest that omitting the source events might be due to goals being seen as intentional events; meaning, goal directed actions have an endpoint with a specific aim or purpose and this may be preferred to starting points. However, if the starting point was more purposeful than the endpoint the starting point may be preferred. Additionally, research suggests that when sources are represented as highly salient or as standing out, infants show they encode these events (Lakusta, et al., 2007).

Infants’ Representations

The previous section discussed several theories and findings of language that are necessary to understand before exploring the current experiment. This next section will examine, the extent to which infants are able to form non-linguistic representations of motion events that reflect the linguistic structure described above. I will also examine how infants form categorical representations of spatial relations. This next section will lead to the current study, which explored infants’ pre-linguistic categorization of goal directed events.

Non-Linguistic Representations

The current study is interested in examining pre-verbal categorical representations of spatial relations. Yet, in order to categorize an event component, infants need to be able to discriminate between different event components. This section explains how to determine if
the infants can pre-linguistically discriminate the changes in motion events. Then, the next section explains how research tests whether infants categorize events components. In regards to discrimination, Infant recognition of a stimulus can be detected due to a change in looking time or pattern in comparison to a previously seen stimulus. Eye gaze is used as a reliable indication of attention (Fantz, 1964; Batki & Baron-Cohen, 2000). Familiarization is a method used to detect discrimination. Familiarization is the procedure used to understand the stimulus recognition formed in infants. This method uses a fixed window of trials and length to display pre-exposed stimuli. Familiarization stimuli are then paired with novel stimuli to compare looking time. This is different from habituation stimuli which is measured either by a fixed trial lengthen (a 50% decrease of looking time per trial) or by the infant’s first away look from stimuli (Fagan, 1970).

A study that looked at infants’ ability to understand changes in the path and manner of motion found that infants were able to discriminate changes in the events compared with the habituated event (Pulverman, Golinkoff, et al., 2008). In this study infants were habituated to an event such as a starfish doing jumping jacks, followed by four differing test events: a control (which was the same as the habituation trial- the starfish doing jumping jacks), a path change a starfish going under a stationary object (in this study it was a green ball), a manner change such as, a starfish spinning over the green ball, and a path and manner change such as a starfish bending past the green ball. The findings suggest that the infants had been able to discriminate the changes based on the increased attention (i.e., increased looking) to all three of the changing trials compared to the habituation. Participants were considered to have habituated when their visual fixation dropped to or below 65% of the time (Pulverman, R., Golinkoff, R. M., Hirsh-Pasek, K., & Buresh, J. S. 2008).
In a study done by Lakusta et al., (2007), it was found that during familiarization infants were able to discriminate goal pathway motion events. In this study 12-month old infants were familiarized to an animated figure (e.g., a duck), which moved to one of two goal objects (e.g., a bowl or block). After familiarization trials the goal object’s locations were changed and the infants viewed the familiar goals in new locations, such as the opposite side from where the object was originally presented. During the test trials infants saw either the same goal object they were familiarized to in a new location or a different object in the original location. Lakusta et al., (2007) found that infants looked longer at animations where the location of the object was the same but the goal object changed in comparison to the goal object remaining the same and location changing. This suggests that infants can discriminate and encode the familiar spatial relationships.

**Categorization.** According to previous research there are different types of categories, which emerge early in development such as, domain level categories (e.g., person vs. food), basic level categories (e.g., bird vs. fish), and subordinate categories (e.g., Dalmatian vs. Huskey) (Eimas & Quinn, 1994; Mandler & McDonough, 1993; Mandler, 2000). Research supports that infants have the ability to form representations of familiar categories as well as perceive the novel stimuli as different from familiar stimuli (Quinn et al., 2001). It is inferred that infants form categories if they generalize to the familiarization stimuli by later showing a novelty preference during test. For example, Quinn (1994) found that as early as 3-4 months infants were able to form categorical representations of above and below. Quinn found this by familiarizing the infants to a dot shown either above or below a solid bar (used as the reference object). During the test phase the infants were shown two events: a familiar in category event (dot above the bar, if familiarized to dots above the bar
during familiarization phase) and a novel category (dot below the bar, if familiarized to dots above the bar during familiarization phase). It was found by using a novelty preference procedure, infants looked at the novel event (e.g., if familiarized to dot above, then the novel event was below; if familiarized to dot below, then the novel event was above) during test, after familiarization phase. Thus, suggesting that infants have the ability to categorically represent the spatial relationships for above and below (Quinn, 1994). However, another study demonstrated that infants’ showed difficulty with categorization when tested with novel objects rather than novel spatial relationships (Quinn et al., 1996). This suggests that infants are able to form spatial categories such as “above” and “below” if the objects are familiarized to them, but may have difficulty categorizing to spatial relationships with novel objects.

Similar to how infants can discriminate between manner and path changes (Pulverman et al., 2008), research has also shown infants’ categorization of motion manner and path (Pruden, et al., 2012). Pruden and colleagues familiarized 7-9 and 10-12 month old infants to a starfish sequentially performing a path event that varied in manner (e.g., spinning, twisting, bending, and performing jumping jacks over a ball). None of the infants showed an a priori preference for any test event before viewing the familiarization trials (that is, on average, infants did not look sig longer at x vs x, prior to any familiarization). During the test events only the 10-12 month old infants showed a preference for the familiar path. This suggests that infants were able to distinguish between the new and familiar paths thus showing evidence for forming a category of path (Pruden, Roseberry, Goksun, Hirsh-Pasek, & Golinkoff, 2012). In the second part of their experiment infants were tested on whether the relation between the figure and the reference object mattered for 10-12 month olds. They
tested this by removing the ball (reference object) from underneath the starfish (figure) during the familiarization trials. By removing the ball the infants were not able to show a preference during test. The researchers suggest that infants’ pay attention to the action of the dynamic figure as well as the relation of the figure and object. In the last experiment Pruden et al., (2012) added a language component to the study to examine if categorization can occur with the help of language for the younger infant group that did not categorize in experiment 1. During familiarization (the same as in experiment 1) a novel label was produced by a female voice. The word “javing” was repeated 16 times over the course of the familiarization trials. During the silent test trial (identical to experiment 1) it was found that when the infants heard a verbal label, they showed a novelty preference (different from experiment 1 without the language component for which the infants’ had a familiarization preference). These findings suggest that with the help of a language aid, infants 7-9 months old were able to exhibit more attention to the familiarization events and in turn were able to form a novelty preference during the test events. The overall findings suggest that 10-12 month old infants have the ability to categorize via paths with relational information and younger infants can also form categorizations with the help of a language component (Pruden, Roseberry, Goksun, Hirsh-Pasek, & Golinkoff, 2013).

In addition to motion paths such as to paths, from paths, and via paths, prepositions are also used for specific place location events such as: containment (e.g., in) and support (e.g., on) (Casasola, 2008; Casasola, 2005, Casasola, Cohen, & Chiarello, 2003). The spatial prepositions in and on are particularly pertinent to the current study because the motion events examined in the current study use the spatial relations in and on.
In a study done by Casasola & Cohen (2002) 6 month old infants were able to represent categories of containment (e.g., a pen inside a cup) as a familiar spatial relation in contrast to the spatial relation of support (e.g., a ball on a desk). Casasola and Cohen did this by habituating infants to four different spatial relationship events using in (containment) as the spatial relationship. For example the infants would see an event such as a hand placing a toy monkey in a basket (loose fitting containment) or a peg in a block (tight fitting containment). When the infants were tested they were shown a novel object with a familiar spatial relationship in, such as a cup being placed in a dog bowl paired with a novel object with an unfamiliar spatial relationship on, such as a toy turtle being placed on a pole. The infants’ looking duration was longer for the novel spatial relationship on, which suggests that the infants were able to categorize the difference of containment for in. However, the research suggests it is not until 18 months old that they are able to form support categories of on. The research suggests that the category formed for the support on is much more concrete than in; thus, showing that the infants start with the narrower concept and will later generalize to the broader idea of support (Casasola & Cohen, 2002).

Lakusta and colleagues wanted to explore a broader category of endpoint that encompasses containment, support, and proximity. In a recent study, (Lakusta et al., 2014) looked at whether infants’ representations of goal and source events are broad, such as the semantic representations of language (in language, manner of motion events that have different specific spatial relationships, such as in, on and next to, all have endpoints). As discussed in Casasola & Cohen, 2002, these goals also show up in events such as the containment and support events described above. Lakusta et al., 2014 tested 14-month old infants with two differing between-subject conditions. In the goal conditions infants were
familiarized with different goal events having endpoints (e.g., a duck walking to a tree or a duck walking on a box). In the source conditions infants were familiarized with source events having a starting point (e.g., a duck walking away from a mailbox). Next to and on top of were set as the familiarized goal spatial relations whereas, away from and off of were set as the familiar source spatial relations. Infants in both conditions saw six sequential test trials. The infants would see a familiar figure (the same duck used during familiarization events), a familiar object (the same box used during familiarization events) and a novel spatial relation (in). The test trial would be followed with a duck going out of a box. Both relations are considered novel because the infants never saw containment (into/out of) during familiarization trials however, one is more novel because the other test has a starting point such as walking out of the box (if they are in goal familiarization condition and for source familiarization the more novel event would the duck going into the box). In the next test trial infants saw a duck moving into a bowl followed by a duck moving out of a bowl. The bowl in the test event is seen as even more novel because the infants have never seen the bowl in familiarization. Lastly, they see a plane going into and then out of a bowl. This is the most novel because it has novel object (bowl), figure (plane-not seen during familiarization), and novel spatial relation. Each test trial becomes increasingly different from the events seen during familiarization. If infants in the goal familiarization condition showed evidence for categorization to the goal familiarization events (duck going to the reference object) then the infants would look at the novel out of category source event longer during the test event. If infants in the source familiarization condition categorized to the source familiarization events (duck going away from the reference object) then they would look longer at the goal events during the test event.
Additionally Lakusta and colleagues (2014) tested a baseline condition. In this condition infants only saw test events without familiarization trials. This was to test if there was any baseline a priori preference of endpoints versus starting points. They found that in the baseline condition the infants looked longer at the goal events (duck going into box) over the source events (duck going out of box). This suggests there is a goal bias.

However, in the goal familiarization condition, infants no longer show this baseline preference to look at goal events during the test. This is suggestive evidence for a goal categorization because the infants are familiarized with end points and can form this ‘goal’ category and when the infants see endpoint versus starting points during test they are now generalizing to what they have previously seen to a new instance of an endpoint. Source familiarization did not show any significant difference from the baseline condition. Infants have a category of goal, which extends to endpoints in motion events with different spatial relations, reference objects, and figures. But, there is no evidence for source categories.

In experiment 2 of their study, Laura Lakusta and colleagues created super salient source objects. Similar to the first experiment there were two conditions of 14-month old infants. One condition was familiarization to the same motion events as above, but using the ‘super sources’ (e.g., a duck walking away from a large rainbow box). The infants then received sequential test events where they would see the same super salient box or bowl but different containment relation (out of the box). Similar to the first experiment they used the same duck and plane. In experiment 2 there was a baseline condition identical to the baseline condition in the first experiment except with the replacement of super salient reference objects. The results from the baseline were the same as the first experiment: infants’ showed an a priori preference to the goal events even with the super sources. However, the infants
who were familiarized with the super sources looked at the novel goal event during test suggesting that they were able to form source categories if the source is salient enough (Lakusta et al., 2014).

**Current Study**

The focus of the current experiment is to expand upon the research done by Lakusta et al., (2014). The current study will determine whether infants can form categorical representations of spatial paths involving endpoints of animate objects. Specifically, infants were familiarized with spatial relationships depicting a duck moving “onto” or “next to” a reference object. Infants were always tested with a different spatial goal path of moving “into” a reference object versus moving “out of” a reference object (Figure 3). In addition to the spatial relationship changing from familiarization to test there were three different phases (or blocks) of the experiment (Figure 3): a test trial which included a familiar figure (duck) and a familiar reference object (box), a test trial with a familiar figure (duck) and a novel reference object (bowl) and finally a test trial with a novel figure (monkey) and a novel reference object (bowl). If infants look longer at the novel motion pathway event (“out of”) vs. the novel goal path event (into) during the test trials compared to how they looked at these two events before the familiarization trial then we may be able to infer that they formed a categorical representation of a goal path. If so, this suggests that when infants view the familiarization trials they will be able to later discriminate the novel event that is not categorically familiar. Novel figures and reference objects are used to test if infants can form this categorical representation broadly as changes occur. Although this current experiment was an extension of Lakusta and colleagues (2014) previous work, some changes were made. In the current experiment, there was a change in design. By using the preferential looking
paradigm, baseline preference data for the goal and source events were collected before familiarization for each participant (thus what was previously a between subject variable was now a within subject variable). Additionally the age group was extended. Because there is previous evidence for 14-month old categorization (Lakust et al., 2014), the current experiment explored whether younger (10-month) and older (18-month) infants showed the same pattern of categorization and to shed light on the interaction between language and categorization.

**Method**

**Participants**

Participants were 25 10-month-old infants (Mean age = 9 months, 28 days; Range: 9 months, 11 days to 10 months, 17 days; 11 males, 15 females), 32 14-month-old infants (Mean age= 14 months, 13 days; Range: 13 months, 25 days to 15 months, 6 days; 16 males, 14 females), and 29 18-month-old infants (Mean age= 17 months, 28 days; Range: 17 months, 15 days to 18 months, 20 days; 16 males, 13 females). No infants were completely excluded from the final sample, although not all infants completed all the blocks in the experiment (see below). One 14-month old infant’s data was excluded from only block C (their data was used for block A and block B analyses). This participant was considered an outlier because the participant had a z score greater than 2 standard deviations above the mean.

**Materials.** The materials included two digital palmcorder cameras, one of which was used to record the participant and the second camera to record the stimuli. Both cameras were Panasonic Operating Digital Video Camcorders model, 3CCD/3DCC. A Dell Latitude laptop model E6440 was used to present the stimulus material. This laptop was connected to
a 2012 Samsung Series 5 television monitor, which projected the stimulus. Recordings from the two cameras were streamed via a 2009, 27-inch Apple iMac was where recordings from the two cameras were streamed and exported into iMovie through a converter. The converter switchboard that was connected to the television, cameras, and iMac was a, Datavideo Digital Video Switcher model SE500.

**Stimuli.** The stimuli were different motion events created in Adobe Flash. Events included one familiar figure, four familiar objects, one novel figure, and one novel object. The familiar figures and objects are ones that the infant would view during familiarization, salience, and test trials and the novel figures and objects are ones that the infant would only view during salience and test trials. The familiar figure was an animated cartoon white duck (Figure 1a) and the familiar objects were a cartoon yellow box, white mailbox, green tree, and red block (Figure 1e). The novel figure was an animated cartoon brown monkey and the novel object was a cartoon green bowl (Figure 2). The duck and the box were designated as the familiar object and figure because infants would see them during the familiarization trials whereas the monkey and bowl were not seen during any familiarization trials; thus, being designated as the novel figure and object (see design below). Each event started and ended with a red curtain that opened and closed (.5 seconds); followed by a centering stimulus (3 seconds), which was a picture of a flashing baby (Figure 1b) in the center of the screen accompanied by a 3-second audio clip from *The Baby Einstein Music Box Orchestra.*

The motion events were an animated cartoon figure (duck or monkey) moving *away* from a source object or going *to* a goal object. There were four familiarization events (Figure 2e) and six test trials events (Figure 3). All events began with a cartoon animation of a red curtain, which opened for .5 seconds. Then, the events for the goal paths, a figure
walked from behind the curtain and to the goal object for a total of 2 seconds. The object stayed next to, on, or in the goal object for a total of 2.31 seconds. The animated curtain closed for .5 seconds and remained closed for .15 seconds. For the source events the figure walked away from the object to behind the red curtain for a total of 2 seconds and stayed behind the curtain for a total of 2.31 seconds. Familiarization events were the same as the goal events; except there were four different familiarization trials strung together for a total of 22 seconds. There were no linguistic stimuli in the events.

Experimental Design. The Preferential Looking Paradigm (PLP) (following Pruden et al., 2012) without linguistic stimuli was used. All infants participated in an introduction, salience, familiarization, and a test phase for each block. (Figure 2). All infants participated in all three blocks however, some infants may not have seen all three blocks due to fussiness. If an infant did not last until the test trial at the end of the block because of fussiness, that would determine if that block had to be dropped. The order of block presentation (Block A, B, or C presented 1st, 2nd, 3rd,) was counterbalanced across infants. There were a total of 12 possible conditions. The first four conditions presented block A first, block B second, and block C third. The second four conditions presented block B, block C, and then block A and the final four conditions presented block C, block B, and block A. Block A tested familiar figure (duck), familiar object (box), and novel spatial relationship (into). Block B tested familiar figure (duck), novel object (bowl), and novel spatial relationship (into). Block C tested novel figure (monkey), novel object (bowl), and novel spatial relationship (into). There were four conditions for each block ordering because the side of the screen on which the events appeared (source vs. goal on the right or left) was counterbalanced across all conditions (Figure 2).
Introduction phase. Depending on which condition was presented first infants were presented with a curtain opening and then the familiar figure (duck) or novel figure (monkey) on one side of the screen for 5.45 seconds (Figure 2a). The curtain would close and the centering stimulus would appear for 3 seconds (Figure 2b). Then, on the opposite side of the screen from the first introduction slide, the curtain would open for another 5.45 seconds. Depending upon the figure that was presented during the first introduction slide (familiar or novel), the same figure was presented during this slide as well, just on the opposite side of the screen (Figure 2c). During each of these introduction events, the figure traversed alone back and forth from left to right on the respective side of the screen. The introduction phase was used to make sure that infants looked at both sides of the screen during the experiment (a way to check for side bias). The introduction phase also served the purpose of introducing the infants to the figure, which the infant would later be tested on. The order of appearance on each side of the screen and which figure was traversing (familiar or novel figure) was counterbalanced.

Salience phase. The salience phase was used as a baseline directly following the introduction phase and before familiarization phase or test event to determine if the participant showed an a priori preference to a particular side of the screen or a particular event (either goal or source). The salience phase for each block was identical to the respective test phase for that block. There were a total of 3 possible salience and matching test phases per condition. During salience, infants viewed two simultaneous motion (goal and source) events performed by the same figure (familiar or novel). The goal motion event was the figure going into a box and the source event was the same figure going out of a box (Figure 2d). Either goal or source motion event was simultaneously presented side by side.
on the screen for 5.45 seconds, looped twice for a total of 10.9 seconds. The side that the goal or source event was presented was counterbalanced across all conditions.

**Familiarization phase.** Infants sequentially viewed four different 22-second goal motion events that filled the entire screen. Each event started with a curtain opening and ended with a curtain closing. All four of the differing events were strung together to make one 22-second familiarization event (Figure 2e). There were four different combination strings of the four-familiarization events. All four of the familiarization strings were separated by our centering stimuli of the flashing baby for 3 seconds, yielding a total of 103 seconds of exposure for the entire familiarization phase per condition. The familiarization phases all used the familiar figure (duck), to traverse the goal path motion event. For example, every block of every condition, infants saw the duck walking onto a block, to a tree, onto a box, and to a mailbox.

**Test phase.** The test phase was identical to the salience phase that was previously presented directly before the familiarization phase of the respective block (Figure 2f). The test phase looked to see if infants were able to categorize the manner of motion (into) across the goal exemplar paths as one unitary concept similar to the familiarization trials they were presented with earlier (to, onto) using either a novel or familiar figure (duck/monkey). There were three different combinations of possible blocks that combined the novel object with familiar figure, novel figure, with novel object, and familiar figure with familiar object for both goal and source motion events for a total of 3 different counterbalanced possibilities (Figure 3). As with previous studies (Pruden et al., 2012) each 12-second test trial was repeated twice for a total of 4 test viewings.
For the introduction phase, infants viewed the video once on the left and once on the right. During the Familiarization phase, videos were viewed sequentially, not simultaneously. The following were counterbalanced: order that each block was presented, 1st Introduction trial presented on the left or right, order of familiarization trial presentation, and “in category” event presented on the left or right. The flashing baby centering stimulus separated each slide.
Figure 3. For block A, the stimulus was a familiar object and familiar figure with a novel spatial relation (in/out). For block B, the stimulus was a familiar figure and a novel object (bowl) with a novel spatial relation (in/out). For block C, the stimulus was a novel object (bowl), novel figure (monkey), with a novel spatial relation (in/out). Novelty is determined if it is new object, figure, or event that was not previously seen during familiarization trials.
Procedure. Infants were seated on their parent’s lap the entire time approximately four feet away from a 40-inch television monitor. The monitor was on top of a four foot in width by six-foot in length table that had a floor length cloth covering around the table. Behind the television screen was a floor to ceiling curtain, which divided the room so the equipment and experimenters would be hidden from the participant’s view during the experiment. Two video cameras were used to record the infant’s eye gaze and the stimuli presented on the screen. The camera used to record the infant’s eye gaze faced the infant from an upward angle and was two feet from the ground mounted on a tripod. This camera was located underneath the television and table. A small hole was cut out of the cloth covering for the camera lens. The camera used to record the stimuli from the infant’s point of view was mounted on a shelf behind the participant on at a downward angle, five feet above the ground. Both camera recordings were streamed into a switchboard into iMovie on the iMac desktop located behind the curtain where the experimenter could watch the infant live. The stimuli were presented by a laptop that was connected to the monitor for the infant to view.

Before presenting the video, the experimenter oriented the infant’s eye gaze to the screen. The experimenter took a set of keys and jingled them in the center of the screen, the top of the screen, above the television, the bottom of the screen, below the television, on either side of the screen, and then off to either side of the television screen. The experimenter said “this is the middle, this is the top, too high, this is the bottom, too low, this is the side, too far, this is the other side, too far” respectively to each orientation previously described. This process was intended to help coders decipher the looking direction by setting an individual orientation for each participant. Directly after orientating the infant, the
experiment went behind the curtain and said “Look (baby’s name) Look!” On the second “look” the experimenter pressed Play on the stimulus laptop and the video began. All parents were asked to keep their eyes closed and remain quiet during their participation to ensure that the parents could not influence their child’s behavior while watching the video. If a parent influenced their child’s response such as pointing at the screen, turning their head to look at a particular side of the screen or talking to their child about the events, all data for their child was excluded from analyses.

Coding. Each participant was coded off line, meaning, the infants’ eye gaze direction and looking time were recorded and coded after the experiment was over. A computer-coding program, Datavyu, was used to generate and record looking time (in milliseconds) and direction for each slide. After each participant’s looking duration and direction for each slide was coded using Datavyu, the amount of time the infant spent looking away from the stimulus was calculated. If any infant looked away from the screen for 60% of the time, they would be removed from the data. For each test, the average of test trial one and test trial two was used to represent looking time for test.

Reliability. In order to assess reliability for looking time and direction, a second coder blind to original coding, recorded looking time and direction. The reliability script generated a cell for the second coder to code for every 6th look of the original coded document. After the second coder was complete, a script through the coding program Datavyu generated a report on percent agreement between coders. For 10, 14, and 18 month-old infants respectively, there was a 94.47%, 95.27%, and 94.45% inter rater reliability between coders.
Results

Familiarization

Infants’ looking time decreased from the first familiarization trial to the last familiarization trial across all block conditions for 10-month ($M_s = 15.88, 14.06; SEs = .68, .72$) 14-month ($M_s = 18.68, 16.14; SEs = .67, .67$), and 18-months ($M_s = 28.72, 24.57; SEs = 1.64, 1.5$). The difference in looking time between trial one and trial four was significant for each age 10, 14, and 18-month respectively, ($t(25) = 2.77, p = .01; t(29) = 3.93, p < .01; t(28) = 4.66, p < .01$) (Figure 4).

Due to the block design, further analysis was performed to explore individual block looking times for each age. For block A 10-month old infants did not show a decrease in looking time between trials one and trial four ($M_s = 13.36, 13.33; SEs = 1.43, 1.22$). There was not significant difference between looking times. In block B, and C, 10-month old infants did show a decrease in looking time between trial one and trial four, respectively, ($M_s = 17.53, 15.53; SEs = .92, .91; M_s = 15.95, 13.6; SEs = 1.0, 1.14$). The different in looking time was significant for both block B ($t(24) = 2.57, p = .02$) and block C ($t(23) = 2.32, p = .01$).

The 14-month old infants showed a decrease in looking time between trial one and trial four for block A ($M_s = 18.71, 16.13; SEs = 1.18, 1.24$), block B ($M_s = 19.29, 16.13, SEs = .76, 1.03$) and block C ($M_s = 16.71, 15.91; SEs = .99, 1.08$). The difference in looking time was not significant for block A or C but, was significant for block B ($t(24) = 3.67, p < .001$). Similarly, 18-month old infants showed a decrease in looking time between trial one and trial four for block A ($M_s = 19.27, 15.64; SEs = 1.13, 1.13$), block B ($M_s = 19.27, 16.85; SEs = .85, 1.01$) and block C ($M_s = 18.84, 15.75; SEs = .80, 1.21$). The difference in looking time
between trial one and trial four was significant for each block A, B, and C respectively, ($t$ (19) = 2.93, $p < .01$; $t$ (25) = 2.66, $p = .01$; $t$ (24) = 2.82, $p < .01$).
Figure 4. Average looking time in seconds for each familiarization trial collapsed across all 3 block conditions. The significant declining trend across blocks for each age range indicates that the infants were able to familiarize to the stimuli presented during the four familiarization trials.
**Novelty Preference Score.** In order to assess categorization a novelty preference score (NPS) was used. Novelty preference scores are used in designs that tests categorization using the PLP methodology (Pruden et al., 2012). It can be inferred that infants are forming categorizations to familiar stimuli if they look at the novel event during test (Fantz, 1964). The novelty preference score used in the current experiment was the looking time at the novel category (source) divided by the sum of the infants’ looking at the novel (source) and familiar category (goal) (source/source+goal). Although I use a calculated novelty preference score I have also included a chart (Chart 1) which displays a chart of raw looking times in seconds for each block across all ages.

**Baseline v. Test Trial Prediction.** Previous research (discussed at lengthen in the introduction) as does the current study shows evidence for a goal bias in infants. Thus, in order to provide a stringent test of infants’ categorization, in the current study the novelty preference score that was calculated for the test trials is compared to the NPS for the salience (baseline) trials. During the salience trials it is hypothesized that the infants will display a robust goal bias (e.g., looking at the goal events longer than the source events). Thus, if infants are categorizing goal paths during familiarization, during the test trials there should be a decrease of goal bias and an increase of source looking time compared to how long the infants looked at the goal vs. source during the salience trials.

**Test trials.** Since each block tested a different ‘level’ of categorization, the analyses is separate for each block. A 2 x 3 mixed ANOVA examined the effects of test trial type (Salience, Test) and age (10, 14, 18-months).

**Block A overall test trial.** Main effect of test trail type and main effect of age was not significant (ps > .05) however there was a significant interaction between overall test trial
type and age for block A, $F(2, 57) = 3.20, p = .05$. Due to the significant interaction between age and test trial type for block A (novel spatial relation), a planned comparisons two-tailed paired *t*-test was performed for each age group comparing salience with novelty preference score (Figure 5). Ten-month old infants showed an increase of looking time at the novel source event during test, however this was not significant, $t(16) = -.74, p > .05$; average means ($M_s = .38, .45; SE_s = .05, .04$). Eleven out of 17 10-month old infants showed the pattern (Wilcoxon signed rank test, $z = .83, p = .41$). The 14-month old infants showed a significant increase of looking time at novel source events during test compared to the salience phase $t(20) = 2.15, p = .04$; average means ($M_s = .33, .40; SE_s = .05, .04$). 14 out of 21 14-month old infants showed a novelty preference (Wilcoxon signed rank test, $z = 2.14, p = .03$). Eighteen month old infants showed an increase of looking time at novel source events during test compared to the salience phase, although this difference was not significant, $t(19) = -1.02, p > .05$; average means ($M_s = .38, .45; SE_s = .07, .06$). Eight out of 20 18-month old infants showed the pattern (Wilcoxon signed rank test, $z = -1.31, p = .19$). Thus for block A, when examining how long infants looked at the novel source path event vs. the familiar goal path event during the entire test trial and comparing this to infants' looking pattern during salience trial, only the 14-month olds arguably showed evidence for categorization of goal paths.

*Block B overall test trial.* Main effect of test trial type and main effect of age was not significant ($ps > .05$). There also was no significant interaction between overall test type and age for block B for 10, 14, and 18-month olds. Only 10 out of 25 10-month old infants showed an increase in novelty preference during test compared to salience phase (Wilcoxon signed rank test, $z = -.15, p = .15$), 13 out of 25 14-month olds showed a novelty preference
(Wilcoxin signed rank test, \( z = -.34, p = .74 \)) and 14 out of 26 18-month olds showed the pattern (Wilcoxin signed rank test, \( z = .47, p = .64 \)). Thus for block B, when examining how long infants looked at the novel source path event vs. the familiar goal path event during the entire test trial and comparing this to infants’ looking pattern during salience trial, none of the age ranges showed evidence for categorization of goal paths.

**Block C overall test trial.** Main effect of test trial type and main effect of age was not significant \((p > .05)\). However, there was a significant interaction between overall test type and age for block C, \( F(2, 68) = 3.81, p = .03 \) for 10, 14, and 18-month olds respectively. Planned comparisons 2-tailed paired *t*-test were performed for block C (novel spatial relation, novel figure, novel object) to explore the significant interaction between age and test trial type (Figure 5). Ten-month old infants showed a *decrease* in looking time at the novel test event compared to salience phase, although this difference was not significant, \( t (23) = 1.56, p > .05 \); average means \((M_s = .54, .46; SEs = .04, .05)\). Only 11 out of 24 10-month olds showed the novelty preference pattern (Wilcoxin signed rank test, \( z = -1.11, p = .27 \)). The 14-month old infants did not show an increase or decrease of novelty looking time for block C, \( t (21) = -.46, p > .05 \); average means \((M_s = .36, .36; SEs = .05, .03)\). Thirteen out of 22 infants showed the pattern (Wilcoxon signed rank test, \( z = .34, p = .73 \)). The 18-month old infants showed a significant increase in novelty preference during test compared to salience phase, \( t (24) = -2.4, p = .03 \); average means \((M_s = .42, .511; SEs = .04, .04)\). Sixteen out of 25 18-month olds showed the pattern for block C (Wilcoxon signed ranks test, \( z = -2.06, p = .04 \)). Thus for block C, when examining how long infants looked at the novel source path event vs. the familiar goal path event during the entire test trial and comparing this to infants’
looking pattern during salience trial, only the 18-month olds arguably showed evidence for categorization of goal paths.

*First 2-Second Looking Time.* As with previous research, the first 2-seconds of the overall test trials, in addition to the overall test trials were calculated to find the novelty preference score. Daniel Swingley (2011) has examined processing speed during looking time in language studies in infants that use the preferential looking paradigm. Infants who respond quickly and make an early decision show variability in their eye movement however, the research by Swingley also suggests that the looking time throughout the remainder of the test trial is similar to the first 2-second window. Thus for the first 2-second looking time for block A, when examining how long infants looked at the novel source path event vs. the familiar goal path event during the first 2-second test trial and comparing this to infants’ looking pattern during salience trial, none of the age ranges showed evidence for categorization of goal paths.

*Block A first 2-seconds of test trial.* Main effect of test trial type and main effect of age was not significant (ps > .05). There was also no significant interaction for the first 2-seconds of test type and age for block A for 10, 14, and 18-month olds. Only 9 out of 17 10-month old infants showed a novelty preference for the first 2-seconds of test (Wilcoxon signed rank test, $z = .83, p = .41$), 11 out of 21 14-month olds showed a novelty preference for the first 2-seconds of test compared with salience (Wilcoxon signed rank test, $z = .85, p = .39$) and only 8 out of 20 18-month olds showed the pattern for the first 2-seconds of test (Wilcoxon signed rank test, $z = .40, p = .69$).

*Block B first 2-seconds of test trial.* Main effect of test trial type and main effect of age was not significant (ps > .05). There was also no significant interaction for the first 2-
seconds of test type and age for block B for 10, 14, and 18-month olds. Fifteen out of 25 10-month old infants showed an increase in novelty preference for the first 2-seconds of test compared with salience (Wilcoxon sign rank test, \( z = 1.43, p = .153 \)), 15 out of 25 14-month olds showed a novelty preference for the first 2-seconds of test (Wilcoxon signed rank test, \( z = 1.14, p = .25 \)) and 14 out of 26 18-month old infants showed this pattern for the first 2-seconds of test (Wilcoxon signed rank test, \( z = .26, p = .80 \)). Thus for the first 2-second looking time for block B, when examining how long infants looked at the novel source path event vs. the familiar goal path event during the first 2-second test trial and comparing this to infants’ looking pattern during salience trial, none of the age ranges showed evidence for categorization of goal paths.

**Block C first 2-seconds of test trial.** There was no significant interaction however, there was a significant main effect for the first 2-second test trial type for block C, \( F(2, 66) = 12.36, p = .001 \); average means for 10, 14, and 18-month olds respectively (\( Ms=.59, .41, .53; SEs = .04, .05, .04 \)) (Figure 6). Fifteen out of 24 10-month old infants showed a novelty preference for the first 2-seconds of block C (Wilcoxon signed rank test, \( z = 1.51, p = .13 \)), 10 out of 20 14-month old infants showed a novelty preference for the first 2-seconds of block C (Wilcoxon signed rank test, \( z = 1.55, p = .12 \)) and 19 out of 25 18-month olds showed the pattern for the first 2-seconds of block C (Wilcoxon signed rank test, \( z = 2.68, p = .007 \)). Results revealed a main effect for the first 2-seconds test for block C (novel spatial relation, novel figure, novel object) with no interaction, suggesting that the novelty preference score for each age group did not differ from each other. As shown in Figure 5, all age groups, looked longer at source than the goal event when comparing the test trial to salience phase.
Chart 1. Raw looking times for each block across all ages. A paired *t*-test was performed for each goal and source salience, test trial 1 (T1), test trial 2 (T2), Average T1/T2, T1 first 2-seconds, T2 first 2-seconds, and average first 2-seconds of T1/T2 raw looking times. Significant values are bolded.
Figure 5. Paired sample t-test for each block (salience v. overall test) was performed within each age.
Figure 6. Paired sample t-test for each block (salience v. first 2-s of overall test) performed within each age.
Discussion

The purpose of this thesis was to examine whether 10-18 month old infants have the ability to pre-linguistically categorize the spatial relationship of goal path in motion events that reflects semantic structure. The prediction was, if infants were able to form a category ‘goal’ over the course of being familiarized to the events then, they would show a novelty preference for the source events during the test trials compared to their baseline preference. Ten, 14, and 18-month old infants showed evidence for categorization by showing an increase of looking time at the source events longer during the test event compared to how long they looked at the source event during the salience trials. Due to the block design of the study, (each block testing a different level of categorization), an analysis for each block was conducted separately. In the first 2-seconds of block C, which was the most novel event compared to the familiarization events (see Figure 3) (e.g., a monkey going to a bowl paired with a monkey going away from a bowl), there was a main effect of trial type, with no interaction with age during the first 2-seconds; suggesting that all ages showed a significant novelty preference during the first 2-second window of the test trials. When examining the looking duration for the overall test trial for block C there was a significant interaction between test trial types with age; only 18-month old infants showed a significant increase of a novelty preference during overall test compared to salience. In block A, the most familiar event compared to the familiarization events (see Figure 3) (e.g., a duck going to a box paired with a duck going away from a box) only the 14-month old infants showed a significant increase of novelty preference during the overall test event compared to the salience preference. Although not significant, the 10 and 18-month old infants are following the same pattern as the 14-month olds and are exhibiting an increased novelty preference.
There was no evidence for categorization during the first 2-second window of the test trials for block A. In block B which has a familiar figure and novel object (e.g., a duck going to a bowl paired with a ducking going away from a bowl) infants did not show an increase in looking time for the source event during test compared to salience. There was no evidence either for the first 2-second looking time for block B either.

In addition to an increased novelty preference, 10, 14, and 18-month-old infants showed evidence for familiarization, suggesting that they did encode the events and that they were able to generalize to the novel goal directed events as described above. While exploring individual blocks, 10-month old infants showed evidence for familiarization for blocks B and C however, not for block A. Fourteen and 18-month old infants showed evidence of familiarization for blocks A, B, and C. Research suggests that infants as young as 3 months old are able to demonstrate more attention to novel stimuli in comparison to familiar stimuli when measuring their visual fixation after a familiarization trial event (Fagan, 1970). Thus the findings in the current experiment suggest that infants are able to familiarize to the goal events and therefore, show a novelty preference during test events. These findings provide further support of evidence about the ability of infants to categorize to the goal motion events, although differences were observed for which blocks infants showed evidence of novelty preference.

The pattern that is occurring in block C (novel spatial relation, novel object, novel figure) from 10-18-month olds is consistent with Mandler and McDonough (1996). Mandler and McDonough (1996) suggest that early on concepts that children develop are more basic. The example they give is if an infant observes a cat eat then, the infant can induce the general notion that all cats eat. As the infant experiences more events in the world
then their generalization becomes increasingly more abstract. Their notion would extend from all cats eat to, birds, fish, dogs, etc., all eat. This idea can extend to the categorizations seen in the current experiment because the older infants have experienced more events therefore; can form more general categorizations such as changing the familiar objects and figures to novel objects and figures and still seeing categorization. Recall that for Block C, 10 and 14 month olds showed evidence for categorization during the first 2-seconds of the overall test, but, only the 18-month olds showed it for both the first 2-second and overall test measures. Perhaps the 10 and 14-month old infants need more time than the 18-month olds to explore the differences of novel figure and novel reference object. Although their first look is at the novel source event, they may not be showing the same generalization as the 18-month old infants who are showing categorization for block C.

Additionally, the pattern that the infants show in the first 2-seconds of block C is consistent with the first 2-second looking time research by Daniel Swingley (2011), who looked at processing speed of infants during language studies. He suggested that infants have the ability to respond quickly to make an early decision in eye gaze studies and suggested the optimal window for looking time is within the first 2 seconds of the trial. This is consistent with the main effect seen by the 10, 14, and 18-month old infants block C. They appear to be responding quickly to make a decision about their preference although eventually showing variability by exploring the rest of the stimuli.

In block A, only the 14-month old infants are showing a significant novelty preference during test, suggesting that perhaps they were the only age group that categorizes goals across events that are highly familiar. Mareschal & Quinn (2001), who explored spatial relationships for spatial relationships above, below, and between, found that infants
first learn how to recognize spatial relationships in familiar objects and then later on can
generalize this spatial relationship to novel objects. Quinn also suggests that each spatial
relation categorization has different ages which infants make the transition from simple to
abstract categorization. Perhaps the 14-month old infants are at the cusp age of transitioning
to generalizing the spatial relationship across novel events therefore, are able to show
categorization in block A which is the most familiar event.

The 14-month olds showing significance for block A raises the question of, why are the 18-month olds not showing significance for block A if this is the most ‘simple’
categorization test? However, there is evidence that indicates that older infants may grow
bored of familiar events more rapidly than younger infants (Hespos and Baillargeon, 2001).
The research also suggests that because the older infants prefer to look at novel events to
familiar events, perhaps the familiarization trials need to be reduced (Casasola, 2005). In a
study that examined habituating children to few (e.g., 2) or many (e.g., 6) events, they found
that older infants are able to form abstract spatial categories with less (e.g., 2) familiar events
and when shown more (e.g., 6) familiar events were shown they did not attend to the spatial
relation (Casasola, 2005). This suggests that the 18-month old infants in the current study
may have grown bored during block A because the object and figure are the same as the
object and figure in familiarization. In future studies, perhaps the 18-month old infants
should be presented with fewer familiarization trials for the ‘simple’ events.

It was surprising that infants did not show a novelty preference for block B. However, Casasola (2005) examined spatial relations for the support preposition on. In her
findings she suggests that the amount of variability in order for infants to generalize depends
on what the infant is attending too. Infants follow the specific-to-abstract progression in
categorization. For example, increasing the variability may work best with events the infants can readily attend to and conversely limited variability would work best in events that infants have a hard time noting. Casasola (2005) suggests that because the infants failed to attend to changes in spatial relation, the event might not have been a sufficiently engaging task. She followed up her findings by adding a linguistic component to increase variability. She concluded that the research needs to continue in the direction of manipulating variability because when a linguistic component was added the infants appeared to increase their attention to the events and showed evidence for forming categorizations of spatial relation. Perhaps in the current study, during block B the familiar agent (e.g., duck) and novel reference object (e.g., bowl) is not enough variability for the infant; or is the variability right in the middle of too much and not enough? In future research perhaps changing the representation to a novel figure (e.g., the monkey) and keeping the reference object the familiar (e.g., the box) might increase the variability for the infant and increase their generalization. This also raises the question of, how closely are the infants paying attention to the reference objects and figures? Is the change in objects and figures distracting the infants from paying attention to the spatial relationship?

The current findings are related to Lakusta et al., (2014) who found evidence which suggests that 14.5-month old infants are able to categorize goal and ‘super source’ motion events by looking less at the goal events during test trials than during the baseline condition. Although this current experiment was an extension of their previous work, there are some differences to consider. In their experiment they randomly assigned infants to a baseline condition, goal path familiarization condition, and a source path familiarization condition; baseline information was not collected before familiarization events, they were all separate...
(their design was between subject). They also had another experiment that tested ‘super sources’ (larger and brighter) source events and a separate baseline condition as well with ‘super sources’. They did not use the preferential looking paradigm; the events were played sequentially and all events were looped until either the infant looked away for more than 2 seconds or if 60 seconds time had elapsed. The test events were the same as the current experiment however; in their design instead of using a monkey for a novel figure they used a plane. Additionally, the current experiment put an extension on the ages being tested by looking at younger infants (10 months) and older infants (18 months). The current results extend what Lakusta and colleagues found by showing that 10 and 18-month old infants are also showing similar evidence for categorization. The current experiment suggests that 10, 14 and 18-month old infants across increasingly abstract block conditions are showing evidence for categorization suggests that infants at this age have the ability to map pre-linguistic thoughts into a linguistic structure using goal and source pathway events. Lastly, the previous experiment could not examine different types of test trials separately. The current block design allows for this and reveals that an increase in variability perhaps is the best for all ages.

This current study however raises the question, is categorization related to comprehension in preverbal infants? Specifically, does categorization of motion events support language comprehension and production for spatial language or does comprehension of spatial language support motion event categorization? For example, as explained by Jackendoff (1983) goal events, in English, are described by prepositions such as to, into, onto and source events are described by prepositions such as from, out of, off of. When describing the goal events seen in this experiment such as: into the box, next to a mailbox, or on the
block, the general preposition *to* could actually be used to describe all of these events, such as in the test trial "the duck moved *to* the box. Conversely, source events can be described with the preposition *from*. According to Jackendoff, path events use the broad terms of *to* and *from* (1983). This raises the question of, how are parents describing these events to their children while acquiring language? If a parent would describe these events as all using the word *to* (e.g., *to* the mailbox) then is language maybe influencing the commonality of these events for infants as they are learning language, thus the infant is able to conceptualize a category of goal; or does the motion category for the infant exist innately, which would then support language? Continuing to look at 10-month olds' categorization with 18-month olds would be the most telling because 10-month old infants most likely are not comprehending or producing spatial language yet whereas, 18-month olds may be; so, if language is driving categorization it would be expected to see the 18-month olds showing much categorization and not seeing this trend in 10-month olds. But, if categorization is driving language then it would be expected to see both age groups showing categorization. Incorporating a language comprehension component to the current experiment could do this.

Another critical part to continue exploring for categorization of goal and source path events is the change of possession and change of state that Jackendoff (1983) discusses in his Thematic Relationships Hypothesis discussed in the Introduction. If infants' categorizations for the goal and source motion paths extend to different conceptual domains such as change of possession (Brooke takes the pen; Brooke is the endpoint or goal / Brooke gives the pen; Brooke is the starting point or source of the event), as well as change of state (the leaves turn to yellow; the end state color yellow is the goal / the leaves turn from yellow; the starting
state of yellow is the source) then the representations of infants’ goal and source paths would be a an abstract map for language.

Additionally, the results in the current experiment show that infants are able to form categorizations when using animate, intentional objects however; do infants have the ability to categorize non-intentional events? For example, Lakusta & Landau (2012) tested both adults and toddlers with inanimate, non-intentional figures. They described an object as being inanimate or non-intentional as an object that moves without any self propelled motion, which is different from the duck or monkey used in the current study. The duck in the current study is an animate figure that uses the self-propelled action of walking to and from the reference objects. Lakusta & Landau (2012) found that there is a goal bias when the adults and children were asked to describe the inanimate, non-intentional motion events (e.g., a tissue flew to the tape). However, a study done by Lakusta & Carey (2015) shows that unlike the language goal bias seen in adults and children, infants do not show a goal bias for inanimate, non-intentional objects. The question is, if infants can categorize the duck intentionally moving to various reference objects, would a non-intentional figure such as a piece of paper moving to a reference object also be categorized even though these non-intentional, inanimate events are not goal-directed motions? Creating events and a design that replicate the current experiment except replacing the animate, intentional figures with inanimate, non-intentional figures would show if infants’ could form categories for these events they do not have a baseline preference for.

**Conclusion**

To conclude, the current experiment suggests that infants between 10-18 months old can form categorizations for goal-oriented events across varying events. This result was
expected due to the literature on infants’ categorization of novel object, manner, motion, path, and figure. However, the current findings also encourage further research to test the convergence between language comprehension and production with categorization. It is important to understand how infants conceptualize these events cognitively for later learning and for communication once language is acquired.
References


