

THE 'WHO' AND 'WHERE' OF EVENTS:
INFANTS' PROCESSING OF FIGURES AND GROUNDS IN NONLINGUISTIC
EVENTS

A Dissertation
Submitted to
The Temple University Graduate Board

In Partial Fulfillment
of the Requirements for the Degree
DOCTOR OF PHILOSOPHY

by
Tilbe Göksun-Yörük
Temple University
August 2010

Examining Committee Members:

Kathryn Hirsh-Pasek, Advisory Chair, Department of Psychology
Nora Newcombe, Department of Psychology
Peter J. Marshall, Department of Psychology
Kim Curby, Department of Psychology
Jason Chein, Department of Psychology
Roberta Golinkoff, External Member, School of Education, University of Delaware

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ABSTRACT

The ‘Who’ and ‘Where’ of Events:

Infants’ Processing of Figures and Grounds in Nonlinguistic Dynamic Events

Tilbe Göksun-Yörük

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Dissertation Advisory Committee Chair: Dr. Kathy Hirsh-Pasek

Learning relational terms such as verbs and prepositions is fundamental to language development. To learn relational words, children must first dissect and process dynamic event components, and then uncover how the particular language they are learning encodes these constructs. Building on a new area of research, this dissertation investigated two event components, *figure* (i.e., the moving entity) and *ground* (i.e., the stationary setting) that are central to learning relational words. In particular, we examine how English- and Japanese-reared infants process figures and grounds in nonlinguistic events and how language learning interacts with their conceptualization of these constructs. Four studies were designed to probe our questions. Study 1 examined English-reared infants’ ability to form nonnative ground categories encoded only in Japanese. For example, “crossing a road,” which extends in a line and is bounded, is expressed differently than “crossing a field” that extends in a plane and is unbounded. We found that infants can detect the geometry of the ground and form a nonnative ground category. Study 2 indicated that the path of an action plays a role in construing these categorical ground distinctions such that without the bounded paths infants do not differentiate

between grounds. Study 3 demonstrated that even though infants notice figures and grounds in static representations of the dynamic events (even earlier for the ground discrimination), the Japanese categorical ground differentiation no longer emerged. In the last set of studies, we showed that despite the sensitivity to the event structure and categorical ground distinctions in dynamic events by both English- and Japanese-reared infants (Study 4a), only Japanese toddlers retained these categorical distinctions (Study 4b). Overall, these results suggest that 1) infants distinguish between figures and grounds in events with differential attention to static and dynamic displays; 2) before learning much about their native language infants form nonnative event categories; and 3) the process of learning language appears to shift earlier formed categorical boundaries.

ACKNOWLEDGMENTS

When I moved to Philadelphia from Istanbul five years ago, I knew that a new path in my life has started, but I was not sure how I would surmount the difficulties and adapt to a new country. It was because of the help, support, trust, and love from so many mentors, colleagues, friends, and family members that the process of the graduate school and dissertation had been less painful. I would like to show my appreciation to these wonderful people at least a little bit here.

Through my years in graduate school, I kept thinking that an advisor could make this tough process unbearable or lovely. I felt so fortunate to have one of the magnificent advisors, *Dr. Kathy Hirsh-Pasek*, who knows how to have fun while working and who truly enjoys research. She is one of the most enthusiastic, intellectual, inspirational, creative, and considerate people I have ever met in my life. She taught me not only how to be a good researcher, but also how to prioritize life and family over anything else. Without her, the ideas in this dissertation would never have been formulated in such a compelling and powerful fashion. Thank you Kathy for being the best!

I would like to give my immense appreciation to *Dr. Roberta Michnick Golinkoff*, who has been my co-advisor on many projects I have conducted in graduate school. Her passion for research, her excitement, her imaginative mind, her critical analyses on each aspect of a study, and her orientation to detail provided me the force to start and complete this dissertation.

I feel very lucky to be very close to and to learn a lot from one of the most intellectual people in academia, *Dr. Nora Newcombe*. Her diligence, her rational mind, the powerful analysis on various areas, and her out-of-the-box thinking have contributed

tremendously to my education in the graduate school. Her invaluable criticisms strengthened my arguments in this dissertation. I am indebted for her support during the graduate school years.

I would also like to show my gratitude to my other dissertation committee members *Dr. Peter J. Marshall*, *Dr. Kim Curby*, and *Dr. Jason Chein*. Their feedback on this work was priceless. I specifically want to thank Peter for being such a great instructor. His ‘Infancy Seminar’ that I took in my first year facilitated my profound thinking about the issues related to infancy and helped me to interpret my dissertation data.

My dearest appreciation is to *Dr. Mutsumi Imai*, without whom this dissertation could not happen. The chapter that she wrote with Dr. Victoria Muehleisen set the basis for this dissertation. I am grateful for her continuous help on this project and for being my consultant in each step of the studies. I would also like to thank *Dr. Hiroyuki Okada* for providing his lab resources for data collection and *Haruka Konishi* for collecting Japanese data and bearing with me through this long process.

At Temple, I was very fortunate to be part of many research groups. First and foremost, I would like to thank all members of Temple Infant Lab Group for many feedbacks in various stages of this dissertation work. No words would be sufficient to thank our current and former lab coordinators, *Katrina Ferrara*, *Wendy Shallcross*, *Russell Richie*, and *Yannos Misitzis*, for their help in data recruitment and data collection. I would also like to thank *Stacey Austin* for being such an amazing honors thesis student and for her help in data coding. Second, I truly appreciate the help of the lab coordinators *Aimee Stahl* and *Zeke Strober* for data collection at the University of Delaware Language

Project. Third, I would like to thank Spatial Intelligence and Learning Center (SILC) and in particular the RISC group at Temple for their invaluable feedback on my research and for their patience on listening to the similar talks several times.

Graduate school can be intolerable without friends. I would like to deeply thank *Sarah Roseberry* for our intellectual and daily conversations, editing my manuscripts, collaborating on many projects, and just sharing the same environment, countless conferences, difficulties, and happiness in the last five years; *Kelly Fisher* for helping me on everything from the first day on I met her, her friendship, her support and trust on me; *Alex Twyman* and *Mark Holden* for our endless conversations on any topic, their support, and our lovely dinners; and *Justin Harris* for our long conversations, his sense of humor, lovely company, and critical analyses on my projects.

I always feel the privilege of having many close friends inside and outside of academia, who support me in any circumstances. I was very fortunate to start my long journey in the small apartment of *Sedef Uzunur*, who helped me when I needed. I have no idea what I would do without *Çağla Aydın*. Her calmness, encouragements, our long phone conversations, and sharing ideas have been amazingly helpful in this process. I would also like to thank *Özge Kaş Uygur* for being a great friend during this difficult process and for giving me the feeling that graduate school at Temple is very similar for different areas. Finally, I would like to show my appreciation to my wonderful friends, *Pinar Aküzüm Ateş*, *Burcu Uluöz Tüyel*, *Burcu Berk Taptık*, *İpek Dinçer Bilgili*, *Aslı Günaydın Sümer*, *Çiğdem Canoğuz İnan*, and *Deniz Timsel*, who are physically on the other side of the ocean, but spiritually with me all the time.

I feel lucky to be surrounded by two amazing families. Without their emotional, motivational, and material support, a graduate student life would be terrible. I would like to start with my mom *Selva Göksun* and my dad *Zafer Göksun*. Their love, trust, and encouragements helped me when I have been away from home. I know that they cheer up more than me for my achievements. I am who I am only because of them. My second family members, my mother-in-law *Tülin Yörük* and my father-in-law *Ali Yörük* have supported me from the first time on I decided to come to the US. Their trust and help promoted me to fulfill my goals. I am also very lucky to have two great brothers, *Onur* and *Can Yörük*, after having only a sister for many years! My dear grandmother *Düriye Göksun* could not see my graduation. However, I know that she would be so proud of me. I always felt her unconditional support, love and warm sentiments. Her patience and perseverance in life taught me a lot and shaped who I am. ‘Having a sister is like having a best friend forever.’ My sister, *Hande Göksun*, and I have proven this quote. In any given circumstances, her love, support, and critical eye on problems, and our long conversations on anything connected me to life. She has always encouraged me with all my decisions even when sometimes they opposed her personal choices such as my move to the US.

More than anything else, I would like to thank my beloved husband *Erdem Yörük* for being my other half. Without him, this dissertation would never be finished. His love, support, calmness, our elongated discussions about any topic, his analytical mind, his solutions to problems, and more importantly being with me no matter what have been countless in the steps of the academic career. I dedicate this dissertation to Erdem who incessantly writes the chapters of life with me.

To Erdem Yörük

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CHAPTER 1

INTRODUCTION

Learning relational terms such as verbs and prepositions is fundamental to language development. Verbs, in particular, are centerpieces of sentences. Verbs and prepositions afford us the capability to describe static and dynamic relations between objects and participants in events (e.g., the cup is *on* the table or the dog is *chasing* the woman). In some languages (e.g., Korean), verbs are used to capture the spatial relations that are represented as prepositions in English. For example, while English uses a single preposition for “on” (as in “put a cap *on* a pen” or “put an apple *on* one’s hat”), Korean has many verbs for “on,” depending on what article of clothing is being put on, and how tightly one object fits “on” another (as a cap *on* a pen versus an apple *on* a table).

The study of the acquisition of relational terms has inspired a multi-disciplinary approach bringing together distinct fields such as linguistic theory, event processing, and language development. Until quite recently, however, little research has illuminated how children master these terms on the way to language competence (e.g., Casasola & Cohen, 2002; Choi, 2006; Göksun, Hirsh-Pasek, & Golinkoff, 2010; Golinkoff, 1981; Golinkoff & Hirsh-Pasek, 2008; Hirsh-Pasek & Golinkoff, 2006; Lakusta, Wagner, O’Hearn, & Landau, 2007; Mandler, 1992; 2004; Pruden, Hirsh-Pasek, Maguire, & Meyer, 2004; Pulverman, Golinkoff, Hirsh-Pasek, & Buresh, 2008; Shipley & Zacks, 2008; Wagner & Carey, 2005; Wagner & Lakusta, 2009). This dissertation builds on this new area of research investigating two unexplored event components, *figure* (i.e., the moving entity) and *ground* (i.e., the stationary setting) both central to learning relational words. In particular, we examine English- and Japanese-reared infants’ ability to process figures

and grounds in nonlinguistic events.

What Does it Take to Learn Relational Words?

To learn relational terms like verbs and prepositions, infants must perceive the actions and events that languages express (e.g., walking, running, over, under). Then, they must learn which event components are encoded in their native language and how their language packages these components (Gentner, 1982; Gentner & Boroditsky, 2001; Gentner & Bowerman, 2009; Golinkoff & Hirsh-Pasek, 2008; Tomasello, 1995). For example, to learn the verb ‘march,’ an English-reared infant must differentiate the act of ‘*marching*’ from, say, ‘*jumping*’. The Turkish-reared infant must make this distinction as well. However, the act of “marching” is encoded as a verb in English “*march into the class*” whereas in Turkish “*sınıfa yürüyerek girdi - go into the class *marchingly**”) it surfaces as an adverb – if at all. In her Natural Partitions Hypothesis, Gentner (1982) claimed that “lexicalizing” relational terms is more demanding than simply perceiving movement, connections between actors, and directional changes within events (see also Gentner & Bowerman, 2009). Discovering the actions and events might not be as difficult as mapping these concepts onto language, regardless of the language being learned (e.g., Gentner, 1982; Golinkoff, Jacquet, Hirsh-Pasek, & Nandakumar, 1996; Golinkoff et al., 2002; Haryu, Imai, Okada, Li, Meyer, Hirsh-Pasek & Golinkoff, 2006; Tomasello, 1995; Gillette, Gleitman & Gleitman, Lederer, 1999). Tomasello (1995) called this the “packaging problem”: the child must discern which aspect of an event is being labeled and the last ten years of research suggest that this is a daunting task.

Foundational Constructs in Events

Linguists like Talmy (1985) outlined a number of components that describe the kinds of semantic relations that are codified across languages (see also Jackendoff, 1983; Lakoff, 1987; Langacker, 1987; Talmy, 2000). Among the most central are *path* or the trajectory of an action with respect to a ground (e.g., over or under); *manner* or how the action is performed (e.g., jumping or running); *figure* (the moving or conceptually movable entity) and its relation to the *ground* (the reference entity or a stationary setting); *source* (beginning point of an event) and *goal* (ending point of an event). Other constructs refer to spatial relations (Choi & Bowerman, 1991; Talmy, 1985) like *containment* (putting things *in* a container) and *support* (putting things *on* a surface). These conceptual foundations create the semantic bases for world-to-word relations.

This linguistic taxonomy for relational terms meets psychological theory in two dominant theories. Slobin (1996) suggests that children need to “think for speaking,” meaning that the very same event will be described differently depending on the language to which the child is exposed. Thus, children must notice the set of distinctions speakers make in daily conversation (see also Slobin, 2001) and must package these distinctions in ways that are consistent with the native language. Hence, languages are not “neutral coding systems of an objective reality” (Slobin, 1996, p. 88).

Mandler (1992, 2004) adopts an explicitly developmental perspective focusing on how children view the events that language will encode. Inspired by linguists such as Johnson (1987), Lakoff (1987), Fauconnier (1994), Langacker (1987), and Talmy (1985; 1987), Mandler searches for the underlying basis of the concepts expressed across the world’s languages. She suggests that prior to language, infants construct *image-schemas*

to store fundamental meanings that derive from perceptual meaning analysis. Through attention, infants redescribe perceptual information into a simpler form that reaches awareness. Common image-schemas are those of *path* (trajectory of motion, start and end of path, up-down), *link*, *containment* (into- and out-of-container), and *support* (onto-surface, off-of-surface), which are later combined to derive basic conceptual categories such as *animacy*, *causality*, and *agency*. For example, a figure's ability to rapidly change path (without apparent external impetus) signals that it might be an animate object.

According to Mandler, important aspects of the conceptual constructs are their close link to motion and the fact that they are spatial in nature (Mandler, 2004, 2007, 2010). Among these constructs *path* is the simplest form of representation, because objects follow a trajectory regardless of the characteristics of the object itself or the details of the trajectory. Therefore, the basic concepts of events might be path descriptions in terms of going *in*, *out*, *on*, *off*, *up*, and *down* (Mandler, 2007).

These theories have in common that children begin by analyzing events taking place around them and by learning to focus on just those aspects of the event that their language expresses. They differ in that while Slobin is agnostic to the source of the nonlinguistic constructs language encodes, Mandler considers these constructs to be conceptual "primitives," available very early in development.

Building on these theories as well as Gentner (1982) and Gentner and Bowerman (2009), we suggest that children naturally carve continuous events into language-accessible units. These language-general concepts are gradually construed in language-specific ways. Sensitivity to distinctions in events becomes heightened or dampened as the conceptual framework makes contact with language. Therefore, infants bring new

perspectives to their interpretation of spatial and event components. In a way then, they are *trading spaces* as they learn language (Göksun et al., 2010). Contrary to the Whorfian linguistic relativity hypothesis that posits that language shapes our perception of the events, in our view, language orients infants' attention to or emphasizes some relations in events over others (for other reviews see Hespos & Spelke, 2007).

Recent research suggests that infants possess a repertoire of conceptual foundations before language maps onto these constructs. Before moving into the discussion of two recently studied semantic constructs, *figures* and *grounds*, we address the theoretical underpinnings for the trading spaces hypothesis: How do infants process nonlinguistic spatial and event components? In the following two sections, we present findings on how infants process events in general and whether infants examine particular components in events.

Infants' Processing of Events

An event can be defined “a segment of time at a given location that is perceived by an observer to have a beginning and an end and their relations” (Zacks & Tversky, 2001; p.3). Before infants process components of events like path-manner or source-goal, we need to ask whether infants view “event components” as psychological units.

Infants notice and track an object's motion at birth and the perception of objects is better when these objects are in motion (e.g., Haith, 1980; Kremenitzer, Vaughan, & Kurtzberg, 1979). Further, infants prefer to look at a moving stimulus compared to a stationary one (Kellman, Spelke & Short, 1986; Slater, Morison, & Town, 1985; Smith, Johnson & Spelke, 2003). This might in part be explained by research indicating that specific cells are responsive to movement in the infant visual system; cells that undergo

very little development during the first year of life (e.g., Dobkins & Teller, 1996; Hamer & Norcia, 1994). Furthermore, infants link the moving points into a unified dynamic representation of a human body, for instance, recognizing the human gait from the movement of point light displays attached to the joints of a person moving in complete darkness (Bertenthal, Proffitt, & Cutting, 1984; Bertenthal, 1993).

The ability to detect movement is so finely tuned in infancy that babies discriminate changes in patterns of motion (e.g., Bogartz, Shinskey, & Schilling, 2000; Cashon & Cohen, 2000) and remember specific patterns (Bahrick & Pickens, 1995). By 3 months of age, infants distinguish biological from nonbiological motion for both people and other mammals (Bertenthal, 1993; Arterberry & Bornstein, 2002). Mandler (2004) argues that this ability to note biological vs. nonbiological motion, contingent motion, and self vs. other instigated motion is critical for object and event recognition (see also Rakison & Poulin-Dubois, 2001; Rakison, 2003, 2005).

Infants not only detect motion, but use it to parse actions within events. At around 4 months of age, they extract up and down movements of a ball in continuous motion (Spelke, Born, & Chu, 1983). Six-month-old infants dissect a stream of motion into distinct actions when familiarized with a puppet performing either jumping or falling acts. For example, they might enumerate the jumps relying on boundaries between each jump (Sharon & Wynn, 1998; Wynn, 1996, but see also Clearfield, 2004). In a highly influential study on event segmentation, Baldwin, Baird, Saylor and Clark (2001) presented 10- to 11-month-olds with a clip depicting an everyday action (e.g., a woman grasping a towel from the ground). In the interrupted test trial, the clip paused in the middle of the intentional action. Infants noticed a break in the ongoing action, suggesting

that they parse dynamic intentional action. In a very recent study Hespos and colleagues (2009) habituated 6- to 8-month-olds to two events like putting *in* and putting *over* in a counterbalanced order. At test, they were shown two continuous trials: one where two of the three events were familiar (*in-behind-over* sequence) or a sequence where all three events were novel (*on-behind-under* sequence). Infants at both age groups looked longer to the sequence in which all events were novel, suggesting that they detected familiar action in continuous events. That is, when familiar and novel components were rearranged in a sequence, infants detected the familiar actions and looked longer at the novel sequence. The follow-up studies also showed that infants could also notice a target action if shown previously in a continuous event.

Based on these findings, we can conclude that during the first year infants use motion to segment events and to individuate both inanimate-animate actions that generate the basis for their processing of foundational constructs in events. Once infants perceive the actions within events, they must also detect those aspects of events that are related to linguistic expressions (Clark, 2003). In particular, they must look into the event in detail and recognize the type units within it. How do infants process information for events that are lexicalized by relational terms?

Processing Non-linguistic Foundational Constructs in Events

To make the case that infants are sensitive to event constructs that will be realized differently across various languages, we need to illustrate how infants 1) detect distinctions between event components, and 2) categorize these components (Golinkoff & Hirsh-Pasek, 2008).

Some event components closely examined in the literature are containment, support, path, manner, source, and goal. Additionally, in our lab, we have started to investigate figure and ground, which will later be discussed in more detail. These constructs share three features. First, they are perceptually accessible to infants (Mandler, 2004). For these constructs to be useful for language, they must be noticed and categorized across different actors, locations. Second, these components are universally codified across languages (Jackendoff, 1983; Talmy, 1985, 2000). For example, the *path* of an event is expressed in many languages with verbs (e.g., *descend*, *exit*) and prepositions such as *into* and *across*. Third and importantly, while they are all linguistically expressed, languages differ in the ways in which they encode these constructs (e.g., climb *up* in English whereas *tırmanarak çıktı* “go up climbingly” in Turkish).

Containment-Support

A *containment* relation occurs when something is fully or partially surrounded by a container (e.g., *in*), and a *support* relation refers to the contact of an object on top of surface (e.g., *on*). Although many languages use terms similar to *in* and *on* in encoding containment and support, they express them in vastly different ways. In Korean, for example, containment and support events are labeled on the basis of tight or loose fit between the objects (i.e., degree of fit). The spatial verb *kkita* crosscuts the English categories of *put in* and *put on*, that describes a tight-fitting relation between the objects (Choi & Bowerman, 1991; Gentner & Bowerman, 2009). Putting a ring *on* a finger and putting a book *in* a cover are both described with the verb *kkita* in Korean (Choi, 2006).

Using the dependent variables of both looking time and reaching behavior, Baillargeon and her colleagues show that by 6 months of age, infants are capable of discriminating the spatial relations of containment, support, and occlusion (e.g., Aguiar & Baillargeon, 1999; Baillargeon, Needham, & DeVos, 1992; Hespos & Baillargeon, 2001a, 2001b, 2008). In these studies, infants were presented two types of events: a possible or expected event and an impossible or unexpected event. For example, for a possible containment event, an object was lowered inside a container. In the impossible event, the same object was lowered into a closed container. Longer looking times at the impossible/unexpected than at the possible/expected event indicated the detection of physical violation. Two-and-a-half month-olds looked longer at the impossible event, which indicates that at this age, infants have an understanding of both containment and support events. That is, they know that in a containment event an object is lowered *into* an open container and in a support event an object is lowered *onto* a closed container.

Further, even English-reared 5-month-olds distinguish between tight- and loose-fit events in both containment and support categories (Hespos & Spelke; 2004). After familiarization to one of these relations (e.g., an object fits tightly into a container), infants were presented with both a familiar relation (tight-fit) and a novel relation (loose-fit). Infants looked longer at the novel relation, suggesting an ability to differentiate between tight- and loose-fit relations that are not typically lexicalized in English.

Relational terms also refer to categories of events rather than individual units. To learn the spatial expressions of languages, infants are required to move beyond discrimination of event components and form categories of these components. This level of abstraction serves as a precursor for reasoning about these relations as well as for

learning spatial terms. For example, infants need to understand that both narrow and wide boxes can *contain* objects or that ‘putting a frame on a wall’ and ‘putting a glass on a table’ are similar to one another.

Casasola and Cohen (2002) habituated 9- to 11- and 17- to 19-month-old infants to four examples of one of the containment, support or tight-fit categories. Following habituation, infants were tested with one of the familiar events seen during habituation (e.g., *containment*: a stuffed monkey in the basket), an event with familiar objects in a novel relationship (e.g., a stuffed monkey on a car), novel objects in the familiar habituation relationship (e.g., a turtle in the box), and novel objects in a novel relationship (e.g., a blue car on a red car). Nine- to 11-month-old infants formed a category of containment with both familiar and novel objects, but were not able to create a support category. Seventeen- to 19-month-olds were sensitive to support and tight-fit relations with familiar objects, but they did not extend the category knowledge to novel objects. Thus, the containment relation is constructed earlier than the support relation. Further evidence suggests that even 6-month-old infants abstract *containment* relations (Casasola, Cohen, & Chiarello, 2003). Decreasing the number of exemplars of the category (i.e., from six to two) helped infants to form a support relation at 14 months of age, but this is still very late compared to formation of the containment category (Casasola, 2005a).

Because infants are sensitive to Korean distinctions of tight- and loose-fit (Hespos & Spelke, 2004), they might categorize the degree of fitness even if they are not exposed to Korean. In fact, they do. Both English- and Korean-reared 9-month-old infants categorized events observing the common degree-of-fit relation (i.e., tight- or loose-fit;

McDonough, Choi, & Mandler, 2003), considering “a key in a keyhole” to be the same relation as “a cork in a bottle”. Thus, prelinguistic infants from different language environments extract the common relation (i.e., tight or loose fit) in events and categorize them. In a recent study, Choi (2006) showed that by 24 months of age English-reared children still differentiate between tight- and loose-fit containment relations.

Taken together, studies on containment and support spatial relations suggest that infants differentiate and form prelinguistic categories of spatial constructs, even when their native language does not encode the specific relations (e.g., Casasola & Cohen, 2002; Hespos & Baillargeon, 2001; Hespos & Spelke, 2004). These empirical findings on spatial relations provide evidence for theories on conceptual precursors for learning relational terms (Gentner, 1982; Gentner & Boroditsky, 2001; Mandler, 1991, 2004, 2010).

Path-Manner

Path is defined as a figure’s trajectory relative to a ground and *manner* refers to how the action is performed. For example, in the sentence “John is *running into* the room,” John is the figure, *running* is the manner and *into* is the path of the event. However, English often conflates motion with *manner* in the main verb (as in *running*) and expresses the *path* in a “satellite” prepositional phrase, as in, “... *into the room*.” In contrast, Turkish conflates the motion with *path* in the main verb (as in *girdi* “go into”) and expresses *manner* in a subordinated verb or adverbial phrase; *kosarak* “*runningly*.”

Seven-month-old English infants attend to path and manner changes in nonlinguistic dynamic events (Pulverman & Golinkoff, 2004). In particular, after being habituated to an animated starfish performing both a *path* and a *manner* (e.g., a starfish

twisting over a ball) infants increased their attention at test to both a *path* change (e.g., starfish twisting *under* a ball) and a *manner* change (e.g., starfish *spinning* over a ball). Similar results were obtained from Spanish-reared and Mandarin-reared infants (Pulverman, Chen, Chan, Tardif, & Meng, 2007; Pulverman et al., 2008). The evidence from 14 to 17 months of age suggests that infants at this age recognize path and manner as independent components in the event. For example, when they watch “spinning over a ball,” infants realize that *spin* and *over* are two individual parts of the one event (Pulverman et al., 2008).

Findings for path and manner discrimination have also been replicated using naturalistic scenes and human agents, such as a young child crawling in front of a bush (Casasola, Hohenstein, & Naigles, 2003). For *manner* change, infants watched the young child hopping in front of a bush. For *path* change, infants saw the young child crawling towards/ away from a shrub. Infants as young as 10 months of age noticed changes in both *path* and *manner*.

As in the case of containment and support, infants are required to move beyond detecting differences between event components and to put them into categories. By way of example, a category of ‘around’ must include a wide range of actions performed by different actors such as a woman *jumping around* a circle, a car *speeding around* the building, or a bird *flying around* the tree. If they are to form a category of ‘around,’ infants witnessing these events need to discern the similarities among them.

Using the same stimuli as Pulverman et al. (2008) with the Preferential Looking Paradigm, in two studies, Pruden and colleagues (Pruden, Roseberry, Göksun, Hirsh-Pasek, & Golinkoff, under revision-a; Pruden, Göksun, Roseberry, Hirsh-Pasek, &

Golinkoff, under revision-b) investigated 7- to 15-month-old infants' ability to form categories of events based on path and manner using a preferential looking paradigm (Golinkoff et al., 1987; Hirsh-Pasek & Golinkoff, 1996). In the path study (Pruden et al., under revision-a), infants were familiarized to four events (one after another) in which the starfish performed four different manners, all along the same path (e.g., spinning *over*, jumping jacks *over*, bending *over*, and toe-touching *over*). They were then tested on two novel events presented simultaneously, side by side. In the within-category event, the familiarized path was paired with a novel manner (e.g., twisting *over*). In the out-of-category event, a novel path was paired with the same novel manner (e.g., twisting *under*). In the manner study (Pruden et al., under revision-b), infants were familiarized to four events with the same manner (e.g., *spinning over*, *spinning under*, *spinning past*, and *spinning around*) and tested on two novel events with either the familiarized (in-category) or novel (out-of-category) manner (e.g., *spinning behind* vs. *jumping jacks behind*, respectively). If infants had successfully categorized the events, they should have shown a clear preference for one test event over the other. The earliest evidence of path categorization emerged at 10 to 12 months. Infants preferred to watch the out-of-category event. By 13 to 15 months, infants could form a category of manner, as evidenced by a preference for the within-category events, indicating that infants are able to extract the common path or manner in a series of dynamic events and form categories of path and manner.

Additional evidence on path-manner categorization comes from studies with realistic stimuli. A replication of the Pruden et al.'s path categorization study with realistic stimuli indicated that infants abstract the invariant path by 13 months of age

(Tynan et al., 2009). For example, infants extract the common path ‘around’ from various instances such as a woman *running around* a tent, a woman *crawling around* a tent, and a woman *twirling around* a tent. Salkind, Sootsman, Golinkoff, Hirsh-Pasek, and Maguire (2002) examined 9- to 11-month-olds’ formation of categories of *manner* across agents. Infants were habituated to two clips that depicted different actors performing the same full-body action (e.g., jumping jacks). There were 3 test trials: a novel actor performing the same full-body action, a novel actor performing a novel full-body action, and a control trial. Infants’ attention was increased to the novel actor performing a novel action trial. Likewise, Song (2009) found that 10- to 15-month-olds formed nonlinguistic categories of two manners (i.e., jumping and marching) over five different actors along five different paths (see also Song et al., 2006). These studies extend the findings of animated and controlled lab stimuli to realistic stimuli and provide further evidence that prelinguistic infants abstract an *invariant manner* and *invariant path* in real-life settings (Salkind et al., 2002; Song, 2009; Tynan et al., 2009).

The ability to discriminate and categorize path and manner is reminiscent of children’s competency with containment and support. Infants in the first year differentiate and categorize paths and manners (Pulverman & Golinkoff, 2004; Pruden et al., 2004). The current findings demonstrate how infants interpret nonlinguistic events, which is a crucial first step in learning to express them in language.

Source-Goal

A body of literature explores infants’ conceptualization of goals in events and its relation to intention. These studies ask whether infants jointly process the intent of an actor’s action with respect to a *goal*.

One line of research suggests that infants follow rational paths to achieve the goal within possible situational constraints (e.g., Csibra & Gergely, 1998; Csibra, Biro, Koos, & Gergely, 2003; Gergely, Nadasdy, Csibra, & Biro, 1995; Gergely, Bekkering, & Kiraly, 2002; Gergely & Csibra, 2003). Using rational actions as a basis, infants attribute goals to the behaviors of humans (Sodian, Schoeppner, & Metz, 2004), hands (Phillips & Wellman, 2005; Woodward & Sommerville, 2000), puppets (Sodian et al., 2004), robots (Kamewari, Kato, Kanda, Ishiguro, & Hiraki, 2005), and even geometric shapes (Gergely et al, 1995; Csibra et al., 2003; Wagner & Carey, 2005). By way of example, Gergely et al. (1995) habituated infants to the scene of a small circle approaching a large circle by means of jumping over an obstacle. At the test phase, they removed the obstacle and infants saw the same jumping over action that was presented before or a straight-line goal approach was shown. Nine-month-old infants looked longer at the same jumping approach, which indicates that the action is unexpected and an inefficient means to the *goal* when the obstacle is no longer present.

In addition to the influence of rational paths, Woodward and her colleagues demonstrated that by the end of their first year, infants' encoding of goals in nonlinguistic events relies on the animacy of agents (e.g., Sommerville & Woodward, 2005; Woodward, 1998, 1999; Woodward, Sommerville, & Guajardo, 2001). For example, Woodward (1998, 1999) found that infants attend to the goals of action when it is performed *intentionally* by an *animate* actor, but not an inanimate 'mechanical hand' actor or unintentional action (see also Meltzoff, 1995, 2007; Tomasello, 1999; Woodward, 1998; Woodward, Sommerville, & Guajardo, 2001).

In a motion event, *source* refers to the figure's movement from a reference object by a variety of possible "from or away from paths." Thus, a source might be the chair from which the dog moves toward his bowl – the goal. *Goal* refers to the figure's movement to a reference object, using "to or towards paths" (Jackendoff, 1983; Talmy, 1985). Languages code goals more frequently than sources, possibly because the endpoint of an event is more important for further action.

When 12-month-old infants were habituated to motion events, such as a duck moving out of a bowl and onto a block, infants looked longer only when the goal (i.e., the block) was changed. They apparently failed to notice when the source of the action changed. However, when the perceptual saliency of the sources was increased by making the source (i.e., the bowl) object bigger and wagging the figure at the source object, infants did notice sources. Even though they preferred goals over sources when the two categories were pitted against each other, 12-month-olds seemed to attend to both components of dynamic events (Lakusta et al., 2007; see also Wagner & Carey, 2005). This finding corroborates the frequently reported goal-bias in both the infant and adult literatures (e.g., Csibra & Gergely, 1998; Regier & Zheng, 2007; Woodward, 1998).

In a very recent study, Lakusta and Carey (2008) asked whether infants form these goal and source categories in motion events. Using a similar design to that of Casasola and Cohen (2002), in the *goal category* condition, infants were initially habituated, for example, to a toy duck moving towards a tree. Then, they saw a spatial relation change (the duck is moving in a box), spatial relation and the reference object change (the duck is moving in a bowl), and finally a spatial relation, reference object, and actor change (a plane is moving in a bowl). In the *source category* condition, infants were

presented with the same changes, except the objects were sources and the action was *moving out*. Results demonstrated that 14-month-old infants form a ‘category of goal’ that consists of different spatial relations, reference objects, and agents, but not inanimate objects. However, the same age group did not form a category of source for very similar events.

Together, studies on sources and goals in motion events shed light on our understanding of how these components are encoded prelinguistically. The present findings support for Mandler’s theory on the importance of animacy for the conceptualization of source and goal (Mandler, 2004) and also build upon the literature by hinting at the striking impact of intentionality in processing goals.

The New Case: Figure and Ground

Consider an infant watching a child running on the beach. While the infant observes this event her mother says to her, “Look! The girl is running on the sand!” How does the infant discern that the girl is the person doing the action (the figure), that the sand is the surface on which the action is occurring (the ground), and that running is the action being performed (the meaning of action)?

The relationship between a static figure and a static ground was initially studied by Gestalt psychologists (e.g., Koffka 1935; Wever, 1927). Since then, the perception of figure and ground has been investigated primarily in the literature on adults’ event processing (e.g., Kimchi & Peterson, 2008; Peterson & Gibson, 1994). There is also some research on infants’ perception of figure and ground relations (e.g., Johnson & Aslin, 1998; Johnson & Mason, 2002; Kauffman-Hayoz, Kauffman, & Stucki, 1986). However,

research is needed to assess infants' ability to differentiate between dynamic figures on various grounds in real life settings as a prerequisite for learning relational terms.

In dynamic motion events, the *figure* is a moving or conceptually movable entity that performs the action with respect to a reference point or a stationary setting – the *ground* (Talmy, 2000). That is, the figure of an event is the prominent agent or object undergoing motion in the event. Infants perceptually access figure and ground in events, and languages universally express events using these components.

Why is it important to study infants' processing of dynamic figures with respect to grounds? The discrimination of humans in dynamic events is also associated with the concepts of agency and animacy that are constructed in the first two years of life (Eimas, 1994; Mandler, 1992, 2004; for a review see Rakison & Poulin-Dubois, 2001). The interpretation of other people as agents (Johnson, 2000) is related to understanding the role people play in causal events (e.g., Golinkoff, 1975, 1981; Golinkoff & Kerr, 1978, Poulin-Dubois & Schultz, 1990; Oakes, 1994); the intentionality behind a person's movement as the person moves to a certain goal (e.g., Phillips, Wellman, & Spelke, 2002; Woodward, 1998, 2003); and the means agents use to attain goals (Sodian, Schöppner, & Metz, 2004).

The *ground* in a dynamic event is a reference point in the form of an object or the stationary setting of the scene. Ground information is important for the linguistic encoding of motion events. In English, for example, the prepositions *over*, *into*, *through*, and *across* specify both a path that the *figure* follows and the spatial properties of the *ground* object. Hence, 'into' not only refers to a path that the figure moves along, but also indicates that the ground object is some kind of enclosure (Talmy, 2000). When the

ground is the setting where an action takes place, different relational terms implicitly encode different grounds. For example, ‘across’ implies a relatively stable surface that can be traversed, while ‘along’ implies a more or less horizontal principal axis (Jackendoff, 1992).

Intriguingly, some languages like Korean or Japanese, encode ground distinctions directly in their verb structure (Choi-Jonin & Sarda, 2007; Muehleisen & Imai, 1997). Japanese, for example, classifies motion path verbs into two categories: directional-path and ground-path verbs. *Directional-path* (DP) verbs define the direction of motion relative to a starting point or goal (e.g., *hairu* ‘enter’, *iku* ‘go’, *kaeru* ‘return’, *kuru* ‘come’), and do not restrict the *ground* on which the motion occurs (Muehleisen & Imai, 1997). However, *ground-path* (GP) verbs such as *wataru* ‘go across’, *koeru* ‘go over’, and *nukeru* ‘pass through,’ incorporate properties of the ground along with the direction of motion (Beavers, 2008; Muehleisen & Imai, 1997; Tsujimura, 2006). The spatial geometry of the ground is the key to assigning the correct verb to a motion event. These verbs code properties of the ground along with the direction of motion and the static scenes of these actions do not evoke the use of these specific verbs on specific grounds. For example, in the sentence *Jun wa kawa/michi o watatta* ‘Jun crossed the river/street,’ the meaning of *wataru* ‘go across a barrier dividing two points’ implies that there is both a starting point and a goal, and that the ground is a flat extended surface such as a river or a street. By definition, the verb *wataru* is not applicable to grounds such as a field or a tennis court that have no clear borders or barriers that demarcate the two sides of the plane. Instead, to describe a crossing action on these grounds, a more generic verb *tooru* ‘go across a continuous plane’ is used. Thus, when actions take place against different

kinds of grounds, the Japanese verb changes (see Figure 1 for a schematic description of *wataru* and *tooru*). Compared to DP verbs, these GP verbs are very specific in regards to the ground that they encode (Muehleisen & Imai, 1997). Given this encoding of grounds in verbs in Japanese, but not in English verbs, we have an opportunity to study whether infants can detect these features of grounds that are not expressed in their language.

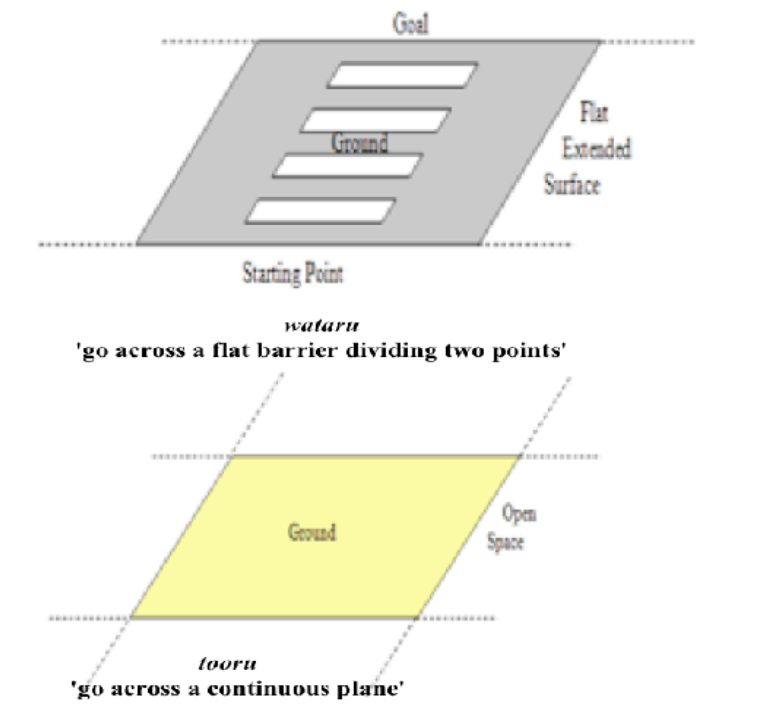


Figure 1. The top panel presents the schematic description of *wataru* 'go across a flat barrier dividing two points' and the bottom panel shows the schematic description of *tooru* 'go across a continuous plane.'

In our lab, we started to test whether infants discriminate between figures and grounds in nonlinguistic dynamic motion events (Göksun, Hirsh-Pasek, & Golinkoff, under revision). We particularly choose a salient and perceptually accessible ground-path verb to test: *wataru* 'go across a flat barrier dividing two points.' The case of figure and ground as precursors for learning verbs and prepositions offers a new direction for at least to three reasons. First, despite significant advances in the field of prelinguistic constructs,

only a small set of event components relevant to relational terms has been examined. Second, prior studies on the degree-of-fit relation in containment and support events touch on how children view grounds but are ambiguous as to whether infants interpret these events in terms of their final outcomes or to the dynamic process that yields these outcomes. That is, a concept like “in” may be represented as the static *endpoint* of the event - *the toy in the box* rather than as the *action* of putting the toy in the box (dynamic). Last, differences in encoding ground between languages allow us to examine whether infants are sensitive to non-native distinctions before learning ambient language.

In the preliminary research, using the Preferential Looking Paradigm, we conducted two parallel figure and ground discrimination studies. Infants were shown televised displays of *different figures* (people) crossing *various grounds* (e.g., a railroad track, a road or a tennis court). In figure discrimination, English-reared 8- and 11-month-olds were familiarized with a scene in which one figure (e.g., a woman) crossed a ground (e.g., a railroad track). At test, the familiar event (the woman crossing the railroad track) was paired with a new event that changed only the figure (e.g., a *man* crossing a railroad track). The dependent variable was looking time at the novel versus the familiar events. Results showed that only 11-month-olds discriminated between figures. Although, 8-month-olds were attentive and watched the clips, they did not distinguish between the figures.

In ground discrimination, infants of the same age saw the same event in familiarization (e.g., a woman crossing a railroad track). At test, however, infants saw the familiar event (the woman crossing the *railroad track*) paired with a new event that changed only the ground (e.g., the woman crossing a *road*). Even though these were

English-reared children with no experience in Japanese, the comparison of the grounds was also manipulated according to Japanese ground distinctions. In Japanese, the verb *wataru* ‘go across a barrier dividing two points’ (see Figure 1) is encoded with the grounds such as a railroad track, a road, a street, or a bridge. In contrast, a field or a tennis court are not typical grounds for the verb *wataru* because they are either open areas with no boundaries or do not separate the two sides of the ground. These grounds are encoded with the more generic verb *tooru* ‘go across a continuous plane.’ In one condition of ground discrimination, then, we compared grounds that are both coded with the verb *wataru* (e.g., *within-category* “a road vs. a railroad track”). The other condition compared a ground that used the verb *wataru* ‘go across a barrier dividing two points’ and a ground that used the verb *tooru* ‘go across a continuous plane’ (e.g., *across-category* “a railroad track vs. a tennis court”).

Results indicated that neither 8- nor 11-month-olds differentiated among different grounds. Additional data from 14-month-olds, however, displayed a preference for the *novel* over familiar grounds. Further analyses demonstrated that this age group discriminated grounds from *across-category* comparisons in Japanese (e.g., a railroad track vs. a tennis court comparison) significantly better than grounds from *within-category* comparisons (e.g., a railroad track vs. a road) as encoded by the Japanese. A control study using the same movies in grayscale replicated the results and argued against the possibility that infants were simply using the color of the grounds as a feature for ground discrimination.

Lastly, the findings showed that in both studies infants younger than 14 months of age have a holistic recognition of figures and grounds. For example, after seeing a man

walking on a road, an infant initially treats the man and the road as a holistic event, rather than extending the figure (e.g., the man) and his action (e.g., walking) to a new ground (e.g., a tennis court). Thus, infants initially process figure and ground as a composite rather than separate pieces.

To summarize, infants discriminate figure changes earlier than ground changes in dynamic events. This is consistent with previous studies on other conceptual precursors such as containment-support and source-goal, which demonstrate that infants notice some components in events earlier than others. For example, infants distinguish the goal of an action before the source of an action (Lakusta et al., 2007) and containment events before support events (e.g., Casasola & Cohen, 2002).

The findings from the ground discrimination study suggest that prelinguistic infants are sensitive to a categorical distinction between grounds made in Japanese but not in English. In particular, the grounds coded by the verb *wataru* share certain geometric features: They are bounded and extend in a line with specific starting and ending points. In contrast, other grounds do not have these features. English-reared infants attend to these common features between *wataru* grounds, and notice the changes in grounds only when the ground changes in ways marked linguistically as distinct Japanese categories. This is comparable to English-reared 5-month-old infants' sensitivity to the degree-of-fit relation encoded only in Korean (Hespos & Spelke, 2004).

The Present Studies

Although these initial findings from infants' processing of figures and grounds in dynamic nonlinguistic events are impressive, several questions remain unanswered with respect to the nature of this processing and possible developmental changes among

different language groups. The studies in this dissertation aim at furthering this research and address these inquiries to better examine the constructs figure and ground and their relation to learning verbs and prepositions. Four studies were designed.

Study 1 extends the findings from the English-reared infants discrimination of grounds. In the original studies, infants were better at noticing changes when two grounds belong to two *different* ground categories as marked in Japanese (across-category comparisons). The first study replicates these findings and then asks whether infants merely discriminated between grounds or whether they formed a category of event components. Thus, we ask whether infants can form a category for *wataru* that involves bounded grounds and flat barriers divided spatially by two points.

Studies 2 and 3 manipulate factors hypothesized to be central to infants' discrimination of figures and grounds in the dynamic *crossing* event. These studies tease apart the role of *path* and *spatial-temporal* interaction in crossing events. In particular, Study 2 examines the interaction between the path of the motion and the ground (crossing vs. walking alongside a particular ground) in differentiating between grounds. In Study 3, we compare the data from dynamic events with those collected from static scenes of the same events to identify whether infants notice the same event components to the same degree in static vs. dynamic displays.

Study 4 moves beyond the features associated with figure and ground discrimination (i.e., the nature of noticing figures and ground) by exploring the influence of language exposure on the detection of grounds. In particular, this study poses two questions: 1) Do Japanese-reared infants differentiate grounds in a way that parallels the

findings of English-reared infants?; and 2) Does infant early categorical distinctions in events change when they are exposed to their ambient language?

Together, these studies shed light on the link between event perception and language learning by addressing two salient, but only recently explored components in events. The findings in this dissertation add to what we know about *what* very young children perceive in events, *how* they notice event components, and how attention to event components might adapt as children learn their native language.

CHAPTER 2

GENERAL METHODOLOGY

Participants

A total of 185 infants between 7 and 21 months of age made up the final sample for these studies (24 infants in Study 1; 22 infants in Study 2; 67 infants in Study 3, 74 infants in Study 4). For each study, the number of males and females forming the final sample of each experiment are reported in the methods section. These age groups were chosen because previous findings suggest that infants discriminate various event components prior to producing their first words between 7 and 12 months of age (Lakusta et al., 2007; Pulverman et al., 2004) and language knowledge might interact with the conceptualization of these event components between 14 and 21 months of age (e.g., Choi, 2006; Pulverman et al., 2008).

For Studies 1 and 2, infants younger than 13 months of age were not recruited, because in the foundational studies explained above, children younger than this age were not be able to discriminate between grounds in dynamic events. However, for Study 3 where we used static pictures of the dynamic stimuli, we recruited younger infants to see the potential developmental difference given to static and dynamic stimuli in infancy.

The English-reared infants were mainly tested at Temple University Infant Lab, Philadelphia, PA. Infant Language Project at the University of Delaware, Newark, DE, tested around 20% of the infants in each study. All children were recruited through a commercially available purchased list. After sending letters about Temple Infant Lab and our studies, we called the families to explain the specific study and to schedule an appointment to participate in the experiment. A very similar procedure was followed to

recruit the children at Delaware. In the Study 4, Japanese-reared children were recruited from Tamagawa University Baby Lab (with collaborators Mutsumi Imai and Hiroyuki Okada) with the help of a trained Japanese-English bilingual research assistant.

All infants were full-term at birth and came from monolingual households. Infants were considered full-term if they were born within 2 weeks of their due date. The reasons for the exclusion of multilingual and premature infants were that, (1) infants raised in multilingual households would encode events differently than infants raised in monolingual households, and (2) premature infants might have language delays (e.g., Le Normand & Cohen, 1999; Aylward, 2002).

The final sample size for Studies 1-3 and for Study 4's English sample mostly involved Caucasians. Hispanic, Asian-American, and African-American participants formed approximately 5% of this sample size. This percentage of minority participants in our studies matched census numbers for the catchment area. Additionally, the families were primarily from middle- or upper-class income levels. The studies in this dissertation did not consider racial/ethnic status or socio-economic status as part of the design or as factors in the analyses.

Stimuli

The stimuli consisted of televised displays of four people (a woman, a man, a 6-year-old girl, and a 6-year-old boy) crossing one of the six grounds (railroad track, road, narrow street, bridge, tennis court, and grassy field) from left to right. The same stimuli were used in the original figure and ground discrimination studies (see Figures 2 and 3). In a 175 X 125 pixel image of the scene, children had an average height of 28 pixels and adults had an average height of 40 pixels. Each crossing event lasted 6 seconds. For each

exposure, a 12 second movie that contained 2 identical crossing events were presented. Thus, infants watched each event twice. The same stimuli were used in the Study 1, Study 3, and Study 4. In the Study 2, the same grounds were used when people were walking alongside rather than crossing. The details are given in the Chapter 4. No linguistic audio accompanied these scenes. Stimuli were videotaped outdoors and movies were made using Final-Cut Pro-3D.

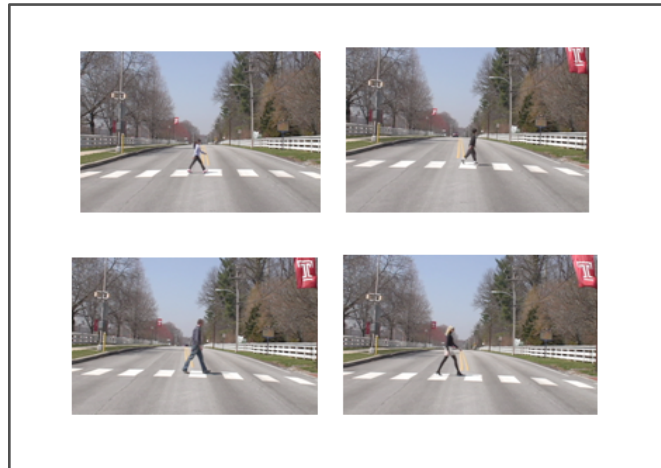


Figure 2. Figures (a girl, a boy, a man, and a woman) used in the figure discrimination study

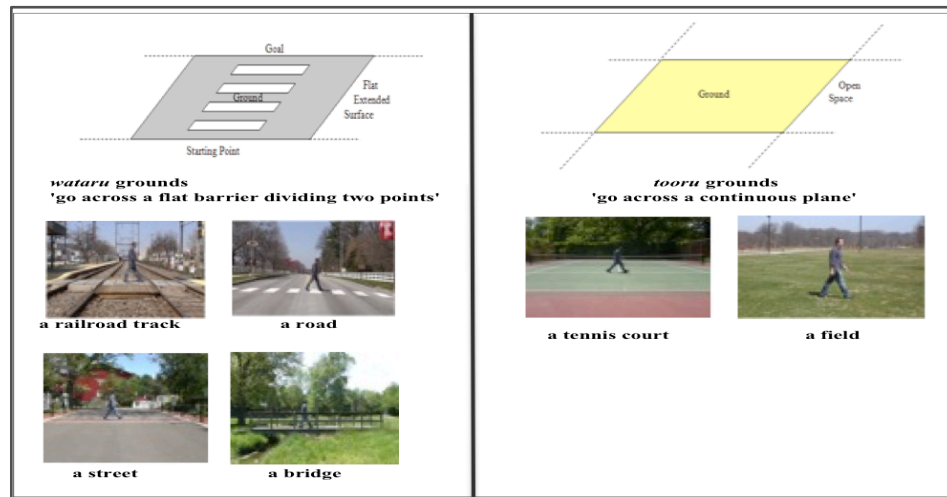


Figure 3. The left panel presents the grounds (a railroad track, a road, a street, and a bridge) used in the present study that are encoded by *wataru*. The right panel shows the grounds used for *tooru* (a tennis court and a field).

Common Measures

1. MacArthur Communicative Developmental Inventory (MCDI)

The MCDI is a reliable and valid parent report assessing language and communication development of children between 8 to 30 months of age (Fenson et al., 1994, 2000). Two short form versions of the MCDI were used in these studies: infant and toddler forms. The infant short form includes a vocabulary checklist of a total of 89 words including nouns (62%), verbs (15%), adjectives and adverbs (12%), and pronouns, sound effects (11%). In addition to this, we used a relational infant vocabulary checklist drawn from the long version of MCDI (see Appendix A). This list contains an additional 55 verbs and 11 prepositions (Fenson et al., 2000). Because this dissertation investigates the learning of relational terms, we increased the number of relational words such as climb, draw, around, and behind as in some of the previous dissertation works from our labs (Maguire, 2004; Song, 2009). For each word, parents check whether their child comprehended and/or produced the word. The total number of comprehended and produced words was counted to create infant's current lexicon. We used the infant short form of MCDI for infants between 7 and 18 months.

The toddler version of MCDI included 100 words: nouns (52%), verbs (18%), adjectives and adverbs (15%), and pronouns, prepositions, and sound effects (15%). Again, the list contained nouns, verbs, and prepositions (Fenson et al., 2000). The additional relational vocabulary list was drawn from the long version of MCDI (Fenson et al., 1994). In the toddler version, parents checked only the words their children produced (see Appendix B). We used the toddler short form of MCDI for infants between

19 and 30 months. In Study 4, the Japanese version of MacArthur CDI (Ogura & Murase, 1991) was used for the Japanese-reared children.

2. General Method: The Preferential Looking Paradigm (PLP)

The main paradigm that was used in this dissertation was the Preferential Looking Paradigm (Golinkoff et al., 1987; Hirsh-Pasek & Golinkoff, 1996). Infants watched a movie that contains four main phases: introduction, salience, familiarization, and test trials. The design and stimuli for different studies are presented in each study (see Figure 4 for a sample design from the figure discrimination study).

Introduction Phase. An animated character appeared first on one side of the screen and then on the other to ensure that infants were familiarized to clips playing on both sides of the screen. The side on which this event appeared first was counterbalanced across condition. Each presentation was 6 seconds long.

Salience Phase. Infants first saw what was to later become the test trial. This was used to determine whether there was any *a priori* preference for either clip. The salience phase contained a 12-second clip of two events on a split-screen (e.g., a man crossing a road vs. a woman crossing a road). If there had been more than one test trial, the salience would have contained both test trials. The side of presentation of each event and the order of the trials were counterbalanced across condition.

Familiarization Phase. In the discrimination studies, infants watched four 12-second clips of exactly the same stimulus on the full screen such as a woman crossing a railroad. In the Study 1 (the categorization study), infants watched 3 different clips that involved a person crossing different grounds on each 12-second clip. The details of the clips are explained under each study.

Test Phase. Infants watched two test events simultaneously on the split-screen for 12 seconds. No linguistic stimuli or any audio is accompanied the clips. The target event for the side on which it appeared and the order of the test trials were counterbalanced across condition. The stimuli and details of test phase are described under each study.

	FIGURE DISCRIMINATION STUDY Visual Stimuli	
<i>Salience Change Trial</i> (12 sec)	 a man crossing a road	 a man crossing a railroad track
<i>Salience Complex Trial</i> (12 sec)	 a woman crossing a road	 a woman crossing a railroad track
<i>Familiarization</i> (4 times – each 12 sec)	 a man crossing a road	
<i>Test Change Trial</i> (12 sec)	 a man crossing a road	 a man crossing a railroad track
<i>Test Complex Trial</i> (12 sec)	 a woman crossing a road	 a woman crossing a railroad track

Figure 4. A sample movie sequence for the figure discrimination study in dynamic events

Attention-Getter. A 3-second smiling baby face accompanied by the children’s song “Oh, Susanna” was used to separate the trials in each phase of the experiment. The attention-getter had two purposes: to renew infants’ interest in the movie and to reorient the infants’ looking to the center of the screen before they had to choose between pairs of stimuli in the split-screen trials.

Procedure

Through a commercially available purchased list, we initially sent letters to all families in the list. Then, to schedule an appointment to participate in the experiment, we choose and call families whose children were in appropriate age for the studies. When the families arrived at the lab, the experimenter welcomed them in the laboratory playroom. Parents filled out the informed consent forms on behalf of their children and themselves for participation in the studies (see Appendices C-F for the consent forms). They were also asked to complete the appropriate vocabulary checklist. While parents were completing the paperwork (i.e., consent forms and vocabulary checklist), children played in the playroom and became familiar with the laboratory environment. Then, both the parent and the child went to the PLP video room. As seen in Figure 6, the child was seated on the lap of her parent centered in front of a 44-inch television. They positioned 100 cm away from the screen. We also asked the parent to keep her eyes closed during the study so as not to influence the child's direction of eye gaze. If violated, we would exclude that child's data from the analyses.

We placed two cameras to the right and left of the television (38 cm away). One video camera on the right side ran the movie of the study and another video camera on the left side recorded the child's eye gaze. After the experimenter started recording the movie, he or she left the room to avoid influencing infants' attention during the experiment. Following the completion of the study, infants received a small gift either a Temple Infant Lab t-shirt or a toy of their choice.

Coding

The dependent variable for the PLP experiments was looking time towards each event. Following completion of the experiment, reliable coders coded the videos. The

coders were always blind to the condition in which infants had participated to ensure that they do not know the target side in the movie. For each phase (introduction, salience, familiarization, test phases, and attention-getters), infants looking times in terms of visual fixation were coded. During attention-getters and familiarization phases, infants' looking to the center of the screen and during the introduction, salience, and test phases, attention to the left or right side of the screen were coded. Each infant was coded twice to obtain the reliability of .99 within each coder. Additionally, one independent coder coded 25% of the infants for each study to analyze the correlation between two people's coding.

Taking an infant's total amount of looking time from all phases and dividing this number by the length of the whole study (the total time in each phase) calculated attention. If the result had been below .50 meaning that infants looked at the movie less than 50% of their looking time, the data would have been removed from analyses. Side bias was calculated by getting infants' total looking to the right side of the screen and dividing the number by their total looking time to both right and left sides of the screen. In this calculation, only split-screen phases were included. If the calculation had been greater than .80 or less than .20 meaning that they look at one side of the screen 80% of their total looking time, we would have excluded the data from analyses. All other data were analyzed. The number of infants excluded for side bias or inattentiveness is reported in each study.

In addition to low attention and side bias, prematurity, being bilingual, and inability to finish the experiment were other criteria for exclusion from the final sample. The excluded participants are reported in each study.

CHAPTER 3

CATEGORIZATION OF GROUNDS

Categorization is the primary means of coding experience that helps reduce the demands of limited memory storage, perceptual and reasoning processes by creating similar representations for related objects, relations or events (Gershkoff-Stowe & Rakison, 2005). Verbs and prepositions refer to categories of events rather than individual units. Consider a cat walking towards a tree, a woman walking upstairs, and a child walking in the playground. Although these actions look different, all are described using the verb ‘*walk*.’ This motion verb *walk* refers to a *category* of events performed by different people and an animal, on various grounds with different trajectories, and presumably varied goals. In categorizing these events, infants need to learn to put perceptually similar and dissimilar events together.

The ability to categorize objects (e.g., Arterberry & Bornstein, 2002; Madole & Oakes, 1999; Mandler, 2000; Gershkoff-Stowe & Rakison, 2005; Pauen, 2000; Quinn & Eimas, 1996) and static spatial relations such as below, above, and between (e.g., Quinn, 1994; Quinn, Adams, Kennedy, Shettler, & Wasnik, 2003) appears in the first half of the first year of life. Recent research also demonstrates that infants between the ages of 9 and 13 months categorize other spatial relations such as containment, a path of an action, and a manner of an action (e.g., Casasola et al., 2003; McDonough et al., 2003; Pruden et al., under revision-a, under revision-b). For example, infants abstract an invariant path (e.g., *under*) over many manners (e.g., *bending* under, *twisting* under, and *toe-touching* under). These studies move beyond whether infants detect a change in an event (e.g., whether jumping is different from running) and examine infants’ abstraction of spatial event

components (e.g., extracting *jumping* over various paths).. Importantly, prelinguistic infants are capable of categorizing nonnative contrasts such as abstracting the tightness or looseness of object relations in containment events by English-reared babies (McDonough et al., 2003).

The aim of Study 1 is to assess English-reared infants' ability to categorize grounds based on nonnative contrasts of grounds. In the original ground discrimination studies with dynamic events, we found that infants discriminate between grounds when they belong to two different categories according to Japanese, but not English. In particular, after familiarized to a dynamic scene where a figure was crossing a ground (e.g., a woman crossing a *road*), at test English-reared 14-month-olds noticed differences only when the familiar ground was compared with a novel ground from a different category according to Japanese distinctions (e.g., the same woman crossing a *road* vs. a *tennis court*). Thus, infants detected the difference between *wataru* 'flat barriers dividing two sides' grounds (a railroad track, a road, a street, and a bridge) and *tooru* 'continuous plane' grounds (a tennis court and a field). On the other hand, grounds from the same category *wataru* were treated similarly. These findings suggest that English-reared infants are able to notice nonnative ground distinctions in events.

Although, this study shows that infants make categorical distinctions, to make a decision of within- vs. across-category distinctions, infants would need to compare more than two grounds and to treat all grounds that are labeled by the Japanese word *wataru* 'flat barriers dividing two points' in one category and those labeled by the word *tooru* 'continuous plane' in another. Here we ask whether English-reared infants with no exposure to Japanese nonetheless form a *category* of ground that is represented in

Japanese, but not in English?

The present study is also a control for the *wataru* ‘flat barriers dividing two points’ category. This time we ask whether infants extract the common properties among *wataru* grounds and extend it to a new exemplar. “*Wataru*” grounds are flat barriers dividing two points, have specific starting and ending points, bounded, and extend in a line such as a street, a road and a bridge. Although other perceptual features such as the background or color of the grounds are different, with the crossing action, these grounds share same properties. When the grounds do not meet these criteria, *tooru* ‘continuous plane’ is used.

In Study 1, 14-month-old infants were recruited as participants. This age group was chosen due to the results from the discrimination study that indicates that infants younger than this age do not differentiate between grounds. We present infants 3 different *wataru* grounds in familiarization. At test, infants were shown either a novel *wataru* ground and a *tooru* ground or two *tooru* grounds. If infants extract the common properties among the *wataru* grounds in familiarization phase, they should look longer to one side when the comparison was between *wataru* and *tooru* categories. Following Pruden et al. (under revision), we expected that infants would look longer at the familiar ground. In contrast, we predict that infants should look equally to two *tooru* grounds at test, because they are both out of the category grounds they saw in familiarization. As in all preferential looking studies, we hypothesized that infants will have no preference to one side of the split-screen in the salience trial before exposure to any events.

Method

Participants

Twenty-four 14-month-old ($M = 14.00$, $SD = .92$, range: 13.02 – 15.29; 13 males) English-reared infants participated in this study. All infants were monolingual and full-term at birth. An additional 1 infant (4%) was excluded from data analyses due to experimental error ($n = 1$). See general methods section for the recruitment and sample characteristics.

Stimuli

The stimuli were the same used in dynamic ground discrimination described (see Chapter 2 for the details of the stimuli).

Procedure

Infants were tested using the Preferential Looking Paradigm (for details of the paradigm, phases, and coding, see the general methods section).

The procedure was similar to the discrimination studies, with a difference in familiarization. After the introduction phase, infants were initially exposed to the *salience* phase that consisted of one trial that would later be the test trial (12 seconds). Then, during *familiarization* phase they sequentially watched a figure crossing three different *wataru* grounds: a woman crossing a railroad track, the same woman crossing a road, and the same woman crossing a narrow street. Thus, the only change was in the grounds as the same person in each scene carried out the same actions. Finally, infants saw two *test* trials. In the *wataru* vs. *tooru* test condition (condition 1), the comparison was **between** two different kinds of Japanese grounds *same figure/novel wataru ground* (a woman crossing a bridge) and *same figure/novel tooru ground* (a woman crossing a tennis court). In the *tooru* test condition (condition 2), the comparison was within the same Japanese grounds but nonetheless with novel grounds *same figure/novel tooru ground* (a woman

crossing a tennis court) and *same figure/another novel tooru ground* (a woman crossing a field). The procedure was same in all conditions (see Table 4 for a sample condition in this study and Appendix G for all conditions). The grounds that appeared on each side of the split-screen were counterbalanced for both salience and test trial.

	GROUND CATEGORIZATION STUDY Visual Stimuli	
<i>Salience Trial</i> (12 sec)	 a woman crossing a bridge	 a woman crossing a tennis court
<i>Familiarization 1</i> (12 sec)	 a woman crossing a railroad track	
<i>Familiarization 2</i> (12 sec)	 a woman crossing a road	
<i>Familiarization 3</i> (12 sec)	 a woman crossing a street	
<i>Test Complex Trial</i> (12 sec)	 a woman crossing a bridge	 a woman crossing a tennis court

Figure 5. A sample movie sequence for the ground categorization study

Coding

Fifteen percent of all videotapes were coded by a second person for inter-coder reliability ($r = .996$, $SD = .002$).

Results

We calculated infants' percentage of looking time towards each scene in the split-screen for *salience* and *test* trials. No gender differences appeared in either salience or test trials ($ps > .11$). In the following analyses, the data was collapsed for gender.

The Salience Phase

To evaluate whether infants had a priori preference for either event in the salience phase before watching any clips, we conducted a paired samples t-test. Results indicated that infants had balanced looking to both sides of the screen in the salience trial regardless of the condition, $p > .44$, suggesting that our event clips were equally salient to infants (see Figure 6).



Figure 6. Mean percentages of looking times to sides of the screen in the salience trial in the ground categorization study

The Familiarization Phase

Looking times during the familiarization phase were examined to determine whether infants attended to the familiarization events and whether there was a difference in attention between two conditions. A repeated-measures ANOVA with condition (condition 1 and condition 2) as the between-subject variable and 3 familiarization trials as within-subject variables yielded no main effect of trial or a trial by condition

interaction, $ps > .13$. This suggests that infants in both conditions were equally attentive to different event clips at the familiarization. Figure 7 presents infants' looking times during familiarization across the trials.

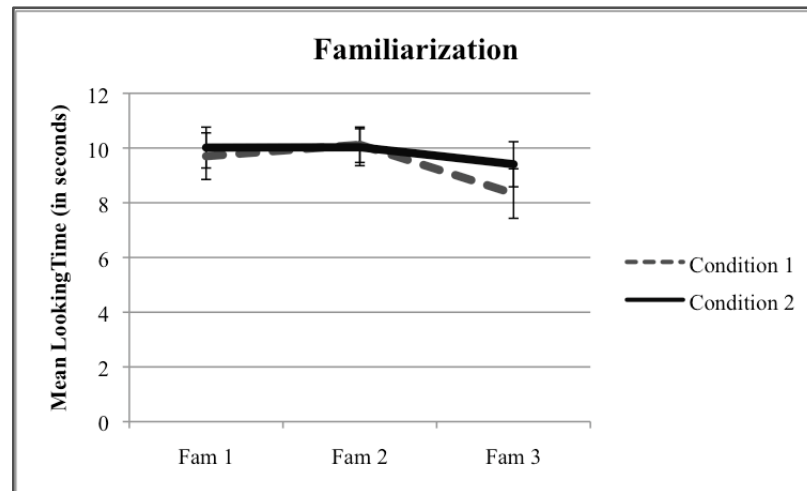


Figure 7. Average looking time in seconds (out of 12 seconds) in the familiarization phase for both conditions in the ground categorization study

The Test Phase

First, infants' attention to the whole movie was compared to the 50% attention criterion we had for all the Preferential Looking Studies. We found that infants in this study were attentive to the whole movie, $t(21) = 10.39$, $p = .00$.

Second, a paired samples t-test indicated that infants' looking preferences in test trial 1 and test trial 2 did not differ $p > .50$. Thus, in the further analysis, we used an average of these two exactly same test trials.

In the condition 1, one ground was from the same category and the other one was from a different category (*wataru* vs. *tooru* ground comparisons at test). In the condition 2, both grounds were from different category than the familiarized grounds (both *tooru* grounds). Thus, it was not plausible to compare "familiarity" or "novelty" preferences between conditions. For this reason, paired samples t-tests were conducted within each

condition to examine whether infants preferred to look at one side of the split-screen longer. Results indicated that in the condition 1 infants looked significantly longer to the side where there was a new exemplar of the wataru ground, $t(11) = 2.15$, $p = .05$, which was also above chance level $t(11) = 2.01$, $p = .05$ (7 out of 11 infants looked longer to the familiar ground at test). That is, infants in this condition preferred to look at the *within-category* ground. For example, if an infant had been familiarized with three events that involved grounds such as a woman crossing a *railroad track*, the same woman crossing a *road*, and the same woman crossing a *narrow street*, at test, they would have preferred to look at the side where there was the same woman crossing a *bridge* (within Japanese category), rather than crossing a *tennis court* (across Japanese category, see Figure 8). On the contrary, infants in the condition 2 had similar percentage of looking times to either side of the screen, $p > .64$, suggesting that infants showed no preference for these two novel grounds that both belong to *tooru* ‘continuous plane’ category. Thus, infants noticed the properties of the wataru grounds and extended it to a new exemplar. Finally, in either conditions, there was no main effect of ground comparisons, $F_s < .94$ and $p_s > .43$.

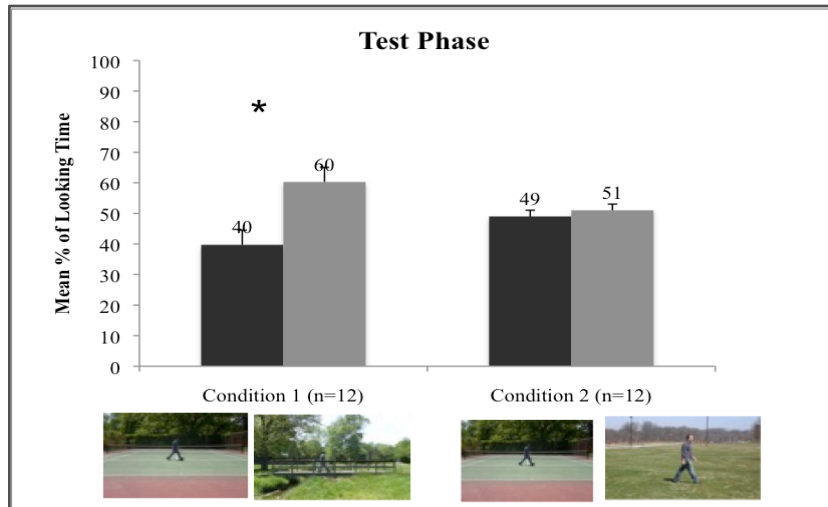


Figure 8. Mean percentages of looking times during test trials (the average of test 1 and test 2). In the condition 1, the light grey bar indicates looking at a within-category ground (a novel exemplar of 'wataru') and the dark grey bar represents looking at a novel category exemplar. In the condition 2, both the light grey and dark grey bars were novel grounds belonging to 'tooru' category. $*p < .05$.

Lastly, we examined whether there were any correlations between the language scores obtained from MCDI and relational vocabulary measure and infants' looking times during the test phase in both conditions. The results from the Pearson correlations (two-tailed) indicated that there were no significant relationships between these variables, $ps > .43$. Thus, children's vocabulary knowledge and categorization of these grounds were not related (see Appendix H for vocabulary scores).

Discussion

The goal of the Study 1 was to assess whether infants were able to form a category of *ground* that is represented in Japanese, but not in English. The findings confirm our predictions and suggest that English-reared infants at 14 months of age are able to extract the common spatial geometry of *wataru* 'flat barriers dividing two points' and to extend it to a new exemplar. This study ensures that infants at this age not only detect the categorical distinctions between two grounds as in the discrimination study, but also derived the common characteristics of grounds from the same categories and extend it to

a new ground sample from the same category. In particular, infants are able to attend to the specific perceptual features associated with *wataru* ‘flat barriers dividing two points’ grounds. Although at first glance these grounds seem to be different from each other, they all have noteworthy starting and ending points, bounded, and extended in a line. In contrast, *tooru* ‘continuous plane’ grounds do not have the same characteristics and infants do not put these *tooru* grounds into the *wataru* ground category. Although we did not test whether infants categorize different instances of *tooru*, the results at least present that infants form *wataru* ground category. These findings make two contributions to the literature.

First, together with the discrimination study, we indicate that English-reared nascent language learners are capable of detecting non-native distinctions in events. This ability shows that before they can produce their native language, infants notice various distinctions in events that are marked across languages. English-reared infants do not only notice the changes in grounds when the ground changes from one Japanese category to another (as in the discrimination study), but also group these grounds into one category. This is reminiscent of English-reared 5-month-old infants’ sensitivity and categorization of the degree-of-fit relation encoded only in Korean (Casasola & Cohen, 2002; Hespos & Spelke, 2004; McDonough et al., 2003).

Second, this research is among the first to demonstrate that infants abstract common features from *dynamic* scenes. Previous research focused mostly on static spatial relations such as above, below, and between (Quinn, 1994; 2003; Quinn, Cummins, Kase, Martin, & Weissman, 1996; Quinn, Norris, Pasko, Schmader, & Mash, 1999). Only recently, dynamic event components such as path and manner (e.g., Pruden

et al., under revision-a, under revision-b; Pulverman et al., 2008) have been investigated.

The present study adds to the literature by examining whether infants extract other components in dynamic events.

It is also noteworthy that the discrimination and categorization of the ground categories tested do appear later than does categorization of other event components studied in the literature. Why might this be the case? Due to the complexity and dynamic nature of the present events (i.e., various background features, motion events), the categorization of grounds appears later than the categorization of static relations and other dynamic spatial relations.

In sum, the Study 1 presents evidence that 14-month-old English-reared infants categorize grounds based on the distinctions made in Japanese and not in their mother tongue. Infants abstract a common geometry among the *wataru* ‘flat barriers dividing two points’ grounds and extend it to novel grounds from the same category, but not to novel grounds across categories.

CHAPTER 4

ALONGSIDE STUDY

The original ground discrimination study suggests that infants dissect scenes in dynamic *crossing* events. But exactly what infants are processing in these events is still unclear. To ensure that infants are really processing *wataru* as a “crossing” event, this study examines how infants process the same grounds when the path is changed from “crossing” to another one such as “walking alongside/near.” That is, is the Japanese category really referring to some combination of the ground and the path or merely to the ground? Thus, this study explores the “path” component of the ground-path verbs and serves a control for the ground discrimination study in dynamic events in two ways. First, by altering the *path*, we examine the role of *path* in ground-path verbs for the discrimination between grounds. Do infants notice ground changes when the path is walking alongside/near the grounds rather than crossing the ground? Second, this study provides more evidence about infants’ categorical ground discrimination by removing ground distinctiveness. In the original ground discrimination study, we found that infants noticed changes in grounds better when the comparison was between categories (*wataru* vs. *tooru*; e.g., a railroad track vs. a field). The verb “*wataru*” in Japanese is not warranted with roads, railroads, streets or bridges if the path is not “crossing” those grounds (Muehleisen & Imai, 1997). By making the path “boundless” rather than “crossing within boundaries,” all six of the grounds used in the prior study would now be labeled with the more general verb *toru* ‘walk’ in Japanese. They would thus be treated as belonging to the same category in both Japanese as they are in English. Hence changing

the spatial configuration of a dynamic event results in a different way of encoding in Japanese.

Here, we tested three questions: 1) Do English-reared 14-month-olds differentiate between various grounds in “walking alongside” events?; 2) Are they sensitive to categorical ground distinctions that had been apparent in the wataru exemplars used in Study 1? and 3) Do these infants have a holistic view figure and ground or do they separate figure from ground? Similar to the original ground discrimination study, infants were familiarized with a dynamic scene, in which a person is walking alongside a ground (e.g., a woman walking alongside a railroad track). At the first test trial (change trial), they saw the same event simultaneously presented with a novel event changed the ground only (the same woman walking alongside *a railroad track* vs. *a road*). If infants discriminated between grounds in the change test trial, they would look longer to the side depicting a *novel* ground (the woman walking alongside a *road*). In the second test trial (complex trial), infants were shown two novel scenes (*a man* walking alongside the same *railroad track* vs. the same *road*). By changing the person on both sides, we contrasted two novel figure-ground relations. If infants separate grounds from figures, they should look longer to the side in which both components are novel (*a man* walking alongside *a road*). In contrast, if they merely recognize that something changes, there would be similar looking time response to both sides of the screen, because the figure (e.g., the man) is new on both sides. Lastly, no main effect of the ground condition was predicted because the “across” path renders no differential encoding of the verbs in Japanese (i.e., the grounds do not have boundaries and “wataru” does not operate for any of the grounds) and does not highlight the boundaries regularly noted in situations that use

“wataru.”

Method

Participants

Twenty-two 14-month-old ($M = 13.82$, $SD = .64$, range: 13.00 – 15.17; 12 males) English-reared infants participated in this study. All infants were monolingual and full-term at birth. An additional 8 infants (26%) were discarded from data analyses because of prematurity ($n = 1$), experimental error ($n = 1$), and fussing-out during the experiment ($n = 6$). See general methods section for the recruitment.

Stimuli

As in the other experiments, stimuli consisted of televised displays of people (a woman and a man) and six grounds (railroad track, road, narrow street, bridge, tennis court, and grassy field). This time we used the act of “walking” near/alongside the grounds rather than “crossing” (see Figure 9). Each event lasted 6 seconds. In each trial, children watched a 12-sec movie that contained two walking alongside events. To compare the results with the original crossing study, we again made different comparisons of grounds (*e.g.*, a railroad track – a road, a railroad track – a tennis court or a road – a field). In total, there were six conditions (see Appendix G for all conditions). No linguistic audio accompanied these scenes. Stimuli were videotaped outdoors and movies were made using Final-Cut Pro-3D.



Figure 9. Grounds used in the ground discrimination study with the action of walking near/alongside.

Procedure

Infants were tested using the Preferential Looking Paradigm (for details of the paradigm, phases, and coding, see the general methods section).

The procedure was exactly the same as that used in the original figure and ground studies. After the introduction phase, infants were initially exposed to the *salience* phase that consisted of 2 trials (12 seconds each). Then, during *familiarization* phase they watched a figure walking near a ground (e.g., a woman walking near/alongside a railroad track) 4 times. Finally, they saw two *test* trials comparing: 1) *same figure/same ground* (a woman walking near a railroad track) vs. *same figure/novel ground* (a woman walking near a road) and 2) *novel figure/same ground* (a man walking near a railroad track) vs. *same novel figure/novel ground* (a man walking near a road). The presentation order of the salience trials, test trials, and the side of the novel ground were counterbalanced across conditions. The procedure was same in all conditions (see Figure 10 for a sample condition in this study).

Coding

The coding for Study 2 was exactly the same as in the dynamic ground study with 17% of all videotapes coded by a second person for inter-coder reliability ($r = .989$, $SD =$

.005).

	ALONGSIDE STUDY Visual Stimuli	
<i>Salience Change Trial</i> (12 sec)	 a woman walking alongside a road	 a woman walking alongside a railroad track
<i>Salience Complex Trial</i> (12 sec)	 a man walking alongside a road	 a man walking alongside a railroad track
<i>Familiarization</i> (4 times – each 12 sec)	 a woman walking alongside a railroad track	
<i>Test Change Trial</i> (12 sec)	 a woman walking alongside a road	 a woman walking alongside a railroad track
<i>Test Complex Trial</i> (12 sec)	 a man walking alongside a road	 a man walking alongside a railroad track

Figure 10. A sample movie sequence for the alongside study

Results

We calculated infants' percentage of looking time towards each scene in the split-screen for *salience* and *test* trials. No gender differences appeared in either salience or test trials ($ps > .15$). Thus, gender was not considered as a separate factor for further analyses.

The Salience Phase

To evaluate whether infants had a priori preference for either event in the salience trials, we conducted paired samples t-tests. Results showed that infants looked equally to

both sides in both salience trials, $t_s < .24$, $p_s > .82$, suggesting that our event clips were equally salient to infants before they watched the familiarization trials (see Figure 11).

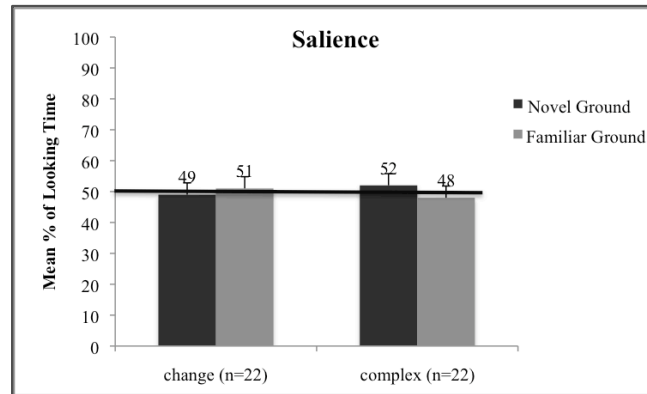


Figure 11. Mean percentages of looking times to the sides of the screen in the salience trials, which became the 'novel' and 'familiar' grounds at the change and complex test trials.

The Familiarization Phase

Looking times during the familiarization phase were examined to determine whether infants attended to the events and whether there was a difference in attention between within- and across-category comparisons. A repeated-measures ANOVA with condition (within- vs. across-category) as the between-subject variable and 4 familiarization trials as within-subject variables yielded only a main effect of trial, $F(3, 60) = 5.33$, $p = .01$, $\eta_p^2 = .21$. No main effect of condition or an interaction between trial and condition were found. As shown in Figure 12, infants' looking times declined during familiarization across the trials.

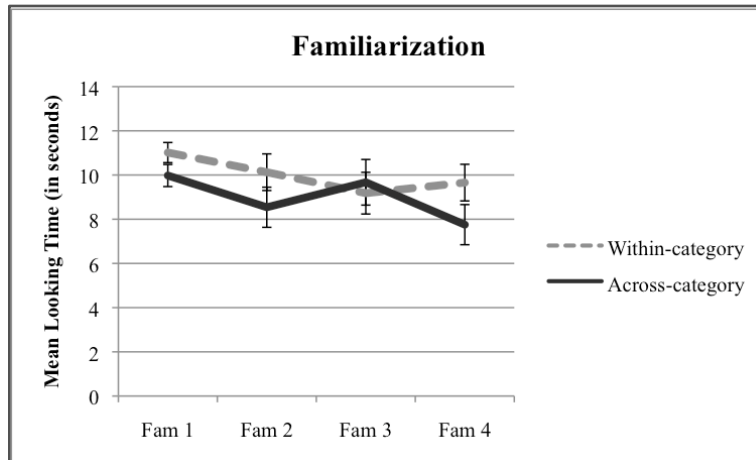


Figure 12. Average looking time in seconds (out of 12 seconds) in the familiarization phase in both the within- and across-category comparisons.

The Test Phase

Infants were attentive to the whole movie, $t(21) = 9.94, p = .00$. Nevertheless, paired samples t-tests indicated that infants did not differentiate between grounds in either test trial, $t_s < 1.22, p_s > .25$. Only 4 infants looked longer to the novel ground at change trial. Further analysis yielded no main effect of ground condition and ground comparisons in either test trial, $F_s < .71, p_s > .39$. These findings suggest that when the path of the action has changed from *crossing* to *walking alongside*, infants no longer noticed the changes in grounds in either within- or across-category comparisons (see Figures 13 and 14).

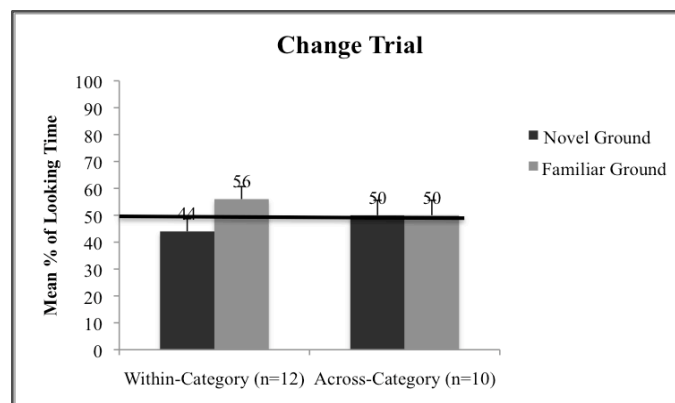


Figure 13. Mean percentage of looking times to the 'novel' and 'familiar' grounds at the change trial in

both within- and across-category conditions.

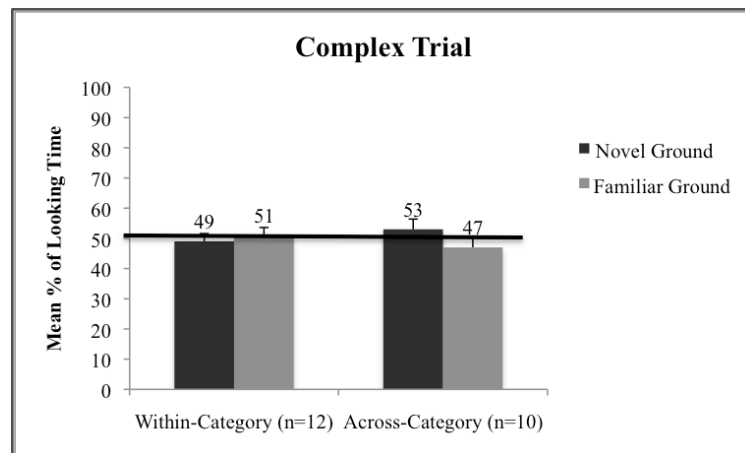


Figure 14. Mean percentage of looking times to the ‘novel’ and ‘familiar’ grounds at the complex trial in both within- and across-category conditions.

To examine whether there was an effect of the trial order in discriminating between grounds, a MANOVA with trial order (whether infants watched trial 1 or trial 2 first) as the between-subject variable and each trial as within-subject variables revealed no main effects, $F_s < 2.16$, $p_s > .16$.

Lastly, to examine whether there were any correlations between the language scores obtained from MCDI and relational vocabulary measure and infants’ looking times during the test phase (test 1 and test 2). The results from the Pearson correlations (2-tailed) found no significant relationships between these variables, $p_s > .86$ (see Appendix H for vocabulary scores of children).

Discussion

In this study, we examined whether infants notice ground changes across “Japanese” categories when the path of the motion was modified from *crossing* to walking *alongside/near* the grounds. Importantly, grounds are distinctly labeled in Japanese only in a crossing event and not in an alongside event. Thus, we projected that children would no longer highlight the distinction between the prior *wataru* and *tooru*

grounds in this study. Results showed that 14-month-old infants did not differentiate between grounds when figures were walking near and not across grounds. In addition, infants' categorical ground discrimination in crossing events was lost in this study. Given that infants did not attend to categorical distinctions in the change trial, it would be surprising to obtain any significant results in the complex trial. Infants seemed to be change-blinded to the changes in the ground. In the complex trial where both events involved a *novel figure* (e.g., a man), infants might have focused on the change of the figure and looked equally to both sides of the screen.

Why are infants change-blinded to 'where' the action occurs in these walking events? One strong possibility as we proposed in the introduction is that infants might now group all grounds into one category and treat all grounds as *within-category* grounds. With this boundless trajectory all grounds seem to be very similar. Although the TV screen makes a boundary for the action of the figure, because there were no sides of the grounds available on the video, infants might not extract a bounded ground from the movie. They might interpret all scenes as reflecting *toru* 'walking.' Thus, the spatial configuration of a dynamic event as represented in the interaction between the path and the ground is key to assigning the categorical distinctions.

Another possibility is that even though infants perceive these grounds, they might not retain this information or identify the ground information as relevant to these events. Research on infants' physical knowledge demonstrates that there is a discrepancy in infants' ability to detect the same change in different events (e.g., Baillargeon, 2004; Wang, Baillargeon, & Paterson, 2005; Wang & Baillargeon, 2006). For example, 11-month-olds notice the change of an object's height in an occlusion event, but not in a

covering event. Moreover, 12.5-month-olds detect the same change in a covering event, but not in a tube event (Wang & Baillargeon, 2006). Infants might need to identify height as a relevant variable for an event to detect the height change in that particular event. Likewise, when the ground information is relevant as in the crossing events, infants may better be able to encode and compare it with a novel ground.

In sum, infants in Study 2 failed to notice changes in grounds when people were walking alongside the grounds rather than crossing them. Future studies need to explore the possible mechanisms for this change-blindness in dynamic events.

CHAPTER 5

STATIC STUDY

Verb learning demands that learners perceive the spatial-temporal interaction inherent in dynamic events, because verbs capture a categorical moment in the unfolding event. Consider a woman running on the street. The woman runs in space, on a ground (i.e., the street) within a specific period of time. As she runs, both spatial and temporal dimensions change. Both of these dimensions are important in verb learning. We next asked how infants represent figures and grounds in static displays of the dynamic events. These scenes preserve the spatial dimension but not the spatial and temporal interaction or the temporal aspect of those events. A picture of a dynamic event takes “a slice in time” as if the temporal dimension is *frozen* while maintaining a static spatial configuration. Is the dynamic information important to the kinds of categories formed for verb learning or would static slices in time equally preserve the dimensions reflected in verb learning?

Past literature on containment, support, and degree of fit studies all utilized dynamic events showing a hand that placed objects into particular spatial relationships. Yet, the crucial distinctions between these events could be made based on the *static endpoints* of the events. For instance, “putting a toy tightly into a box” would be presented as an actual hand moving a toy tightly into a box, resulting in a static scene. In stark contrast, the ground-path verbs used in Japanese represent the interaction of the *path* of the *figure* against a particular type of *ground*. The verb *wataru*, for example, ‘flat barriers dividing two points’ from the dynamic ground discrimination study implies a dynamic motion on a particular ground rather than just a representation of the ground

itself. This was the lesson from Study 2 demonstrating that changing that interaction to one that no longer represents “crossing” between these barriers is enough to disrupt attention to the ground on which the action takes place. It is possible that by teasing apart the spatial and temporal dimensions, static events might no longer represent these scenes as different enough to be codified with different verbs (Muehleisen & Imai, 1997).

No research (of which we are aware) has investigated infants’ ability to distinguish figures and grounds in static representations of dynamic events. Only one study examined infants’ attention to the relation between figure and context by using pictures of animals and vehicles on various grounds (Bornstein, Arterberry, & Mash, 2010). They found that 6-month-old infants categorize colored photographs of animals and vehicles across various contexts in which the figures appear (e.g., a tiger in the green field, a tiger on a beach, and a tiger in a parking lot). The authors concluded that in category learning, infants initially focus on objects and ignore the contextual information.

Study 3 explored whether eliminating the temporal, but preserving the spatial aspect of an event enhanced or detracted from infants’ ability to distinguish different figures and grounds. Instead of dynamic events, we used screenshots of the people when they were in the middle of the screen (see Figures 1 and 2 from Chapter 1).

In the dynamic figure study, infants noticed figure changes at 11 months of age, which is earlier than the detection of ground changes. Presumably, the person’s movement with respect to spatial-temporal relationship orients infants’ attention to figures rather than grounds in dynamic events. For the static representations, attention might be evenly divided into figure and ground. Alternatively, a static display might thus reduce attention to the figure and give priority to the ground, yielding an earlier

discrimination of grounds. It is interesting that Bornstein et al. (2010) found that infants disregard the context in categorizing vehicles and animals. Why then might the context be so salient in our stimuli? Two possibilities come to mind. First, people figures might evoke differential effects in discriminating grounds. That is, children might look at the relationship between a figure and a ground more when the figure is a person. The current study and Bornstein et al. study are also different in terms of task demands. In categorization, infants require to attend and compare more than two scenes, which might result in ignoring the context. In the current discrimination study, infants will pay attention to only two scenes simultaneously that might reduce the memory demands and notice ground changes.

Eight- and 11-month-old infants' processing of figures and grounds was tested in static versions of the dynamic motion events used in the original figure and ground discrimination studies. These age groups were chosen to parallel those in the original dynamic figure and ground discrimination studies.

First, as in all studies, we hypothesized that there would be no *a priori* preference to static scenes before familiarization to a specific figure or ground. Second, similar to the dynamic experiments, we hypothesized that infants would look longer to the *novel* figure or the *novel* ground in the change test trial. Third, in the complex test trial, if infants separate figures from grounds, they must look longer to the side in which both components are novel. In contrast, if they still recognize that something changes, there would be similar looking time response to both sides of the screen. Fourth, infants might not be sensitive to different ground distinctions (i.e., within- vs. across-category distinctions) in static events that no longer have a temporal or dynamic spatial dimension.

Last, infants might detect grounds earlier than they did in dynamic events, due to the presence of a static figure, which might not attract as much attention as a dynamic figure.

Method

Participants

Thirty-five 8-month-old ($M = 8.14$, $SD = .85$, range: 6.30 – 9.23; 18 males) and 32 11-month-old ($M = 11.12$, $SD = .88$, range: 10.02 – 12.25; 13 males) English-reared infants participated. Infants were randomly assigned to the figure discrimination (17, 8-month-olds and 16, 11-month-olds) or the ground discrimination study (18, 8-month-olds and 16, 11-month-olds). All infants were monolingual and full-term at birth. An additional 22 infants (25%) across two age groups and two studies were excluded from data analyses because they were bilingual ($n = 3$), premature ($n = 1$), there was an experimental error ($n = 4$), and the children had low attention to the video clips ($n = 12$), or they had a side bias ($n = 2$).

Stimuli

Static displays of the same videos used in the original figure and ground discrimination studies were shown on television. This time, instead of dynamic events, we used screen shots of the figures (a woman, a man, a six-year-old girl, and a six-year-old boy) depicted when they were in the middle of the screen (equally distant from both ends of the screen). All stimuli at all phases were static versions of the dynamic events. No linguistic audio accompanied these scenes. Stimuli were videotaped outdoors and movies were made using Final-Cut Pro-3D (see Figures 2 and 3 in Chapter 2).

The figures were presented on different grounds within in each condition. For grounds, we again preserved two conditions based on how Japanese would encode these

ground verbs in dynamic contexts. One condition involved the comparison of two grounds from the category of *wataru* (e.g., a road vs. a railroad track) and the other condition included cross-category comparisons (e.g., a road vs. a tennis court).

Procedure

Infants were tested using the Preferential Looking Paradigm (for details of the paradigm and phases, see the general method section in Chapter 2).

The presentation of the stimuli was the same as in the dynamic figure and ground studies. After the introduction phase, infants were initially exposed to the *salience* phase that consisted of 2 trials (12 seconds each). Then, during *familiarization* phase infants watched the static representation of a figure crossing a ground (e.g., static picture of a woman crossing a railroad track) 4 times. Finally, they saw two *test* trials. In the static figure discrimination infants watched: 1) *same figure/same ground* (a woman crossing a railroad track) vs. *novel figure/same ground* (a man crossing a railroad track) and 2) *same figure/novel ground* (a woman crossing a road) vs. *novel figure/same novel ground* (a man crossing a road). Figure 4 from the dynamic figure study represents a sample video sequence for the static figure discrimination study (due to showing the dynamic stimuli as static on paper).

In the static ground discrimination infants watched 1) *same figure/same ground* (a woman crossing a railroad track) vs. *same figure/novel ground* (a woman crossing a road) and 2) *novel figure/same ground* (a man crossing a railroad track) vs. *same novel figure/novel ground* (a man crossing a road). The presentation order of the salience trials, test trials, and the side of the novel figure or novel ground were counterbalanced (see Chapter 2 for the details of running the study in the lab).

Coding

The coding for Study 3 was exactly the same as the dynamic figure and ground studies and the alongside study, with 20% of all videotapes coded by a second person for inter-coder reliability ($r = .994$, $SD = .003$).

Results

We calculated infants' percentage of looking times towards each scene in the split-screen for *salience* and *test* trials. No gender differences emerged for each study in either salience or test trials ($ps > .14$). Thus, gender was not considered as a separate factor for further analyses.

The Salience Phase

To evaluate whether infants had *a priori* preference for either event in the salience trials, we conducted a MANOVA with age (8- and 11-month-olds) and study (figure or ground) as the between-subject variables. No main effect of age or study or any interactions between them was found for the percentage of looking time to the one side in each salience trial ($Fs < 1.98$, $ps > .09$). This suggests that our event clips were evenly salient to infants before they watched the familiarization trials (see Figures 15 and 16).

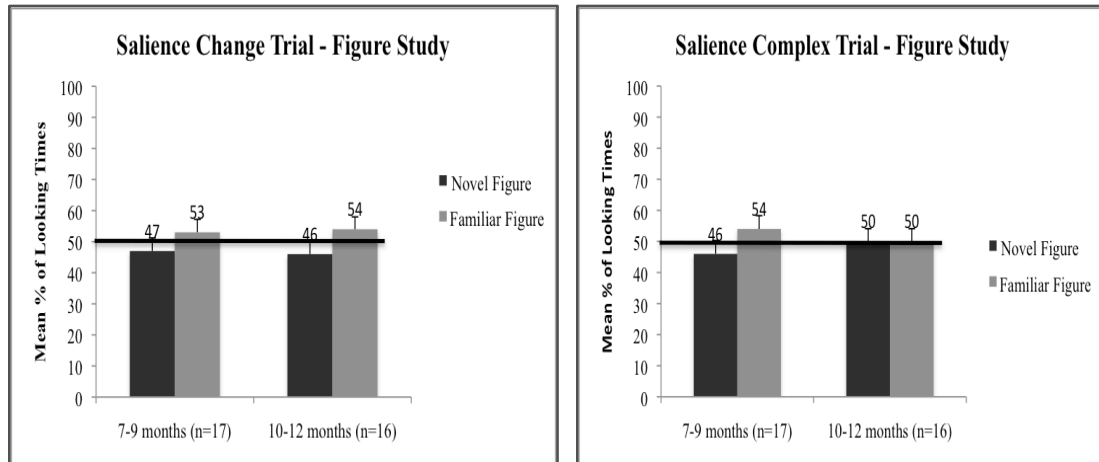


Figure 15. Mean percentage of looking times to the sides of the screen in the salience change (left graph) and salience complex (right graph) trials in the static figure study, which became the ‘novel’ and ‘familiar’ figures at the change and complex test trials.

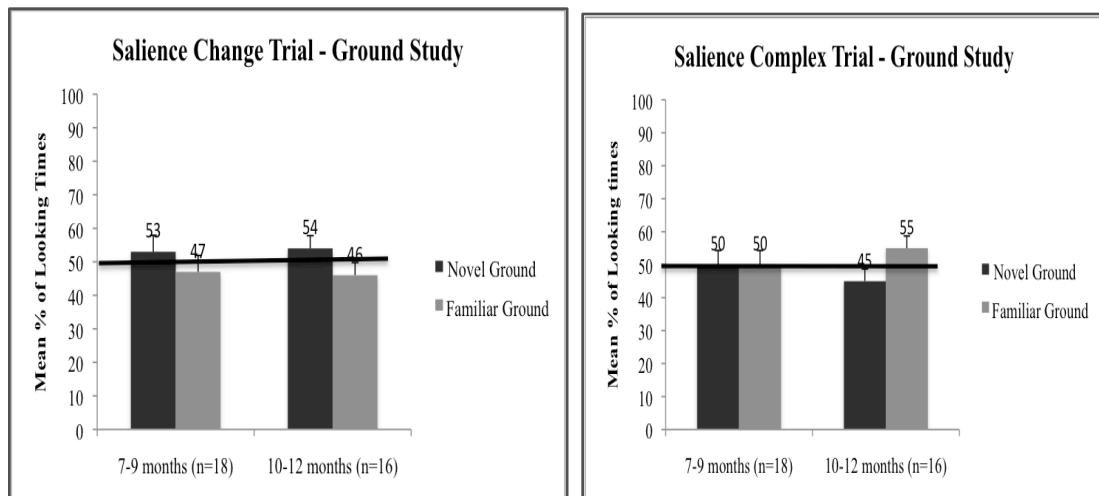


Figure 16. Mean percentage of looking times to the sides of the screen in the salience change (left graph) and salience complex (right graph) trials in the static ground study, which became the ‘novel’ and ‘familiar’ grounds at the change and complex test trials.

The Familiarization Phase

Looking times during the familiarization phase were examined to determine whether there were any age or study differences in infants’ attention to the events. A repeated-measures ANOVA with age (8- and 11-month-olds) and study (figure or ground) as the between-subject variables and 4 familiarization trials as the within-subject variables yielded no main effects of age or study nor any interactions between them ($F_s <$

1.14, $ps > .21$). As shown in Figure 17, infants at both age groups and studies were equally attentive during all familiarization trials. Although, there was a decline in looking across the trials, this was not significant.

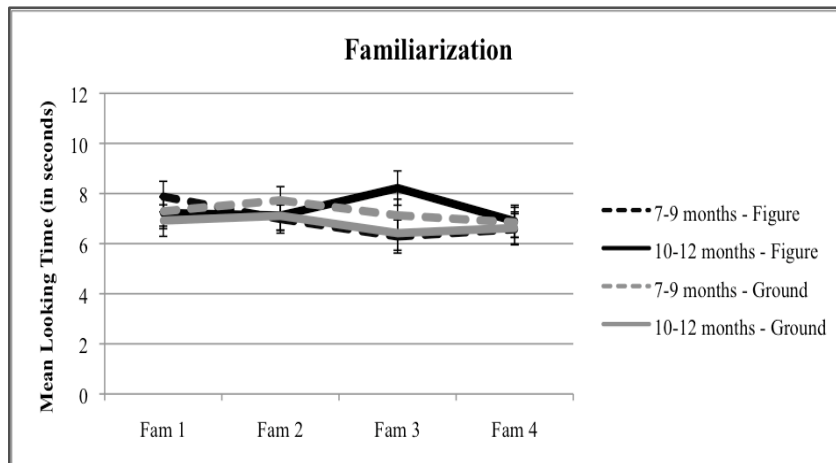


Figure 17. Average looking time in seconds (out of 12 seconds) in the familiarization phase in the static figure and static ground studies by 8- and 11-month-olds.

The Test Phase

A repeated-measures ANOVA with age (8- and 11-month-olds) and study (figure or ground) as the between-subject variables was used to examine infants' looking times to the target event (novel figure or novel ground) in the change and complex trials.

Results revealed main effects of trial, $F(1, 63) = 14.36, p = .00, \eta_p^2 = .19$ and age group, $F(1, 63) = 8.03, p = .01, \eta_p^2 = .11$, as well as trial by age group interaction, $F(1, 63) = 7.52, p = .01, \eta_p^2 = .11$. No interaction with the study type (figure or ground) was found.

The interaction was driven by a significant age difference in the change trial. That is, only 11-month-olds were able to differentiate between figures and grounds and they only differentiated these in the change trial. Infants at both age groups were equally attentive to the whole movie (64% and 66%, respectively for 8- and 11-month-olds), which was above chance level for both age groups, $ts > 4.02, ps = .00$. However, only the

older age groups in both studies looked significantly longer to the novel figure or novel ground at the change trial, which were both above chance level, $p > .01$ (see Figures 18 and 19, left graphs). 13 out of 16 infants in the figure study and 15 out of 16 infants in the ground study looked longer to the novel figure or novel ground at the change test trial. No main effect of different comparisons was revealed for figure or ground studies. Infants at both age groups did not separate the familiar figure or ground from the novel one in the complex trials (see Figures 18 and 19, right graphs). Interestingly, and as predicted, infants detected the grounds in static scenes earlier than they noted ground changes in dynamic displays.

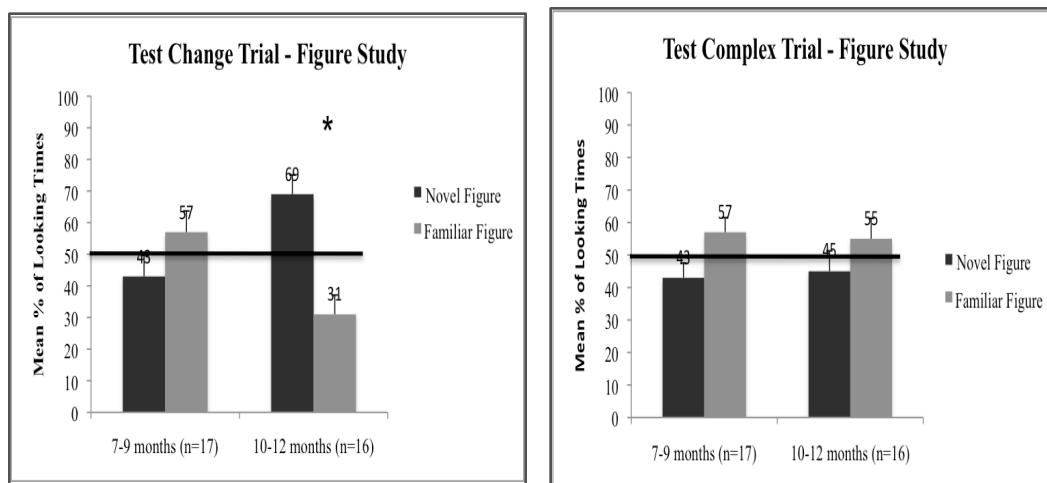


Figure 18. Mean percentage of looking times to the ‘novel’ and ‘familiar’ figures at the change trial (left graph) and at the complex trial (right graph) by 8- and 11-month-olds. * $p < .01$.

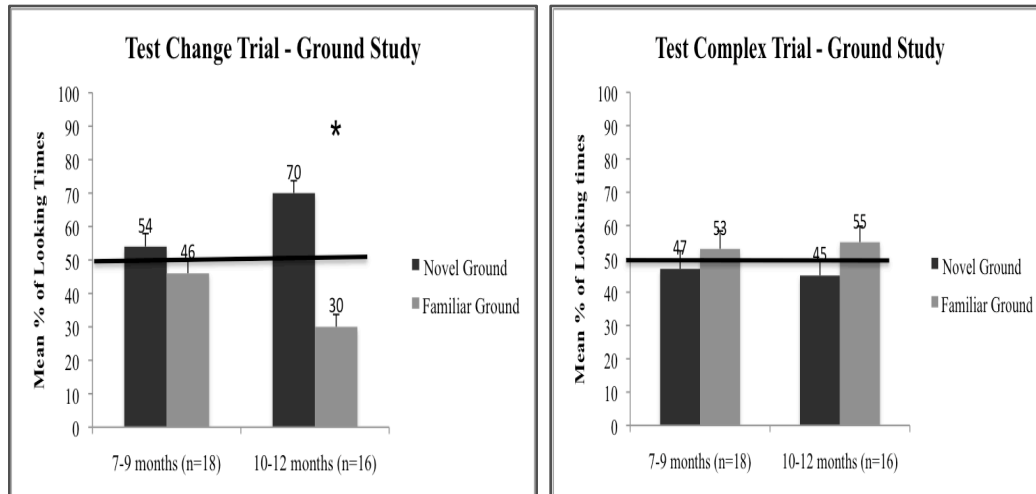


Figure 19. Mean percentage of looking times to the ‘novel’ and ‘familiar’ grounds at the change trial (left graph) and at the complex trial (right graph) by 8- and 11-month-olds. * $p < .01$.

Next, we analyzed whether infants were sensitive to the categorical ground distinctions coded by Japanese in static representations that lacked a temporal component. In stark contrast to what we found in the original dynamic study, infants looked similarly to novel grounds *regardless* of the categorical distinction in Japanese, $F_s > 2.29$, $ps > .24$. That is, when only the ground changed from what they had seen in the familiarization, 11-month-olds looked longer to the novel ground in both within- and across-category comparisons, $ts > 2.68$, $ps > .03$ (see Figure 20).

To examine possible effects of the trial order in discriminating between figures and grounds, a MANOVA with trial order (whether infants watched trial 1 or trial 2 first) and study (figure or ground) as the between-subject variables and each trial as the within-subject variables yielded no main effect of trial or study or any interaction between them, $F_s < 2.85$, $ps > .09$.

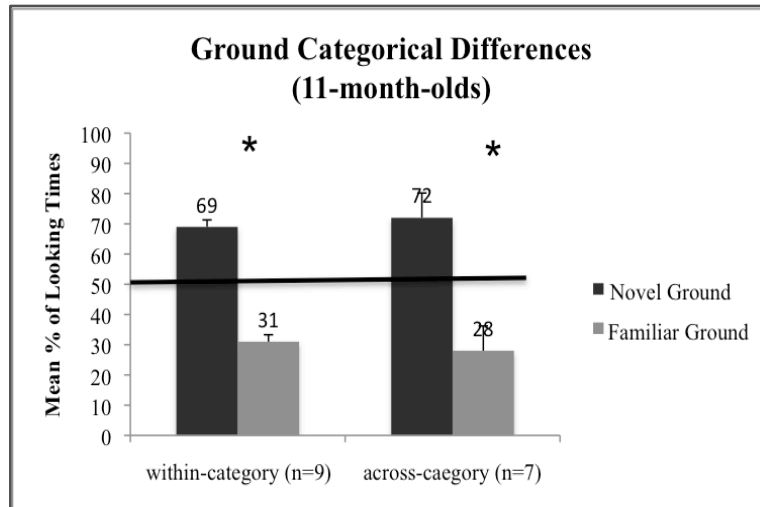


Figure 20. Mean percentage of looking times to the novel grounds at the change trial by 11-month-olds in within- and across-category conditions. $*p < .03$.

Lastly, to examine whether infants' discrimination of figures and grounds were related to their vocabulary knowledge, correlations were conducted between the language scores (obtained from MCDI and relational vocabulary measure) in each study (figure or ground) and infants' looking times during the test phase (change and complex trials). As a result of the partial correlations (2-tailed) controlling for age, no significant relationships between these variables were obtained in either figure or ground studies, $ps > .11$ (see Appendix H for vocabulary scores).

Discussion

Results from the Study 3 demonstrated that English-reared infants differentiated static figures by 11 months of age, which was the same age at which they detected moving figures in dynamic motion events. In contrast, ground discrimination was noted earlier when the stimuli were static. In particular, infants noticed the change in grounds in static events 3 months before they did so for dynamic events. However, children in both the figure discrimination and the ground discrimination studies did not notice the figure or ground changes when both events in the split-screen involved a novel component

(complex trial). Finally, in the static versions of the dynamic events, infants did not distinguish between the types of grounds coded in Japanese. They treated *within-* and *across-category* comparisons of grounds similarly.

This experiment suggests that infants do not process static and dynamic events in the same way (Cutting & Profitt, 1981). They did discriminate figures at the same age in both static and dynamic displays. This finding also raises questions about why infants successfully distinguish animals and vehicles in various environments at 6 months of age in an earlier study (Bornstein et al., 2010), but detect static and dynamic human figures later. Nevertheless, in that study, 6-month-olds did not attend to changes in the background, but focused on the focal objects (animals or vehicles) while categorizing these objects. One reason that processing might be more difficult in this study in relation to Bornstein et al. is that we presented the humans using a lateral view of the figures on the screen, which made it more difficult to notice high-interest faces. Another explanation might be the size and location of the objects: the people were in the middle and the grounds occupied more space in comparison to the size of the figures in the static events. On the other hand, in our study, 11-month-olds discriminated between grounds in static pictures. It is plausible that certain aspects of scenes such as the background or ground are more difficult to be recognized by younger infants.

The removal of the dynamic aspects of the event also had the effect of enhancing infants' ability to distinguish between different grounds. Presumably, the person's movement in the dynamic scenes oriented infants' attention to figures rather than grounds. Movement is a strong predictor of infants' attention to figures (e.g., Kellman & Spelke, 1983; Otsuka & Yamaguchi, 2003). Thus, younger infants may be *change-blind*

to the scene in which the action occurs when there are moving figures. Additionally, when both components were static, infants might have processed a static figure quickly, allowing them to spend more time focusing on the grounds. However, the current data is not sufficient to determine whether these possibilities are correct.

The findings from the complex trial suggest that (although not significant) infants have a tendency to look longer only when there was one component different from the familiarization trial. For example, in the figure discrimination, if infants see “a woman crossing a road,” in the complex trial, they look at the “a woman crossing a railroad,” (ground change) rather than “a man crossing a railroad” (both figure and ground changes). Similarly, in the ground discrimination, if infants see “a woman crossing a road,” in the complex trial, they look at the scene where “a man crossing a road,” (figure change) rather than “a man crossing a railroad” (both figure and ground changes). Infants might recognize that there were changes in both sides, so they might look for a familiar component. Experiments on infants’ memory (Hayne, Rovee-Collier, & Borza, 1991; Rovee-Collier, 2001) and object individuation (Xu, 1999; 2007) are suggestive that children might initially have a holistic recognition of figure + ground. Later, they consider figure as independent from ground. Previous research from path and manner also shows that infants initially note only manner or only path changes at 7 months of age, but processing these semantic components as individual structures occurs after learning path + manner as a complex. Together with the findings from the dynamic figure and ground studies, we suggest that in both dynamic and static displays, infants before 14 months of age do not treat figure and ground as independent or separate components of a

motion event, but rather holistically detect differences between composite events (Pulverman et al., 2004).

A critical finding in this study was the disappearance of the categorical Japanese ground distinctions in the static versions of the same dynamic events. Without dynamic motion, infants differentiated grounds both within- and across-categories, indicating that the perceptual distinctions between grounds in across-category comparisons were not more salient than within-category comparisons. Static scenes fail to evoke the type of the interaction between the figure and ground evident in dynamic scenes that result in categorizing the grounds in Japanese. Dynamic information that involves the spatial and temporal interaction is necessary to reflect categories for verb learning. A slice in time without the temporal component of an event is not enough to maintain categorical ground-path distinctions in events.

Taken together, the static figure and ground studies indicate a differential developmental trajectory for static and dynamic events for the detection of grounds, but not for the figures. Nevertheless, the discrimination of grounds is not restricted to across-category grounds. In static displays ground changes are very salient to infants. Future studies using eye-gaze tracking analysis can present additional evidence on the process of detecting figures and grounds in static and dynamic events.

CHAPTER 6

CROSS-LINGUISTIC COMPARISON

Once they isolate and categorize components in events, children need to lexicalize these event components in their native language. The *concept-to-language hypothesis* posits that event categories are acquired before language can have its influence. Early event categories are then highlighted or dampened by how the native language interacts with the event categories that are formed. (e.g., Göksun et al., 2010; Hespos & Spelke, 2007; Slobin, 1985). That is, children *trade spaces* by dampening attention to some event components and heightening sensitivity to others (Göksun et al., 2010) in ways that are consistent with their native tongue. This hypothesis is against the extreme view of the *language-to-concepts hypothesis*, which suggests that children are prompted to parse nonlinguistic events as they learn language (Whorf, 1956). That is, language is the tool that enables children to find components in the events they witness. In a recent paper, Gentner and Bowerman (2009) take a middle ground approach and propose that some spatial categories that have cognitive and perceptual commonalities might exist prelinguistically, but others that are less salient and are represented more rarely crosslinguistically demand language exposure to be learned.

The findings on infants' event processing as discussed in Chapter 1 support the first hypothesis (e.g., Casasola & Cohen, 2002; Göksun, Hirsh-Pasek, & Golinkoff, 2010; Golinkoff & Hirsh-Pasek, 2008; Lakusta, Wagner, O'Hearn, & Landau, 2007; Mandler, 1992; 2004; Pruden, Hirsh-Pasek, Maguire, & Meyer, 2004; Pulverman, Golinkoff, Hirsh-Pasek, & Buresh, 2008; Wagner & Carey, 2005; Wagner & Lakusta, 2009). A considerable amount of research also supports Gentner and Bowerman's middle approach

(e.g., Bowerman & Choi, 1994, 2001; Choi & Bowerman, 1991; Haun, Rapold, Call, Janzen, & Levinson, 2006). Infants' early categories of event components seem to be universal, regardless of whether and how they are encoded in the ambient language. Nevertheless, only a subset of event categories was tested. As proposed by Gentner and Bowerman (2009), the event categories that are uncommon across languages might not be present prelinguistically.

Our findings on infants' processing of grounds in dynamic events demonstrate that English-reared infants notice non-native ground distinctions in events. However, the evidence up to this point is inconclusive about the role of language on processing these categorical ground distinctions. The first question is whether Japanese-reared infants process grounds in dynamic events. If the concept-to-language hypothesis is correct, we should replicate our findings with Japanese-reared infants. Second, do the early categorical distinctions infants notice in events change as they are exposed to their ambient language? Only Japanese children immersed in a language that uses these distinctions, would continue to notice the distinction between different classes of grounds, as they become speakers of the language.

Language might play various roles in event processing (Göksun et al., 2010; Golinkoff & Hirsh-Pasek, 2008). For example, hearing a label might facilitate the abstraction of the event components (e.g., Casasola, 2005b; Pruden & Hirsh-Pasek, 2006) or language input might interact with the interpretation of these constructs (e.g., Allen et al., 2007; Bowerman & Choi, 1994; Choi & Bowerman, 1991; Gentner & Bowerman, 2009; Maguire et al., 2010; Papafragou, Massey, & Gleitman, 2006; Özçaliskan & Slobin, 1999). Here we examine how both the exposure to a particular native language

(here Japanese) and the vocabulary level of the child relate to the perception of the event components.

Previous research has shown that children's sensitivity to non-native categorical distinctions decrease over time (e.g., Choi & Bowerman, 1991; Choi, 2006; Gentner & Bowerman, 2009). For example, Choi (2006) found that after the second year of life, English- and Korean-speaking children diverge in how they process *kkita* (tight-fit in) vs. *nehta* (loose-fit in) spatial relations. Even though English-speaking children at the ages of 29 and 36 months decreased in sensitivity to the difference between tight- and loose-fit containment events, Korean-speaking children maintained those distinctions. Hence, language-specific aspects of these spatial categories influence children's nonlinguistic sensitivity in this study by around 29 months of age.

One might however expect that sensitivity to non-native distinctions is not a function of the language environment per se, but rather to how much language children comprehend and produce. Under this scenario, the children's non-native analysis of event components would be related not only to the kind of language but also inversely related to vocabulary level in their native language. We might then hypothesize that children who have more words in their lexicons relative to their peers might be worse at noticing non-native semantic distinctions whereas children with fewer words might still differentiate between event components not expressed in their native language. This assumption is similar to the weak analogy from phonetic discrimination. For example, English-reared 7-month-olds who were better at discriminating native phonemes, when tested at 14, 18, 24, and 30 months, produced a greater number of words and larger utterances with greater sentence complexity. In contrast, better *non-native* phoneme

discrimination (Mandarin Chinese) predicted to reduce later language ability (Kuhl, Conboy, Padden, Nelson, & Pruitt, 2005; see also Tsao, Liu, & Kuhl, 2004).

Studies on event components validate that vocabulary size correlates with the detection of non-native semantic distinctions. English-speaking 29-month-old children with more words in their vocabularies relative to their peers, or the ability to produce the word *in*, were *less* likely to perceive the difference in the Korean degree-of-fit compared to low vocabulary children or to those who did not yet produce the word *in* (Choi, 2006). In contrast, Korean-speaking children at the same age, and regardless of vocabulary level, still demonstrated sensitivity to tight- versus loose-fit containment categories. Likewise, Pulverman et al. (2008) found that 14- to 17-month-old English-reared infants who had greater vocabularies by maternal report were more attentive to *manner* changes than to *path* changes, which mirrors English's vastly greater number of manner than path verbs. On the other hand, Spanish-reared infants with low vocabularies paid more attention to manner than did their high vocabulary counterparts. Spanish has relatively fewer manner verbs than does English. Perhaps the low vocabulary Spanish learners were still attending to the event components less frequently encoded their language. Alternatively, attention to manner might delay Spanish-reared infants' ability to learn more verbs (Pulverman et al., 2008).

These findings taken together suggest that learning language dampens the detection of categorical differences that are not encoded in one's native tongue. To the extent that vocabulary is a reflection of native language learning, children who acquire more words are more likely to make native distinctions in events and less likely to make non-native distinctions.

In the final study of this dissertation we asked whether Japanese-reared infants differentiate between grounds similar to English-reared infants and whether the early categorical distinctions infants notice in events change when they are exposed to their ambient language.

Study 4a: Discrimination of Grounds by Japanese-reared Infants

In Study 4a, we examined how Japanese-reared infants processed grounds in dynamic events and whether they were receptive to the categorical ground distinctions encoded in Japanese. Fourteen-month-old Japanese-reared infants were tested. Since infants from English speaking environments differentiate between grounds at this age, we chose 14-month-olds for the Japanese sample. First, as in all the previous studies, it was hypothesized that there would be no preference to one side of the split-screen in the salience trials. Second, if infants discriminate between grounds in the change test trial, they will look longer to the side where there is *novel* ground. Third, in the complex test trial, if infants separate grounds from figures, they will look longer to the side in which both components are novel. However, if they still recognize only that something changes, there would be similar looking time response to both sides of the screen. Last, similar to English-reared infants' responses, Japanese-reared infants would also differentiate grounds better when the comparison was between two categories in Japanese (*wataru* vs. *tooru*) as opposed to within the same Japanese verb category (*wataru*).

Method

Participants

The final sample was comprised of 26 14-month-old Japanese-reared infants ($M=14.07$, $SD=.74$, range: 13.01 – 15.26; 15 males). Data was collected in Tamagawa

University Baby Lab with the help of a trained Japanese-English bilingual research assistant. Once data collection was completed, the data were sent to us for coding. All infants were full-term and came from monolingual Japanese households. An additional 5 infants (15%) were excluded from data analyses because they fussed-out during the experiment ($n = 4$) or had low attention to the video clips after coding ($n = 1$).

Stimuli

The stimuli were the same used in dynamic ground discrimination described in Chapters 1 and 2 (see Figure 3). Figures 21 and 22 present sample movie sequences for the within- and across-category comparisons (see Appendix G for all conditions).

	GROUND DISCRIMINATION STUDY <u>Within-Category</u> Visual Stimuli	
<i>Salience Change Trial</i> (12 sec)	 a man crossing a road	 a man crossing a railroad track
<i>Salience Complex Trial</i> (12 sec)	 a woman crossing a road	 a woman crossing a railroad track
<i>Familiarization</i> (4 times – each 12 sec)	 a man crossing a road	
<i>Test Change Trial</i> (12 sec)	 a man crossing a road	 a man crossing a railroad track
<i>Test Complex Trial</i> (12 sec)	 a woman crossing a road	 a woman crossing a railroad track

Figure 21. A sample movie sequence for the ground discrimination study in dynamic events (within-category comparison)

Procedure and Coding

Similar to the experimental procedure at Temple Infant Lab, the experimenter welcomed the families when they arrived at Tamagawa University Baby Lab. Parents filled out the informed consent forms on behalf of their children and themselves for participation in the studies. These forms were the same ones used with English-speaking families. A Japanese native speaker translated all forms to Japanese and Temple University IRB approved them (see Appendices E and F).

Parents were also asked to fill up the Japanese version of MacArthur CDI (Ogura & Murase, 1991). When the parents completed the paperwork, both the parent and the child went to the video room where the child was tested by the PLP. The rest of the procedure was the same as of studies conducted at Temple Infant Lab.

The coding was identical to the previous studies, with 12% of all videotapes coded by a second person for inter-coder reliability ($r = .992$, $SD = .005$).

	GROUND DISCRIMINATION STUDY <u>Across-Category</u> Visual Stimuli	
<i>Salience Change Trial</i> (12 sec)	 a man crossing a road	 a man crossing a field
<i>Salience Complex Trial</i> (12 sec)	 a woman crossing a road	 a woman crossing a field
<i>Familiarization</i> (4 times – each 12 sec)	 a man crossing a road	
<i>Test Change Trial</i> (12 sec)	 a man crossing a road	 a man crossing a field
<i>Test Complex Trial</i> (12 sec)	 a woman crossing a road	 a woman crossing a field

Figure 22. A sample movie sequence for the ground discrimination study in dynamic events (across-category comparison)

Results

No gender differences appeared in either salience or test trials ($ps > .87$) and gender was not considered as a separate factor for further analyses.

The Salience Phase

Two paired samples t-tests were conducted to see whether Japanese infants had *a priori* preference for either event in the salience trials. Infants looked similarly to the sides of the screen in both salience trials, $ts < .75$, $ps > .46$, indicating that the event clips were equally salient to infants before they watched the familiarization trials (see Figure 23).

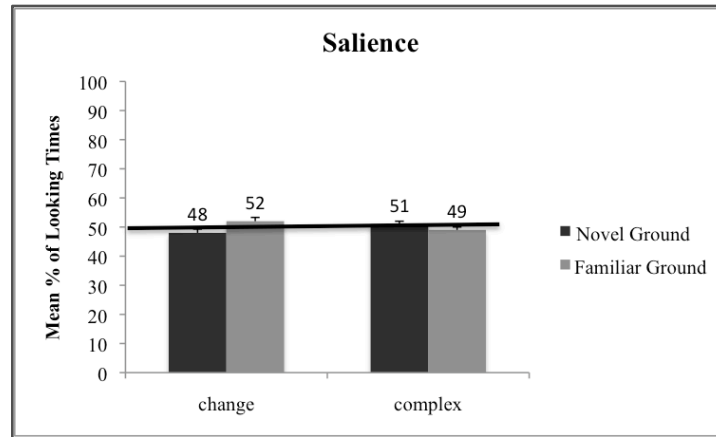


Figure 23. Mean percentage of looking times to the sides of the screen in the salience change and complex trials by 14-month-old Japanese-reared infants.

The Familiarization Phase

Looking times during the familiarization phase were examined to determine whether infants attended to the events and whether there was a difference in attention between within- and across-category comparisons. A repeated-measures ANOVA with condition (within- vs. across-category) as the between-subject variable and 4 familiarization trials as within-subject variables yielded only a main effect of trial, $F(3, 72) = 4.44$, $p = .01$, $\eta_p^2 = .16$. No main effect of condition or an interaction between trial and condition were found. As shown in Figure 24, infants' looking times declined during familiarization across the trials.

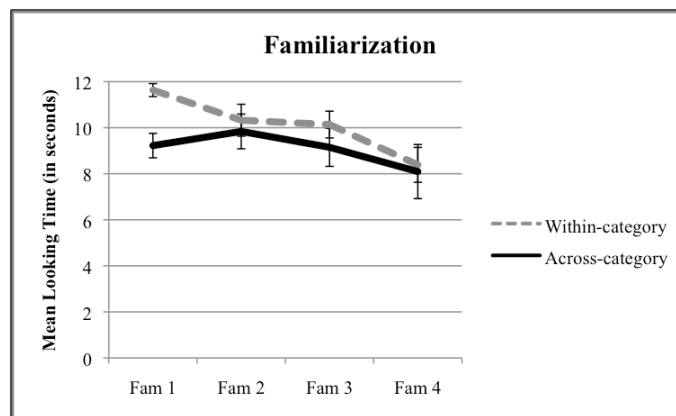


Figure 24. Average looking time in seconds (out of 12 seconds) in the familiarization phase in the within- and across-category conditions by 14-month-old Japanese-reared infants.

The Test Phase

First, infants' attention during the whole movie was calculated. We found that infants' attention to the movie was over chance level (79%), $t(25) = 16.68, p = .00$. Paired samples t-test indicated that infants noticed the ground changes only in the change trial, $t(25) = 3.04, p = .01$. Further analysis yielded a main effect of ground condition again only for the change trial, $F(1, 24) = 10.33, p = .01, \eta_p^2 = .31$ (see Figure 25, left graph). All, but 1 infant, looked longer to the novel grounds at test trial. This ratio was comparable to the English-reared infants' looking preferences at the across-category change in the original ground study: 11 out of 13 infants.

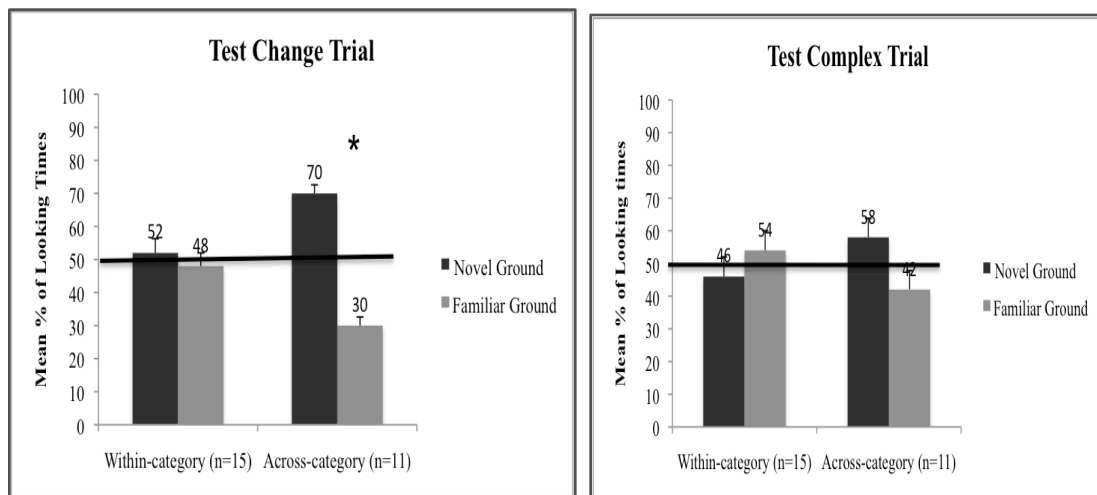


Figure 25. Mean percentage of looking times to the 'novel' and 'familiar' grounds at the change trial (left graph) and at the complex trial (right graph) by 14-month-olds in within- and across-category conditions. * $p < .01$.

Second, we tested the effect of the trial order in discriminating between grounds in two ground conditions. A MANOVA with trial order (whether infants watched change or complex trial first) and ground condition (within- vs. across-category) as the between-subject variables and each trial as within-subject variables revealed no main effect of trial or an interaction between trial and ground condition in either test trial, $F_s < .39, p_s > .98$.

Lastly, to examine whether infants' discrimination of grounds were related to their vocabulary knowledge, correlations were conducted between the language scores (obtained from MCDI and relational vocabulary measure) for each ground condition (within- vs. across-category) and infants' looking times during the test phase (change and complex test trials). No significant relationship was obtained between language scores and discrimination between grounds in either condition, $ps > .98$ (see Appendix H for the vocabulary scores).

Discussion

In the Study 4a, we asked whether Japanese-reared distinguished categorical ground distinctions. We found that at 14 months of age, infants only looked longer to the novel ground in the across-category comparisons. Although the same trend seemed to happen in the complex trial, this time infants did not significantly prefer one side to another. Given the findings from the other studies in this dissertation, this result is not surprising. Several factors might contribute to infants' failure to separate grounds from figures in these scenes.

First, it might be early for infants to see figure and ground as separate components. At this age with complex stimuli, infants might attend to any changes. Then, when at least one component is different on both sides of the screen, infants would fail to look to the "more novel" side. Second, due to the saliency of dynamic figures in events, when we use a novel figure on both sides in the novel events, infants might attend to the novel figure and disregard the grounds, which results in equivalent looking times to two events on the split-screen. Third, to recognize the familiar or novel grounds in simultaneous presentations of two novel events might be a hard task at this age. Pulverman et al. (2008)

showed that infants see path and manner as separate components at 14 to 17 months of age; however, they presented the stimuli sequentially in a habituation paradigm, which might allow infants to focus on each component better. Future studies should tease apart the role of these factors on separating a figure from a ground in dynamic events.

The most intriguing finding of this study is that 14-month-olds from Japanese language environments, with less exposure to their native language, demonstrated very similar sensitivity to distinctions among grounds in dynamic events. Our results contribute to the mounting evidence that suggest that children's relational word learning is first rooted in the perception of nonlinguistic events (e.g., Göksun et al., 2010; Hespos & Spelke, 2007). Like English- and Korean-reared infants' detection of the degree-of-fit relations in containment and support events encoded only in Korean (Choi, 2006), English- and Japanese-reared 14-month-olds attend to ground distinctions in nonlinguistic events along the lines of their representation in Japanese. These promising results support the concept-to-language hypothesis and also Gentner and Bowerman's (2009) assumption that some event categories might be acquired before learning language. An accurate assessment of these theories cannot be complete without testing the role of language learning on these event constructs. In the next study, we examine both English- and Japanese-reared toddlers attention to the ground categorical distinctions in dynamic nonlinguistic events.

Study 4b: Discrimination of Grounds by English- and Japanese-reared Toddlers

In the final study of this dissertation, we explore the link between learning a native language (i.e., English or Japanese) and processing grounds in nonlinguistic events. If infants *trade spaces* as they learn their ambient language, we expect to see differences

between English- and Japanese-reared toddlers en route to learning relational terms. Nineteen-month-old English- and Japanese-reared toddlers who generally pass the 50-word mark were recruited as participants. At around 18 months of age, children seem to undergo a remarkable increase in the number of vocabulary they produce (e.g., L. Bloom, 1973; Dromi, 1987; Gopnik & Meltzoff, 1987; but see P. Bloom, 2000). Therefore, this is a perfect age at which to test the effect of language environment on processing nonlinguistic event categories.

We have two general predictions: 1) Japanese children, immersed in a language that uses ground distinctions (*wataru* ‘flat barriers dividing two points’ vs. *tooru* ‘continuous plane’) should both notice and maintain the distinction between these classes of grounds when they become speakers of the language; 2) If language influences perception of these distinctions, English reared children with greater vocabularies should have less sensitivity to distinctions in the non-native language than would their counterparts with smaller vocabularies. Hence, only English-reared toddlers with relatively small vocabularies would continue to attend to Japanese categorical ground distinctions.

Following these predictions, as in the Study 4a, first, we hypothesized that there would be no preference to one side of the split-screen in the salience trials. Second, if toddlers discriminate between grounds in the change test trial, they will look longer to the side where there is *novel* ground. Third, in the complex test trial, if toddlers separate grounds from figures, they should look longer to the side in which both components are novel. Fourth, only Japanese-reared toddlers will maintain categorical ground distinctions whereas English-reared toddlers will dampen these distinctions. Lastly, English-reared toddlers with lower, but not with higher vocabulary knowledge would continue to

differentiate between the classes of grounds.

Method

Participants

The final sample was consisted of 24 19-month-old ($M=19.15$, $SD= 1.02$, range: 17.29 – 21.29; 13 males) English-reared toddlers and 24 19-month-old ($M=19.28$, $SD= 1.10$, range: 17.29 – 21.29; 11 males) Japanese-reared toddlers. The data collection was identical with Studies 1-4a. All infants were full-term and came from monolingual English and Japanese households. An additional 10 infants (17%) across two language groups were excluded from data analyses because they were bilingual ($n = 1$), fussed-out during the experiment ($n = 7$), had low attention to the video clips ($n = 1$) or had a side bias ($n = 1$).

Stimuli, Procedure, and Coding

The stimuli, procedure, and coding were exactly the same as the original ground discrimination study and as Study 4a. 12% of all videotapes coded by a second person for inter-coder reliability ($r = .995$, $SD= .004$).

Results

No gender differences appeared in either salience or test trials ($ps > .87$). Thus, data was collapsed for gender in the further analyses.

The Salience Phase

Neither English-reared nor Japanese-reared toddlers had any preference for either event in the salience trials, $ts < .84$, $ps > .41$, indicating that the event clips were equally salient to infants before they watched the familiarization trials (see Figure 26).

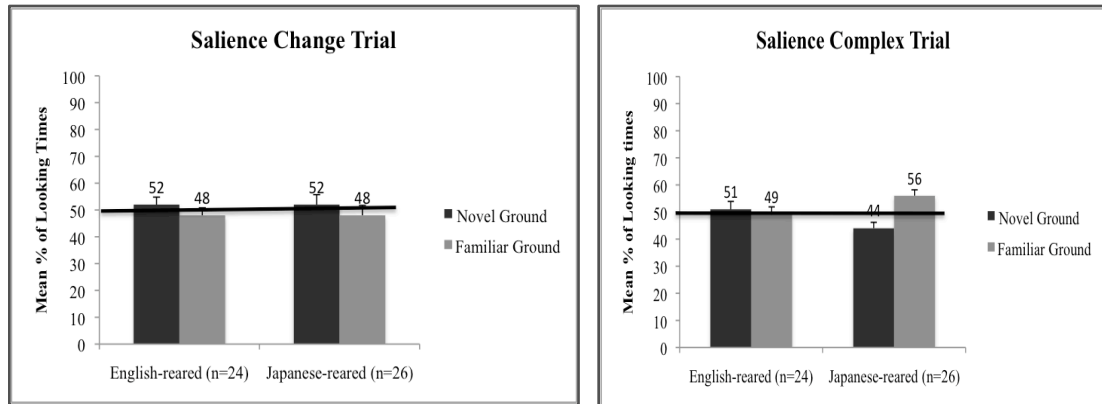


Figure 26. Mean percentage of looking times to the sides of the screen in the salience change (left graph) and salience complex (right graph) trials by 19-month-old English- and Japanese-reared infants.

The Familiarization Phase

Looking times during the familiarization phase were examined to determine whether infants in both language groups attended to the events and whether there was a difference in attention between within- and across-category comparisons. A repeated-measures ANOVA with language group (English vs. Japanese) and condition (within- vs. across-category) as the between-subject variables and 4 familiarization trials as the within-subject variables yielded only a main effect of trial, $F(3, 132) = 8.48$, $p = .01$, $\eta_p^2 = .16$. No main effect of language group or condition or any interactions were found. As shown in Figure 27, infants' looking times in both language groups declined during familiarization across the trials.

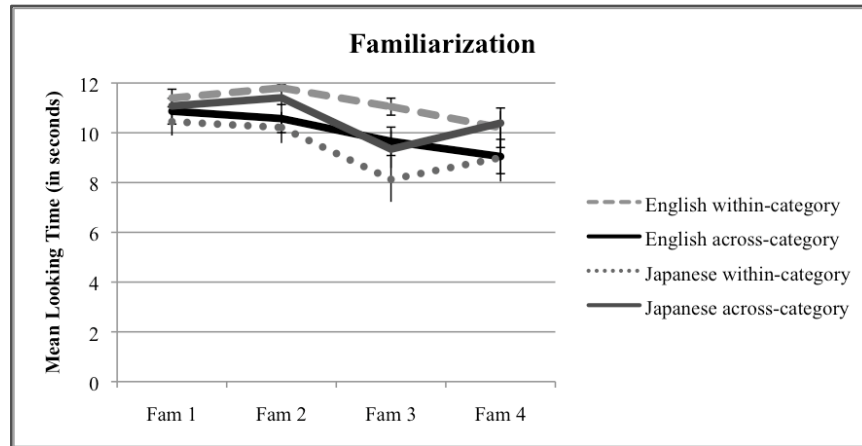


Figure 27. Average looking time in seconds (out of 12 seconds) in the familiarization phase in the within- and across-category conditions by 19-month-old English- and Japanese-reared infants.

The Test Phase

First, we examined whether toddlers in both language groups differentiated between grounds in the test trials. A MANOVA using language group as the between-subject variable and two test trials as the within-subject variables resulted in a marginally significant main effect of language group on the change test trial only, $F(1, 46) = 3.35$, $p = .07$, $\eta_p^2 = .01$ (see Figure 28). Although, infants at both age groups were equally attentive to the whole movie (87% and 83%, respectively for English- and Japanese-reared toddlers, $p > .26$), Japanese toddlers were better than English-reared toddlers in differentiating between grounds when there was only a change in the ground. No difference between language groups was found for the complex test trial, $F > 1.4$, $p < .24$, because neither language group looked longer to one side at this test trial (see Figure 29).

Second, the effect of ground condition (within- vs. across-category) was calculated. A MANOVA using language group and condition as the between-subject variables and two test trials as the within-subject variables yielded main effects of language group and condition only in the change test trial, $F(1, 44) = 4.34$, $p = .04$, $\eta_p^2 =$

.09 and $F(1, 44) = 8.42, p = .01, \eta_p^2 = .16$. This analysis did not reveal a language group and condition interaction. Additionally, no significant differences were found between language groups or conditions in the second test trial.

Planned pair-wise comparisons indicated that only Japanese-reared toddlers who were in the across-category condition looked longer to the novel ground in the change trial, $t(11) = 5.19, p = .01$ (see Figure 28). Japanese-reared children in within-category condition and English-reared children in both conditions looked equally to both sides at test, $t_s > 1.72, p_s < .11$. Together, these findings suggest that 19-month-old Japanese-reared toddlers continued to notice changes in grounds when the grounds were from different categories.

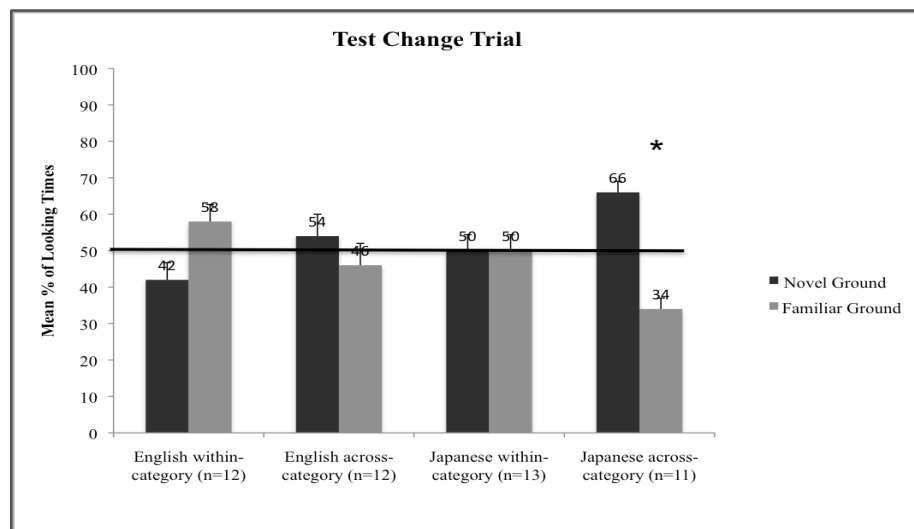


Figure 28. Mean percentage of looking times to the ‘novel’ and ‘familiar’ grounds at the change trial in within- and across-category conditions by 19-month-olds. * $p < .01$.

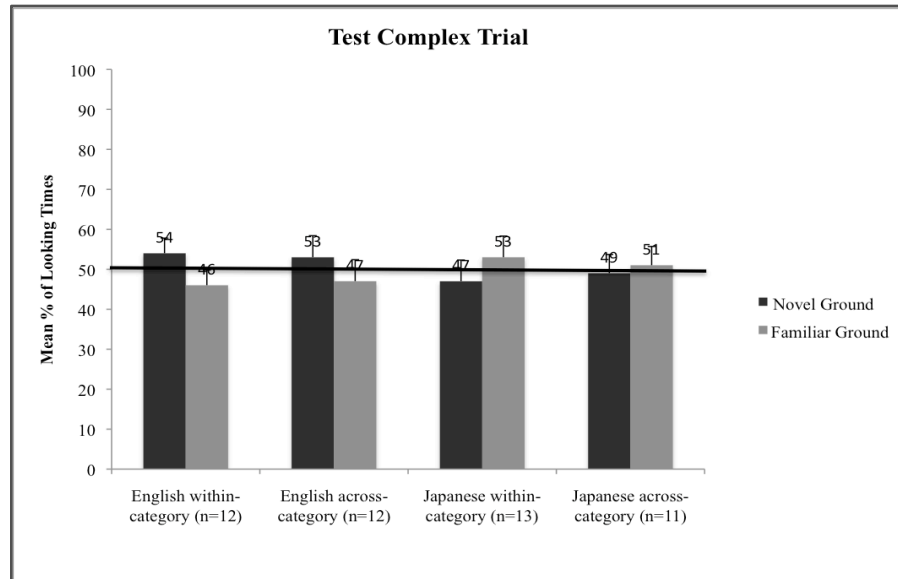


Figure 29. Mean percentage of looking times to the ‘novel’ and ‘familiar’ grounds at the complex trial in within- and across-category conditions by 19-month-olds.

Next, we tested the effect of the trial order in differentiating between grounds in two ground conditions. A MANOVA with trial order (whether infants watched trial 1 or trial 2 first), language group (English vs. Japanese), and ground condition (within- vs. across-category) as the between-subject variables and each trial as within-subject variables revealed no main effect of trial or no interactions among these variables in either test trial, $F_s < 2.31$, $p_s > 1.14$. That is, the order children saw the change or complex trial did not affect whether or not they notice the changes in grounds.

Lastly, to test the effect of vocabulary level as reported by parents, 19-month-olds in both language groups were divided into low vs. high vocabulary groups by a median split. For English-reared children, toddlers with *low* vocabularies continued to detect non-native ground distinctions at 19 months while those with higher vocabulary levels did not, $F(1, 10) = 5.01$, $p = .04$, $\eta_p^2 = .33$. No difference was found for low- and high-vocabulary Japanese-reared toddlers (see Appendix H for vocabulary scores).

Discussion

In the last study of this dissertation, we predicted that only Japanese children, immersed in a language that uses ground distinctions would maintain these distinctions whereas English-reared toddlers might dampen attention to distinctions not noted in their native language. The results confirmed the predictions. Even though 14-month-olds from both English and Japanese language environments were equally sensitive to distinctions that the Japanese language makes among grounds in dynamic events (from Study 4a and the original ground study), this effect was dampened for English-reared toddlers once they passed the 50-word milestone in their native language. These findings were not the consequence of general attentional difference between language groups. This finding offers preliminary evidence (although with a small group of children) that language plays a role in dampening event components the way in which we process events. Only infants whose vocabulary size was above the median showed reduced sensitivity to Japanese ground distinctions when witnessing dynamic events.

As in the other studies of this dissertation, we did not find an evidence for infants' separation for a figure and a ground as independent components of an event. The same factors discussed in the previous studies might apply to the current results. Nevertheless, to move beyond the hypothetical factors, future research needs to seek out when and how toddlers in different language environments treat a figure and a ground as independent components of an event.

The sensitivity to ground distinctions is not a function of language environment *per se*, but rather to how much language children are reported to comprehend or produce. Although this was not a longitudinal study, it appears that increased exposure to English

dampens sensitivity to ground distinctions once present. Hence, individual differences in the rate of learning the native language might be related to the attention to nonnative distinctions in events. These findings corroborate with Choi (2006) who also showed that the vocabulary knowledge is an indicator of dampening nonnative categorical distinctions.

Our findings begin to reconcile the long-standing debate between Whorfian and anti-Whorfian views that turn on the role of language in shaping cognition, and provide support for the concept-to-language hypothesis at least for very central and highly perceptual constructs in events. That is, children's initial perception of events is not a "kaleidoscopic flux of impressions" as suggested by Whorf (1956) that awaits language for its organization. Rather, infants by 14 months are forming categories of the components of nonlinguistic events that appear to be the same regardless of the ambient language. Language appears to play a role in shaping the perception of events once children notice how language highlights different aspects of events.

CHAPTER 7

GENERAL DISCUSSION

Figure and ground are fundamental elements of events and are codified across languages. Whether you speak English, or Turkish or Japanese, your language will comment on events by often expressing the figure in the event and sometimes expressing the ground. Parallel to other spatial and event components such as path-manner and containment-support, figure and ground are perceptually accessible, universally recognized, and codified differently across languages. Yet, these components have only recently been the subject of research designed to gain an understanding of how language might be rooted in infant perception. This dissertation expands the literature by beginning the exploration of figure and ground, and by centering on the connection between nonlinguistic event perception and language learning. In particular, our findings evince whether and how very young children perceive figures and grounds in events and what how this perception might be modified when children start learning their native language.

The studies in this dissertation, together with the original figure and ground discrimination studies in dynamic events, yield four conclusions. First, English-reared infants noticed changes of figures and grounds in dynamic events (the original studies). Notably, infants were receptive to categorical ground distinctions for a *crossing* action in dynamic events even though their language does not reflect these distinctions. That is, the distinction between grounds that is reflected in Japanese proved to be a “default” for English-reared infants. Furthermore, English-reared infants can detect the geometry of the ground using multiple exemplars of this nonnative ground category and extend it to a novel exemplar from the same category (Study 1). Second, the path of the action provides

a robust cue for detecting different kinds of grounds with respect to categorical distinctions in Japanese. Using a boundless path like moving alongside rather than moving across resulted in a failure to notice the ground changes in dynamic events (Study 2). Thus, the path and the ground interact in infant perception of ground categories. Third, the interaction between path, as represented in the figure's movement against the ground, and the ground is critical to understanding event parsing for language. That is, when we process events for language, spatio-temporal dimensions of the scene matter. This was revealed in Study 3 English-reared infants detected figures and grounds in static representations of the dynamic crossing events, but no longer differentiated between the Japanese grounds of *wataru* and *tooru*. Here both within- and across-category comparisons were treated similarly (Study 3). Last, the early sensitivity of categorical ground distinctions by English- and Japanese-reared infants diverged as children begin to process language patterns in their native languages. Japanese, but not English-reared toddlers preserved these distinctions, suggesting that the process of learning language appears to shift early-formed categorical boundaries (Study 4).

Together, the current studies in this dissertation present evidence on how infants parse events into components and the interaction of native language input and vocabulary knowledge on these early event perceptions.

Developmental Trends

As Mandler (2004) and Gentner (1982) argued, infants seem to have the conceptual underpinnings for learning language (see also Golinkoff & Hirsh-Pasek, 2008). Yet, some of these concepts surface later in development than others like noticing goal changes before source changes in motion events (Lakusta et al., 2007). This

dissertation continues to reveal developmental trends.

The first is that infants process figures earlier than grounds in dynamic displays. Figures are also expressed earlier than other conceptual distinctions in children's early utterance combinations (e.g., Clark, 1979; Grace & Suci, 1981; Tomasello & Merriman, 1995). Research with toddlers also demonstrated that visual attention was focused on the agents in a dynamic scene (Robertson & Suci, 1980). Hence, it is not surprising that infants process the human figures earlier than the grounds in the scenes. On a related point, the perceptual saliency of event components might be related to their different developmental trajectories. Perhaps a moving, animate figure commands infants' attention more so than a stationary ground. Clark (2009) suggests that children's early conceptual categories are influenced by perceptual Gestalts. Thus, a figure is against a ground, and the moving figure object would be more salient than any one part of the scene. From very early on, infants are sensitive to motion and differentiate biological from nonbiological movement (Bertenthal, 1993).

The same differential trajectories are also exhibited in the detection and abstraction of other spatial and event components: containment earlier than support, path before manner, and goal before source (e.g., Casasola & Cohen, 2002; Lakusta et al., 2007; Pruden et al., under revision-b). This apparent inconsistency in the developmental progression may be a function of which constructs are expressed more *universally* than others. That is, the more prevalent a distinction is across languages, the more likely it is to come early. Differential trajectories might reflect the perceptual saliency of some of the components over others.

Second, changes are more recognizable in static compared to dynamic displays. In particular, the dynamic events in this research impede the recognition of changes in grounds. When the dynamic aspects of the event are removed, infants' ability to differentiate between grounds is improved. The change-blindness in dynamic scenes might be a result of the selective attention given to the focal and moving object or the significance of information to the whole event such as in the case of alongside study.

Even adults have difficulty detecting obvious changes in a picture of a scene when two pictures are presented sequentially (Simons & Levine, 1997). Nevertheless, cross-cultural differences appear in the detection of changes in the scenes (Ji, Peng, & Nisbett, 2000, 2004; Masuda & Nisbett, 2001, 2005). For example, Nisbett and colleagues have investigated East Asians' (e.g., Japanese, Chinese, and Taiwanese) and North Americans' attention to the context and figures and how culture influences their perceptions. East Asians are more attentive to the relationship between objects and their environment than North Americans (Ji, Peng, & Nisbett, 2000, 2004). Masuda and Nisbett (2001) asked Japanese and American adults to describe underwater scenes involving a focal fish moving across a field of fish, sea animals, and other static features like rocks. Compared to Americans, Japanese-speaking adults described the background of the scene and expressed more relationships between focal fish and the background. In another study, using the *change blindness paradigm* (i.e., failure to detect the changes in one scene, after exposure to the scene), Masuda and Nisbett (2005) displayed two animated scenes (e.g., a farm) that differed in small details. American adults again detected changes in the focal objects, but Japanese adults noticed the changes in the context and the relationships between objects. Although these findings were mainly

discussed with its relation to cultural variations, the evidence corroborates with our results on the difference between Japanese and American toddlers' differentiation of grounds in dynamic events.

Last, infants do not appear to see figure and ground as independent components of the same event. In these displays, none of the age groups from two language samples demonstrate a clear indication of separating a figure from a ground. In particular, infants do not look longer to “more novel” sides when both sides have a new component. Future studies need to investigate whether and when infants are able to disconnect a figure from a ground in dynamic events.

Trading Spaces

Despite differences in the ways in which languages encode foundational event components, preverbal infants seem to process these event constructs similarly before language has a chance to influence their perception (Göksun et al., 2010; Hespos & Spelke, 2004; 2007; Mandler, 2004; McDonough, Choi, & Mandler, 2003). The results of *ground discrimination* in dynamic events by both English-and Japanese-reared infants support the claim that early event perception might be universal. English-reared infants are sensitive to the nature of the ground in a way that is more specific than encoded by the English verb ‘cross.’ That is, irrespective of the language environment in which infants are raised, they detect non-linguistic components of events, and infants attend to fine-grained distinctions in events even when these are not codified in their native language.

The conceptual underpinnings for the learning of a language's relational terms are in place as proposed by the concept-to-language hypothesis. As children lexicalize these

components in their native tongue, they appear to tune into certain semantic distinctions over others, influenced by the ambient language. Furthermore, there is the suggestion that the more language they know, the more attentive they are to native over non-native encodings of these constructs. *Trading spaces* occurs when a semantic component (such as containment, support or ground categories) is semantically heightened or dampened to match the expression of that component in the ambient language by either subtly dividing their spatial and temporal world further or by creating a broader category. When the dynamic and temporal events meet with language, language learners dampen attention to some event components and heighten sensitivity to others.

These findings are reminiscent of, though not analogous to, the universal phonological categories prelinguistic infants possess (e.g., Eimas, Miller, & Jusczyk, 1987; Kuhl et al., 1997; Werker & Tees, 1984). Unlike in phonological development, however, reorganization in semantic development refers to the hierarchy of preferences people develop rather than to the loss of the ability to note these non-native event distinctions in the absence of lengthy training as adults (Tees & Werker, 1984).

Limitations and Future Research

Few studies have asked how language influences event perception and whether the trend for infants is from universal to language-specific patterns. By bridging linguistics and event perception, this dissertation on figure and ground in events illuminates infant processing of events on the way to learning language. There is still much to explore on infants' ability to notice and abstract spatial and event components that are fundamental for learning verbs and prepositions.

First, other figures and grounds should be tested to validate our findings. As a first

step we chose prominent figures (people) in events. What constitutes figures and grounds in events? For example, the presence of *people* in a scene might enhance infants' attention, and thus their ability to notice changes. But will children have similar reactions to different figures such as cars, animals, and balls? Because the verb 'crossing' is permitted for all types of figures (e.g., the ball crossed, the person crossed, the dog crossed), children should respond similarly to different figure types in nonlinguistic events and extend their verbs to various figures. Preliminary results from an ongoing study, using balls as figures in dynamic events, found that infants at 8 months of age discriminate between two different kinds of balls in the same crossing events on the same grounds. Although unexpected, it might be the case that figures are more difficult to differentiate in these complex events when they are people (Austin, Göksun, Hirsh-Pasek, & Golinkoff, 2010). Future studies should continue to tease apart the role of animacy in noticing figures in different scenes.

Second, in this research, we also selected the most perceptually salient ground-path categories. To generalize our conclusions, other grounds that are incorporated in verbs should be examined. More cross-linguistic studies as well as studies with bilingual children are required to confirm our assertions about the universal to language-sensitive shift. Developmental patterns across typologically varied languages and ways in which children acquire the biases of their native language will shed light on the links between language and thought.

Third, little is also known about the long-term consequences of perceiving and categorizing relations in events. Longitudinal studies examining multiple conceptual precursors and their later relations to language development, specifically to verb learning

must be conducted. Preliminary results from ongoing research are promising: infants' ability to categorize foundational components in a nonlinguistic task of *path* and *manner* is correlated with verb learning, but not with a nonlinguistic spatial task (Roseberry et al., 2009). How would figure and ground discrimination in events be related to later verb learning?

Fourth, future studies are required to assess the neural underpinnings of event perception in infancy and its link to language learning. Until recently, infant neural development has been investigated using coarser analysis of brain activation such as EEG and ERP. The new advancements in noninvasive techniques for infants that use high spatial resolution such as near infrared spectroscopy (NIRS) and magnetic field changes (MEG) provide insights onto the connections between neural networks and infants' early cognitive abilities such as speech perception and object processing (e.g., Hespos, 2010, Kuhl & Rivera-Gaxiola, 2008; Wilcox et al., 2005, 2008, 2009). Furthermore, the whole-brain imaging techniques will aid in early diagnoses of developmental disabilities as well as inform bilingual brains (Kuhl & Rivera-Gaxiola, 2008).

Finally these findings might carry implications for the learning of relational terms like verbs and prepositions in special populations. Perhaps problems in the learning of relational terms result partially from the inability to either perceive event components or reorganize event components with native language exposure. Children with autism, for example, might have particular problems with the processing of figures, because they show less attention to people in their environment. In contrast, autistic children might find some figures such as cars to be intrinsically more interesting than people (Sasson, Turner-Brown, Holtzclaw, Lam, & Bodfish, 2008). Thus, children with autism might

respond differentially to the same event when there are different types of figures.

Conclusions

Research has recently made progress in uncovering the nonlinguistic constructs in events that are related to learning relational terms. This dissertation examined an uncharted area of nonlinguistic constructs and its conceptualization in early childhood through learning language. Infants apparently distinguish between figures and grounds in events with differential attention to static and dynamic displays. Infants are also sensitive to non-native categorical ground distinctions only for the action of *crossing* in dynamic events. Language environments and knowledge about the native language heighten or dampen these categorical ground distinctions. Infants, thus, *trade spaces* as they learn language. Our findings open a new avenue for examining the relationship between nonlinguistic concepts and their representations by examining the processing and learning of relational terms across languages.

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MacArthur Short Form Vocabulary Checklist: Level I

Child's Name _____ Sex _____
Birthdate _____ Today's Date _____

For words your child understands but does not yet say, mark the first column (understands). For words that your child not only understands but also says, mark the second column (understands and says). If your child uses a different pronunciation of a word, mark it anyway.

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Additional Word List

Please circle:

U for all the words your child UNDERSTANDS

US for all the words your child UNDERSTANDS AND SAYS

Action Words

bite	U US	help	U US	show	U US
blow	U US	hit	U US	sing	U US
break	U US	hug	U US	sleep	U US
bring	U US	hurry	U US	smile	U US
bump	U US	jump	U US	splash	U US
clean	U US	kick	U US	stop	U US
close	U US	kiss	U US	swim	U US
cry	U US	look	U US	swing	U US
dance	U US	love	U US	take	U US
draw	U US	open	U US	throw	U US
drink	U US	play	U US	tickle	U US
drive	U US	pull	U US	touch	U US
eat	U US	push	U US	watch	U US
fall	U US	put	U US	walk	U US
feed	U US	read	U US	wash	U US
finish	U US	ride	U US	wipe	U US
get	U US	run	U US	write	U US
give	U US	say	U US		U US
go	U US	see	U US		U US

Prepositions and Locations

away	U US	inside	U US	there	U US
back	U US	off	U US	under	U US
down	U US	on	U US	up	U US
in	U US	out	U US		U US

APPENDIX B
VOCABULARY CHECKLIST – TODDLER VERSION

MacArthur Short Form Vocabulary Checklist: Level II (Form A)

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*For information/copies, contact the Developmental
Psychology Lab, San Diego State University, San Diego, CA 92182

Child's Name _____	Sex _____
Birthdate _____	Today's Date _____

VOCABULARY CHECKLIST
Children understand many more words than they say. We are particularly interested in the words your child SAYS. Please mark the words you have heard your child use. If your child uses a different pronunciation of a word, mark it anyway.

baa baa	☐	hat	☐	sky	☐	all gone	☐
meow	☐	necklace	☐	party	☐	cold	☐
ouch	☐	shoe	☐	friend	☐	fast	☐
uh oh	☐	sock	☐	mommy	☐	happy	☐
woof woof	☐	chin	☐	person	☐	hot	☐
bear	☐	ear	☐	bye	☐	last	☐
bird	☐	hand	☐	hi	☐	tiny	☐
cat	☐	leg	☐	no	☐	wet	☐
dog	☐	broom	☐	shopping	☐	after	☐
duck	☐	comb	☐	thank you	☐	day	☐
horse	☐	mop	☐	carry	☐	tonight	☐
airplane	☐	plate	☐	chase	☐	our	☐
boat	☐	trash	☐	dump	☐	them	☐
car	☐	tray	☐	finish	☐	this	☐
ball	☐	towel	☐	fit	☐	us	☐
book	☐	bed	☐	hug	☐	where	☐
game	☐	bedroom	☐	listen	☐	beside	☐
applesauce	☐	bench	☐	like	☐	down	☐
candy	☐	oven	☐	pretend	☐	under	☐
coke	☐	stairs	☐	rip	☐	all	☐
cracker	☐	flag	☐	shake	☐	much	☐
juice	☐	rain	☐	taste	☐	could	☐
meat	☐	star	☐	gentle	☐	need	☐
milk	☐	swing	☐	think	☐	would	☐
peas	☐	school	☐	wish	☐	if	☐

Has your child begun to combine words yet, such as "nother cookie" or "doggie bite?"		
☐ Not Yet	☐ Sometimes	☐ Often

Additional Word List

Please check off all words that your child SAYS:

VERBS:

☐ bite	☐ blow	☐ break	☐ dry
☐ build	☐ bump	☐ buy	☐ take
☐ catch	☐ chase	☐ clap	☐ think
☐ climb	☐ close	☐ cook	☐ wait
☐ cry	☐ cut	☐ dance	☐ watch
☐ drink	☐ drive	☐ drop	☐ write
☐ dump	☐ eat	☐ fall	☐ feed
☐ find	☐ finish	☐ fit	☐ fix
☐ get	☐ give	☐ go	☐ hate
☐ have	☐ hear	☐ help	☐ hide
☐ hit	☐ hold	☐ hug	☐ hurry
☐ jump	☐ kick	☐ kiss	☐ knock
☐ lick	☐ like	☐ listen	☐ look
☐ love	☐ make	☐ open	☐ paint
☐ pick	☐ play	☐ pour	☐ pretend
☐ pull	☐ push	☐ put	☐ read
☐ ride	☐ rip	☐ run	☐ say
☐ see	☐ shake	☐ share	☐ show
☐ sing	☐ sit	☐ skate	☐ sleep
☐ slide	☐ smile	☐ spill	☐ splash
☐ stand	☐ stay	☐ stop	☐ sweep
☐ swim	☐ swing	☐ bring	☐ talk
☐ taste	☐ tear	☐ carry	☐ throw
☐ tickle	☐ touch	☐ clean	☐ wake
☐ walk	☐ wash	☐ cover	☐ wipe
☐ wish	☐ work	☐ draw	

PREPOSITIONS AND LOCATIONS:

☐ about	☐ there	☐ of
☐ away	☐ with	☐ out
☐ by	☐ around	☐ under
☐ inside/in	☐ behind	
☐ off	☐ for	
☐ over	☐ next to	
☐ up	☐ on top	
☐ above	☐ of	
☐ back	☐ to	
☐ down	☐ at	
☐ into	☐ beside	
☐ on	☐ here	

APPENDIX C
CONSENT FORM

Project Title: Conceptual primitives for processing actions and events

Investigators: Kathy Hirsh-Pasek, Ph.D., Professor, Dept. of Psychology, 267-468-8610

Tilbe Goksun, M.A., Graduate Student, Dept. of Psychology, 267-468-8610

Welcome to the Temple Infant Laboratories at Ambler. Please take a moment to fill out this consent form so that your child can participate in the research. This research study examines spatial language learning. In order for a child to be able to understand and use verbs, the child must be able to perceive similarities and differences in a wide range of actions. We will observe how your child perceives, discriminates and categorizes a series of actions presented to them on a television screen. From your child's responses, and those of other children's, we will try to piece together how it is that children perceive and categorize action. Your child's responses and name will always be kept confidential. All results will be tallied at the group level rather than by individual response. Subject data will be stored for three (3) years after the completion of the study. If at any time, you or your child would like to stop the experiment, let us know. You are free to quit at any point during the experiment. You may be called in the future to participate in a similar study, participation is not mandatory at that time. There are no known risks associated with this study beyond the risks of everyday life.

Let me take this moment to thank you and your child for joining us in the exciting process of scientific discovery. If you have any questions about language development or about this experiment in particular, please give me a call: (267) 468-8610. If you would like further information regarding the rights of a research subject, you may contact Richard Throm at (215) 707-8757.

I, _____ (name), agree to let my child
_____ (child's name) participate in this study of spatial language
development with Kathy Hirsh-Pasek and Tilbe Goksun. As part of the research, I agree
to allow my child to be videotaped and understand that the videotape will be used for
research and educational purposes only. My name and my child's name will be kept
confidential at all times.

Signature _____

date _____

Thank you,

Principle Investigator Signature

APPENDIX D
CONSENT FORM: PERMISSION TO VIDEOTAPE

Project Title: Conceptual primitives for processing actions and events
Investigator: Kathy Hirsh-Pasek, Ph.D., Dept. of Psychology, 267-468-8610
Tilbe Goksun, M.A. Dept. of Psychology, 267-468-8610

I give Tilbe Goksun and Haruka Konishi permission to videotape my child and me during my child's participation in this study. I understand that the videotape will only be used as part of the research project at Temple University. I understand that the videotape will be used for several months for data analysis purposes only. Subject data will be stored for three (3) years after the completion of the study. I have already given written consent for my child's participation in this research project. At no time will my name or my child's name be used. I understand that I can withdraw my permission at any time. Upon my request, the videotape will no longer be used. I understand that I will not be paid for being videotaped or for the use of the videotape.

If you have further questions, please feel free to ask during your visit or contact me by phone (above) or by mail at: Temple University, Department of Psychology, Philadelphia, PA 19122. If you would like further information regarding the rights of a research subject, you may contact Richard Throm at (215) 707-8757.

This form will be placed in my records and will be kept at the Temple Infant Lab by
Tilbe Goksun

Parent(s) Signature_____

Date_____

Principle Investigator Signature

date

Authorized Representative Signature

APPENDIX E
JAPANESE CONSENT FORM

同意書

研究題名：行動や出来事の語源の概念的学習

調査者：キャシー、ハーシパゼック 教授 博士号 心理学部
ティルベ ゴクセン 修士号 心理学部

電話番号：267-468-8610

参加者様

この研究にご参加頂く上で同意書のご記入が必要となりますのでご協力よろしくお願い致します。この研究は、言語の空間的な学習を調査する目的で行います。子供が動詞の活用法を理解し、活用するには様々な行動の違いや似た部分を識別する能力が必要となります。大人の調査では、様々な状況をどのように理解するのかを調査します。言語の調査を様々な国で行う目的は言語によってその人の物事の見え方を左右するのかをするためです。参加者様の名前と調査結果は常にこちらで保護し、伏せさせていただきます。すべての調査結果は個人レベルでなくひとつのグループとして保管されます。なので、個人のデータとして特定することはありません。個人の調査結果は調査終了後三年間保管されます。その後は破棄されます。調査のどの段階でも参加を取りやめることは可能です。その場合はいつでもお知らせください。

将来的にまた似た調査を行う場合、またご連絡させて頂く可能性があります、その際、ご協力は強制ではありません。今まで、この調査からの副作用や危険が被験者の方に及んだことはありません。

今回、科学の発展のためにご協力頂けることを深く感謝し致します。もし言語発達もしくはこの調査の詳細に関して何か質問等ございましたら、こちらの電話番号におかけください。(267) 468-8610 被験者の権利に関してのご質問の場合はリチャード

ソーム:(215) 707-8757にご連絡ください。

私_____ (お名前) は、キャシー、ハーシパゼックとティルベ

ゴクセンの行う言語の空間的な学習の調査に参加をすることを同意します。また自らが録画されることを許可します。そして録画されたテープが研究もしくは教育目的だけのために使用されることを承諾します。そして私の実名は常に伏せられます。

サイン_____

本日の日付_____

ご協力誠にありがとうございます。

日付_____

調査責任者

被験者 番号 # _____

調査 _____

APPENDIX F
JAPANESE CONSENT FORM: PERMISSION TO VIDEOTAPE

同意書：ビデオ録画の許可

調査題名：行動や出来事の語源の概念的学習

調査者：キャシィー、ハーシパゼック 教授 博士号 心理学部
ティルベ ゴクスン 修士号 心理学部

電話番号：267-468-8610

私はティルベ ゴクスンと小西

悠に私の子供をビデオ録画することと調査に参加させることを許可いたします。
私はこのビデオテープがテンプル大学の調査目的のみに使用されることを承諾します。
このビデオテープは調査終了後3年までこちらで保管します。私はもう既に私の子供の調査の参加の同意を済ませています。調査のどの段階でも私もしくは私の子供の実名が使われることはありません。私は、調査のどの時点でも、参加の中止が可能なことを理解しています。もし私が望む場合ビデオテープの破棄が可能なことを認識しています。このビデオテープの使用から利益を得ることは出来ないことを把握しています。

もし質問等ございましたら、いつでも下記に記されている調査責任者に連絡してください。

テンプル大学、心理学部 フィラデルフィア、ペンシルベニア 19122
参加者の権利に関してより詳しい情報が必要な場合リチャード
ソームに (215) 707-8757 ご連絡お願いいたします。

この同意書はティルベ

ゴクスンの所属するテンプル大学の研究室で保管されます。

お父様・お母様のサイン_____

日付_____

調査責任者_____

日付_____

調査代表者_____

日付_____

APPENDIX G

CONDITION SHEET FOR STUDIES

STUDY 1: GROUND CATEGORIZATION

Condition		Order	Salience	Familiarization 1	Familiarization 2	Familiarization 3	Test 1	Test 2
1		LRRLRL	woman tennis court- woman bridge	woman road	woman railroad	woman street	woman tennis court- woman bridge	woman tennis court- woman bridge
2		RLRLRL	man road - man grassy field	man railroad	man bridge	man street	man road - man grassy field	man road - man grassy field
3		LRLLLL	woman grassy field - woman bridge	woman street	woman railroad	woman road	woman grassy field - woman bridge	woman grassy field - woman bridge
4		RLLLLL	man grassy field - man tennis court	man road	man bridge	man railroad	man grassy field - man tennis court	man grassy field - man tennis court
5		LRRRLRL	woman grassy field - woman tennis court	woman railroad	woman street	woman road	woman grassy field - woman tennis court	woman grassy field - woman tennis court

STUDY 2: ALONGSIDE STUDY

Condition		Order	Salience 1	Salience 2	Familiarization	Test 1	Test 2
1	within	LRRLRL	woman road - woman railroad	man railroad - man road	woman railroad	woman road - woman railroad	man railroad - man road
2	across	RLRLRL	woman road - woman tennis	man tennis- man road	man road	woman road - woman tennis	man tennis- man road
3	across	LRLLLL	woman bridge - woman grass	man grass - man bridge	woman bridge	woman grass - woman bridge	man bridge - man grass
4	within	RLRLRL	woman road - woman bridge	man bridge - man road	man bridge	woman bridge - woman road	man road - man bridge
5	across	LRRRRRL	woman tennis - woman railroad	man tennis - man railroad	woman tennis	man tennis - man railroad	woman tennis - woman railroad
6	within	RLLLLL	woman street - woman railroad	man street - man railroad	man railroad	man street - man railroad	woman street - woman railroad

STUDY 3: STATIC FIGURE DISCRIMINATION

Condition		Order	Salience Trial 1	Salience Trial 2	Familiarization	Test 1	Test 2
1		LRRLRL	woman road - man road	woman railroad - man railroad	man road	woman road - man road	woman railroad - man railroad
2		RLLLLL	boy road - girl road	girl railroad - boy railroad	boy railroad	girl railroad - boy railroad	boy road - girl road
3		LRRRRRL	girl road - boy road	girl tennis - boy tennis	girl tennis	girl road - boy road	girl tennis - boy tennis
4		RLRLRL	woman bridge - girl bridge	woman grass - girl grass	woman bridge	woman grass - girl grass	woman bridge - girl bridge

STUDY 3: STATIC GROUND DISCRIMINATION

Condition		Order	Salience Trial 1	Salience Trial 2	Familiarization	Test 1	Test 2
1	within	LRRLRL	man railroad - man road	woman railroad - woman road	man railroad	man railroad - man road	woman railroad - woman road
2	within	RLLLLL	girl railroad - girl road	boy railroad - boy road	boy railroad	boy railroad - boy road	girl railroad - girl road
3	across	LRRRRRL	boy road - boy tennis	girl road - girl tennis	girl tennis	boy road - boy tennis	girl road - girl tennis
4	across	RLRLRL	woman bridge - woman grass	girl bridge - girl grass	woman bridge	girl bridge - girl grass	woman bridge - woman grass

STUDY 4: GROUND DISCRIMINATION in DYNAMIC EVENTS

Condition		Order	Salience Trial 1	Salience Trial 2	Familiarization	Test 1	Test 2
1	within	LRRLRL	woman railroad - woman road	man railroad - man road	woman railroad	woman railroad - woman road	man railroad - man road
2	across	LRRRRRL	woman road - woman tennis	man road - man tennis	man road	woman road - woman tennis	man road - man tennis
3	within	RLRLRL	boy railroad - boy road	girl railroad - girl road	boy railroad	boy railroad - boy road	girl railroad - girl road
4	across	LRRLRL	boy road - boy tennis	girl road - girl tennis	girl road	boy road - boy tennis	girl road - girl tennis
5	across	RLLLLL	woman bridge - woman grass	girl bridge - girl grass	woman bridge	girl bridge - girl grass	woman bridge - woman grass
6	within	LRRRRRL	boy railroad - boy street	man railroad - man street	man railroad	man railroad - man street	boy railroad - boy street
7	across	RLRLRL	man bridge - man grass	girl bridge - girl grass	girl bridge	girl bridge - girl grass	man bridge - man grass
8	within	RLLLLL	boy street - boy railroad	woman street - woman railroad	boy railroad	woman street - woman railroad	boy street - boy railroad

APPENDIX H
VOCABULARY SCORES IN EACH STUDY

	Mean	SEM	Median	Range
STUDY 1 (n=24)				
Total Vocabulary	53.21	7.07	53.5	6-149
Relational Vocabulary	23.75	3.42	21.5	0-65
STUDY 2 (n=20)				
Total Vocabulary	60.05	9.07	56	11-166
Relational Vocabulary	20.7	3.95	15	1-66
STUDY 3				
<i>Figure (8-month-olds, n=15)</i>				
Total Vocabulary	8	2.17	5	0-33
Relational Vocabulary	2.6	1.38	0	0-20
<i>Figure (11-month-olds, n=14)</i>				
Total Vocabulary	18	3.89	14.5	4-58
Relational Vocabulary	6.21	2.02	3	0-25
<i>Ground (8-month-olds, n=13)</i>				
Total Vocabulary	8.62	3.47	4	0-48
Relational Vocabulary	2.92	1.49	1	0-20
<i>Ground (11-month-olds, n=16)</i>				
Total Vocabulary	33.94	5.9	36	2-69
Relational Vocabulary	12.31	2.56	12.5	0-32
STUDY 4*				
<i>(14-month-olds, Japanese, n=24)</i>				
Total Vocabulary	104.88	20.14	79.5	0-370
Relational Vocabulary	17.13	4.24	7.5	0-65
<i>(19-month-olds, Japanese, n=23)</i>				
Total Vocabulary	153.2	27.72	133	0-461
Relational Vocabulary	18.7	5.06	7	0-75
<i>(19-month-olds, Japanese, n=22)</i>				
Total Vocabulary	46.38	11.08	31	6-229
Relational Vocabulary	17.62	6.31	8	0-129

* The Japanese long list MCDI version was used in Study 4.