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# Body Part Structure Knowledge in Infancy

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# BODY PART STRUCTURE KNOWLEDGE IN INFANCY

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THESIS

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A thesis submitted in partial fulfillment of the
requirements for the degree of Master of Science in the
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By

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ABSTRACT OF THESIS


BODY PART STRUCTURE KNOWLEDGE IN INFANCY

Human faces, bodies, and hands convey critical social information (e.g., emotions, goals, and desires). Infants, like adults, are sensitive to such social information. Unlike infants' knowledge of the structure of the human face and body, not much is known about infants' knowledge of hands and feet. The current study tested infants for their preference between intact hand images and ones in which the same hands were distorted (i.e., location of at least one finger was altered to distort the typical structure of the hand). Infants at 3.5 months of age had a preference for the reorganized hand image, demonstrating that 3.5-month-olds have sufficient knowledge of the configural properties of hands to discriminate between intact versus distorted images. Furthermore, when the same images were inverted, infants displayed no such preference, indicating that infants were not relying solely on low-level features to detect differences between intact versus reorganized hands. Contrastingly, when shown images of intact and reorganized feet, even 9-month-olds did not exhibit evidence of sensitivity to structural disruptions in images of feet. These results indicate that infants' structural knowledge of hands, but not necessarily feet, develops along the same trajectory as their knowledge of faces and bodies.



KEYWORDS: Infant Development, Body Part Processing, Social Cognition



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# Chapter One:

## Introduction

A vast amount of social information, such as an individual's emotions, goals, and desires, can be gathered simply from viewing human faces, bodies, or even hands. Infants, like adults, are sensitive to such social information. For example, they can discriminate between emotions in static images of faces even by 4 months of age (LaBarbera, Izard, Vietze, & Parisi, 1976). As early as 9 minutes after birth, newborns prefer to look at face-like stimuli (Goren, Sarty, & Wu, 1975). This finding was replicated years later to further indicate that from birth, infants are sensitive to first-order structural information in faces (Johnson, Dziurawiec, Ellis, & Morton, 1991). First-order information refers to the basic spatial configuration of social stimuli. For example, all faces share the same configuration, with the major features like eyes, nose and mouth arranged in a particular manner.

Bodies and body parts, such as hands and feet, also are defined by particular first-order configurations (Reed, Stone, Bozova, & Tanaka, 2003; Slaughter & Heron, 2004; Zieber, Kangas, Hock, & Bhatt, 2015). Zieber et al. (2015) found that by 3.5-months of age infants are sensitive to first-order relations that define human bodies. It is unknown, however, whether infants are sensitive to structural properties of body parts, specifically hands and feet. The purpose of the current study is to determine at what point during development infants' knowledge of the configural properties of hands and feet is advanced enough that they are sensitive to first-order disruptions in images of these body parts. If infants are sensitive to the configural properties of hands and feet, it would indicate that body representation originates quite early in life.

Infants might be sensitive to first-order information in hands and feet because they, like adults, obtain important information through socially-relevant stimuli such as faces, bodies, hands, and possibly even feet (Longhi et al., 2015; Maurer, Le Grand, & Mondloch, 2002; Reed et al., 2003; Zieber et al., 2015). The body and face are important sources when it comes to conveying and identifying emotions, intentions, and goals as well as social characteristics of individuals, such as sex. Similarly hands are seen as an extension of the body that can be used to indicate goals and desires through gestures (Morrisey & Rutherford, 2013). While the nature of the social information signaled by feet has not been clearly specified, it is known that infants begin reaching for objects with their feet before their hands (Galloway & Thelen, 2004).  Therefore, it is possible that both the hands and the feet are significant components of infants' body knowledge quite early in life. Thus, it is important to examine whether infants' representations of these body parts includes first-order structural information.

**Development of Face and Body Processing in Infancy**

There is reason to believe that infants are born with a template of the human face that directs early attention to and engenders a preference for facial stimuli early in life (Morton & Johnson, 1991). Minutes after birth, newborn infants prefer to look at face-like stimuli, which indicates that there is an evolved predisposition to respond to faces or face-like stimuli from birth (Goren et al., 1975; Mondloch et al., 1999). As noted earlier, we recognize a human face as a face because its features are arranged in the standard configuration of two eyes being located above a nose, with the nose located above a mouth (Maurer, et al., 2002). It has been found that when this kind of first-order information is disrupted by way of inversion, adults' recognition of peoples' facial expressions is hindered (for a review, see Valentine, 1988).

Body processing is similar in many aspects to face processing. For example, Reed, Stone, Grubb, and McGoldrick (2006) found that changing first-order spatial relations by scrambling part positions changes the way adults' process structural information. Thus, as in the case of faces, one part of the body cannot just be arbitrarily attached to any other part of the body; the specific spatial relations between these parts are critical. Slaughter and Heron (2004) suggested that such visuo-spatial knowledge of human bodies is first evident sometime between 15 and 18 months of age. However, as noted earlier, Zieber et al. (2015) found that 3.5-month-olds are sensitive to the first-order relational structure of bodies. In that study, which used a spontaneous preference procedure, infants exhibited a preference for bodies with parts in wrong locations over intact bodies. The reason for the discrepancy between the two studies is not clear; however, it could have something to do with the male stimuli used by Slaughter and Heron versus the female stimuli used by Zieber et al. (2015). Studies show that infants process male and female faces differently with an advantage in female face processing (for a review, see Ramsey, Langlois, & Marti, 2005). This female advantage may be reflected in better performance in the Zieber et al. study than in the Slaughter and Heron studies (also see Gliga & Dehaene-Lambertz, 2005).

**Development of Hand and Foot Processing in Infancy**

Hands are an extension of the body and are integral to the understanding of goal-directed actions. Previous research has examined how often hands are the focus in natural scenes in infancy (Aslin, 2009), whether infants perceive a hand motion as goal-directed

(Guajardo & Woodward, 2004; Woodward, 1998), and how newborns view hand movements (Longhi et al., 2015). Hands may also be closely associated with positive reinforcement in infancy. For instance, hands reach for and grasp infants when the caretaker is attempting to soothe or obtain the infant's attention.

When shown natural scenes captured using a head-mounted camera on an infant at 15 weeks and again at 38 weeks of age, infants 4- and 8-months-old rarely looked at hands in natural scenes, except in cases where the infants played with blocks (Aslin, 2009). In these instances, hands were looked at more than 20% of the time, even more than looking to the faces. Similarly, Yoshida and Smith (2008) also used a head-mounted camera and found that 18-month-old infants spent the most time looking at their own hands on an object, and the second most frequent view was observing their parent's hands on the object.

While 6-month-old infants may normally not spend much time looking at hands (e.g., Aslin, 2009), infants this age have been shown to interpret the motion of hands as goal-directed (Woodward, 1998). When infants were habituated to a hand reaching for and grasping one of two toys, infants looked longer during test trials when the actor's arm moved in the same direction as in the habituation trials, but grasped a different toy. However, this effect goes away when the procedure is done with a claw or a hand wearing a glove (Guajardo & Woodward, 2004). It seems that when the surface features of the hand are disrupted, it affects the way infants interpret grasping motions. Also, Longhi et al. (2015) found that newborns looked longer at an impossible hand movement over a possible one, which means they are able to visually discriminate between a movement that they have accumulated sensory-motor experience with versus a movement that they have not experienced before. In addition, Mason and Bremner (2013) found that infants at 8 months of age can discriminate between a typical and an atypical hand, but only after the infants were primed with images of typical hands. It is not yet known what knowledge about the structure of hands infants come in to the lab with.

Furthermore, mirror neurons may explain how infants possess knowledge of hands. Jeannerod (1994) posits that certain neurons are responsible for the internal representation of an action. Rizzolatti, Fadiga, Gallese, and Fogassi (1996) were able to identify certain neurons in primates that reacted to meaningful actions of hands, faces, and particular types of body movements. Of particular interest is the fact that there are certain areas of the Japanese monkeys' brain that are directly responsive to hand movements (Taira, Mine, Georgopoulos, Murata, & Sakata, 1990). This suggests that there may be areas of the brain dedicated to the processing of hands, which may indicate an innate or early development of knowledge about hands in humans. However, it is unknown whether humans possess these same neurons. Nevertheless, it is possible that even infants possess knowledge of hands through the presence of mirror neurons.

While a few studies have examined infants' processing of hands, to our knowledge, no prior study has examined infants' knowledge of feet. In one study, however, young infants were found to visually aim their feet to contact an object (Galloway & Thelen, 2004). In that study, infants who were around twelve weeks of age contacted a toy with their feet before contacting it with their hands. It was not until infants were approximately sixteen weeks old that they began to reach for a toy with their hands first. The findings from this study indicate that goal-directed motor behaviors develop earlier in the legs than in the arms. This could indicate that feet are salient stimuli for infants, which suggests that their knowledge about bodies could include information about specific body parts.

## The Current Study

Overall, infants seem to demonstrate some knowledge of the typical movements and functions of hands within the first year. However, while there is a considerable amount of research on infants' knowledge of the structure of the human face and body (e.g., Goren et al., 1975; Slaughter & Heron, 2004; Tanaka & Farah, 1993; Zieber et al., 2015), little is known about infants' first-order processing of human hands and feet. This study sought to remedy the gap in the literature by documenting the developmental trajectory of first-order information processing of hands and feet in infancy.

## Chapter Two:

## Experiment 1

In this study, we examined whether 3.5-month-old infants demonstrate sufficient knowledge of the configural properties of hands to be sensitive to first-order structural disruptions. This age group was chosen because it has been shown that 3.5 month-olds exhibit sensitivity to first-order relational information in bodies (Zieber et al., 2015). Additionally, by 4 months of age infants show increased attention to hands engaged in play (Aslin, 2009). This suggests that infants' aforementioned knowledge of first-order relational information in bodies could extend to hands.

## Method

### Participants

Eighteen 3.5-month-old infants (mean age = 111 days, *SD* = 19.69; 5 female) successfully completed this study. An additional 3.5-month-old's data were excluded from analyses due to experimenter error. Infants were recruited through birth announcements in the local newspaper and from a local hospital. The majority of the participants were from middle-class, Caucasian families (Caucasian = 14, African American = 1, Asian= 1, Caucasian/African American = 1, Caucasian/Hispanic =1).

### Stimuli

The stimuli were images of hands positioned in intact and reorganized configurations (Figure 1). The intact images were created using Poser 2.0 software (Curious Labs, Santa Cruz, CA), and they were modified using Adobe Photoshop CS5 to generate the reorganized images. Six unique hand gestures were constructed using six different hands. Moreover, a reorganized version of each hand was constructed by altering the location of at least one finger (Figure 1). The reorganization was such that it altered the first-order configuration of the hands. To increase generalizability of the findings, for three of the hands, only one digit was moved, while the other three hands had two, three, or four digits moved to new locations.

**Apparatus and Procedure**

Infants were seated approximately 45 cm in front of a 50-cm computer monitor in a darkened chamber. They were seated on the lap of a parent, who was wearing opaque glasses that prevented him/her from seeing the images on the screen and potentially biasing the infant's looking patterns. Infants were tested on six 10-s test trials in a spontaneous preference paired-comparison procedure. Two images, an intact hand and a reorganized version of that hand, were presented on the screen side by side, with the reorganized hand having a horizontal and vertical visual angle of 13.56º and 16.81º, and the intact hand having a horizontal and vertical visual angle of 13.02º and 17.00º, respectively. A spontaneous preference procedure was chosen because we sought to examine what knowledge infants have without any training or exposure in the lab. At the beginning of each trial, infants saw alternating purple and green shapes to direct their attention to the center of the screen. Once the infant's attention was on the center of the screen, as determined by the experimenter via a live video feed, the first test trial began. An intact hand image and its corresponding reorganized image appeared on the screen, with one hand appearing on the left and the other on the right. Within each condition, the left/right location of the intact hand was counterbalanced across infants and across each pair of hand stimuli. Half of the infants were tested on three of the six pairs of hand stimuli while the other infants were tested on the other three.

A video camera located on top of the monitor recorded the infant's looks. A naïve coder unaware of the left-right location of the stimuli then coded the infant's performance offline using a DVD player slowed to 25% of the normal speed. A second coder verified coding reliability for 25% of the infants. The Pearson correlation between coders was .96.

## Results and Discussion

The dependent measure was the percent preference for the reorganized hand across all six trials (see Table 1). This was calculated by dividing the total looking time to the reorganized hand across all six trials by the total looking time to both the intact and reorganized hand across all six trials; this number was then multiplied by 100. An outlier analysis (Tukey, 1977; using SPSS version 22.0) revealed that the score of one infant was an outlier, and this score was not included in the final analyses. A one-sample $t$ test indicated that 3.5-month-olds' percent preference for the reorganized hand ($M$ = 53.71%, $SE$ = 1.26; see Table 1) was significantly different from chance (50%), $t(16) = 2.94$, $p = .010$, $d = 0.71$. Thirteen out of the 17 infants had a mean preference for the reorganized hand that was above chance (binomial $p = .025$). This preference for the reorganized hand indicates that infants as young as 3.5 months are sensitive to the first-order structure of hands.

Table 1

*Mean (and Standard Error) Raw Look Durations and Percent Preference*

| | Condition | N | Mean Raw Look Duration for Intact Stimulus (s) | Mean Raw Look Duration for Reorganized Stimulus (s) | Mean Reorganized Percent Preference (%) | *t* (versus chance) |
|---|---|---|---|---|---|---|
| <u>Experiment 1:</u> | | | | | | |
| 3.5-month-olds | Hands | 17 | 90.78 (3.32) | 105.84 (4.35) | 53.71 (1.26) | 2.94* |
| <u>Experiment 2:</u> | | | | | | |
| 3.5-month-olds | Inverted Hands | 18 | 89.13 (5.70) | 85.03 (5.91) | 48.50 (2.13) | -.70 |
| <u>Experiment 3:</u> | | | | | | |
| 3.5-month-olds | Feet | 18 | 89.58 (4.43) | 97.61 (7.28) | 50.73 (2.86) | .26 |
| 5-month-olds | Feet | 18 | 99.14 (4.55) | 100.86 (4.70) | 50.36 (1.63) | .22 |
| 9-month-olds | Feet | 18 | 97.34 (4.15) | 98.20 (3.85) | 50.21 (1.09) | .19 |

* $p$ = .01, significantly different from chance (50%).

Figure 1

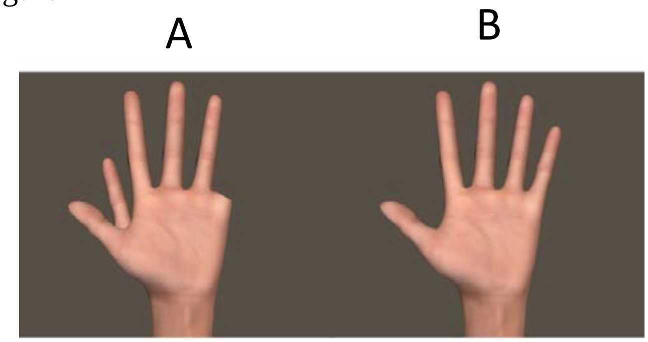


*Figure 1*. Examples of a reorganized hand (A) and intact hand (B).

## Chapter Three:

## Experiment 2

Infants in Experiment 1 exhibited a preference for reorganized over intact hand images. While this is consistent with the idea that infants are sensitive to the first-order configuration of hands, it is also possible that infants' performance in Experiment 1 was not specific to the processing of hands. Some low-level features of the stimuli may have driven the preference. For example, the intact hand images may have been more symmetrical than the reorganized images. To test this possibility a new group of infants was tested in the same manner as infants in Experiment 1 but with inverted images. If some low-level features of the stimuli had caused the infants' preference in Experiment 1, the same preference should be exhibited when the images are inverted because all low-level stimulus features, such as symmetry, would still be present in inverted stimuli. If, however, no preference emerges in the inverted condition, one can conclude that the preference documented in the upright condition is due to infants' sensitivity to the reorganization. Inversion was chosen as a control for this study because past research has documented the inversion effect (i.e., discrimination with upright but not inverted stimuli) in infants with other social stimuli (Bhatt, Bertin, Hayden, & Reed, 2005; Zieber et al., 2015). Morrisey and Rutherford (2013) found an inversion effect in the perception of hands with adults, suggesting that inversion would be an appropriate control for our study also.

### Method

#### Participants

Eighteen 3.5-month-old infants (mean age = 104 days, *SD* = 8.17; 12 female) successfully completed this study. They were recruited in the same manner as those in Experiment 1. The majority of the infants were from middle-class, Caucasian families (Caucasian = 15, African American = 2, Caucasian/Hispanic =1).

**Stimuli, Apparatus, and Procedure**

The stimuli were the same as those used in Experiment 1, but the images were flipped about the horizontal axis (see Figure 2). The same equipment and procedures utilized in Experiment 1 were used here. Coding of the infants' performance was conducted in the same manner as in Experiment 1. A second coder verified the coding reliability of 25% of the infants for each age group. There was a Pearson correlation of .96 between coders.

**Results and Discussion**

The dependent measure was the same as in Experiment 1; i.e., percent preference for the reorganized hand across all six trials. An outlier analysis (Tukey, 1977; using SPSS version 22.0) conducted as in Experiment 1 revealed no outliers. A one-sample $t$ test comparing infants' preference for the reorganized hand ($M$ = 48.50%, $SE$ = 2.13) indicated that the preference for the reorganized hand was not significantly different from chance, $t(17) = -.70$, $p > .05$, $d = 0.17$. Thus, infants in Experiment 2, who were tested with inverted versions of the stimuli used in Experiment 1, failed to exhibit a preference between intact and reorganized hand images. This indicates that performance in Experiment 1 was not due to low level stimuli features, but rather knowledge about hands.

Furthermore, an independent-samples *t* test comparing the 3.5-month-olds' percent preference for the reorganized hand in the upright condition of Experiment 1 versus the inverted condition of Experiment 2 revealed that the groups' scores were significantly different from one another $t(33) = 2.07$, $p < .05$, $d = 0.71$. Thus, 3.5-month-olds exhibited a significant inversion effect when tested on their knowledge of the first-order configuration of hands. This suggests that infants have a fairly sophisticated knowledge of hands early in life.

Figure 2

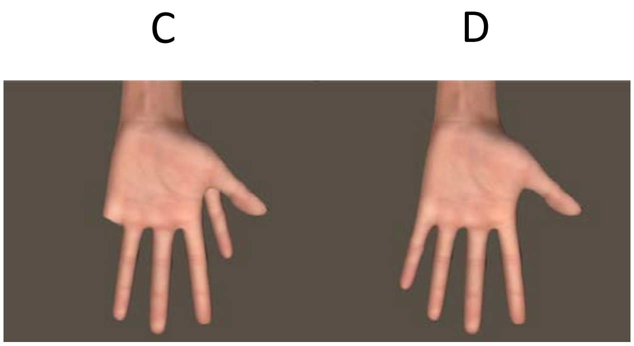


*Figure 2.* Examples of an inverted reorganized hand (C) and an inverted intact hand (D).

## Chapter 4:

## Experiment 3

Experiments 1 and 2 indicated that infants are sensitive to the first-order configuration of hands. As discussed in the Introduction, it is possible that infants have similar knowledge of feet because young infants appear to “reach” for objects with their feet (Galloway & Thelen, 2004), suggesting greater use of feet than hands early in life and because young infants have a fair deal of exposure to their feet due to their typical supine position. On the other hand, infants likely have more exposure to the hands of people around them than to their feet, and it is possible that infants’ knowledge about feet develops more slowly than their representation of hands. We addressed these possibilities in the current experiment. We first tested 3.5-month-old infants for their preference between intact and reorganized images of feet in exactly the same manner as the infants in Experiment 1. Finding that infants this age do not exhibit a preference, we then tested 5- and 9-month-old infants. In the following description, therefore, we report the performance of 3.5-, 5-, and 9-month-olds in a task that examined their preference between images of intact feet versus reorganized feet.

### Method

#### Participants

Eighteen 3.5-month-old infants (mean age = 99 days, *SD* = 6.92; 8 female), eighteen 5-month-old infants (mean age = 150 days, *SD* = 5.81; 10 female) and eighteen 9-month-old infants (mean age = 270 days, *SD* = 8.13; 9 female) successfully completed this study. Four infants were replaced due to their overall looking times being less than 20% throughout the duration of the study (n =2), experimenter error (n =1), and the presence of a side bias (i.e., looking greater than 90% to one side across all trials; n =1). Participants were recruited in the same manner as those in Experiments 1 and 2. The majority of the infants were from middle-class, Caucasian families (Caucasian = 39, African American = 3, Asian = 2, Caucasian/African American = 4, Caucasian/Asian = 1, Caucasian/Hispanic = 2, Caucasian/Hispanic/American Indian = 1, Caucasian/African American/Hispanic = 2).

**Stimuli, Apparatus, and Procedures**

The stimuli were images of feet positioned in intact and reorganized configurations (Figure 3), which were generated in the same manner as the hands used in Experiment 1. The reorganized foot has a horizontal and vertical visual angle of 10.37º and 16.88º, and the intact foot has a horizontal and vertical visual angle of 10.48º and 16.48º, respectively. The same equipment and procedures used in Experiments 1 and 2 were used here. Coding of the infants' performance was also conducted as in Experiments 1 and 2. A second coder verified the coding reliability of 25% of the infants. The Pearson correlations between the two coders' scores were .93, .97, and .94, respectively, for 3.5-month-olds, 5-month-olds, and 9-months-olds' data.

## Results and Discussion

As in Experiments 1 and 2, the dependent measure was the percent preference for the reorganized stimulus across all six trials. An outlier analysis (Tukey, 1977; using SPSS version 22.0) of performance at each age separately revealed no outliers at any age. One-sample *t* tests comparing each age group's percent preference for the reorganized foot with chance (50%) found that the preference for the reorganized foot was not significantly different from chance at any age (3.5-month-olds: $M$ = 50.73%, $SE$ = 2.86, *t*(17) = .26, *p* =.801, *d* = 0.06; 5-month-olds: *M* = 50.36%, *SE* = 1.63, *t*(17) = .22, *p* =.830, *d* = 0.05; 9-month-olds: *M* = 50.21%, *SE* = 1.09, *t*(17) = .19, *p* =.852, *d* = 0.04). Therefore, there was no evidence of sensitivity to first-order disruptions in feet at any of the age groups tested.

Figure 3

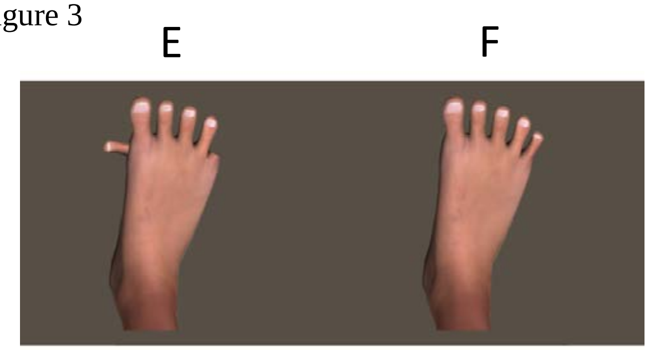


*Figure 3.* Examples of a reorganized foot (E) and intact foot (F).

# Chapter 5:

## General Discussion

This study found that by 3.5 months of age, infants have attained sufficient knowledge of the configural properties of hands to be able to discriminate images of intact hands from ones in which the parts were reorganized to disrupt the typical first-order configuration of hands. Infants also exhibited an inversion effect with hands, i.e., discriminating first-order configural changes in upright images but not inverted images. The inversion effect indicates that infants were not relying solely on low-level features to detect differences between intact versus reorganized hands. In contrast, even by 9 months of age, infants do not show evidence of the discrimination of such first-order disruptions in images of feet. These findings extend the growing body of work on infants developing knowledge about bodies to include isolated body parts (Reed et al., 2003; Slaughter & Heron, 2004; Zieber et al., 2015). Specifically, the findings of Experiments 1-3 demonstrate a relatively sophisticated representation of hands but not of feet early in life.

Since hands are an integral part of the body that aid in the expression of emotion, goals, and desires (Morrisey & Rutherford, 2013), the finding that infants as young as 3.5 months of age have knowledge about the structure of hands adds to the already existing literature on bodies and their social importance (Bhatt, Hock, White, Jubran, & Gelati, 2016; Reed et al., 2003; Zieber et al., 2015). These findings also indicate that infants' knowledge of bodies extends beyond the overall body to include certain parts, such as the hands. Due to the fact that infants are constantly exposed to hands attached to their own and other peoples' bodies (Aslin, 2009; Yoshida & Smith, 2008), there is potential for a great amount of information to be learned early on about the structure and function of hands.

While hands and feet may seem to be similar in structure, there are, in fact, many differences between the two. The first of these differences can be seen in the structure of the digits. The digits on hands are longer and provide more opportunity to be manipulated or spaced out than the toes on feet. Furthermore, digit lengths are much more variable on the hand than on the foot. There is also a difference in the bases, or anchors, of hands and feet. The foot offers a longer, less regular base than the palm of the hand. Additionally, the thumb on the hand protrudes off the side of the palm, whereas all of the toes remain on the top of the base of the foot. These differences in structure may have led to the differences observed in the present experiments. Thus, one limitation of the current study is that these inherent structural differences between hands and feet meant that the degree of differences between intact and reorganized images could not be equated for hands and feet. While the changes of the digits was consistent across the two different types of stimuli, it was not possible to equate the degree of displacement due to the fact that there is less room for variation on a foot compared to a hand. This could have resulted in differences in discrimination difficulty between intact and distorted stimuli in the two conditions. In other words, the differences observed in knowledge of hands and feet in this study could be due to the fact that the feet distortions were physically smaller than hand distortions.

Another limitation of this study is that the spontaneous preference procedure used may not have been sensitive to infants' knowledge of feet. It is possible that infants were able to discriminate between intact and reorganized images of feet, but did not show a preference for one kind of stimulus over the other. In other words, because only preference was tested in the paired-comparison procedure, the difference between performance on hands and feet may have been due to differences in preference rather than lack of knowledge about intact feet per se. Perhaps exposing infants to a discrimination procedure in which infants' ability to discriminate between intact and reorganized images of feet is tested or priming infants with feet before showing them the test stimuli in a preference procedure, or creating distortions that are more exaggerated could help facilitate infants' display of knowledge about the first-order structure of feet.

It would also be beneficial to examine other components of 3.5-month-olds' knowledge of hands. For instance, hands are not only characterized by the relative location of parts but are also defined by the relative size of parts. For example, the fingers are of a certain length compared to the size of the palm.  Would infants notice a change if part sizes are distorted beyond the normal range of possibilities (e.g., lengthening or shortening fingers beyond normal limits)? If so, it would suggest that part proportions are also included in young infants representations of hands. Examining how infants interpret proportional changes in body parts also adds to the already existing body of research with adults saying that proportions are significant sources of social information (Johnson & Tassinary, 2005, 2007; Tassinary & Hansen, 1998). Additionally, Zieber et al. (2015) found that infants at 3.5 months of age exhibited a preference between a normal versus a proportionally distorted body image when the images were presented in the upright, but not the inverted, orientation.

Taken together, the findings of this study demonstrate that infants' knowledge of bodies at 3.5 months of age extends to first-order distortions of hands, thus indicating knowledge of body parts develops early in life. The results indicate that infants' knowledge of hands seems to develop along the same trajectory as their knowledge with faces and bodies. However, a possible interpretation of the current results is that the developmental trajectories of foot and hand knowledge differ in regards to timing. This suggests that more research is necessary to obtain a comprehensive understanding of the development of body part knowledge in infancy.

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**Education**

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**Professional Positions Held**

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| 2015 - Present | Research Assistant, Department of Psychology, University of Kentucky |

**Scholastic and Professional Honors**

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| 2015-2016 | University of Kentucky Graduate School Travel Award |

**Professional Publications**

**Journal Articles**

Bhatt, R.S., Hock, A., White, H., Jubran, R., Kangas, A. (2016). The development of body structure knowledge in infancy, *Child Development Perspectives, 10*(1), 45-52.

Heck, A., Hock, A., White, H., Jubran, R., & Bhatt, R. S. (2016). The development of attention to dynamic facial emotions. *Journal of experimental child psychology*, *147*, 100-110.

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White, H., Hock, A., Jubran, R., Heck, A., & Bhatt, R. S. (in prep). Visual scanning of males and females in infancy.

**Presentations in Professional Meetings**

Hock, A., Jubran, R., White, H., & Bhatt, R.S. (2015). *Infants' Attention to Emotion in Bodies.* The Society for Research in Child Development, Philadelphia, PA. March 19-21, 2015. (poster presentation).

Hock, A., White, H., Jubran, R., & Bhatt, R.S. (2015). *Development of Body Representation in Infancy: Scanning of Specific Body Regions of the Different Sexes.* The Society for Research in Child Development, Philadelphia, PA. March 19-21, 2015. (poster presentation).

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