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Multimodal Sex-Related Differences in Infant and in Infant-Directed Maternal Behaviors During Months Three Through Twelve of Development

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Using the concepts of sensory and affective experience, this work relates the concepts of socialization and cognitive development to the embodiment of gender in the human infant. Evidence obtained from biweekly observations from 30 children and their mothers observed from age 3 months to age 12 months revealed measurable sex-related differences in how mothers handle and touch their infants. This work offers novel approaches to visualizing combinations of behaviors with the aim of encouraging researchers to think in terms of suites of action rather than singular sensory or motor systems. New avenues of research into the mechanisms which produce sex-related differences in behavior are suggested.

Keywords: gender and development, embodiment, socialization, dynamic systems, 3-dimensional visualization

The relationships between parental socialization during infancy, individual infant characteristics at birth, and the emergence of small sex-related differences in infant behavior toward the end of postnatal year 1 (Goldberg & Lewis, 1969) followed by larger differences in toddlers (Jadva, Hines, & Golombok, 2010) are poorly understood. Ruble, Martin, and Berenbaum (2006) offer a tripartite framework balancing biological, socialization, and cognitive developmental investigations of gender development. In agreement with Ruble et al. (2006) and with Deaux (1993), we use the term "sex" to designate a genital or demographic category: male or female (Deaux, 1993). We use the term "sex-related" to designate behaviors or preferences that are often (but not always) linked to genital or demographic characteristics, while we apply the term "gender" to stereotypes, concepts, or beliefs about human male or female preferences or behaviors. As charted by Ruble et al. (2006) any individual may manifest such stereotypes, concepts or beliefs in his or her identity or self-perception, preferences (e.g., for toys or playmates), and behaviors (e.g., engaging in gender-typed play, activity or occupations).

Although the above terminology differs from that used in much of the animal literature on sex determination, sexual differentiation, and sociosexual behavior where the dictum is to avoid use of the word gender (Crews, 1988), it does not completely solve the problem of when or when not to use the term gender. If, as we suggest in this article, even nonconscious gender stereotypes held by a caregiver leads to different patterns of touch and caregiver generated movement for male and female infants, and if these patterns differentially affect infant nervous system development, then caregiver gender-related behaviors might literally become embodied in an infant. We refer to this possibility as infant "embodied gender." On one level it is a biological phenomenon, and thus can be mistaken for an innate aspect of sex, but it has come into being via a process that involves caregiver behaviors that derive from their own embodied and cognitive gendered belief systems.

Gender self-perception and related behaviors are frequently understood as properties that appear during particular periods of development (Chiu et al., 2006; Zucker, 2008). As such their presence or absence can be measured via observation or experi-

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mentation and they take on the characteristics of a fixed trait (Lippa, 2008). In this article, we join with others (Fausto-Sterling, García Coll, & Lamarre, 2012a, 2012b; Martin & Ruble, 2010; Martin, 1998) in arguing that gendered characteristics and identities are not traits, but rather dynamic processes that depend on context and individual history (Spencer et al., 2006; van Geert & Steenbeek, 2005). In this report we visualize and analyze sex-related differences in maternal and infant behaviors observed in 3- to 12-month-old infants. In addition to more traditional analyses, we use a multimodal landscape visualization, an approach designed for the study of sex differentiation in animals to visualize differently measured traits, normally viewed singly, as part of a suite or network of developmental changes that occur in a particular developmental time frame (Crews, Lou, Fleming, & Ogawa, 2006; Scarpino, Gillette, & Crews, 2014).

Writing from an anthropological perspective McIntyre and Edwards (2009) identify seven behaviors found in more than a few cultures that seem to differ between boys and girls by the age of 3 and older. These include: girls work more, boys play more, children in groups self-segregate by sex, boys spend more time at greater distances from their mothers than girls, girls have more infant contact and care, boys engage in more rough and tumble play, while girls play groom more and boys play fight more. We suggest that to understand how these behavioral differences emerge we need to study the process of embodying gender as it occurs between caregiver and child from birth until the emergence of the specific behavior of interest (McIntyre & Edwards, 2009).

During the developmental period that we report on most sex-related differences were in routine maternal behaviors (touching, moving the child from one spot to another, etc.). We argue that these small interactions be considered as important aspects of early infant experience. Anderson et al. (2000) define experience as a process that "captures transactions between the organism at multiple levels of analysis" (p. 249) encompassing cellular, behavioral, and cultural features. For motor development they further distinguish active, self-generated activity from passive locomotion such as being carried by a parent or having their limbs stimulated by an adult. In this article we ask whether specific gender practices are selectively applied to genitally different infants thus producing gendered experiential worlds, and whether development within such worlds gradually leads to the emergence of embodied gender, first in toddlers, then during childhood (Martin & Ruble, 2010), and ultimately through the time course of adulthood. Although not specifically applied to gender, similar ideas have been introduced, debated, and refined by a number of research groups (Allen & Bickhard, 2013; van Geert & Steenbeek, 2013). Within the animal literature a longstanding and common thread is the importance of experience and the emergent nature of biological and psychological processes (Gottlieb, 1997; Kuo, 1976; West-Eberhard, 2003).

We suggest that experience includes vocal interactions, touch, affect, and the establishment of dyadic interactions between the infant and caregiver (Feldman & Eidelman, 2003; Lavelli & Fogel, 2002). In a cross sectional study of touch, for example, Ferber, Feldman, and Makhoul (2008) showed that the mother's affectionate touch during caregiving explained the observed variance in reciprocity between mother–infant dyads beyond smaller effects of infant gender, age, and birth order. They also note that the decrease in maternal touch with infant age may relate to the emergence of infant locomotion. Because of the importance in attachment theory of dyadic synchrony, and of infant mobility for cognitive, social, and relational growth, Ferber et al. (2008) urge additional studies of the relationship between mother–infant touch and the development of locomotion, while Moreno, Posada, and Goldyn (2006) report that affectionate touch relates inversely to infant activity level while stimulating touch correlated positively with infant activity.

Hsu and Fogel (2003a) report sex-related differences in engagement patterns between mothers of males versus mothers of females and their infants. In a symmetrical pattern both mother and infant are mutually engaged; in an asymmetrical pattern, one partner actively tries to engage a passively attentive pair member and in unilateral communication, one partner tries a variety of means to engage the attention of a socially disengaged pair member. History and timing matter as the more success the dyad has in achieving symmetrical communication at any one time, the greater success they have in the following period. This concept of complementarity between interacting individuals also has a rich history in animal research (Crews, 1975, 1992;Lehrman, 1965) Again, sex (as defined above for human research) turns out to be relevant. On average male infants have a harder time self-regulating and take longer to move from a unilateral to a mutually engaged state. Thus, the frequency of this state is still increasing in mother–son dyads at 3–9 months but has already stabilized in mother–daughter dyads. (Malatesta, Culver, Tesman, & Shepard, 1989; Weinberg, Tronick, Cohn, & Olson, 1999).

A small but significant body of work has documented the influence of sex of child on parental behavior or differences in behavior between mothers and fathers when playing with infants. In a longitudinal study of infants at 4, 8, and 12 months, Karrass, Braungart-Rieker, Mullins, and Lefever (2002) studied 5-minute segments of free play between parent and infant. They found that gender, infants' manipulative exploration, and maternal physical encouragement of attention at 4 months, and maternal verbal encouragement of attention at 12 months are positively related to language at 1 year (Karrass, Braungart-Rieker, Mullins, & Lefever, 2002). In an age-divided cross-sectional study Clearfield and Nelson (2006) analyzed maternal speech and play behaviors in six mother–son and six mother–daughter pairs each at ages 6, 9, and 14 months. Their finding, that mothers engaged more in dyadic conversations with their daughters, and that there were no infant sex differences in vocalization is consistent with our results on a longitudinal sample (Clearfield & Nelson, 2006; Sung, Fausto-Sterling, Garcia Coll, & Seifer, 2013).

Crawley and Sherrod (1984) videotaped seven 10- and 13-month-old infants in home play with one or both parents, observing that the play patterns of mothers differed from those of fathers, a result confirmed by Laflamme and colleagues in a larger and more recent study (Laflamme, Pomerleau, & Malcuit, 2002). These authors also found that parents of boys provided more physical stimulation than did parents of girls, confirming an older, cross-sectional examination of six month old infant interaction with their parents (Landerholm & Scriven, 1981). With the exception of high amounts of paternal physical play, Power and Parke (1983)—in a cross-sectional study on 8-month-olds—found few sex differences in parental infant interactions. Finally, in a series of studies, Feldman and her colleagues have confirmed, and extended to include biological measures, the findings of different maternal- and paternal–infant interactions (Feldman, 2007b; Feldman, Gordon, Schneiderman, Weisman, & Zagoory-Sharon, 2010). Keller, Otto, Lamm, Yovsi, and Kartner (2008) compared 5-min segments of vocal interactions taken weekly from 0–3 months in German and Cameroonian families. This rare cross-cultural study found cultural differences in the timing of vocal interactions that reflected differences in cultural modes of vocal interaction (Keller, Otto, Lamm, Yovsi, & Kartner, 2008). Perhaps the most significant conclusion from this literature is that few if any sex differences can be measured in the infants, but there are observable differences in parental behaviors toward daughters versus sons; further, the behaviors of mothers compared to fathers may differ, perhaps modeling to and producing embodied sex/gender patterns in the growing infant.

In the current study we were able to extend the literature by using a detailed longitudinal data set on a larger sample size than had been feasible for some of the cited studies. We initiated a project to test the general hypothesis: that socialization, especially in infancy, consists of the minutiae of everyday infant experience. As with some of the earlier studies, we examined moment to moment interactions between caregiver and infant multimodally. In addition to using traditional statistical approaches to multi modal analyses (Grossmann, 2010; Smith, 2005; Esther Thelen, 2000) we wanted to visualize behavioral suites and to determine whether they exhibited sex-related differences. In this article we use a graphical three-dimensional (3D) functional landscape analysis developed by Scarpino, Gillette, and Crews (2014) to analyze such differences in coordinated suites of maternal touch (Crews, Rushworth, Gonzalez-Lima, & Ogawa, 2009; Scarpino et al., 2012).

The current report is part of a larger study that examines sex/gender-related behaviors using a set of videotapes made available to us from a previous investigation of infant temperament. Our results on vocalization and maternal discipline have already been published (Ahl, Fausto-Sterling, Garcia-Coll, & Seifer, 2013; Sung et al., 2013) and here we focus on aspects of maternal touch. Given reports such as that of de Barbaro, Johnson, and Deák (2013) and others cited earlier in the introduction, that the "social revolution" of triadic play (mother–infant–object) that emerges at 12 months is a new property produced from continuous sensorimotor development scaffolded in earlier mother–infant interactions, it seem especially interesting to see whether forms of touch and of motor stimulation relate to the sex of the infant in any fashion (de Barbero, Johnson, & Deák, 2013). Future analyses of our data will delve more deeply into motor socialization and object play.

Method

Participants and Data Sources

We used a subset from 50 families originally observed and taped by Seifer, Sameroff, Barrett, and Krafchuk (1994) for an investigation of infant temperament. We address the age of this data set in the Discussion section. We matched all 50 families for the age at each individual observation and noted those for which a home visit was missing. Using the matching table as a guide, we chose the 30 families that best matched for infant age and completeness of time points. We examined two 5-min observations per month extracted from home play sessions for ages 3 to 12 months (15 boys and 15 girls and their mothers). Each 5-minute observation began 2 minutes after the start of the play together segment of the tape (there were also play alone and care-taking segments on the tapes) and ended 7 minutes later. Participants were first-time mothers and their full-term babies. The mothers were White, predominately middle and working class, married women from the state of Rhode Island. Their four-factor socioeconomic status (SES) averaged 1.96 (SD = .75, range 1–4). The average age of the mothers was 29.1 years (SD = 4.2, range 22.2–36.9) on their child's birth date. None were working full-time during their child's first year. There were no differences between mothers of boys and mothers of girls in terms of mothers' age and SES. Furthermore, Seifer, Sameroff, Barrett, and Krafchuk (1994) report no sex-related differences in temperament (mood, approach, activity, and intensity) between boys and girls for the larger sample from which our study group was derived.

Procedure

During the original data collection, trained research assistants videotaped mother–infant interactions weekly in the infants' homes. Home visits normally lasted 1 hour and were rescheduled if the infant was asleep or ill during the appointed time. During each hour-long session, the mother was asked to spend at least 10 min playing with her infant. Activities, structured naturally by the mother and infant, were captured on videotape using a single camera. For most observations, the 10-min play period occurred in a contiguous block of time, but in some cases extended play might be broken. For example, a mother might play with her infant about 5 min, change a diaper and then return to playing with her infant (Seifer et al., 1994).

In the current analysis, after matching for infant age, we randomly selected 5-min observation segments from two play sessions per month for months 3–12, ideally giving 20 observations per infant. In reality there were missed observations resulting from difficulties maintaining weekly visits, or in finding a continuous 5-min segment of free play on a particular tape. Eleven infants (six girls/five boys) had all 20 observations. Seven (three girls/four boys) had 19. Seven (five girls/ two boys) had 18, three (one girl/two boys) had 17, and one boy each had 16 and 15 observations. The missing observations are random and we mitigated the effects of these missing points by combining monthly data into 2-month groups. Behaviors were coded on a second-by-second basis using Observer XT 7 software (Noldus Information Technology, Wageningen, Netherlands).

Rater Reliability

Coders were considered reliable upon having attained an average Cohen's kappa of .60 or above across at least 6 different observations in their training. To report the reliability of each code, two research assistants double-coded about 15% of the 561 observations of mother–infant play together scenes. The average Kappa score for the reliability is the mean score of 61∼81 observations.

Choosing and Defining Codes

We began this project with a broad literature review of reported sex-related differences in early development. As reported in previous publications, reliable differences do not appear until after the first year of life (Fausto-Sterling et al., 2012a, 2012b). Following in the theoretical footsteps of Thelen and her colleagues, we reasoned that gender-related processes that might lead to the embodiment of sex/gender would precede their actual emergence (Thelen, 1995a, 2000; Thelen & Smith, 1994). Given the general nature of our prior hypotheses about which infant and maternal behaviors might be relevant to the process of gender formation, we cast our initial net widely, reading the child development literature to see what behaviors—whether previously linked to sex/gender or not—were commonly studied, and which of these we could discover information about from the set of videotapes at our disposal. The sex-related differences reported here provide more specific starting points for future studies of the embodiment of sex/gender in infancy.

The larger categories identified included motor activity and play (Adolph & Joh, 2007; Cossette, Malcuit, & Pomerleau, 1991; Goldberg & Lewis, 1969; Hadders-Algra, 2002; Thelen, 1995b; Thomas & French, 1985), infant and maternal vocalization (Bornstein et al., 1992; Brundin, Rödholm, & Larsson, 1988; Fenson et al., 1994; Hsu & Fogel, 2001; Hsu & Fogel, 2003b), object-related interactions (Beebe, Lachmann, & Jaffe, 1997; Bigelow, MacLean, & Proctor, 2004; Corbetta & Snapp-Childs, 2009; Crawley & Sherrod, 1984), affectionate and caring touch (Cohn & Tronick, 1989; Ferber, Feldman, & Makhoul, 2008; Field, 2010), and frames of play (Feldman & Greenbaum, 1997; Fogel & Dekoeyer-Laros, 2007; Fogel, Garvey, Hsu, & West-Stroming, 2006; Fogel & Thelen, 1987). Within these big groups we devised subcodes, based as closely as possible on existing literature and tested them all on a small sample (two mother–daughter and two mother–son pairs). After further refining the codes to assure reliability and to eliminate behaviors that did not seem to occur in our sample, we expanded our efforts until we had coded all 30 families, biweekly from 3 through 12 months.

Maternal touch. The definitions and categorization of maternal touch codes, as well as the average kappa among raters (range .7–1.0) are given in the Appendix.

Infant motor activity. The definitions of infant gross motor activity codes are given in Appendix. The average kappa among raters for infant gross motor activity was 0.712.

Statistics and Graphing

Standard statistics were performed using the basic functions of SPSS. We compared frequencies and durations of a variety of maternal and infant behaviors using the method of Crews, Lou, Fleming, and Ogawa (2006) and Scarpino et al. (2012) for producing 3D landscapes for measures that have different scales of measurement. Plotting the values in 3D produces a landscape in which the actual values are at the apex or nadir of each "mountain" or "valley." The peaks and valleys above or below the plane signify the directionality of change.

Results

Gender and Mother–Infant Interactions 3–12 Months

Maternal touch. By age 3 or earlier gendered behavioral preferences and self-identity may become embodied in a neurosensory and neuromuscular sense (Fausto-Sterling, 2012), with touch as a mediating mechanism. We compared patterns for a variety of maternal touch types in mothers of girls and mothers of boys from 3 to 12 months. The analyzed touch codes are described in the Appendix. We followed Ferber et al. (2008) by first combining the codes into three categories—positive, stimulatory, and instrumental (Ferber et al., 2008). While testing statistically for significant change over time and for group differences, we also visualized the relative relationships of these behaviors to one another using the functional landscape method devised by Crews and his colleagues (Crews et al., 2006; Scarpino et al., 2012).

Statistical analyses of grouped touch categories. We first examined sex and age patterns for total maternal touch, using a 2 (mothers of boys vs. mothers of girls) $\times$ 5 (five 2-month age groups) repeated measures ANOVA. The combined frequencies of all types of maternal touch showed a significant linear decrease with increasing age of infant, $F(4, 25) = 25.79$, $p < .000$, partial $\eta^2 = .479$. We also found a significant linear effect for Month $\times$ Sex, $F(4, 25) = 2.61$, $p = .039$, partial $\eta^2 = .085$; see Table 1A) Pairwise comparisons of mothers of boys and mothers of daughters using a grand mean and Bonferroni correction (as executed by SPSS) revealed that mothers of boys touched their child more than mothers of girls ($p = .012$). Post hoc t tests comparing touch frequency by 2-month groupings for mothers of differently sexed children showed significant differences during the 3–4 month, $t(28) = 2.85$, $p = .008$, and 5–6 month time period, $t(28) = 2.60$, $p = .015$. As the total frequency of touching fell with increasing age, the sex-related difference disappeared. The combined duration in seconds of the other coded touch types followed a similar linear pattern. Although we observed a linear decline with age, $F(1, 28) = 50.51$, $p < .001$, $\eta^2 = .643$, there were no significant Sex $\times$ Age interactions.

The observation of sex-related differences in total touch frequency led us to explore the next question: Are particular kinds of touch more favored by mothers of one or the other sex? Following Ferber, Feldman, and Makhoul (2008), we first analyzed three grouped touch categories—positive, stimulatory, and instrumental. We hypothesized that there might be differences in stimulatory and instrumental touch that could facilitate later sex differences in activity and modes of play between boys and girls. Positive maternal touch (affectionate and caretaking behaviors) frequency showed a significant linear decline with increasing infant age, $F(4, 25) = 31.13$, $p < .001$, partial $\eta^2 = .526$, but the Sex $\times$ Month interaction was not significant and showed no significant polynomial patterns. Positive maternal touch (affectionate and caretaking behaviors) duration showed a significant linear decline with increasing infant age, $F(4, 25) = 10.44$, $p < .001$, partial $\eta^2 = .549$.

Instrumental touch includes all instances in which the mother assists the infant in moving, sitting, or handling an object. Analysis of the frequency of instrumental touch revealed significant within-subjects effects for month groups, $F(4, 25) = 16.30$, $p < .001$, partial $\eta^2 = .368$, and for Month $\times$ Sex interaction ($F(4, 25) = 2.71$, $p = .033$, partial $\eta^2 = .088$). Both showed a significant linear decline with age. Pairwise comparison of the grand mean showed a significant sex difference ($p = .018$, with Bonferroni correction). T tests performed for sex differences in each month group showed a significant difference between frequency of instrumental touch

Table 1
Touch Frequency

Frequency	Mothers of males mean (*SD*)	Mothers of females mean (*SD*)	$F(4, 25)$
A. Total touch			
3–4 months	5.19 (1.57)	3.21 (2.19)	25.79 (infant age)***
5–6 months	4.41 (1.09)	3.42 (0.98)	11.01 (Sex × Age)*
7–8 months	3.03 (1.57)	2.67 (1.66)	
9–10 months	1.74 (0.80)	1.65 (0.95)	
11–12 months	2.19 (1.43)	1.48 (1.10)	
B. Instrumental touch			
3–4 months	7.85 (3.40)	4.24 (3.57)	16.30 (infant age)***
5–6 months	6.78 (2.87)	4.85 (2.65)	2.71 (Sex × Age)**
7–8 months	4.44 (2.33)	4.21 (3.12)	
9–10 months	2.26 (1.04)	2.08 (1.56)	
11–12 months	3.36 (2.21)	2.21 (2.30)	
C. Stimulatory touch			
3–4 months	3.31 (1.98)	1.69 (1.43)	17.09 (infant age)***
5–6 months	2.62 (1.34)	2.02 (1.28)	3.25 (Sex × Age)+
7–8 months	1.17 (0.82)	1.16 (0.94)	
9–10 months	0.76 (0.67)	0.91 (0.91)	
11–12 months	0.91 (0.76)	0.75 (0.96)	

Note. Frequency = mean number of touch events per 5-min observation period averaged for each 2-month interval.
$^{+}$ $p = .027$. * $p = .039$. ** $p = .033$. *** $p < .001$.

by mothers of boys versus mothers of girls for infants in the 3- to 4-month-old age group, $t = 2.834$, $p = .008$. Analysis of duration/5-min observation period revealed significant within-subjects effects for month groups, $F(4, 25) = 15.70$, $p < .001$, partial $\eta^2 = .258$ but no Sex × Age interactions (see Table 1B).

Stimulatory touch includes play lifting, gross motor stimulation ("bicycle" play), and rocking and jiggling the infant. An analysis of the frequency of stimulatory touch revealed significant within-subjects effects for month groups, $F(4, 25) = 17.09$, $p < .001$, partial $\eta^2 = .379$, and for Month × Sex interaction, $F(4, 25) = 3.25$, $p = .027$ (after applying the Huyn-Feldt correction for unequal variance). The frequency of these behaviors also decreased linearly with increasing infant age, $F(4, 25) = 17.09$, $p < .001$, partial $\eta^2 = .379$, as did the Sex ∗ Month interaction. Pairwise comparisons of mothers of boys and mothers of daughters, however, did not reach significance. An analysis of the duration of stimulatory touch/5-min observation period revealed significant within-subjects effects for month groups, $F(4, 25) = 12.36$, $p < .001$, partial $\eta^2 = .754$, but no Month × Sex interaction (Table 1C).

Landscape representations and statistical analyses of individual touch categories. Because we found both developmental and sex-related differences in group touch codes, we also examined individual touch codes in order to specify more clearly which maternal behaviors differed in a sex-related fashion. Furthermore, we wished to visualize suites of behavior. To accomplish this goal, using methods established by Crews and colleagues, we developed landscape graphs (see Figure 1) that contained all eight maternal touch codes in a single image (Crews et al., 2006; Crews et al., 2009; Scarpino et al., 2012). In these graphs the data are calculated as a percent of maximum for each code so that the peaks are directly comparable. Figure 1A represents the mean duration of eight touch codes for mothers of boys, and Figure 1B for the mothers of girls. Figure 1C represents the residual difference after the data for mothers of girls have been subtracted from the mothers of boys. Thus peaks that project above the landscape plane indicate higher values for mothers of boys and those that project below the plane higher values for mothers of girls. Significant differences are indicated with the traditional asterisks. The results of repeated measures ANOVA conducted for the frequency of each touch code and significant p values for within-month group differences are presented in Table 2. For visual comparison Figure 2 contains graphs of the estimated marginal mean duration for each maternal touch code as development progressed from 3 to 12 months.

Visualizing all of the maternal touch behaviors in this fashion provides additional insights into our grouped results. For example, when we considered positive touch codes together we found no significant gender effects although there were significant effects for infant age. An examination of Figures 1 and 2 shows why—the two codes (caretaking and affectionate touch) have opposite effects—with mothers of boys engaging for longer periods in affectionate touch and mothers of girls for longer periods in caretaking touch. The latter difference is significant for the 3–4 ($p = .04$) and 5–6 ($p = .02$) month periods, and declines significantly with time, $F(4, 25) = 5.11$, $p < .01$, partial $\eta^2 = .450$. Turning to the subcodes that contribute to significant Gender × Age effects found for combined instrumental touch, we find that mothers of boys spent more time repositioning (assist shift) the infant at four of the five month groups (see also Figure 2A). The sex of infant-related differences are either highly significant ($p < .01$; 3–4, 7–8, and 11–12 months) or significant ($p = .03$; 5–6 months) except for the 9–10 month period where the difference does not attain significance. Turning next to the stimulatory group, one code differs significantly during months 3–4 but not thereafter: Mothers of sons spend significantly more time play lifting than do mothers of daughters ($p = .01$; see also Figure 2B).

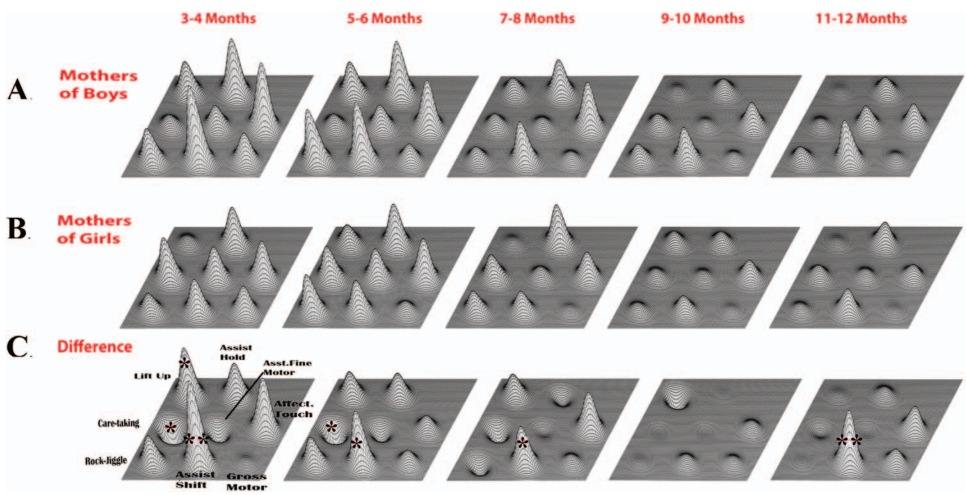

Figure 1. (A) Peaks represent the relative duration of eight types of touch engaged in by mothers of boys between 3 and 12 months of age. The identity of each peak is given in Figure 3C. (B) Peaks that project above the landscape plane indicate higher values for mothers of boys and valleys that project below the plane represent higher values for mothers of girls. Peaks represent the relative duration of eight types of touch engaged in by mothers of girls between 3 and 12 months of age. The identity of each peak is given in Figure 3C. (C) The remaining peaks after subtracting the data from the mothers of girls from that for the mothers of boys. * $p = .05$. ** $p = .001$. See the online article for the color version of this figure.

Infant Motor Activities

Landscape representations of multiple touch codes over time enable us to examine simultaneously occurring parental behaviors at a glance. Our results, however, raise a new question: Are there any behavioral patterns in the infants themselves that might evoke particular parental responses? We present a landscape graph of infant motor behaviors (described in the Appendix) in Figures 3A and 3B (duration and frequency of lying-rollover) and 3C and 3D (duration and frequency of sitting). Here we report frequency as well as duration because it seems possible that an infant behavior (e.g., lying and kicking, or lying still) might induce a maternal behavior such as lifting up which would interrupt and thus lessen the duration of the infant's behavior. As there were no sex-related differences for infant upper body activity (reaching, rocking and bouncing, pointing) we do not present these data graphically. The graphs in Figure 3A and 3B show that there are no differences between male and female infants in the duration of time spent lying and rolling over, lying kicking, lying still, or sitting and bouncing.

A repeated measures ANOVA of the frequency of maternally assisted sitting (Figure 3C) revealed significant within subjects effects for month groups, $F(4, 25) = 5.22)$, $p = .003$, partial $\eta^2 = .455$, and for Month $\times$ Sex interaction, $F(4, 25) = 2.74)$, $p = .05$, partial $\eta^2 = .305$. *T* tests performed for sex differences in each month group showed a significant difference at 3–4 months, $t = 3.05$, $p = .005$, and 11–12 months, $t = 2.72$, $p = .01$. While boys sat more often with maternal assistance during the 3–4 month time period, during this same time period girls sat for longer durations (Figure 3D) with nonhuman (other) assistance, $t = -2.13$, $p = .05$. Finally (Figure 3C), males have a significantly higher overall sit number during months 7–8, $t = 2.43$, $p = .03$; 9–10, $t = 2.29$, $p = .03$; and 11–12, $t = 2.71$, $p = .01$.

Given the possibility that differential lifting and shifting might contribute to later movement differences in boys and girls, we thought it important to see whether these differential maternal behaviors might in principle be a response to infant sex differences in crying or activity level. Although we coded for crying, we did not specifically measure activity levels. Thus, it was not possible to do a lag-sequence analysis to test directly possible relationships between specific infant activities and maternal lifting and shifting. Nevertheless we assessed overall infant behavior for potential sex-related differences. Using both repeated measures ANOVA and month group comparisons by sex we found no significant differences in either crying frequency or duration (data not shown), but as with most of the traits we coded there was a significant decline in crying frequency and duration with age (for duration Huyn-Feldt corrected $F(4, 25) = 3.14$. $p = .03$; for frequency Huyn-Feldt corrected $F(4, 25) = 3.15$, $p = .02$). While we did not code explicitly for activity levels in the manner surveyed by Campbell and Eaton (1999), several of the infant codes indicate non purposive "squirminess" of the sort measured by activity level (Campbell & Eaton, 1999). To test whether there were sex-related differences in this aspect of infant behavior we combined data from three codes: lying kicking, sitting-rock, lean bounce and bat, clap, bang, flail (each described in the Appendix). A repeated measures ANOVA showed no significant sex-related differences in the Sex $\times$ Month interaction for either frequency, $F(4, 25) = .62$, $p = .643$; or duration, $F(4, 25) = .60$, $p = .59$ of our measure of activity level.

Discussion

We argue that during human infancy sex-related socialization (which is culturally grounded), and which includes the physical minutia (touching, lifting, moving, supporting new activities) of

Table 2
Analysis of Frequency (per 5-Min Observation) of Individual Maternal Touch Behaviors

	Mothers of males mean (*SD*)	Mothers of females mean (*SD*)	$F(4, 25)$
A. Positive touch			
Caretaking			6.25 (infant age)***
3–4 months†	0.93 (0.67)	1.83 (2.08)	1.61 (Age × Sex)NS
5–6 months††	0.88 (0.52)	1.69 (0.92)	
7–8 months	0.81 (0.92)	1.03 (0.92)	
9–10 months	0.53 (0.58)	0.57 (0.42)	
11–12 months	0.47 (0.53)	0.60 (0.62)	
Affectionate touch			7.23 (infant age)***
3–4 months	5.86 (3.27)	4.57 (4.67)	0.57 (Age × Sex)NS
5–6 months	4.52 (1.22)	4.31 (2.96)	
7–8 months	3.84 (2.95)	2.77 (2.09)	
9–10 months	2.57 (2.01)	2.10 (1.66)	
11–12 months	2.79 (3.20)	1.43 (1.11)	
B. Stimulatory touch			
Lift up			8.23 (infant age)***
3–4 months†	1.37 (1.53)	0.37 (0.50)	4.19 (Age × Sex)**
5–6 months	0.94 (1.14)	0.40 (0.54)	
7–8 months†	0.49 (0.57)	0.13 (0.21)	
9–10 months	0.16 (0.21)	0.50 (1.06)	
11–12 months	0.14 (0.19)	0.10 (0.26)	
Rock–jiggle			
3–4 months	1.90 (1.94)	1.19 (2.17)	
5–6 months	2.53 (1.96)	1.77 (1.76)	
7–8 months	0.69 (0.69)	0.88 (1.02)	
9–10 months	0.41 (0.53)	0.35 (0.57)	
11–12 months	0.43 (0.79)	0.39 (0.59)	
Gross motor			7.71 (infant age)NS
3–4 months	1.90 (1.94)	1.19 (2.17)	0.41 (Age × Sex)NS
5–6 months	2.53 (1.96)	1.77 (1.76)	
7–8 months	0.69 (0.69)	0.88 (1.02)	
9–10 months	0.41 (0.53)	0.35 (0.57)	
11–12 months	0.43 (0.79)	0.39 (0.59)	
C. Instrumental touch			
Assist-shift			17.63 (infant age)***
3–4 months††	5.87 (2.28)	3.32 (2.72)	1.79 (Age × Sex)NS
5–6 months	5.02 (2.54)	3.42 (1.67)	
7–8 months†	3.62 (1.86)	2.29 (1.38)	
9–10 months	1.69 (0.89)	1.42 (1.50)	
11–12 months†	3.21 (2.51)	1.49 (1.54)	
Assist-hold			15.18 (infant age)***
3–4 months††	9.71 (5.09)	4.80 (4.91)	3.39 (Sex × Age)**
5–6 months	8.28 (4.33)	5.66 (4.52)	
7–8 months	4.71 (3.32)	5.24 (4.85)	
9–10 months	2.22 (1.85)	2.18 (1.77)	
11–12 months	2.77 (2.46)	2.30 (3.32)	
Fine motor			1.26 (infant age)NS
3–4 months	0.36 (0.49)	0.88 (1.72)	0.32 (Age × Sex)NS
5–6 months	0.29 (0.34)	0.75 (1.54)	
7–8 months	0.17 (0.31)	0.25 (0.41)	
9–10 months	0.14 (0.19)	0.17 (0.29)	
11–12 months	0.25 (0.31)	0.29 (0.68)	

† $p > .01 < .05$. †† $p > .001 < .01$. ** $p < .01$. *** $p \leq .001$.

daily infant experience, contributes to the production of embodied (and thus biologically grounded) gender. This is an extension to gender development of the ideas laid out by Thelen (2000) on the embodied mind and on the importance of sensory information during the first year of development. The analysis of gender and socialization has become both more nuanced and more sophisticated over the past 30 or so years (Eagly & Wood, 2013). However, analyses of gender and socialization, perhaps reflecting the available literature, neglect potentially important processes occurring during the first year of life. For example, the oft-cited but now 25-year-old review by Lytton and Romney (1991), which found little evidence of gender-differentiated socialization, used a lumped age category of 0–5 years, so that critical information on infancy—if it existed—could not be teased out of their data (Lytton & Romney, 1991). At the same time, a significant literature exists on caregiver touch and infant socialization, but this literature only rarely analyzes gender (Beebe et al., 2007; Corbetta & Snapp-Childs, 2009; de Barbero et al., 2013; Feldman et al.,

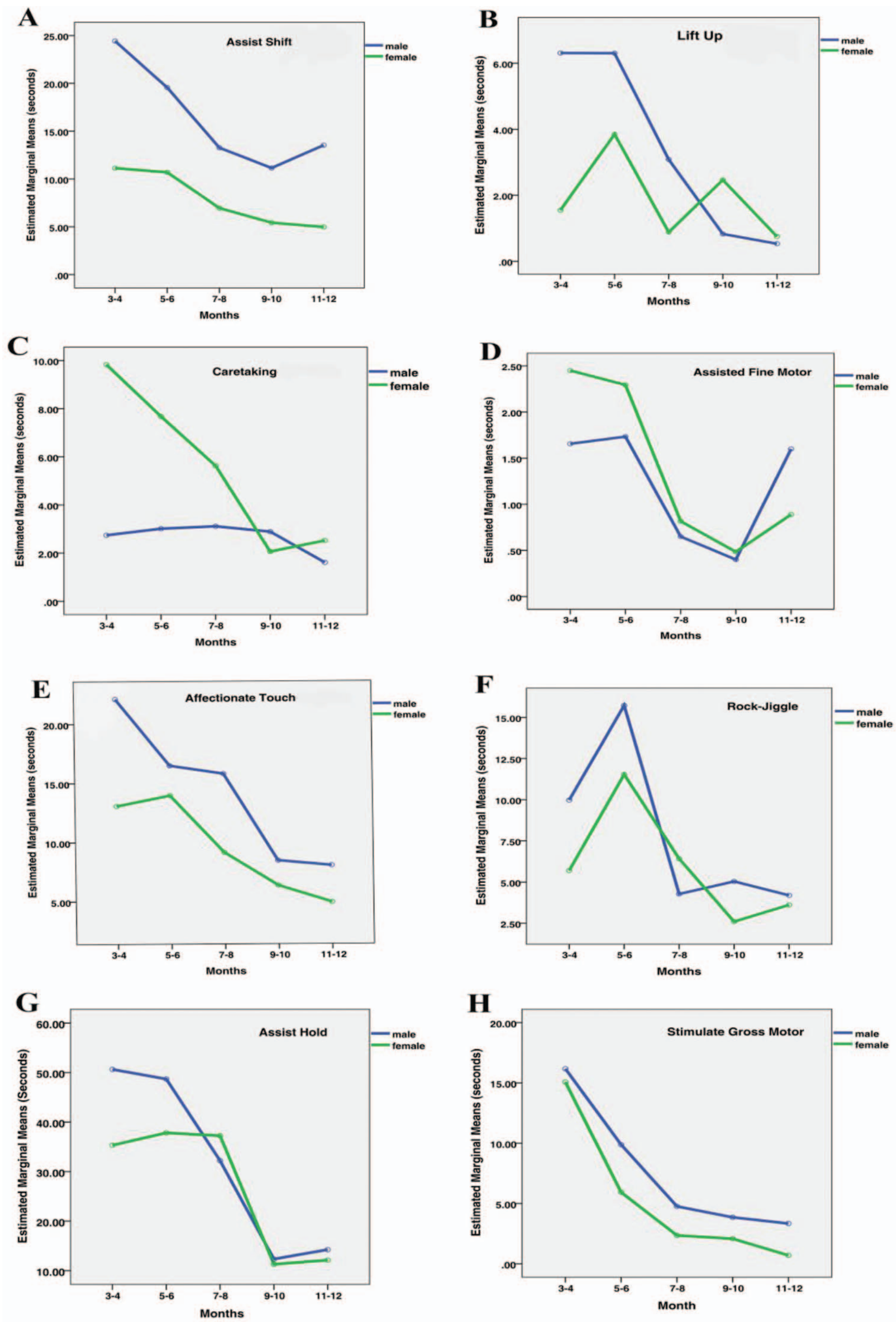

Figure 2. Estimated marginal means (duration) for each maternal touch code from 3 to 12 months. See the online article for the color version of this figure.

2010; Feldman, Weller, Sirota, & Eidelman, 2003; Ferber et al., 2008; Field, 2010; Fogel, Toda, & Kawai, 1988; Jean, Stack, & Fogel, 2009; Moreno et al., 2006; Stone, DeKoeyer-Laros, & Fogel, 2012; Weiss, Wilson, Hertenstein, & Campos, 2000). The one exception to the study of gender socialization during the first year of life involves vocalization and language development, which we have considered elsewhere and is not the focus of the current analysis (Sung et al., 2013).

Eagly and Wood (2013) argue that theories of socialization would benefit from acknowledging the relevance of the evolution of socialization, and by implication knowledge of socialization in animals. Indeed, Thelen's work draws on the voluminous literature

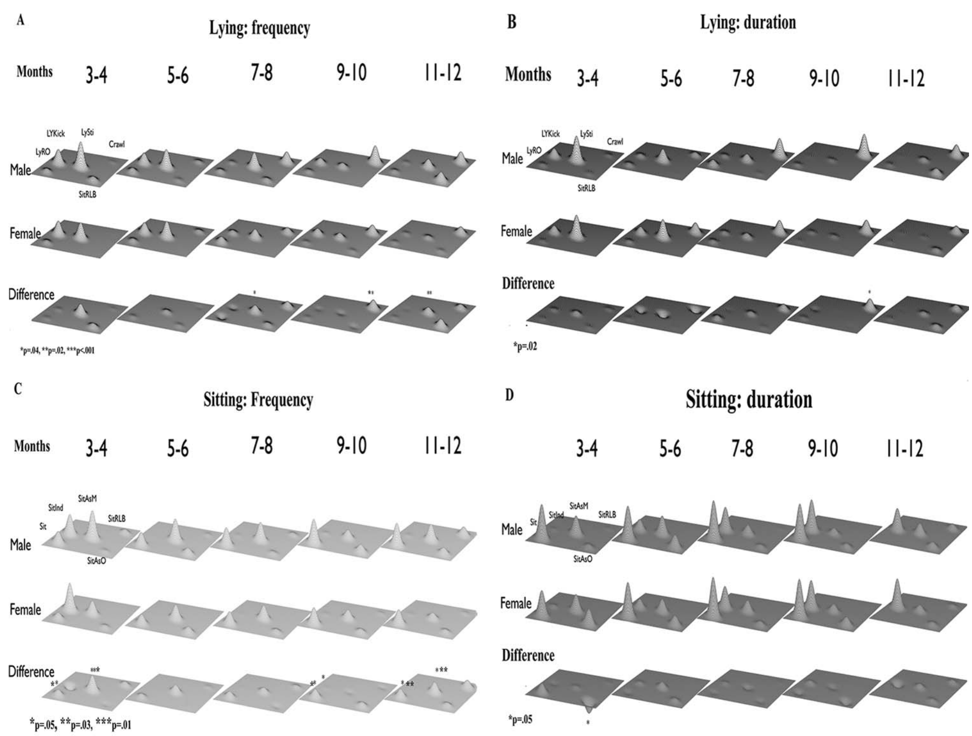

Figure 3. (A) Landscape represents the relative frequency of five types of lying activity engaged in by infants between 3 and 12 months of age. (B) Landscape represents the relative duration of five types of lying activity engaged in by infants between 3 and 12 months of age. (C) Landscape represents the relative frequency of five types of sitting activity engaged in by infants between 3 and 12 months of age. (D) Landscape represents the relative duration of four types of sitting activity engaged in by infants between 3 and 12 months of age. Peaks that project above the landscape plane indicate higher values for boys and valleys that project below the plane represent higher values for girls. Peaks represent the relative duration of eight types of touch engaged in by mothers of girls between 3 and 12 months of age. For each graph the top row portrays the data for boys, the middle row for girls, and the bottom row shows the remaining peaks after subtracting the data for girls from that for boys. Abbreviations: LyRO = lie, roll over; LYKick = kicking while lying on back; LySti = lying still; SitRLB = sit, rock, lean bounce; Crawl = crawl; Sit = sum of all the sit subcodes; SitInd = sit independently; SitAsM = sit, assisted mother; SitAsO = sit assisted other. * $p = .05$. ** $p = .001$.

on the development of behavior in animals which emphasizes complex progression, that each moment in time is based on what has gone before and, at the same time, sets the stage of what will follow (Schneirla & Rosenblatt, 1963). While there is no doubt that experiences early in life lay the foundation for an individual's adult behavior, exactly how this happens in animals continues to be a mystery because few experiments have attempted to dissociate the relative influence of the specific sensitive periods from associated stimuli. Controlling for the cumulative nature of multiple factors during development requires an animal model that can be experimentally manipulated to distinguish between component elements. In rodents, when these normally seamless events are assessed separately, it becomes apparent that it is the composition of the litter that is important in shaping adult behavior, not the uterine environment or the quality and frequency of maternal care. Two examples illustrate this conclusion.

The intrauterine position effect (IUP) posits that secretions of fetal neighbors (in particular testosterone from the male fetus) can affect both physiology and behavior of the adult offspring (Clark & Galef, 1995; Ryan & Vandenbergh, 2002). Thus, a female fetus located between two males (a 2M female) is exposed to higher levels of androgen produced by the neighboring males compared with a female fetus located between two females (a 2F female). As adults these 2M females have lower estrogen and higher testosterone levels, a masculinized phenotype, are less attractive to males, more aggressive to females, and produce litters with significantly greater male-biased sex ratios relative to 2F females. However, this literature does not take into account the postnatal sex ratio of the litter. This is important because the prenatal sex ratio of the litter influences circulating levels of testosterone in the pregnant female (Cameron et al., 2008; Clark, Crews, & Galef, 1991; Clark, Crews, & Galef, 1993) and the postnatal sex ratio of the litter determines the amount of maternal licking of offspring (Moore & Morelli, 1979). By noting the sex ratio at birth (reflecting the intrauterine sex ratio), culling and reconstituting litters on the day of birth, and assigning them to mothers other than their natural mothers, one can deconstruct the progression of developmental experiences. The results of such an experiment show that litter composition (the number of male and female littermates) is more important than the prenatal litter ratio in the sexual activity of males when they were adults. Further, males reared in a female-biased litter are less attractive to females. However, these same males were more efficient maters than those raised in male-biased litters (de Medeiros, Rees, Llinas, Fleming, & Crews, 2010).

There is also a vast literature on the genetic bases of behaviors. It is possible to deconstruct the relative contributions of the litter and specific genes by using knockout mice that lack functional copies of a gene(s) and considering the mixture of genotypes and sexes in the litter. One such a study used the estrogen receptor knockout mouse (ERKO) in which functional estrogen receptor α is lacking (Crews et al., 2009). This work established that both the sex of littermates as well as the genotype of the littermate affects the nature and quality of the individual's behavior later in adulthood as well as the functional neural network of limbic nuclei that underlie these behaviors. Thus, for the rodents studied, it is the context (litter or family) in which the individual is nurtured that shapes the brain and behavior when it is an adult.

While it is not possible to study human development with the kind of manipulative precision found in the animal literature, the fact that evidence from rodents points to the developmental salience of family context, suggests that the kind of detailed study undertaken here provides an important avenue for understanding gender and development. The current article on human development calls for shifting our perspective such that we take into clearer account the physical and emotional care-taking context in the emergence of gender. As already stated, we want to relate the concepts of socialization and cognitive development explicitly to the embodiment of gender in the infant, using the concept of experience (sensory and affective at first, social and emotional as development proceeds; Thelen, 2000). Second, we push on an often assumed time line for obtaining evidence concerning the biological, socialization or cognitive legs of Ruble et al.'s (2006) three-legged gender causation stool. Because there are few good theories of social causation for young infants, researchers often assume that sex-related differences found in early infancy (0–6 months) reflect a biological causation (see, e.g., (Alexander & Wilcox, 2012; Alexander, Wilcox, & Woods, 2009; Connellan, Baron-Cohen, Wheelwright, Batki, & Ahluwalia, 2000). We provide evidence of measurable sex-related differences in how mothers handle and touch their infants in the first 6 months after birth, suggesting the possibility that gender itself becomes embodied through motor and cognitive interactions via a dynamic back and forth that actually begins before birth (Kisilevsky et al., 2003; Kuhl, 2010). In presenting our work we offer novel approaches to visualizing combinations of behaviors that encourage us to think in terms of suites of action rather than singular sensory or motor systems. Finally, we suggest new avenues of research into the mechanisms which produce sex-related differences in behavior.

Maternal Touch

During the first 2–3 years of development, with the already-discussed exception of activity level, newborns are behaviorally undifferentiated with regard to sex/gender, but as children grow toward 3 years of age a few clear sex-related group differences (e.g., toy preference, rough and tumble play, self-segregation by sex during play) emerge, along with individual assertions of gender identity (self-identification as a boy or a girl). Because we theorize that by age 3 or earlier gendered behavioral preferences and self-identity are embodied in a neurosensory and neuromuscular sense (Fausto-Sterling, 2012), touch is one mechanism by which the intergenerational transmission of gender differentiation might plausibly be facilitated. For this reason we compared patterns for a variety of maternal touch types in mothers of girls and mothers of boys from 3 to12 months.

Normal development requires a caregiver's (in this case maternal) touch. In an important series of studies, Feldman and coworkers demonstrated that maternal–infant body contact in the neonatal nursery facilitated healthy coregulation between parents and their infants. One hour of maternal skin to skin contact, daily for 14 days improved the development of infant sleep organization and autonomic functioning, and during the first 6 months improved parental mental health, facilitated mother infant gaze and affective interaction. As development proceeded, effects of early touch intervention could be noted on mental and psychomotor development up to 2 years and as far out as 10 years after birth. The outcomes included improved cognitive development, child stress management autonomic functioning and sleep organization, improved parental mental health and stronger dyadic reciprocity between mother and child (Feldman, 2007a, 2007b; Feldman & Greenbaum, 1997; Feldman et al., 2003; Feldman, Rosenthal, & Eidelman, 2013; Hertenstein & Campos, 2001).

Researchers who study attachment also emphasize the effects on the structure of the attachment system at 12 months of joint mother–infant touch regulation during earlier face to face play (Beebe et al., 2010). Ferber and colleagues (2008) reported that affectionate, but not other types of touch, predict dyadic reciprocity. Jean, Stack, and Fogel (2009) studied the duration of a variety of types of maternal touch in different contexts (lap sitting, floor play) during the first 6 months after birth, reporting—as do we—that total touch duration declined with age, due especially to declines in stroking and patting and tapping (Jean et al., 2009). Stepakoff (2000), studying 4-month-old infants, found that interactions between infant gender, maternal ethnicity, and maternal mental health shaped touch patterns. She argues that tactile communication "serves as an unconscious, presymbolic method of ethnic and gender socialization" (Stepakoff, 2000, Abstract).

For both dyad categories touch interactions are most frequent and of longest duration during 3–4 and 5–6 months of age. There is a significant Sex × Age interaction for total touch frequency, with mothers of sons touching their infants more often than mothers of daughters. Breaking down this result we found a significant Sex × Month interaction for instrumental and stimulatory touch frequency, again with mothers of sons stimulating or moving their infant more often than mothers of daughters. Might these findings relate to later emerging sex-related differences in activity level, and modes of play (girls playing house and infant care, boys play-fighting with greater frequency of rough and tumble play)? Moreno, Posada, and Goldyn (2006) found that more stimulatory and less affectionate touch correlated with symmetrical maternal–infant coregulation, involving eye contract and infant smiling, reaching, and/or vocalizing. In contrast unilateral (nonattuned) patterns, when the infant is self or elsewhere focused and the mother attempts to regain the child's attention, is associated with more affectionate and less stimulatory touch. Feldman (2007b) and de Barbaro, Johnson, and Deák (2013) suggest the importance of coregulation and touch synchrony for the development of object play and fine motor development (Feldman, 2007b). We further speculate that stimulatory touch in infancy might directly stimulate motor development, leading to increased activity levels over time.

Possible touch induced biases in symmetrical coregulation most likely derive from combinations or suites of behaviors. This idea emerges from the landscape maps which visualize all eight individual touch codes together. Mothers of boys spent more time offering affectionate touch to their sons (not significant), but that mothers of daughters used more caretaking touch on their daughters (significant). These observations may relate directly to the findings that in many cultures girls play groom more than boys (McIntyre & Edwards, 2009). An examination of the instrumental touch subcodes revealed that mothers of sons spent significantly more time than mothers of daughters repositioning their child at months 3–8 and 11–12 months of age. Mothers of sons also spent more time stimulating their infants through play lifting during 3–4 months of age. Again we speculate that these differences could contribute to styles of motor activity in toddlers.

The current study is one of only a few detailed longitudinal examinations of possible relationships between patterns of maternal touch, infant sex, and the production of sex-related behaviors (Jean et al., 2009). Our findings that mothers in our sample engaged in significantly more instrumental and stimulatory touch with sons than with daughters suggests two testable hypotheses: First, the increasing sex differences in activity levels after 4 months (Campbell & Eaton, 1999) might result from earlier gender-differentiated dyadic patterns of caregiver-infant interactions. Second, if there are, indeed, sex-related patterns of coregulation and unilateral behaviors, these might relate to emerging patterns of object play, specifically more sedate versus more motorically active patterns so often noted in toddlers. Using a more focused longitudinal design that follows development from birth to 2 or 3 years of age, it should be possible to empirically test these ideas. Even if they are wrong or required evidence-based modification, new studies will advance our understanding of the dynamics of sex/gender embodiment in young children.

Infant Behaviors

Because it is possible that differences in the infants themselves stimulated differential maternal behavior we also presented data on infant behaviors. In a longitudinal study of face to face communication between mother and infant Hsu and Fogel (2003a) reported that the mother was the most active agent during the first 6 months (Hsu & Fogel, 2003a). Nonetheless the communication systems they examined were dyadic, that is, they depended on behaviors from both the mother and the infant. In a similar fashion, we reasoned that our reported differences in maternal touch of sons compared with daughters could be a response to sex-related differences in infant behavior.

Our most interesting finding was that boys sat more often with maternal assistance during the 3–4 month time period but that during this same time period girls sat for longer durations with nonhuman (other) assistance. We hypothesized that the differences in maternal behaviors toward sons compared with daughters could be due to different levels of fussiness or general "squirminess" in the infants themselves. However, we found no differences in the frequency or duration of crying in male compared to female infants. We also created an activity level variable by combining the infant behaviors "lying kicking," "sitting-rock, lean bounce," and "bat, clap, bang, flail" and again found no sex-related differences. As the mean differences (or lack thereof) reported here only offer an overview in future work, it will be important to examine possible relationships between specific infant and maternal behaviors using more "state of the art" lag sequence analyses.

For now, though, our evidence suggests that the differences in maternal behavior are probably maternally motivated during the time period of our study. Still, the differential maternal behaviors we observed could have been conditioned by sex-related infant behavioral differences during the first 3 months after birth, a period not included in our data set. Thus, it is also crucial in future studies to conduct detailed studies of dyadic touch and activity behaviors starting at birth. Further, incorporating birth characteristics and behaviors in years 1 through 3 into the study would enable us to correlate these early infant interactions with later behavioral outcomes.

Historical Nature of the Data

Gender norms and behaviors have certainly changed since the early 1990s when the tapes that we have analyzed were made (Seifer et al., 1994). Nevertheless, analyzing these data holds current relevancy. Much of the most frequently cited literature on socialization stems from this same period or even earlier (e.g., Fagot & Hagan, 1991; Lytton & Romney, 1991; Pomerantz & Ruble, 1998). Our study thus enhances our ability to interpret this still heavily used literature. But what about the present? Eliot, for example, notes that parenting styles change quickly (Eliot, 2009). And it is certainly possible that parents no longer handle their boy and girl infants differently. This possibility strikes us as unlikely given the renewed emphasis on identifying the sex of the child even before birth. At least in the United States and England there is a huge cultural currency in infant gender differentiation, as seen in the popularity of "gender reveal" parties, the purchase of highly sex-stereotyped infant clothing and toys and gender-specific home nursery decorations.[1] Furthermore, historical evidence suggests that the more equal public social gender roles have become, the greater the need to mark sex of the infant (Paoletti, 1987, 1997).

Still, the hypothesis that the subtle, day-to-day handling of and interactions with male and female infants has changed in the past 20 years must be answered empirically. At the very least this study provides a historical baseline for a sample which is, as noted below, culturally limited as well. But we also demonstrate a detailed method and a focus on infancy that can provide a structure for future work on gender and development. Our work begs for more studies, both to see whether and how parenting has changed (including, e.g., parenting behaviors in same sex families, parenting of children of different birth sexes in different places in the birth order, the influences of older and younger siblings of different birth sex, etc.), but also to examine how engendering in infancy happens in culturally differentiated communities both within the

[1] Perhaps most instructive is to put the phrase "gender reveal party" into Google and see what comes up. Many links to news reports and a side bar of pink and blue ads can be found on this link, accessed on April 10, 2015: https://www.google.com/webhp?sourceid=chrome-instant&ion=1&espv=2&thatis,=UTF-8#q=gender%20reveal%20party.

United States, where this data set comes from, and elsewhere in the world.

Developmental psychology is an historical as well as a contemporary field. Thus, it is exciting to see the emergence of digital repositories such as the Databrary (https://nyu.databrary.org/) which will enable the study of development over historical time as well as development within a single generation.

General Data Characteristics—Strengths and Weaknesses

We had the good fortune to access a longitudinal data set with frequent (every other week) sampling and consider one of the strong points of this study to be that we could make a large number of detailed observations of in-home naturalistic interactions between mothers and infants. However, to accomplish such a large coding effort in a reasonable period of time, we had to rely on a relatively small sample size (15 mother–son and 15 mother–daughter) dyads. The fact that the data for each sex-group was often highly variable was, on the one hand to be expected (first time mothers, infant variability, especially in early development), but on the other the variability sometimes limited the statistical significance of the results. The differences for affectionate touch during months 3–4 are a case in point. Although mothers affectionately touched their sons for longer than daughters during this time period, the difference was not significant ($p = .08$) due to the high standard deviations, especially for mothers of daughters. A box plot analysis (data not shown) revealed that two mother–daughter families were significant outliers, affectionately interacting with their daughters 3/2s times above the upper quartile for the mother–daughter dyads during three of the five month groups. These families reflect mother-infant interaction styles that differ from the median. Because of the small sample size, however, we chose to include them in the analysis rather than argue for their exclusion. A larger sample size might smooth out some of the differences in individual family interaction styles, thus enabling better understanding of group differences.

Obtaining larger samples in future studies can be facilitated by focusing on behaviors such as caretaking, affectionate touch, lift up, assist shift, assist hold which showed significance or near significance despite the numbers challenges. Other weaknesses of the current data set include the lack of social and ethnic diversity of our sample, that the time period from birth to 3 months is missing, and that no interactions with fathers or other caregivers are included and that the influence of older and younger siblings of each and both sexes could not be assessed (Hines et al., 2002). Each of these problems can be rectified with new rounds of data collection and analysis.

In conclusion, our work sets the stage for more focused studies aimed at understanding the dynamic interactions which lead to gendered embodiment in human infants, toddlers, and young children. We envision a more selected but still multimodal choice of behaviors to code, sampling from birth, or perhaps even before, the inclusion of neonatal trait characteristics as systems that generate infant and parenting behaviors, and a longer follow-up time period that reaches into the second or third year, when the children themselves begin to express gendered behaviors.

References

Adolph, K. E., & Joh, A. S. (2007). Motor development: How infants get into the act. In A. Slater & M. Lewis (Eds.), *Introduction to infant development* (2nd ed., pp. 63–80). New York, NY: Oxford University Press. http://dx.doi.org/10.1002/9780470147658.chpsy0204

Ahl, R. E., Fausto-Sterling, A., García-Coll, C., & Seifer, R. (2013). Gender and discipline in 5–12-month-old infants: A longitudinal study. *Infant Behavior and Development, 36,* 199–209. http://dx.doi.org/10.1016/j.infbeh.2013.01.005

Alexander, G. M., & Wilcox, T. (2012). Sex differences in early infancy. *Child Development Perspectives, 6,* 400–406.

Alexander, G. M., Wilcox, T., & Woods, R. (2009). Sex differences in infants' visual interest in toys. *Archives of Sexual Behavior, 38,* 427–433. http://dx.doi.org/10.1007/s10508-008-9430-1

Allen, J. W. P., & Bickhard, M. H. (2013). Stepping off the pendulum: Why only an action-based approach can transcend the nativist–empiricist debate. *Cognitive Development, 28,* 96–133. http://dx.doi.org/10.1016/j.cogdev.2013.01.002

Anderson, D. I., Hubbard, E. M., Campos, J. J., Barbu-Roth, M. A., Witherington, D., & Hertenstein, M. J. (2000). Probabilistic epigenesis, experience, and psychological development in infancy. *Infancy, 1,* 245–251. http://dx.doi.org/10.1207/S15327078IN0102_6

Beebe, B., Jaffe, J., Buck, K., Chen, H., Cohen, P., Blatt, S., . . . Andrews, H. (2007). Six-week postpartum maternal self-criticism and dependency and 4-month mother-infant self- and interactive contingencies. *Developmental Psychology, 43,* 1360–1376. http://dx.doi.org/10.1037/0012-1649.43.6.1360

Beebe, B., Jaffe, J., Markese, S., Buck, K., Chen, H., Cohen, P., . . . Feldstein, S. (2010). The origins of 12-month attachment: A microanalysis of 4-month mother-infant interaction. *Attachment and Human Development, 12,* 3–141. http://dx.doi.org/10.1080/14616730903338985

Beebe, B., Lachmann, F. M., & Jaffe, J. (1997). Mother–infant interaction structures and presymbolic self-and object representations. *Psychoanalytic Dialogues, 7,* 133–182. http://dx.doi.org/10.1080/10481889709539172

Bigelow, A. E., MacLean, K., & Proctor, J. (2004). The role of joint attention in the development of infants' play with objects. *Developmental Science, 7,* 518–526. http://dx.doi.org/10.1111/j.1467-7687.2004.00375.x

Bornstein, M. H., Tamis-LeMonda, C. S., Tal, J., Ludemann, P., Toda, S., Rahn, C. W., . . . Vardi, D. (1992). Maternal responsiveness to infants in three societies: The United States, France, and Japan. *Child Development, 63,* 808–821. http://dx.doi.org/10.2307/1131235

Brundin, K., Rödholm, M., & Larsson, K. (1988). Vocal communication between parents and infants. *Early Human Development, 16,* 35–53. http://dx.doi.org/10.1016/0378-3782(88)90085-0

Cameron, N., Del Corpo, A., Diorio, J., McAllister, K., Sharma, S., & Meaney, M. J. (2008). Maternal programming of sexual behavior and hypothalamic-pituitary-gonadal function in the female rat. *PLoS ONE, 3,* e2210. http://dx.doi.org/10.1371/journal.pone.0002210

Campbell, D. W., & Eaton, W. O. (1999). Sex differences in the activity level of infants. *Infant and Child Development, 8,* 1–17. http://dx.doi.org/10.1002/(SICI)1522-7219(199903)8:1<1::AID-ICD186>3.0.CO;2-O

Chiu, S. W., Gervan, S., Fairbrother, C., Johnson, L. L., Owen-Anderson, A. F. H., Bradley, S., & Zucker, K. J. (2006). Sex-dimorphic color preference in children with gender identity disorder: A comparison to clinical and community controls. *Sex Roles, 55,* 385–395. http://dx.doi.org/10.1007/s11199-006-9089-9

Clark, M. M., Crews, D., & Galef, B. G. J., Jr. (1991). Concentrations of sex steroid hormones in pregnant and fetal Mongolian gerbils. *Physiology & Behavior, 49,* 239–243. http://dx.doi.org/10.1016/0031-9384(91)90038-P

Clark, M. M., Crews, D., & Galef, B. G., Jr. (1993). Androgen mediated effects of male fetuses on the behavior of dams late in pregnancy. *Developmental Psychobiology, 26,* 25–35. http://dx.doi.org/10.1002/dev.420260103

Clark, M. M., & Galef, B. G. J., Jr. (1995). A gerbil dam's fetal intrauterine position affects the sex ratios of litters she gestates. *Physiology & Behavior, 57,* 297–299. http://dx.doi.org/10.1016/0031-9384(94)00239-2

Clearfield, M. W., & Nelson, N. M. (2006). Sex differences in mothers' speech and play behavior with 6-, 9-, and 14-month-old infants. *Sex Roles, 54,* 127–137. http://dx.doi.org/10.1007/s11199-005-8874-1

Cohn, J. F., & Tronick, E. (1989). Specificity of infants' response to mothers' affective behavior. *Journal of the American Academy of Child and Adolescent Psychiatry, 28,* 242–248. http://dx.doi.org/10.1097/00004583-198903000-00016

Connellan, J., Baron-Cohen, S., Wheelwright, S., Batki, A., & Ahluwalia, J. (2000). Sex differences in human neonatal social perception. *Infant Behavior and Development, 23,* 113–118. http://dx.doi.org/10.1016/S0163-6383(00)00032-1

Corbetta, D., & Snapp-Childs, W. (2009). Seeing and touching: The role of sensory-motor experience on the development of infant reaching. *Infant Behavior and Development, 32,* 44–58. http://dx.doi.org/10.1016/j.infbeh.2008.10.004

Cossette, L., Malcuit, G., & Pomerleau, A. (1991). Sex differences in motor activity during early infancy. *Infant Behavior and Development, 14,* 175–186. http://dx.doi.org/10.1016/0163-6383(91)90004-C

Crawley, S. B., & Sherrod, K. B. (1984). Parent-infant play during the first year of life. *Infant Behavior and Development, 7,* 65–75. http://dx.doi.org/10.1016/S0163-6383(84)80023-5

Crews, D. (1975). Psychobiology of reptilian reproduction. *Science, 189,* 1059–1065. http://dx.doi.org/10.1126/science.1172294

Crews, D. (1988). The problem with gender. *Psychobiology, 16,* 321–334.

Crews, D. (1992). Diversity of hormone-behavior relations in reproductive behavior. In M. Becker, M. Breedlove, & D. Crews (Eds.), *Introduction to behavioral endocrinology* (pp. 143–186). Cambridge, MA: MIT Press/Bradford Books.

Crews, D., Lou, W., Fleming, A., & Ogawa, S. (2006). From gene networks underlying sex determination and gonadal differentiation to the development of neural networks regulating sociosexual behavior. *Brain Research, 1126,* 109–121. http://dx.doi.org/10.1016/j.brainres.2006.07.031

Crews, D., Rushworth, D., Gonzalez-Lima, F., & Ogawa, S. (2009). Litter environment affects behavior and brain metabolic activity of adult knockout mice. *Frontiers in Behavioral Neuroscience, 3,* 12. http://dx.doi.org/10.3389/neuro.08.012.2009

Deaux, K. (1993). Commentary: Sorry, wrong number—A reply to gentile's call. *Psychological Science, 4,* 125–126.

de Barbaro, K., Johnson, C. M., & Deák, G. O. (2013). Twelve-month "social revolution" emerges from mother-infant sensorimotor coordination: A longitudinal investigation. *Human Development, 56,* 223–248. http://dx.doi.org/10.1159/000351313

de Medeiros, C. B., Rees, S. L., Llinas, M., Fleming, A. S., & Crews, D. (2010). Deconstructing early life experiences: Distinguishing the contributions of prenatal and postnatal factors to adult male sexual behavior in the rat. *Psychological Science, 21,* 1494–1501. http://dx.doi.org/10.1177/0956797610382122

Eagly, A. H., & Wood, W. (2013). The nature-nurture debates: 25 years of challenges in understanding the psychology of gender. *Perspectives on Psychological Science, 8,* 340–357. http://dx.doi.org/10.1177/1745691613484767

Eliot, L. (2009). *Pink brain, blue brain*. Boston, MA: Houghton, Mifflin, Harcourt.

Fagot, B. I., & Hagan, R. (1991). Observations of parent reactions to sex-stereotyped behaviors: Age and sex effects. *Child Development, 62,* 617–628. http://dx.doi.org/10.2307/1131135

Fausto-Sterling, A. (2012). The dynamic development of gender variability. *Journal of Homosexuality, 59,* 398–421. http://dx.doi.org/10.1080/00918369.2012.653310

Fausto-Sterling, A., Coll, C. G., & Lamarre, M. (2012a). Sexing the baby: Pt. 1—What do we really know about sex differentiation in the first three years of life? *Social Science & Medicine, 74,* 1684–1692. http://dx.doi.org/10.1016/j.socscimed.2011.05.051

Fausto-Sterling, A., Coll, C. G., & Lamarre, M. (2012b). Sexing the baby: Pt. 2—Applying dynamic systems theory to the emergences of sex-related differences in infants and toddlers. *Social Science & Medicine, 74,* 1693–1702. http://dx.doi.org/10.1016/j.socscimed.2011.06.027

Feldman, R. (2007a). On the origins of background emotions: From affect synchrony to symbolic expression. *Emotion, 7,* 601–611. http://dx.doi.org/10.1037/1528-3542.7.3.601

Feldman, R. (2007b). Parent-infant synchrony and the construction of shared timing; physiological precursors, developmental outcomes, and risk conditions. *Journal of Child Psychology and Psychiatry, 48,* 329–354. http://dx.doi.org/10.1111/j.1469-7610.2006.01701.x

Feldman, R., & Eidelman, A. I. (2003). Skin-to-skin contact (kangaroo care) accelerates autonomic and neurobehavioural maturation in preterm infants. *Developmental Medicine and Child Neurology, 45,* 274–281. http://dx.doi.org/10.1111/j.1469-8749.2003.tb00343.x

Feldman, R., Gordon, I., Schneiderman, I., Weisman, O., & Zagoory-Sharon, O. (2010). Natural variations in maternal and paternal care are associated with systematic changes in oxytocin following parent-infant contact. *Psychoneuroendocrinology, 35,* 1133–1141. http://dx.doi.org/10.1016/j.psyneuen.2010.01.013

Feldman, R., & Greenbaum, C. W. (1997). Affect regulation and synchrony in mother—Infant play as precursors to the development of symbolic competence. *Infant Mental Health Journal, 18,* 4–23. http://dx.doi.org/10.1002/(SICI)1097-0355(199721)18:1<4::AID-IMHJ2>3.0.CO;2-R

Feldman, R., Rosenthal, Z., & Eidelman, A. I. (2014). Maternal-preterm skin-to-skin contact enhances child physiologic organization and cognitive control across the first 10 years of life. *Biological Psychiatry, 75,* 56–64.

Feldman, R., Weller, A., Sirota, L., & Eidelman, A. I. (2003). Testing a family intervention hypothesis: The contribution of mother-infant skin-to-skin contact (kangaroo care) to family interaction, proximity, and touch. *Journal of Family Psychology, 17,* 94–107. http://dx.doi.org/10.1037/0893-3200.17.1.94

Fenson, L., Dale, P. S., Reznick, J. S., Bates, E., Thal, D. J., Pethick, S. J., . . . Stiles, J. (1994). Variability in early communicative development. *Monographs of the Society for Research in Child Development, 59,* 1–173. http://dx.doi.org/10.2307/1166093

Ferber, S. G., Feldman, R., & Makhoul, I. R. (2008). The development of maternal touch across the first year of life. *Early Human Development, 84,* 363–370. http://dx.doi.org/10.1016/j.earlhumdev.2007.09.019

Field, T. (2010). Touch for socioemotional and physical well-being: A review. *Developmental Review, 30,* 367–383. http://dx.doi.org/10.1016/j.dr.2011.01.001

Fogel, A., & Dekoeyer-Laros, I. (2007). The developmental transition to secondary intersubjectivity in the second half year: A microgenetic case study. *The Journal of Developmental Processes, 2,* 63–90.

Fogel, A., Garvey, A., Hsu, H.-C., & West-Stroming, D. (2006). *Change processes in relationships: A relational-historical research approach*. Cambridge, UK: Cambridge University Press. http://dx.doi.org/10.1017/CBO9780511489686

Fogel, A., & Thelen, E. (1987). Development of early expressive and communicative action: Reinterpreting the evidence from a dynamic systems perspective. *Developmental Psychology, 23,* 747–761. http://dx.doi.org/10.1037/0012-1649.23.6.747

Fogel, A., Toda, S., & Kawai, M. (1988). Mother–infant face-to-face interaction in Japan and the United States: A laboratory comparison using 3-month-old infants. *Developmental Psychology, 24,* 398–406. http://dx.doi.org/10.1037/0012-1649.24.3.398

Goldberg, S., & Lewis, M. (1969). Play behavior in the year-old infant: Early sex differences. *Child Development, 40,* 21–31. http://dx.doi.org/10.2307/1127152

Gottlieb, G. (1997). *Synthesizing nature–nurture: Prenatal roots of instinctive behavior*. Mahwah, NJ: Erlbaum.

Grossmann, T. (2010). The development of emotion perception in face and voice during infancy. *Restorative Neurology and Neuroscience, 28,* 219–236.

Hadders-Algra, M. (2002). Variability in infant motor behavior: A hallmark of the healthy. *Infant Behavior and Development, 25,* 433–451. http://dx.doi.org/10.1016/S0163-6383(02)00144-3

Hertenstein, M. J., & Campos, J. J. (2001). Emotion regulation via maternal touch. *Infancy, 2,* 549–566. http://dx.doi.org/10.1207/S15327078IN0204_09

Hines, M., Johnston, K. J., Golombok, S., Rust, J., Stevens, M., & Golding, J. (2002). Prenatal stress and gender role behavior in girls and boys: A longitudinal, population study. *Hormones and Behavior, 42,* 126–134.

Hsu, H.-C., & Fogel, A. (2001). Infant vocal development in a dynamic mother–infant communication system. *Infancy, 2,* 87–109. http://dx.doi.org/10.1207/S15327078IN0201_6

Hsu, H.-C., & Fogel, A. (2003a). Stability and transitions in mother-infant face-to-face communication during the first 6 months: A microhistorical approach. *Developmental Psychology, 39,* 1061–1082. http://dx.doi.org/10.1037/0012-1649.39.6.1061

Hsu, H.-C., & Fogel, A. (2003b). Social regulatory effects of infant nondistress vocalization on maternal behavior. *Developmental Psychology, 39,* 976–991.

Jadva, V., Hines, M., & Golombok, S. (2010). Infants' preferences for toys, colors, and shapes: Sex differences and similarities. *Archives of Sexual Behavior, 39,* 1261–1273. http://dx.doi.org/10.1007/s10508-010-9618-z

Jean, A. D., Stack, D. M., & Fogel, A. (2009). A longitudinal investigation of maternal touching across the first 6 months of life: Age and context effects. *Infant Behavior and Development, 32,* 344–349. http://dx.doi.org/10.1016/j.infbeh.2009.04.005

Karrass, J., Braungart-Rieker, J. M., Mullins, J., & Lefever, J. B. (2002). Processes in language acquisition: The roles of gender, attention, and maternal encouragement of attention over time. *Journal of Child Language, 29,* 519–543. http://dx.doi.org/10.1017/S0305000902005196

Keller, H., Otto, H., Lamm, B., Yovsi, R. D., & Kärtner, J. (2008). The timing of verbal/vocal communications between mothers and their infants: A longitudinal cross-cultural comparison. *Infant Behavior and Development, 31,* 217–226. http://dx.doi.org/10.1016/j.infbeh.2007.10.001

Kisilevsky, B. S., Hains, S. M., Lee, K., Xie, X., Huang, H., Ye, H. H., . . . Wang, Z. (2003). Effects of experience on fetal voice recognition. *Psychological Science, 14,* 220–224.

Kuhl, P. K. (2010). Brain mechanisms in early language acquisition. *Neuron, 67,* 713–727. http://dx.doi.org/10.1016/j.neuron.2010.08.038

Kuo, Z.-Y. (1976). *The dynamics of behavior development: An epigenetic view*. Oxford, UK: Plenum Press.

Laflamme, D., Pomerleau, A., & Malcuit, G. (2002). A comparison of fathers' and mothers' involvement in childcare and stimulation behaviors during free-play with their infants at 9 and 15 months. *Sex Roles, 47,* 507–518. http://dx.doi.org/10.1023/A:1022069720776

Landerholm, E. J., & Scriven, G. (1981). A comparison of mother and father interaction with their six-month-old male and female infants. *Early Child Development and Care, 7,* 317–328. http://dx.doi.org/10.1080/0300443810070405

Lavelli, M., & Fogel, A. (2002). Developmental changes in mother–infant face-to-face communication: Birth to 3 months. *Developmental Psychology, 38,* 288–305. http://dx.doi.org/10.1037/0012-1649.38.2.288

Lehrman, D. S. (1965). Interaction between internal and external environments in the regulation of the reproductive cycle of the ring dove. In F. Beach (Ed.), *Sex and behavior* (pp. 355–380). New York, NY: Wiley and Sons.

Lippa, R. (2008). The relation between childhood gender nonconformity and adult masculinity–femininity and anxiety in heterosexual and homosexual men and women. *Sex Roles, 59,* 684–693. http://dx.doi.org/10.1007/s11199-008-9476-5

Lytton, H., & Romney, D. M. (1991). Parents' differential socialization of boys and girls: A meta-analysis. *Psychological Bulletin, 109,* 267–296. http://dx.doi.org/10.1037/0033-2909.109.2.267

Malatesta, C. Z., Culver, C., Tesman, J. R., & Shepard, B. (1989). The development of emotion expression during the first two years of life. *Monographs of the Society for Research in Child Development, 54,* 1–104.

Martin, C. L., & Ruble, D. N. (2010). Patterns of gender development. *Annual Review of Psychology, 61,* 353–381. http://dx.doi.org/10.1146/annurev.psych.093008.100511

Martin, K. A. (1998). Becoming a gendered body: Practices of preschools. *American Sociological Review, 63,* 494–511. http://dx.doi.org/10.2307/2657264

McIntyre, M. H., & Edwards, C. P. (2009). The Early development of gender differences. *Annual Review of Anthropology, 38,* 83–97. http://dx.doi.org/10.1146/annurev-anthro-091908-164338

Moore, C. L., & Morelli, G. A. (1979). Mother rats interact differently with male and female offspring. *Journal of Comparative and Physiological Psychology, 93,* 677–684. http://dx.doi.org/10.1037/h0077599

Moreno, A. J., Posada, G. E., & Goldyn, D. T. (2006). Presence and quality of touch influence coregulation in mother–infant dyads. *Infancy, 9,* 1–20.

Paoletti, J. B. (1987). Clothing and gender in America: Children's fashions 1890–1920. *Signs: Journal of Women in Culture and Society, 13,* 136–143. http://dx.doi.org/10.1086/494390

Paoletti, J. B. (1997). The gendering of infants' and toddlers' clothing in America. In K. Martinez & K. L. Amers (Eds.), *The material culture of gender; The gender of material culture* (pp. 27–35). Hanover, UK: University Press of New England.

Pomerantz, E. M., & Ruble, D. N. (1998). The role of maternal control in the development of sex differences in child self-evaluative factors. *Child Development, 69,* 458–478. http://dx.doi.org/10.1111/j.1467-8624.1998.tb06202.x

Power, T. G., & Parke, R. D. (1983). Patterns of mother and father play with their 8-month-old infant: A multiple analyses approach. *Infant Behavior and Development, 6,* 453–459. http://dx.doi.org/10.1016/S0163-6383(83)90256-4

Ruble, D. N., Martin, C. L., & Berenbaum, S. A. (2006). Handbook of child psychology. In N. Eisenberg (Ed.), *Gender development* (6th ed., Vol. 3, pp. 858–932). Hoboken, NJ: Wiley and Sons.

Ryan, B. C., & Vandenbergh, J. G. (2002). Intrauterine position effects. *Neuroscience and Biobehavioral Reviews, 26,* 665–678. http://dx.doi.org/10.1016/S0149-7634(02)00038-6

Scarpino, S. V., Gillette, R., & Crews, D. (2014). MultiDimBio: An R package for the functional landscape analysis of multivariate data. arXiv preprint arXiv:14040594. *Methods in Ecology and Evolution*.

Schneirla, T. C., & Rosenblatt, J. S. (1963). "Critical Periods" in the Development of Behavior. *Science, 139,* 1110–1115. http://dx.doi.org/10.1126/science.139.3559.1110

Seifer, R., Sameroff, A. J., Barrett, L. C., & Krafchuk, E. (1994). Infant temperament measured by multiple observations and mother report. *Child Development, 65,* 1478–1490. http://dx.doi.org/10.2307/1131512

Smith, L. B. (2005). Cognition as a dynamic system: Principles from embodiment. *Developmental Review, 25,* 278–298. http://dx.doi.org/10.1016/j.dr.2005.11.001

Spencer, J. P., Clearfield, M., Corbetta, D., Ulrich, B., Buchanan, P., & Schoner, G. (2006). Moving toward a grand theory of development: In memory of Esther Thelen. *Child Development, 77,* 1521–1538.

Stepakoff, S. A. (2000). *Mother–infant tactile communication at four months: Effects of infant gender, maternal ethnicity, and maternal depression*. New York, NY: St. John's University.

Stone, S. A., DeKoeyer-Laros, I., & Fogel, A. (2012). Self and other dialogue in infancy: Normal versus compromised developmental pathways. *New Directions for Child and Adolescent Development, 2012,* 23–38. http://dx.doi.org/10.1002/cad.20015

Sung, J., Fausto-Sterling, A., Garcia Coll, C., & Seifer, R. (2013). The dynamics of age and sex in the development of mother–infant vocal communication between 3 and 11 months. *Infancy, 18,* 1135–1158. http://dx.doi.org/10.1111/infa.12019

Thelen, E. (1995a). Motor development. A new synthesis. *American Psychologist, 50,* 79–95. http://dx.doi.org/10.1037/0003-066X.50.2.79

Thelen, E. (1995b). Origins of motor control. *Behavioral and Brain Sciences, 18,* 780–783. http://dx.doi.org/10.1017/S0140525X00041030

Thelen, E. (2000). Grounded in the world: Developmental origins of the embodied mind. *Infancy, 1,* 3–28. http://dx.doi.org/10.1207/S15327078IN0101_02

Thelen, E., & Smith, L. (1994). *A dynamic systems approach to the development of cognition and action*. Cambridge, MA: MIT Press.

Thomas, J. R., & French, K. E. (1985). Gender differences across age in motor performance a meta-analysis. *Psychological Bulletin, 98,* 260–282. http://dx.doi.org/10.1037/0033-2909.98.2.260

van Geert, P., & Steenbeek, H. (2005). Explaining after by before: Basic aspects of a dynamic systems approach to the study of development. *Developmental Review, 25,* 408–442. http://dx.doi.org/10.1016/j.dr.2005.10.003

van Geert, P. L. C., & Steenbeek, H. W. (2013). (P) (re) presentations: What are they and how do they develop? Commentary on "Stepping off the pendulum: Why only an action-based approach can transcend the nativist–empiricist debate" by J. Allen & M. Bickhard. *Cognitive Development, 28,* 138–143. http://dx.doi.org/10.1016/j.cogdev.2013.01.004

Weinberg, M. K., Tronick, E. Z., Cohn, J. F., & Olson, K. L. (1999). Gender differences in emotional expressivity and self-regulation during early infancy. *Developmental Psychology, 35,* 175–188. http://dx.doi.org/10.1037/0012-1649.35.1.175

Weiss, S. J., Wilson, P., Hertenstein, M. J., & Campos, R. (2000). The tactile context of a mother's caregiving: Implications for attachment of low birth weight infants*. *Infant Behavior and Development, 23,* 91–111. http://dx.doi.org/10.1016/S0163-6383(00)00030-8

West-Eberhard, M. M. (2003). *Developmental Plasticity and Evolution*. Oxford, UK: Oxford University Press.

Zucker, K. J. (2008). Reflections of the relation between sex-typed behavior in childhood and sexual orientation in adulthood. *Journal of Gay & Lesbian Mental Health, 12,* 29–59.

Appendix

Table A1
Categorization and Definitions of Touch Codes

Touch Code	Category	Definition
Care-taking	Positive	Mother engages physically with infant to perform a caretaking task, such as wiping nose, diapering, dressing or adjusting clothing, cleaning, feeding, burping, or protecting. Kappa=1.00
Affectionate touch	Positive	Any touch or behavior which primarily conveys affection: includes tickles, nuzzles, kisses, stroking, hugging. Kappa= 0.89
Rock-jiggle	Stimulatory	Mother rocks, jiggles, or moves infant in a rhythmic manner. Kappa=0.90
Lift up	Stimulatory	Mother lifts infant into air as a kind of motor play type, not merely for shifting position. Kappa=0.80
Gross Motor	Stimulatory	Mother moves infant's limbs to mimic infant gross motor behavior such as kicking or flailing the arms. Kappa=0.77
Assist Fine Motor	Instrumental	Mother assists infant's manipulation or use of an object; mother holds the infant's hand or fingers. Kappa=0.70
Assist shift	Instrumental	Mother repositions infant, e.g shifts infant from sitting to standing position, or closer to a toy. Little to no effort displayed by infant. Kappa=0.70
Assist hold	Instrumental	To assist infant's locomotion or movement, the mother holds infant's arms, torso, or legs. Kappa=0.70

(*Appendix continues*)

Table A2
Definitions of Infant Gross Motor Codes

Activity	Modifier	Definition
Lying	Still	Infant's position is static
	Roll over	Infant rolls over either from stomach to back or vice versa
	Kick/Leg movement	In lying position, any medium to large gross motor movement of legs
Sitting	Independent	Infant seated without support
	Assisted-Mom	Sits with maternal support
	Assisted-other	Typically in a seat with back support, e.g. high chair, or swing with a back
	Rock/lean/bounce	When sitting independently or other assisted infant rocks or bounces repetitively
Reaching	Grasp/touch object	Infant extends arm to grasp or touch an object
	Offer or show objects	Infant extends arm to offer show an object to the mother
	Other	Infant extends arm in any other fashion
Bat, clap, bang, flail		In contrast to reaching, batting consists of efforts to hit or bang an object or repetitive movement of large arm muscles not directed at a specific object (e.g., flailing).
Pointing		Both arm and finger are extended in the direction of the object of interest.

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