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Culture, carrying, and communication: Beliefs and behavior associated with babywearing

Emily E. Little

The University of Texas at Austin

Cristine H. Legare

The University of Texas at Austin

Leslie J. Carver

University of California, San Diego

Abstract

Ethnographic research suggests mother-infant physical contact predicts high levels of maternal responsiveness to infant cues, yet it is unclear whether this responsiveness is driven by the act of physical contact or by underlying beliefs about responsiveness. We examine beliefs and behavior associated with infant carrying (i.e., babywearing) among U.S. mothers and experimentally test the effect of mother-infant physical contact on maternal responsiveness. In Study 1 ($N = 23$ dyads), babywearing mothers were more likely to interact contingently in response to infant cues than non-babywearing mothers during an in-lab play session. In Study 2 ($N = 492$ mothers), babywearing predicted maternal beliefs emphasizing responsiveness to infant cues. In Study 3 ($N = 20$ dyads), we experimentally manipulated mother-infant physical contact in the lab using a within-subjects design and found that babywearing increased maternal tactile interaction, decreased maternal and infant object contact, and increased maternal responsiveness to infant vocalizations. Our results motivate further research examining how culturally-mediated infant carrying practices shape the infant's early social environment and subsequent development.

Keywords: mother-infant interaction; babywearing; maternal responsiveness; physical contact; touch

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Human infants are born in an altricial state of dependence that is unique among primates, making how mothers – and others – respond to cues critical for neonatal survival (Hrdy, 2011). Maternal responsiveness is defined as prompt, appropriate responses to cues and is associated with a range of benefits for infant development (Ainsworth, 1978; Bornstein et al., 1992; De Wolff & Van Ijzendoorn, 1997). Ethnographic accounts of infant care show that mother-infant physical contact – facilitated by culturally-mediated infant carrying practices – is consistently associated with high levels of maternal responsiveness (Barr, Konner, Bakeman & Adamson, 1991; Caudill & Schooler, 1973; Hewlett et al., 1998; Mesman et al., 2017). Yet the role of physical contact in maternal responsiveness has not been tested among U.S. populations, where the majority of developmental research has been conducted (Nielsen et al., 2017). Here, we test the hypothesis that mother-infant physical contact facilitates increased maternal responsiveness to infant cues. We examine both the behavior (Study 1) and beliefs (Study 2) associated with babywearing, a practice that emphasizes mother-infant physical contact by using slings, wraps, or structured carriers to maintain physical contact with infants through hands-free carrying. We also measure within-subject differences in maternal responsiveness when mothers and infants are in physical contact versus not in physical contact by manipulating mother-infant physical contact in the lab (Study 3).

Babywearing

Using tools to keep infants in close physical contact has a long history in human populations (Wall-Scheffler, Geiger, & Steudel-Numbers, 2007). Newborn non-human primate

offspring are able to cling to mothers to maintain near-constant physical contact. Yet changes in body hair, foot anatomy, upright posture, and post-natal maturity in humans are all associated with the loss of the infant grasping ability (Tanner & Zihlman, 1976). This left human adults with the energetic burden of having to carry infants in-arms. Transporting infants through in-arms carrying is established as the most costly form of parental investment apart from breastfeeding (Altmann & Samuels, 1992). This leads to an estimated metabolic cost increase of 500 kilocalories per day (Gettler, 2010; Leonard & Robertson, 1995; Wall-Scheffler & Myers, 2008). Early hominids may have developed tools to maintain close contact (e.g., cloth slings) to compensate for the high energetic cost of using the arms to carry infants long distances during upright bipedal transit, (Wall-Scheffler, Geiger, & Steudel-Numbers, 2007). The use of tools like slings makes carrying more efficient and less strenuous than in-arms carrying, allowing adults to travel longer and faster.

Babywearing is still the primary method of transporting infants in many non-Western societies around the world (e.g., Mali, Dettwyler, 1988). Populations that engage in high levels of mother-infant physical contact through babywearing and cosleeping (i.e., maintaining physical contact throughout the night by bed-sharing) are characterized as proximal care cultures (Keller, 2002). This sustained physical contact throughout the day and night is proposed to have implications for infant nutrition (e.g., Little, Legare, & Carver, 2018; McKenna & Gettler, 2016; Pisacane et al., 2012) and direct skin-to-skin contact has well documented effects on maternal health and infant development (e.g., Bigelow et al., 2012; Bigelow & Power, 2012; Moore et al., 2012). Less is known about how carrying – without direct skin-to-skin contact – may shape maternal responsiveness and mother-infant interaction. In proximal care cultures, caregivers

respond contingently – in an anticipatory fashion – to infant cues (Barr, Konner, Bakeman & Adamson, 1991; Caudill & Schooler, 1973; Hewlett et al., 1998; Mesman et al., 2017). Yet there are very few studies documenting a connection between physical contact and maternal responsiveness outside of the context of the anthropological literature in non-Western cultures.

Many cultures that practice proximal care also espouse parenting beliefs that emphasize the importance of maternal responsiveness, mother-infant closeness, and minimizing infant distress (e.g., Keller et al., 2009; Lamm & Keller, 2007). These beliefs are referred to as parental ethnotheories, or cultural models used by parents to define their role as parents and their goals for their children and families (Harkness & Super, 2006). Parental ethnotheories predict variation in behavior both within and across populations (e.g., Harwood, Schoelmerich, Schulze, & Gonzalez, 1999; Keller et al., 2004), including specific variation in maternal responsiveness (Bornstein et al., 1992; Broesch et al., 2016; Kärtner et al., 2008; Kärtner, Keller, & Yovsi, 2010). High levels of physical contact are associated with a set of beliefs about infancy that emphasize not only the importance of maternal proximity, but also the need for immediate responses to infant cues and breastfeeding as a strategy to minimize infant distress (e.g., Keller, 2002).

In the U.S. and other Western, industrialized societies, mother-infant interaction is most often characterized as distal care (i.e., face-to-face interaction and object stimulation, Keller et al., 2009). Infants spend the majority of their time in devices that limit physical contact with caregivers, including cribs, strollers, car seats, playpens, bouncers, and swings (Maudlin, Sandlin, & Thaller, 2012). Though babywearing is gaining popularity as an alternative to these bucket-like devices, very little is known about maternal behavior and beliefs associated with this practice among U.S. mothers. One study examined proximal care parenting among a Western population

in the U.K., finding that infants of proximal care parents were carried more and cried less (St James-Roberts et al., 2006). However, this has not been investigated specifically with babywearing among U.S. mothers. It is unclear the extent to which mothers practicing babywearing in the U.S. subscribe to the parenting beliefs traditionally associated with proximal care in non-Western cultures. It is also an open question whether babywearing practices in the U.S. predict increased maternal responsiveness, independent of alignment with proximal care beliefs.

Maternal responsiveness

Maternal responsiveness is operationalized in the literature as contingent changes in maternal behavior occurring within 1-2 seconds of an infant cue (Broesch et al., 2016). Contingent responsiveness shapes social learning (Bigelow & Birch, 1999), language acquisition (Nicely, Tamis-LeMonda, & Bornstein, 1999; Tamis-LeMonda, Kuchirko, & Song, 2014), and attachment formation (Ainsworth, Blehar, Waters, & Wall, 1978; Anisfeld, Casper, Nozyce, & Cunningham, 1990; Dunst & Kassow, 2008). Though developmental implications of maternal responsiveness are well established, little research has investigated what predicts high levels of maternal responsiveness.

A handful of studies have examined the connection between infant carrying and maternal responsiveness among mothers in Western populations. Hunziker and Barr (1986) conducted a randomized controlled trial of increased infant carrying, showing that infants in the experimental group who were carried more cried significantly less than infants in the control group, which the authors interpreted as an increase in prompt responses to infant needs. In the context of breastfeeding, mother-infant physical contact among dyads in the U.S. predicts increased responsiveness to early infant hunger cues (Little, Legare, & Carver, 2018). Anisfeld and

colleagues (1990) randomly assigned at-risk low-income parents to an infant carrying intervention aimed to increase physical contact via babywearing. After three months of the intervention, parents in the physical contact group were more vocally responsive to their infants during a play session. At 12 months, the infants in the experimental group were more likely to be securely attached to their caregivers, suggesting that the increased responsiveness caused by the carrying intervention may have been driving the quality of the mother-infant relationship (Anisfeld et al., 1990).

Yet responsiveness is not expressed in the same way across cultural contexts. Mothers in many proximal care cultures (e.g., Gussii mothers in Kenya, Richman et al., 1992; !Kung San mothers in Botswana, Barr et al., 1991; Nso mothers in Camaroon, Kärtner et al., 2010) respond more often to infant indications of discomfort rather than positive cues as a way to prevent overt displays of distress. In contrast, typical mother-infant interaction in the U.S. (i.e., distal care culture) is characterized by encouragement of positive emotionality. It is an open question whether mothers in the U.S. who practice babywearing show patterns of responsiveness that are similar in quality, modality, and valence to the responsiveness practiced by mothers in proximal care contexts.

Current studies

In three studies, we examined the roles of mother-infant physical contact and maternal beliefs in responsiveness to infant cues during dyadic social interaction. In Study 1, mothers and their infants participated in a face-to-face play session in the lab, where we compared self-identified babywearing and non-babywearing mothers on their contingent responsiveness to infant positive and negative facial cues. We predicted that babywearing mothers would be more

responsive to infant cues overall. Because the ethnographic literature documents that mothers in proximal care cultures often respond more to negative than positive cues to minimize overt displays of distress, we predicted that babywearing mothers – in contrast to non-babywearing mothers – would be more responsive to negative rather than positive infant cues. In Study 2, we examined whether mothers who practiced babywearing have a set of parenting beliefs distinct from non-babywearing mothers. We predicted that babywearing mothers would be more likely to espouse beliefs typically associated with proximal care in non-Western cultures (e.g., responsiveness, on-demand nursing). In Study 3, we manipulated mother-infant contact in the lab with a within-subject comparison of maternal responsiveness to infant cues when wearing the infant in a carrier and when in face-to-face contact (with no physical contact). We predicted that mothers would show increased responsiveness when the infant was in the carrier.

Study 1

Our first objective in Study 1 was to examine whether the practice of babywearing predicted differences in the contingency of maternal responses to infant cues. Mothers who practiced babywearing as the primary method of transporting their infant (babywearers) and mothers who did not practice babywearing (non-babywearers) participated in a face-to-face play session in the lab where we measured overall contingent responsiveness to infant cues. In line with past work (e.g., Anisfeld et al., 1990), we predicted that mothers who practiced babywearing would be more likely to respond contingently to infant cues than non-babywearers.

Our second objective was to test whether babywearing was associated with a difference in the specific type of responsiveness, with regard to the valence of infant cues to which mothers respond. Responsiveness in many non-Western proximal care cultures is characterized by

responding to indications of infant discomfort as a way to mitigate infant distress (Keller et al., 2009; Richman, Miller, & LeVine, 1992). Mothers in many proximal care cultures are more likely to respond to negative versus positive infant cues as a way to address needs and minimize distress rather than stimulating positive emotionality (e.g., Richman et al., 1992; Barr et al., 1991; Kärtner et al., 2010). This is in stark contrast to mothers in the U.S. who go to great lengths to highlight infant positive emotion and respond more enthusiastically to positive cues. Because of these observations of responsiveness among mothers in non-Western proximal care cultures, we predicted that increased physical contact might make mothers in the U.S. more similar to mothers in proximal care culture and therefore more likely to respond to infant negative cues rather than positive cues. We measured the proportion of infant positive cues versus negative cues to which the mother responded. If mothers in the U.S. who practice babywearing are similar to mothers in proximal care cultures, we would expect these mothers to be more likely to respond to infant negative cues rather than positive cues.

Our third objective was to assess differences in infant behavior between infants of babywearing and non-babywearing mothers. Given the bi-directionality of mother-infant interaction, it is difficult to make conclusions about physical contact and maternal responsiveness without taking into account differences in infant behavior that may be indirectly influencing maternal behavior. Here, we are able to document differences in both infant behavior and maternal behavior associated with the practice of babywearing.

Method

All procedures and recruitment methods were approved by the Institutional Review Board of University of California, San Diego.

Participants. Twenty-three mothers and their infants ($M = 9.25$ months, $SD = 2.16$ months, 4.4- 11.93 months) participated in this study. Mothers were categorized as babywearers if they identified babywearing as the primary means of transporting their infant. Mothers were categorized as non-babywearers if they reported using strollers or other methods of transporting their infant. These dyads were recruited both from a subject list compiled from the San Diego County Records Office and from social media recruitment within parenting groups.

Setup. Two FlipCam video cameras were setup with flexible GorillaPod tripods in the experimental room to record the mother-infant interaction. One camera was positioned across from the infant, to record the infant's facial expressions, while the second camera was positioned across from the mother's face. The infant was positioned in a plastic play chair with a plastic tray. There was a rubber play mat on the floor, and mothers were instructed to sit on the floor across from the infant. Figure 1 shows the position of the mother and baby for both conditions.

Procedure. Mothers came into the lab with their infant where the study was explained to them and written consent was obtained. Mothers used a written form to answer basic demographic questions as well as the babywearing categorization question: "What is the primary method you use to transport your baby?" Mothers could only choose one response (babywearing, carrying, car seat, or stroller). Mothers were categorized as babywearers if their response to this question was babywearing. For the play session, mothers were positioned face-to-face across from their infant, who was sitting in a play chair with a tray. Mothers were told to play with their infant however they wanted for two minutes. No toys were provided. The experimenter pressed record on the two video cameras than left the room during the play session while mother and infant were videotaped.

Coding. The videotaped interaction was coded for infant displays of positive and negative affect, infant gaze, and maternal contingent responses to infants' positive and negative cues. Mothers were measured on the overall proportion of infant cues to which they responded contingently, as well as the valence of infant cues to which they responded (i.e., proportion of the infant's positive cues to which they responded, proportion of the infant's negative cues to which they responded). For the behavioral outcome measures, coding was completed by two coders – blind to the hypotheses of the study – through the use of ELAN, video annotation software developed by the Max Planck Institute for Psycholinguistics (Lausberg & Sloetjes, 2009). The coding software allowed for the documentation of the exact start time and end time of each behavior, providing a measure of total frequency and duration of each behavior. Coders first documented the total duration of each infant behavior (positive affect, negative affect, gaze), spending one pass through the video for each behavior. Maternal responsiveness was coded by going back through the video and for each instance of infant positive or negative affect, looking at the one-second window after the behavior to see if the mother's infant-directed behavior changed. The coders completed the first 20% of the participant videos together and any discrepancies were discussed until coders achieved frame-by-frame agreement. All subsequent videos were coded independently.

Overall maternal responsiveness. Contingent responsiveness was coded whenever the mother's infant-directed behavior changed within the one-second window after an infant display of positive or negative affect (e.g., baby smiled and mom smiled, baby frowned and mom vocalized). This temporal window is consistent (e.g., Broesch et al., 2016) or even more conservative (e.g., Anisfeld et al., 1990) than past work in the literature on maternal

responsiveness. For each participant, we calculated total proportion of cues to which the mother responded (total maternal responses divided by total occurrences of infant positive or negative affect).

Maternal responsiveness to positive cues. We calculated the number of positive cues to which the mother responded within a one-second window. For each mother, we calculated the proportion of the infant's positive cues to which she responded (total maternal responses to infant positive affect divided by total occurrences infant positive affect).

Maternal responsiveness to negative cues. We also calculated the specific proportion of negative cues to which the mother responded within a one-second window. For each mother, we calculated the proportion of the infant's negative cues to which she responded (total maternal responses to infant negative affect divided by total occurrences infant negative affect).

Infant positive affect. Positive affect was coded whenever the infant smiled or laughed. A smile was defined as the corners of the infant's mouth being turned upward, with the mouth being either open or closed. For each infant, we calculated the total number of occurrences and total duration (in seconds) during which the baby displayed positive affect.

Infant negative affect. Negative affect was coded whenever the infant frowned, grimaced, or cried. A frown was defined as the corners of the infant's mouth being turned downward, with the mouth being either open or closed. For each infant, we calculated the total number of occurrences and total duration (in seconds) during which the baby displayed negative affect.

Infant gaze. To assess the level of social engagement across the two groups, we measured infant gaze as anytime the infant was looking at the mother's face (irrespective of whether the

mother was currently looking at the infant). For each infant, we calculated the total number of occurrences and total duration (in seconds) during which the baby gazed at the mother.

Results

Fourteen of the mothers were categorized as babywearers and nine of the mothers were categorized as non-babywearers. There was no difference between the babywearers ($M = 9.14$ months, $SE = .59$ months) and the non-babywearers ($M = 9.47$, $SE = .74$) with regard to infant age, $F(1, 22) = .15$, $p = .70$.

Analyses. To test the prediction that babywearing mothers would show increased responsiveness to infant cues, we conducted Analysis of Variance (ANOVA) tests for each of the dependent measures of infant behavior and maternal responsiveness, with group (babywearing versus non-babywearing) as the predictor variable.

Collapsing across the two physical contact groups, infant age was not predictive of infant positive affect, infant negative affect, infant gaze, maternal responsiveness to positive cues, maternal responsiveness to negative cues, or overall maternal responsiveness (all $ps > .1$).

Overall maternal responsiveness. There was a significant difference between the babywearers ($M = .84$, $SE = .05$) and the non-babywearers ($M = .62$, $SE = .07$) with regard to overall proportion of the infant cues to which the mother responded, $F(1, 21) = 5.48$, $p = .03$, $\eta^2 = .22$, see Figure 2.

Maternal responsiveness to positive cues. There was a significant difference between the babywearers ($M = .82$, $SE = .07$) and the non-babywearers ($M = .57$, $SE = .08$) with regard to proportion of the infant positive cues to which the mother responded, $F(1, 21) = 5.13$, $p = .03$, $\eta^2 = .20$.

Maternal responsiveness to negative cues. There was no difference between the babywearers ($M = .83$, $SE = .12$) and the non-babywearers ($M = .59$, $SE = .15$) with regard to proportion of the infant negative cues to which the mother responded, $F(1, 12) = 1.56$, $p = .24$, $\eta^2 = .12$.

Infant positive affect. There was no significant difference between the babywearers ($M = 24.14$ seconds, $SE = 3.42$) and the non-babywearers ($M = 19.40$ seconds, $SE = 4.27$) with regard to duration of infant positive affect, $F(1, 22) = .75$, $p = .40$, $\eta^2 = .03$.

Infant negative affect. There was no difference between the babywearers ($M = 11.27$ seconds, $SE = 5.87$) and the non-babywearers ($M = 8.05$ seconds, $SE = 5.87$) with regard to duration of infant negative affect, $F(1, 22) = .18$, $p = .67$, $\eta^2 = .008$.

Infant gaze. There was no difference between the babywearers ($M = 39.41$ seconds, $SE = 7.19$) and the non-babywearers ($M = 26.72$ seconds, $SE = 8.96$) with regard to duration of infant gaze at their mother, $F(1, 22) = 1.22$, $p = .28$, $\eta^2 = .05$.

Discussion

This study examined whether long-term experience with mother-infant physical contact through babywearing predicted differences in maternal responsiveness in the context of a face-to-face mother-infant play paradigm. Our first finding was in line with our predictions: babywearing mothers were more contingently responsive to infant cues than mothers who did not practice babywearing. This result is consistent with past research showing mothers were more responsive to infant vocalizations after participating in a long-term physical contact intervention (Anisfeld et al., 1990).

In contrast to our predictions, babywearing mothers were more likely to respond to positive cues than non-babywearing mothers, but this group difference was not seen with regard to maternal responses to infant negative cues. Given that responsiveness in proximal care cultures is characterized by responding to indications of discomfort as a way to mitigate infant distress (Keller et al., 2009; Richman, Miller, & LeVine, 1992), we predicted that increased physical contact might make mothers in the U.S. more likely to respond to negative cues. As we see here, however, it may be that positive affect is valued and emphasized to such a high degree in U.S. culture that socialization of positive emotionality supersedes other differences in interaction style and parenting goals.

Our data showed no differences in infant positive affect, negative affect, or gaze across the two groups. Given that mother-infant interaction is a reciprocal and bidirectional process, one possibility is that experience with babywearing influences maternal interaction behavior by first causing a change in the infant. In this study, there were no differences in infant behavior across the two groups, suggesting that long-term experience with mother-infant physical contact may be affecting maternal responsiveness directly, rather than via a change in infant communication.

The primary limitation of the study was the small sample size and the fact that mothers were not randomly assigned to groups. It is possible that the increased responsiveness could be attributed to the experience with physical contact, but it is just as likely that the increased responsiveness could be explained by differences in maternal beliefs associated with the practice of babywearing. For example, mothers may be more likely to practice babywearing if they support a certain (i.e., responsive) approach to infant care. Ethnographic studies conducted in small-scale societies outside of the U.S. demonstrate that the practice of babywearing is closely

tied to a distinct set of maternal beliefs about infant care and maternal responsiveness, yet no study has evaluated the degree to which U.S. babywearing mothers subscribe to these beliefs. In Study 2, we evaluated whether mothers who practice babywearing in the U.S. espouse a parenting ideology that emphasizes responsiveness, providing a potential interpretation of the results of Study 1. We used a maternal questionnaire (Keller, 2002, see Table 1) to assess whether babywearing predicts increased alignment with the values of proximal care culture.

Study 2

Parenting behavior is associated with variation in beliefs about infant care (e.g., Bornstein, Cote, & Venuti, 2001; Broesch et al., 2016; Hewlett & Lamb, 2002; Lamm & Keller, 2007; Shwalb, Shwalb, & Shoji, 1996). The connection between experience with physical contact and increased maternal responsiveness found in Study 1 could be explained by this difference in parenting beliefs, rather than the practice of babywearing. Practices in the U.S. that facilitate increased mother-infant physical contact (e.g., babywearing, cosleeping) are encouraged by certain parenting communities that simultaneously emphasize an infant-led, responsive approach to infant care (e.g., Attachment Parenting, Granju & Kennedy, 1999; Sears & Sears, 2001). Yet differences in actual parenting beliefs associated with proximal care practices have not been documented systematically among U.S. parents. The aim of Study 2 was to measure parenting beliefs associated with the practice of babywearing among U.S. mothers.

Method

All procedures and recruitment methods were approved by the Institutional Review Board of University of California, San Diego.

Participants. We recruited mothers ($N = 492$) of newborn to 12-month-old infants to fill out an online questionnaire. These dyads were recruited from social media postings within U.S.-based parenting groups. Mothers were 20-45 years of age ($M = 30.85$, $SD = 4.49$) and infants ranged from .23 months to 12.98 months ($M = 6.43$, $SD = 3.47$). Mothers had completed an average of 16.09 years of schooling ($SD = 2.61$, 10-25 years). A little over half of the mothers were currently not working (55.19%) and were multiparous (i.e., had more than one child, 68.11%). About half of the mothers were exclusively breastfeeding (51.53%).

Materials. Maternal questionnaire. Mothers filled out an online questionnaire (administered through the Google Forms platform) which assessed demographic factors, babywearing practices, and infant feeding practices.

Demographics. Demographic information was solicited from each mother, including maternal age, maternal education, employment, and number of children.

Breastfeeding status. Given that breastfeeding is closely tied to the beliefs and practices of proximal care cultures, we asked mothers about their current feeding method (exclusive breastfeeding, some breastfeeding, no breastfeeding).

Mother-infant physical contact. To assess long-term mother-infant physical contact, we asked about general use of babywearing as the primary transport method (in comparison with arm carrying or stroller use), as well as variation in the intensity of babywearing (e.g., hours per day spent babywearing, infant age at babywearing initiation). We also measured motivation for babywearing.

Maternal beliefs. To assess parenting beliefs, mothers were asked about their agreement or disagreement with general parenting statements – or “ethnotheories” – regarding different

components of maternal behavior toward a 3-month-old infant. This instrument has been used globally to assess the degree of alignment with proximal care versus distal care parenting goals (Keller, 2002, see Table 1). Responses to each question were on a scale from one (completely disagree) to five (completely agree). Responses from each participant were compiled to form a proximal care belief score, calculated by summing responses from all questions aimed to measure alignment with goals of proximal care parenting culture then subtracting the sum of responses to all questions designed to test alignment with goals of distal care parenting culture. The range of possible scores was negative 20 to positive 20. Any positive score indicated that mothers leaned more toward the values of proximal care culture than distal care culture, and a higher score indicated a greater agreement with the parenting goals characteristic of proximal care culture.

Procedure. After mothers expressed interest in participating in the study, they were contacted electronically by a research assistant who explained the study and obtained consent. Participants filled out the online questionnaire from their home, administered through the Google Forms platform.

Results

Many mothers reported babywearing as their primary infant transport method (72.82%) with the other mothers choosing in-arms carrying (15.92%) and strollers/seats (11.25%). Mothers reported initiating babywearing at age zero to six months ($M = .41$, $SD = 1.01$) and reported babywearing for an average of 2.61 hours per day ($SD = 2.44$, 0-15 hours).

Analyses. We first conducted a linear regression to predict maternal beliefs (i.e., degree of alignment with proximal care culture) from babywearing (versus arms carrying and stroller use), babywearing intensity (hours per week and age of initiation), and babywearing motivation.

We next tested these effects while controlling for potential confounds by including fixed effects for infant age, maternal age, maternal education, employment, parity, and breastfeeding status.

Babywearing (in comparison with strollers) was predictive of a higher overall proximal care belief score, $\beta = 1.643$, $SE = .399$, $t = 4.11$, $p < .0001$, and arm carrying was not, $\beta = 0.371$, $SE = .519$, $t = 0.71$, $p = .475$. Mothers who practiced babywearing had a higher proximal care belief score ($M = 6.637$, $SE = .309$) than mothers who reported carrying in arms ($M = 5.36$, $SE = .651$) or mothers who used a stroller or seat ($M = 2.980$, $SE = .793$), see Figure 3.

There was also an effect of babywearing intensity. Age of initiation of babywearing (in months) was negatively associated with proximal care belief score, $\beta = -0.659$, $SE = .276$, $t = -2.39$, $p = .017$, such that mothers who had started wearing their infant later in development had a lower proximal care belief score. Hours per day spent babywearing was predictive of a higher proximal care belief score, $\beta = 0.314$, $SE = .111$, $t = 2.83$, $p = .005$.

Reason for babywearing was predictive of proximal care belief score, $F(4, 433) = 3.705$, $p = .006$. Specifically, being motivated to babywear because of convenience was negatively associated with proximal care belief score, $\beta = 3.258$, $SE = 1.623$, $t = -2.01$, $p = .045$. Mothers who reported babywearing for convenience had a lower proximal care belief score ($M = 5.234$, $SE = .348$) than mothers who practiced babywearing for social or cultural reasons ($M = 16$, $SE = 5.621$), for bonding ($M = 6.621$, $SE = .554$), or for health and development ($M = 7.603$, $SE = .681$).

In the multivariate model controlling for infant age, maternal age, maternal education, employment, parity, and breastfeeding status, babywearing (versus strollers) was still significantly predictive of a higher proximal care belief score, $\beta = 1.098$, $SE = 0.433$, $t = 2.54$, $p = .012$, while arm carrying was not, $\beta = 1.098$, $SE = .433$, $t = 1.22$, $p = .222$.

Discussion

The aim of this study was to assess the relationship between babywearing practices and proximal care parenting beliefs among U.S. mothers. Proximal care beliefs have thus far primarily been used to describe parenting beliefs and practices outside of Western populations, but measuring intracultural variation is just as important as intercultural comparisons. Here, we show that babywearing mothers were more likely to espouse parenting beliefs characteristic of proximal care culture. Proximal care parenting beliefs were predicted specifically by age of initiation of babywearing and frequency of this practice in hours per day. Given that U.S. parenting generally aligns with distal care beliefs and practices, these data suggest that babywearing may be more than simply a parenting practice, but rather a central component of a sub-culture of U.S. parents.

Underlying beliefs about responsiveness may have driven the differences in responsiveness between babywearers and non-babywearers observed in Study 1. Another possibility is that the act of physical contact itself directly facilitates an immediate increase in responsiveness to infant cues, independent of maternal beliefs. To test this possibility, Study 3 manipulated mother-infant physical contact in the lab to measure the immediate effect of physical contact on maternal responsiveness.

Study 3

Longitudinal studies have shown a long-term effect of infant carrying and direct skin-to-skin contact on maternal responsiveness (e.g., Anisfeld et al., 1990), yet the length of these interventions make it unclear whether physical contact has an immediate effect on responsiveness. Study 3 used a within-subject manipulation of mother-infant physical contact to

experimentally test whether immediate physical contact facilitated increased maternal responsiveness. Mothers were asked to play naturally with their infant in two conditions (physical contact, no physical contact) that were designed to manipulate amount of mother-infant physical contact. In one condition, the infant was positioned in an infant carrier strapped to the mother face-in (physical contact) and in the other condition the infant was positioned face-to-face sitting in a high chair (no physical contact). As mothers and infants were in face-to-face contact for both conditions, amount of visual contact was held constant to isolate the potential effect of physical contact on mother-infant interaction.

The first objective was to test the immediate effect of mother-infant physical contact on maternal responsiveness. Consistent with past work, we measured maternal responsiveness as maternal vocalizations occurring within one second of an infant's vocalization (Brosch et al., 2016). Because infants being strapped to the mother's chest in a carrier made it difficult to measure facial expressions in the physical contact condition, vocalization was a more viable measure of responsiveness in this study. We predicted that mothers would be more vocally responsive to their infant when in immediate physical contact in comparison to when not in physical contact.

Our second objective was to measure differences in maternal and infant behavior between the two conditions. To examine the broader context of mother-infant interaction, we also measured differences in maternal and infant vocalizations, touch, and object contact between the physical contact condition and the no physical contact condition. Most previous work suggesting a connection between mother-infant physical contact and specific modalities of communication has been done across cultures, consistently showing that mother-infant physical contact is associated with increased interaction in the tactile modality (e.g., Little, Carver & Legare, 2016)

and decreased vocal and object-based interaction (e.g., Keller et al., 2004). We predicted that mothers would be more likely to interact with infants using touch (tactile interaction) in the physical contact condition and would be more likely to interact using vocal communication and object stimulation in the no physical contact condition.

Method

All procedures and recruitment methods were approved by the Institutional Review Board of University of California, San Diego.

Participants. Twenty mothers and their 3- to 8-month-old infants participated in this study ($M = 5.62$ months, 2.6-8.6 months, 11 female). Mothers had completed an average of 17.25 years of education ($SD = 1.39$ years, 15- 20 years). Mothers were White (84.21%) or Hispanic/Latina (15.79%). Mothers were recruited from online social media postings to U.S. parenting groups. During this single session study, mothers interacted with their infants in two different conditions (physical contact, no physical contact), the order of which was counterbalanced across participants.

Setup. Two FlipCam video cameras were setup with flexible GorillaPod tripods in the experimental room to record the mother-infant interaction. One camera was positioned across from the infant, to record the infant's facial expressions, while the second camera was positioned across from the mother's face. For the physical contact condition, infants were strapped to their mother's chest with a soft structured infant carrier. Mothers who had their own babywearing carrier were permitted to use their own if they wanted (for comfort) as long as the carrier kept the infant in a face-to-face, tummy-to-tummy position. For the no physical contact condition, the infant was positioned in a plastic play chair with a plastic tray. There was a rubber play mat on

the floor, and mothers were instructed to sit on the floor across from the infant. Figure 1 shows the position of the mother and baby for both conditions. For both conditions, there were simple toys available to use in the room (squishy ball and stacking cups).

Procedure. After obtaining informed consent, the procedure was explained and mothers were asked to provide information about the demographics of their household and infant carrying and feeding practices. For both of the two within-subject conditions (physical contact, no physical contact) mothers were told to play with their infant however they normally do while they were videotaped for two minutes in a playroom alone. For the additional condition (babywearing face-out), mothers were given the same instructions. The mother was not given specific instructions as to whether or not she should use the toys that were provided.

Coding. Mothers were measured on their degree of responsiveness to infant vocalizations. Mothers and infants were also measured on their interaction behavior, scored for the duration of vocalization, touch, and object contact during the play session. Coding was completed by two independent coders – blind to the hypotheses of the study – through the use of ELAN video annotation software developed by the Max Planck Institute for Psycholinguistics (Lausberg & Sloetjes, 2009). The coding software allowed for the documentation of the exact start time and end time of each behavior, providing a measure of total frequency and duration of each behavior. Coders first documented the total duration of each infant and maternal behavior (vocalization, touch, object contact), spending one pass through the video for each behavior. Maternal responsiveness was coded by going back through the video and for each instance of infant vocalization, determining whether the mother vocalized during the one-second window following the infant's vocalization. The coders completed the first 20% of the participant videos

together and any discrepancies were discussed until coders achieved frame-by-frame agreement. All subsequent videos were coded independently.

Maternal and infant characteristics. We solicited information about infant age, maternal age, maternal education, race/ethnicity, and income from all mothers to examine any associations with maternal or infant behavior. We also asked mothers about current use of babywearing as their primary transport method (versus strollers or car seats) and about current breastfeeding status to assess whether the potential physiological bonding facilitated by breastfeeding may have been underlying any differences in maternal or infant behavior. **Maternal responsiveness.** Maternal responsiveness was coded as the number of occurrences of the mother vocalizing in response to an infant vocalization (i.e., within a one-second window). This temporal window is consistent (e.g., Broesch et al., 2016) or even more conservative (e.g., Anisfeld et al., 1990) than past work in the literature on maternal responsiveness.

Maternal vocalization. Vocalization was coded whenever the mother vocalized – either verbal or non-verbal. All voluntary utterances were counted as vocalizations, while all sneezes, burps, or other involuntary noises were not coded as vocalization. Each mother was scored on the duration of time of vocalization during the play session of each condition.

Maternal touch. Maternal touch was coded whenever the mother touched the infant. All voluntary physical contact was counted as tactile interaction, while all passive physical contact (i.e., the inevitable physical contact of having the infant strapped to the mother in the physical contact condition) were not coded as touch. Each mother was scored for duration of time touching the infant during each condition.

Maternal object contact. Any contact by the caregiver with one of the play objects – in the context of the mother-infant interaction – was coded as object contact. Any contact by the mother with an object that was out of sight of the infant (or unable to be felt by the infant) was not included. Each mother was scored for duration of time in object contact during each condition.

Infant vocalization. Infant vocalization was coded whenever the infant vocalized. All voluntary utterances were counted as vocalizations, while all sneezes, burps, or other involuntary noises were not coded as vocalization. Each infant was scored on the duration of time spent vocalizing during the play session of each condition.

Infant touch. Infant touch was coded whenever the infant touched the mother (coding separately for mother-initiated versus infant-initiated, depending on who initiated the touch). All voluntary physical contact initiated by the infant and directed toward the mother was counted as infant touch, while all passive physical contact (i.e., the inevitable physical contact of having the infant strapped to the mother in the physical contact condition) were not coded as touch. Each infant was scored on duration of time touching the mother during each condition.

Infant object contact. Infant object contact was coded as any contact with an object initiated by the infant. Each infant was scored separately for duration of time in object contact during each condition.

Results

Out of the twenty mothers that participated, twelve of the mothers were exclusively breastfeeding, two were formula feeding and breastfeeding, five were breastfeeding and complementary feeding (solids), and one was feeding with only formula. Though all mothers had been recruited from a babywearing-specific social media group, five of the mothers reported that

they no longer used babywearing as their primary means of transporting their infant despite having done so in the past.

Analyses. To test whether mother-infant physical contact had an effect on differences in maternal responsiveness and maternal and infant interaction behavior, we performed repeated measures ANOVAs for each maternal and infant behavior of interest with condition (physical contact versus no physical contact) as the independent predictor variable.

Maternal and infant characteristics. In the no physical contact condition, infant age was negatively associated with duration of infant touch, $\beta = -.49$, $t = -2.36$, $p = .03$, and positively associated with duration of object contact, $\beta = 15.51$, $t = 5.91$, $p = .02$. Infant age was not predictive of duration of infant vocalization in the no physical contact condition, $\beta = .72$, $t = 2.06$, $p = .05$. Infant age was not associated with infant or maternal behavior in the physical contact condition (all $ps > .1$).

In the physical contact condition, maternal age was negatively associated with duration of object contact, $\beta = -3.34$, $t = -2.55$, $p = .02$. Maternal age, maternal education, and ethnicity were not associated with any other maternal or infant behaviors in the physical contact condition or the no physical contact condition (all $ps > .1$).

Breastfeeding status was not associated with any maternal or infant behaviors in the physical contact condition or the no physical contact condition (all $ps > .1$).

Maternal responsiveness. There was a significant difference between conditions in maternal responsiveness, $F(1, 19) = 5.37$, $p = .03$, $\eta^2 = .67$, such that mothers were more responsive to infant vocalizations in the physical contact condition ($M = 3.95$ contingent vocalizations, $SE =$

.76 vocalizations) than in the no physical contact condition contact ($M = 2.15$ contingent vocalizations, $SE = .76$), see Figure 4.

Maternal vocalization. There was no difference in duration of maternal vocalization in the physical contact condition ($M = 38.24$ seconds, $SE = 3.89$) in comparison with the no physical contact condition ($M = 38.81$ seconds, $SE = 3.90$), $F(1, 19) = 0.01$, $p = .92$, $\eta^2 = -0.07$.

Maternal touch. There was a difference between conditions in duration of maternal touch, $F(1, 19) = 11.06$, $p = .004$, $\eta^2 = .52$, such that mothers touched their infants for longer in the physical contact condition ($M = 31.71$ seconds, $SE = 6.31$) than in the no physical contact condition ($M = 6.24$ seconds, $SE = 6.31$).

Maternal object contact. There was not a significant difference between the physical contact condition ($M = 24.39$ seconds, $SE = 6.69$) and the no physical contact condition ($M = 41.98$ seconds, $SE = 6.69$) with regard to duration of maternal object contact, $F(1, 19) = 3.74$, $p = .068$, $\eta^2 = .21$.

Infant vocalization. There was no difference between duration of infant vocalization in the physical contact condition ($M = 3.62$ seconds, $SE = .73$) in comparison with the no physical contact condition ($M = 2.32$ seconds, $SE = .73$), $F(1, 19) = 2.29$, $p = .15$, $\eta^2 = .49$.

Infant touch. There was no difference in duration of infant touch in the physical contact condition ($M = .63$ seconds, $SE = .41$) in comparison with the no physical contact condition ($M = .57$ seconds, $SE = .41$), $F(1, 19) = .009$, $p = .93$, $\eta^2 = .04$.

Infant object contact. There was a significant difference in duration of infant object contact, $F(1, 19) = 9.68$, $p = .006$, $\eta^2 = .56$, such that infants were in contact with objects for less time

in the physical contact condition ($M = 25.44$ seconds, $SE = 9.28$) than in the no physical contact condition ($M = 59.20$ seconds, $SE = 9.28$).

Discussion

To test the immediate effect of mother-infant physical contact on maternal responsiveness and mother-infant interaction, we measured maternal responses to infant vocalizations. We also measured the duration of maternal and infant vocalization, touch, and object contact when the infant was being worn in a carrier versus sitting face-to-face with no physical contact. Consistent with our predictions, maternal responsiveness increased when mothers and infants were in physical contact in comparison when they were sitting across from each other. There was no effect of physical contact on overall duration of maternal or infant vocalizations, confirming that the increase in responsive maternal vocalizations in the physical contact condition was specific to responsiveness rather than reflective of an overall increase in vocalizations. This result is aligned with past work comparing triadic mother-infant interactions with objects in proximal care versus distal care communities that found differences in mother-infant physical contact were not associated with variation in vocalization (e.g., Little, Carver, & Legare, 2016). Though we can only speak to one type of contingent maternal responsiveness from the results of Study 3 (i.e., maternal vocalizations in response to infant vocalizations), this type of responsiveness is particularly important because it is known to confer developmental benefits to infants with regard to language acquisition (Goldstein, Schwade, & Bornstein, 2009; Goldstein & Schwade, 2008; Gros-Louis, West, & King, 2016; Tamis-LeMonda, Kuchirko, & Song, 2014).

In addition to changes in maternal responsiveness, there were overall differences in the modality of mother-infant interaction across the two conditions that warrant further attention.

Mothers engaged in more touch when in physical contact with their infant. This finding has clinical significance. Not only are infants potentially benefitting from the long-term benefits of sustained physical contact from being in a carrier that is suggested by past studies (e.g., Anisfeld et al., 1990), but they are actually being exposed to a qualitatively different type of interaction from mothers as soon as they are put in a babywearing carrier versus being put in a seat. There was a difference in infant object contact across the two conditions, such that infants spent more time in object contact when not in physical contact with their caregiver. This relative difference in emphasis on object play aligns with observations of object contact in proximal care versus distal care communities (Keller, 2002). Though most developmental research focuses on face-to-face interaction and object play as central social environments for learning and development (Akhtar & Gernsbacher, 2008), increasingly more research shows the benefits of physical contact and tactile communication as being critical for developmental and physiological processes (e.g., Charpak et al., 2001; Chwo et al., 2002; Feldman, Eidelman, Sirota, & Weller, 2002; Ferber et al., 2002). More research is needed to understand the developmental implications of these different modalities of maternal interaction with infants.

General Discussion

Mother-infant physical contact is the natural postnatal condition for primates (Bard, 2002) and is associated with a range of benefits for both mother and offspring (e.g., Charpak et al., 2001; Chwo et al., 2002; Feldman, Eidelman, Sirota, & Weller, 2002; Ferber et al., 2002). Yet the effects of this physical contact on maternal behavior and beliefs are not well understood. Here, we tested the prediction that mother-infant physical contact increases maternal responsiveness in U.S. babywearing mothers. Below, we discuss the novelty of our findings and potential explanations,

limitations and recommendations for future research, and broader implications of this research for infant social and cognitive development.

Explanations

Past research has documented an effect of mother-infant skin-to-skin contact on maternal sensitivity and responsiveness (Bigelow et al., 2014; Bigelow, Littlejohn, Bergman, & McDonald, 2010; Bystrova et al., 2009). Yet effects of physical contact via carrying without direct skin-to-skin have been relatively neglected in the literature. We found that mothers who reported more experience with mother-infant physical contact through babywearing were more likely to respond contingently to infant cues than mothers with less experience with long-term physical contact during a face-to-face in-lab play paradigm (Study 1). Babywearing mothers were more likely to report agreement with parenting beliefs characteristic of proximal care cultures (Study 2). When testing the immediate effect of mother-infant physical contact, babywearing facilitated increased maternal tactile interaction, decreased maternal and infant object contact, and increased contingently responsive vocalizations (Study 3).

Proximal care has been primarily used to describe the parenting behavior of small-scale, indigenous communities. However, a movement within many Western countries has led some parents to choose to adopt a proximal care parenting style, despite infant care in Western cultures having historically been characterized as distal care. Proximal care practices and beliefs have many potential implications for infant health and development, yet until now have not been studied among U.S. parents.

There are several explanations as to why physical contact facilitates increased maternal responsiveness. One explanation is that the long-term experience with physical contact promotes

mother-infant bonding over time, increasing maternal motivation to attend to and respond to infant cues. This explanation is supported by the findings of Study 1 showing that mothers with more long term experience with physical contact were more likely to be responsive to infant cues even when not in direct physical contact. This is also supported by the results of Study 2 showing that mothers who practice babywearing are more likely to prioritize maternal responsiveness and other goals of proximal care culture. One limitation of these two studies is that because they were observational, we are unable to conclude whether physical contact changes maternal beliefs or whether maternal beliefs motivate mothers to practice increased physical contact with infants. However, we were able to experimentally demonstrate an immediate, within-subject change in responsiveness in Study 3 caused by amount of mother-infant physical contact. The results of Study 3 suggest that in addition to increasing maternal motivation to respond to infants, physical contact also has a direct, immediate effect on responsiveness. This is potentially explained by the closeness of the infants' body allowing the mother to attend to cues that normally would have been missed (e.g., subtle movements or instances of tactile contact).

Limitations

These studies had several limitations. In Study 1, the self-selection of mothers into the babywearing group versus the non-babywearing group was problematic because it is very likely that mothers who are more responsive in general would be more likely to seek out practices like babywearing. Though the observed differences across the two groups in maternal responsiveness are interesting and warrant future research, the small sample sizes and lack of random assignment limit our ability to draw conclusions about the association of one parenting practice (babywearing) with the observed differences in behavior. It is also difficult to generalize our

findings about mother-infant interaction, given that maternal and infant behavior was observed for such a short time and under an artificial in-lab play environment. In Study 1 and Study 3, more specific information about babywearing should have been solicited, including infant age at babywearing onset, frequency of babywearing throughout the day, and position of babywearing. Study 2 solicited more specific information about duration and motivation for babywearing, yet Study 1 relied on self-categorization as babywearers versus non-babywearers. Future studies should aim to document more nuanced information about babywearing practices.

There were also some broader limitations across all three studies, including a very small sample size in Studies 1 and 3, as well as variation in infant age, both within and across studies. Babywearing is also just one of many practices that facilitates physical contact between infants and caregivers. Though we intentionally chose babywearing as a proxy for long-term physical contact, many other forms of mother-infant physical contact (e.g., cosleeping, infant massage) exist and may provide even more physical contact between infants and caregivers. In future studies, if the effect of physical contact is the primary effect of interest, more comprehensive information should be collected about all forms of physical contact. Another broad limitation of this work is that only mother-infant interaction was examined, and only across a specific population. In future work, it will be important to assess how physical contact relates to infant-caregiver interaction more broadly as there are documented implications of father-infant physical contact as well (e.g., Gettler, 2010; Gettler, Augustin, McDade, & Kuzawa, 2012).

Implications

Maternal responsiveness is important for several domains of infant development. The temporal contingency of responsiveness supports the mapping of words to their referents,

facilitating word comprehension (Tamis-LeMonda, Kuchirko, & Song, 2014), which is demonstrated by longitudinal associations between maternal responsiveness and achievement of language milestones (Tamis-LeMonda, Bornstein, & Baumwell, 2001). Experimental manipulations of maternal responsiveness in the lab show that infants produce more sophisticated pre-linguistic sounds when mothers are more responsive to their vocalizations (Goldstein, Schwade, & Bornstein, 2009; Goldstein & Schwade, 2008; Gros-Louis, West, & King, 2016) and the way parents respond to infant attention during object play is related to word production (Stevens, Blake, Vitale, & MacDonald, 1998). In one study, contingent reactions (i.e., smiling, approaching, touching) to 8-month-olds' babbling facilitated higher quantity and quality (phonologically complex) vocalizations during a mother-infant play session (Goldstein, King, & West, 2003). All of these studies describe the behavior of mothers in Western, educated, industrialized, rich, and democratic ("WEIRD") societies (Arnett, 2008; Henrich, Heine, & Norenzayan, 2010; Nielsen et al., 2017). Many factors including maternal education level (Richman et al., 1992) and culture (Bornstein, Cote, & Venuti, 2001; Bornstein et al., 1992; Broesch et al., 2016; Kärtner, Keller, & Yovsi, 2010) predict variation in maternal responsiveness.

The mother-infant physical contact facilitated by babywearing is more than just a transport method. Babywearing is a socialization tool, and the infant-caregiver physical contact that this practice facilitates is equally as important as the visual cues (i.e., gaze) and auditory cues (i.e., vocalizations) that are emphasized to a much greater degree in the developmental literature (Akhtar & Gernsbacher, 2008). Our data demonstrate that babywearing is associated with increased maternal responsiveness and beliefs associated with proximal care cultures. We also show that physical contact facilitates immediate changes in maternal responsiveness and mother-

infant interaction. Given that the modality of interaction can have an influence on developmental trajectories (e.g., Kärtner, Keller, & Yovsi, 2010), understanding the differences in the modality of social interaction is crucial to understanding early social development. Ethnographic research suggests mother-infant physical contact predicts high levels of maternal responsiveness to infant cues, yet this had not previously been investigated within Western populations. Our data suggest that babywearing among U.S. mothers may play a role in maternal responsiveness, an important component of the infant's early social environment. We hope these studies motivate further research on the short- and long-term effects of infant carrying practices on social interaction and infant development.

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Table 1: Proximal Care Beliefs Questionnaire. To assess maternal beliefs about infant care, mothers responded to the following ten statements regarding the care of a 3-month-old infant on a scale from 1 (completely disagree) to 5 (completely agree). The proximal care beliefs score was calculated by summing responses to statements in the left column (i.e., proximal care) and subtracting the sum of responses to statements in the right column (i.e., distal care). This questionnaire was developed by Keller (2002) and has been used in diverse countries around the world to assess cultural models of parenting.

<p>It is important to rock a crying baby in the arms in order to console him/her</p> <p>1-----2-----3-----4-----5 (completely disagree) (completely agree)</p>	<p>Sleeping through the night should be trained as early as possible</p> <p>1-----2-----3-----4-----5 (completely disagree) (completely agree)</p>
<p>Gymnastics/motor stimulation makes a baby strong</p> <p>1-----2-----3-----4-----5 (completely disagree) (completely agree)</p>	<p>You cannot start early enough to direct the infant's attention towards objects and toys</p> <p>1-----2-----3-----4-----5 (completely disagree) (completely agree)</p>
<p>When a baby cries, he/she should be nursed immediately</p> <p>1-----2-----3-----4-----5 (completely disagree) (completely agree)</p>	<p>It is not necessary to react immediately to a crying baby</p> <p>1-----2-----3-----4-----5 (completely disagree) (completely agree)</p>
<p>If a baby is fussy, he/she should be immediately picked up</p> <p>1-----2-----3-----4-----5 (completely disagree) (completely agree)</p>	<p>It is good for the baby to sleep alone</p> <p>1-----2-----3-----4-----5 (completely disagree) (completely agree)</p>
<p>A baby should be always in close proximity with his/her mother, so that she can react immediately to his/her signals</p> <p>1-----2-----3-----4-----5 (completely disagree) (completely agree)</p>	<p>Babies should be left crying for a moment in order to see whether they console themselves</p> <p>1-----2-----3-----4-----5 (completely disagree) (completely agree)</p>



(A)



(B)



(C)

Figure 1: Experimental setup in Study 1 for both babywearers and non-babywearers (A), as well as the physical condition (B) and visual condition (C) in Study 3.

Maternal Responsiveness and Experience with Physical Contact

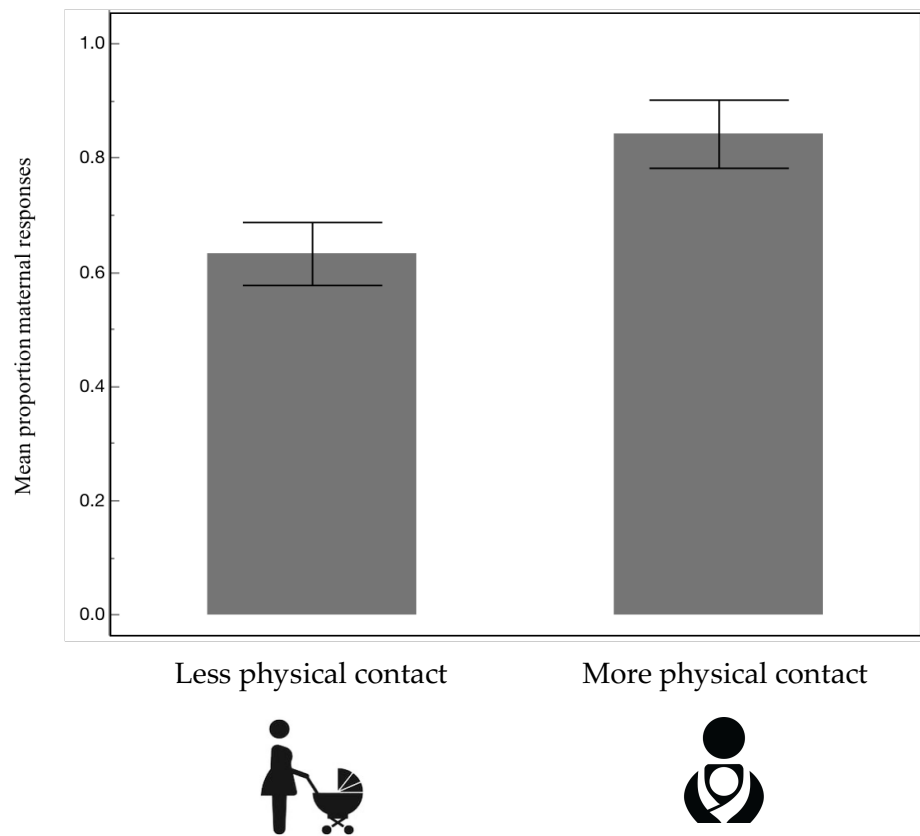


Figure 2: Mean difference in overall maternal responsiveness between mothers with less experience with physical contact and more experience with physical contact in Study 1. Error bars represent standard error of the mean.

Infant Carrying and Maternal Beliefs

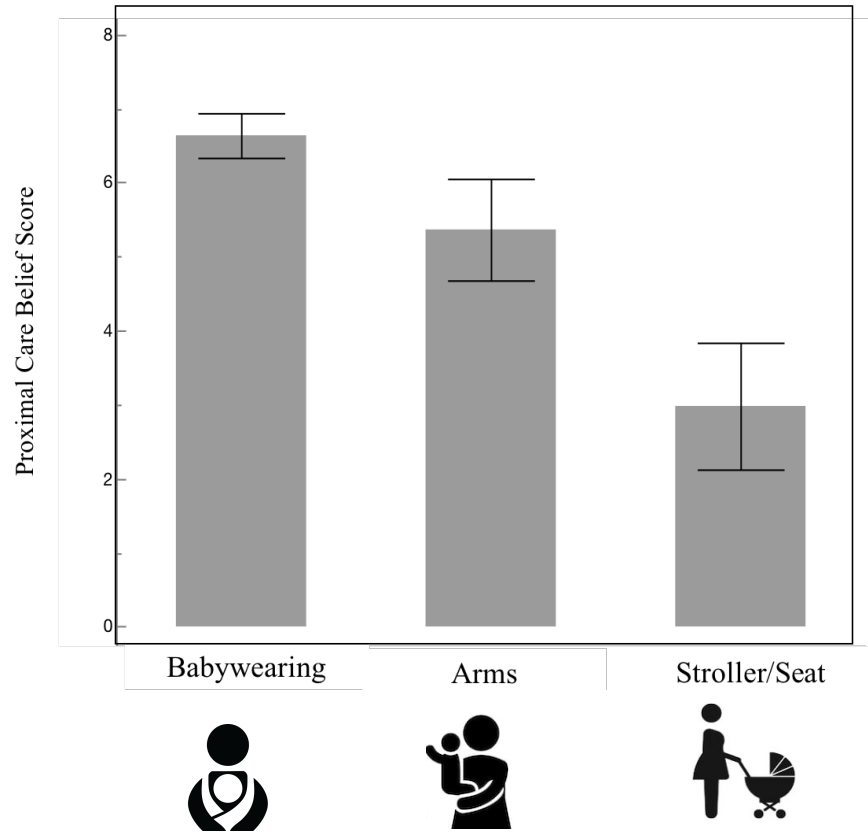


Figure 3: Mean difference in proximal care belief score associated with infant transport method in Study 2. Error bars represent standard error of the mean.

Maternal Contingent Vocalizations

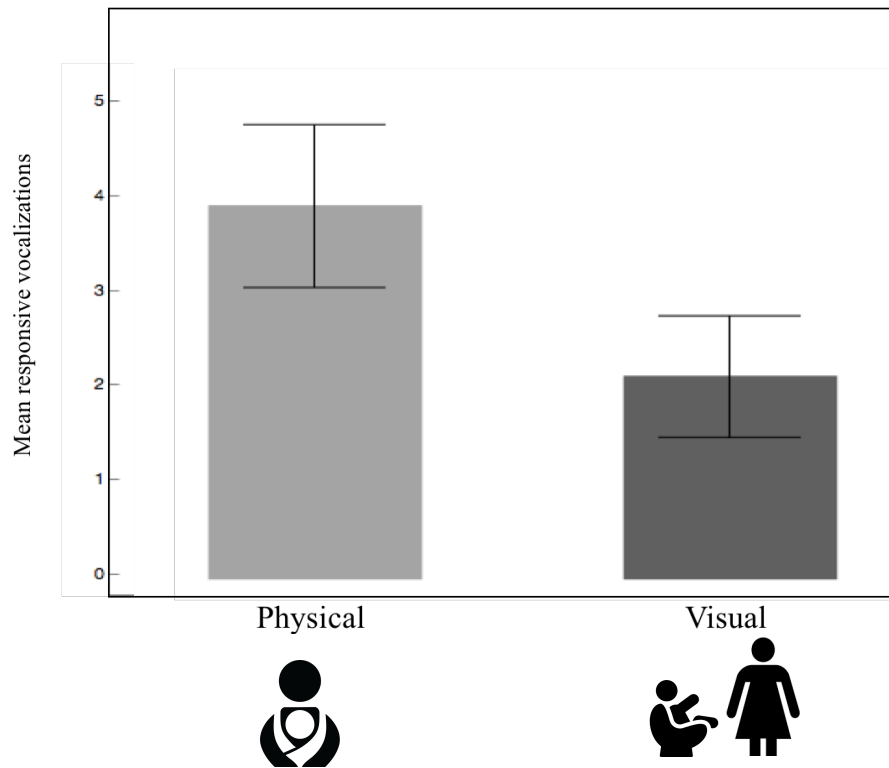


Figure 4: Difference in maternal responses to infants' vocalizations when not in physical contact with their infant and when in physical contact (within-subjects) in Study 3. Error bars represent standard error of the mean.