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Still-face redux: Infant responses to a classic and modified still-face paradigm in proximal and distal care cultures

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ABSTRACT

Literature on infant emotion is dominated by research conducted in Western, industrialized societies where early socialization is characterized by face-to-face, vocal communication with caregivers. There is a dearth of knowledge of infant emotion in the context of social interaction outside of the visual and vocal modalities. In a three-population cross-cultural comparison, we used the still-face task to measure variation in behavior among infants from proximal care (practicing high levels of physical contact) communities in Bolivia and distal care (emphasizing vocal and visual interaction) communities in the U.S. and Fiji. In a modified version of the face-to-face still-face (FFSF), Study 1, infants in the U.S. and Fiji displayed the typical behavioral response to the still-face episode: increased negative affect and decreased social engagement, whereas infants in Bolivia showed no change. For tactile behavior, infants in Bolivia showed an increase in tactile self-stimulation from the interaction episode to the still-face episode, whereas U.S. infants showed no change. In Study 2, we created a novel body-to-body version of the still-face paradigm ("still-body") with infants in US and Bolivia, to mimic the near-constant physical contact Bolivian infants experience. The U.S. and Bolivian infant response was similar to Study 1: US infants showed decreased positive affect and increased negative affect and decreased social engagement from the interaction to the still-body episode and Bolivian infants showed no change. Notably, there were overall differences in infant behaviors between the two paradigms (FFSF and Still-Body). Infants in Bolivia and the U.S. showed increased positive facial affect during the FFSF paradigm in comparison with the Still-Body paradigm. Our results demonstrate the need for more globally representative developmental research and a broader approach to infant emotion and communication.

1. Introduction

Human infants enter the world in need of a caregiver to nurture, hold, and interact with them. Infant-caregiver physical contact and the resulting physiological synchrony is still the primary means of infant-caregiver communication in many populations around the world (Hewlett, 1992). The majority of developmental science, however, studies infant emotion and communication in Western, educated, industrialized, rich, and democratic, or WEIRD populations (Henrich, Heine, & Norenzayan, 2010; Kline, Shamsudeen, &

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Broesch, 2018; Nielsen, Haun, Kärtner & Legare, 2017) where infant communication is typically measured by levels of facial and vocal expressiveness in the context of face-to-face, contingent interaction with caregivers. This has led to a bias in the literature on caregiver-infant interaction with most of the research focusing heavily on visual cues such as facial expressions as the main proxy for caregiver-infant communication (for exceptions, see Little, Carver, & Legare, 2016 and Broesch, Rochat, Olah, Broesch & Henrich, 2016). Yet this pattern of infant-caregiver interaction emphasizing back-and-forth visual and vocal interaction with high levels of positive affect is not only globally unrepresentative, but also historically recent (Akhtar & Gernsbacher, 2008; Field, 2010; Hertenstein, 2002). Not only do many other societies prioritize touch and physical closeness as the way to communicate with infants, but the emphasis of positively-valenced affect is also not universal (Kärtner et al., 2010; Richman et al., 1992; LeVine et al., 1994; Keller, 2002). Furthermore, the heavy emphasis on mother-infant face-to-face play is rooted in dominant, settler, Western societies (Gerlach, Browne, & Suto, 2014; Muir & Bohr, 2019).

One way in which infancy research investigates early social communication is with a procedure developed in the 1970's referred to as the face-to-face still-face (FFSF) paradigm. The still-face paradigm is a prototypical example of this visual and vocal bias in the infant literature and it is based on the distal interaction pattern characteristic of Euro-American middle-class families (i.e., face-to-face visual and vocal interaction encouraging and rewarding positive emotionality and high levels of contingent responsiveness, Tronick, Als, Adamson, Wise & Brazelton, 1978). In this paradigm, infants engage with a social partner, typically the mother, and then the mother is instructed to cease social interaction and maintain a still face – unresponsive and with no affect – for a predetermined duration. Then, there is a reunion episode in which the mother re-engages with the infant. Researchers measure the change in infant behavior between these episodes which typically includes infants responding to the onset of a “still-face” by changing from joyful positive emotional responses during the interaction to negative emotion and fussiness during the still-face episode, and then a slow warm-up and reengagement when the interaction resumes. Furthermore, it has been shown that the degree to which the mother-infant dyad is in synchrony predicts infants' ability to regulate their emotion during the paradigm (Abney, daSilva, & Bertenthal, 2021). Yet, infants in much of the world are socialized in a context of proximal caregiving, where infants are in sustained physical contact with caregivers throughout most of the day and night, often carried on the caregiver's back which minimizes direct face-to-face engagement (Keller, 2002). It is an open question whether infant communication of emotion and infant social engagement with caregivers looks similar during the still-face paradigm among infants in proximal care contexts.

The rationale for the current study is based on the hypothesis that the “standard” infant response to the still face may be a biased product of studying infants and caregivers only from large-scale, urban, and distal care societies. Here, we offer a novel perspective on infant communication of emotion by examining infant social engagement among proximal care and distal care populations using both a classic face-to-face still-face (FFSF) paradigm (Study 1) and a modified version of the still-face that is based on physical contact as a primary form of communication and social engagement, our “Still-Body” paradigm (Study 2). We assessed infant communication of emotion and infant social engagement in a proximal care indigenous community in the rural highlands of Bolivia as well as in two distal care populations including an urban, university population in the U.S. and a rural, subsistence-based island population in Fiji. We were interested in both the contrast between the contexts of proximal and distal caregiving, as well as broader cultural contexts of living in an urban industrialized setting versus a rural, non-Western, subsistence-based context. We examined infant social communication with caregivers as well as their expression of emotions (visual versus physical; positive versus negative affect) and within the context of different social orientations (face-to-face versus body-to-body).

The face-to-face still-face (FFSF) paradigm includes three episodes of interaction between infants and caregivers in a face-to-face social orientation, which was first developed by Tronick and colleagues (Tronick et al., 1978). First, infants engage in a period of typical interaction with their caregiver (interaction episode) followed by a still episode in which the caregiver is instructed to look at their child with a neutral face and refrain from any type of verbal, tactile, or visual interaction (still-face episode). Infants typically show a decrease in positive affect, decrease in gaze at the caregiver, and increase in negative affect from the interaction episode to the still-face episode (i.e., the “still-face effect,” Mesman, van Ijzendoorn, & Bakermans-Kranenburg, 2009), demonstrating infant desire to be active participants in the interaction and their expectations for contingent feedback from social partners. This still-face paradigm has been used to make claims about emotion and arousal regulation (Field, 1995), attachment (Cohn, Campbell, & Ross, 1991), and attunement to the contingency and reciprocity of social interaction (Bigelow, 1998; Trevarthen & Aitken, 2001).

Decades of research show that the still-face effect is consistent across genders, ages, and social strata, thus the literature has largely concluded the still-face effect to be universal (Mesman et al., 2009). The most recent meta-analysis claims one caveat to this universality, “the effect seems to be quite universal, although there are very few studies using the SFP (still-face paradigm) in samples of infants from non-Western societies, limiting the generalization across infants from different cultures” (pp. 32, Mesman et al., 2009). In Mesman et al. (2009) narrative review of over 80 empirical studies conducted with the still-face paradigm, only one study tested infants outside of WEIRD populations (e.g., Chinese infants from urban, middle- to upper-class homes, Kisilevsky et al., 1998). Two additional studies not included in the meta-analysis by Mesman et al. (2009) tested 2-month-olds (Hsu & Jeng, 2008) and 4- and 9-month-olds (Yato, Kawai, Negayama, Sogon, Tomiwa & Yamamoto, 2008) in Taiwan. Notably, in all three of these studies, participants were from urban, middle- to high-income homes where infant-caregiver interaction is characterized by face-to-face interaction and high levels of smiling and eye gaze, indicating these populations were similar in significant respects to WEIRD populations.

Extant still-face studies reflect broader limitations of the infant social communication literature. The still-face paradigm has been used primarily with WEIRD populations and measures emotions based on Western norms for emotion expression (Legare & Harris, 2016; Mesman et al., 2009; Nielsen et al., 2017). The pattern of interaction in which caregivers emphasize visual, face-to-face interaction and high levels of vocal responsiveness is not only culturally distinct, but also historically recent. In contrast, physical contact and tactile communication are the primary means of early social engagement in many – if not most – human societies. Among the Ache hunter-gatherers of Paraguay, infants are in physical contact with a caregiver for 93% of the day due to infants being carried

by the mother during subsistence labor (Hill & Hurtado, 1996). Similarly high levels of infant-caregiver physical contact have been described for the !Kung San hunter-gatherers of Botswana (Konner, 2017) and the Aka of Central African Republic and northern Peoples' Republic of the Congo (Hewlett, 1992). Among the Aka, infants are passed from caregiver to caregiver an average of 7.3 times per hour (Hewlett, 1989). Among the Kipsigis, infants sleep on the mother's breast or back unless there is a sibling present (Super & Harkness, 1986). This socialization context characterized by near-constant physical contact between infant and caregiver is known as proximal care (Keller, 2002; Keller et al., 2009). Proximal caregiving is associated with decreased negative emotions displayed by infants – even within Western cultural contexts. In an observational study of within-culture differences in parenting style among communities in Western Europe, infants of parents practicing proximal care cried 50% less than parents practicing standard Western infant care (St James-Roberts et al., 2006). The connection between the increased physical contact characteristic of proximal care cultures and decreased negative emotions is also supported by experimental evidence. In a randomized controlled trial that increased physical contact through supplemental infant carrying, infants in the experimental group cried significantly less than infants in the control group (Hunziker & Barr, 1986). This may be related to the increase in breastfeeding on-demand supported by both anthropological (Fouts, Hewlett, & Lamb, 2012) and randomized intervention studies (Little, Cioffi, Bain, Legare & Hahn-Holbrook, 2021).

In a cross-country study by Fuertes et al. (2021), they examined infant response to the still-face paradigm in Brazilian and Portuguese infants and identified cross-country differences in infant regulatory behavior patterns. Infant dominant behavioral patterns differed by country and were partly explained by maternal sensitivity. This suggests that there may be differences in the interaction styles of mother-infant dyads across diverse cultural contexts. There are a handful of studies that have examined infant behavior during the FFSF in rural and more traditional societies. For example, one study by Owusu-Ansah, Bigelow, and Power (2019) compared infants and mothers in a proximal care society in Ghana to infants and mothers in a distal care society in Canada. The authors report differences between infants having high and low skin-to-skin contact (SSC) with their mothers. In both societies, skin-to-skin contact accelerated infants' ability to emotionally respond to changes in their mothers' behavior. Notably, infants in this study were just under and over two months of age. This suggests that social expectations are, in fact, shaped by the first social interactions with caregivers as early as the first two months of life.

Despite evidence that proximal care shapes infant emotion expression and possibly emotion regulation, the primary modality of communication used in proximal care (i.e., physical contact) has not been sufficiently integrated into psychological studies of social interactions early in life. Though some researchers have conducted elegant studies testing the importance of physical contact for infant development and maternal behavior (see work by Field, 1995, 2010; Bigelow, Littlejohn, Bergman & McDonald, 2010; Bigelow, Power, MacLellan-Peters, Alex & McDonald, 2012; Bigelow et al., 2014; Owusu-Ansah et al., 2019), physical contact has not yet been included as a primary form of interaction among developmental theories of social engagement and joint attention. For example, eye gaze is the most common proxy for social engagement (Moore, 2008) and shared attention (Carpenter, Nagell, Tomasello, Butterworth & Moore, 1998; Kasari, Freeman, & Paparella, 2006; Moore & Dunham, 1995). Yet this form of communication is potentially less salient when assessing social engagement in proximal care cultures (Akhtar & Gernsbacher, 2008). We address this bias of assessing visual markers of emotion and social engagement in face-to-face paradigms by measuring social engagement with caregivers via touch and tactile self-stimulation in Study 1 and by modifying a widely-used developmental psychology paradigm (i.e., the still-face paradigm) to be more appropriate for proximal care contexts in Study 2.

Proximal and distal caregiving societies differ in their primary modality of communication (Keller, 2002). There have been studies based in urban settings that have addressed the need to look at modality-specific responses to the still-face paradigm. In a series of studies with 5-month-olds, Stack and colleagues manipulated tactile contact in the still-face paradigm to investigate effects of touch on infants' still-face response (Stack & Muir, 1990; Stack & Arnold, 1998). One study documented touch occurring over 65% of the time in caregivers' natural face-to-face interactions with 3-, 6-, and 9-month-olds (Stack & Muir, 1990). In addition, touch was able to attenuate the distressing effects of the still face paradigm, such that 3- to 9-month-olds smiled more and grimaced less when mothers touched infants during the still-face episode of the paradigm, as compared with infants in the traditional no-touch still face (Stack & Muir, 1990; see also Stack & Muir, 1992, 1998). Furthermore, a study with three-month-olds of clinically depressed and non-depressed mothers found that infants of depressed mothers did not differ from other infants in their behavior during a standard still-face episode. The standard still-face episode was followed by a still-face in which mothers were encouraged to touch their infants. In this condition, infants of depressed mothers smiled more and showed less distress and gaze aversion in the still-face-with-touch compared with the regular still-face episode, but infants of non-depressed mothers did not (Peláez-Nogueras, Field, Hossain, & Pickens, 1996). This suggests that infants of depressed mothers – who typically experience less contingent visual feedback from caregivers (Field et al., 2007) – may have developed an increased sensitivity to other cues, such as touch and physical contact. At the same time, depressed mothers have also been found to touch their infants less during face-to-face interactions (Mantis, Mercuri, Stack & Field, 2019). Yet despite a few cross-cultural studies (i.e., Hsu & Jeng, 2008; Kisilevsky et al., 1998; Yato et al., 2008), the majority of infants in existing still-face studies experienced a socialization pattern characterized by contingent visual and vocal feedback. The still-face paradigm has not been tested in populations where socialization does not follow the Western pattern of face-to-face contingent responsiveness. There is a dearth of knowledge about whether and how infant responses to these different types of social interaction might differ in these populations.

The overall objective of the studies was to explore social engagement amongst infants living in regions of the world that have documented differences in childrearing practices. We chose to implement a basic face-to-face still-face paradigm, FFSF, (Study 1) and a modified still-face procedure, “still-body”, (Study 2 to 1) provide more context to the current literature on infant social interactions by examining and describing variation, and 2) provide a springboard upon which future studies may build. While this study is exploratory in nature, our hope is that it will assist and encourage developmental scientists to embark on a journey to a deeper understanding of the role of context in infant social and emotional development. Furthermore, we hope that developmental scientists will see the merit in

understanding the impact of context beyond urban and Western settings in spite of the margin of error and lower sample sizes that inevitably come from conducting fieldwork outside of controlled laboratory settings (see Kline et al., 2018; Amir & McAuliffe, 2020).

2. Method

2.1. Study populations

This research was conducted across three populations: an indigenous population in the rural highlands of Bolivia practicing close physical contact and “proximal caregiving”, an urban, industrialized population in the U.S. practicing “distal caregiving” with emphasis on face-to-face and vocal interactions, and a rural, subsistence-based island population in Fiji also known to privilege a more distal style of caregiving. Below we present a general overview of each study location. Our goal in these studies is not to connect specific predictor variables with behavioral outcomes. Rather, we describe the context for the benefit of the reader to aid in interpretation of our findings and to aid in planning future research.

2.2. Bolivia

In indigenous communities of Bolivia, breastfeeding on demand is widely practiced among Quechua and Aymara mothers, and parents commonly attribute the development of strength to the duration of lactation (Cavagnoud, 2011). Quechua and Aymara parents focus their socialization activities on having infants and young children participate in subsistence tasks, such as planting and harvesting crops, thus teaching them respect for Pachamama, “Mother Earth” (Cavagnoud, 2011). The primary socialization experience of infants is physical contact and perspective-sharing with their caregiver, facilitated by being worn on the caregiver’s back in a woven textile (“aguayo”, Kirberg, 2006) throughout the majority of the day. This position allows for maximal physical contact and relatively little face-to-face interaction. Physical contact is maintained throughout the night by co-sleeping between the infant and mother.

2.3. U.S.

Among middle-class Euro-American sample in the U.S., parent-infant interaction is highly infant-centered, with infant-specific toys, speech, and activities dominating childrearing activities. This differs from the perspective widely held by indigenous communities around the world that infant care can and should be incorporated into adult activities like housework and subsistence demands. Parents interact with infants through high levels of contingent responsiveness through visual and vocal modalities. Speech to infants is exaggerated and has high pitch and intonation, illustrating the typical characteristics of “motherese,” or infant-directed speech. In the U.S., infants generally sleep in separate rooms from their caregivers, and spend much of their day in infant care devices that limit physical contact with caregivers, including strollers, car seats, and bouncers. In fact, caregivers are encouraged by many U.S. healthcare authorities not to co-sleep or breast-sleep with infants for the first year of life, differing from the historical and cultural norm for human bed-sharing (McKenna & McDade, 2005).

2.4. Fiji

In the outer island communities of Fiji, children are surrounded by multiple family members in these small communities of 70–150 people. The first year of caring for an infant consists of an abundance of help and care from the community and family. Mothers are expected to attend to themselves, their new infant, and receive food, childcare, and other domestic help from community members. This allows time for intimate mother-infant relations in the first year of life. In the first year of life, the majority of social experience of an infant is at home with the primary caregiver and one or two other people or at the designated eating location. Infants are spoken to, breastfed and cared for, but they are not typically carried long distances as fathers and other family members tend to gardens and fishing at this sensitive time. In Fiji, physical affection with infants is common among mothers and other caregivers, yet mothers do not wear their babies in slings or wraps to maintain physical contact throughout the day, and instead infants are often sleeping under a net on their own with the mother nearby but not touching. Mothers also talk to their infants in ways that resembles mothers in the U.S., raising the pitch and slowing down speech (Broesch & Bryant, 2014).

2.5. Hypotheses and rationale

We used both the classic still-face paradigm (Study 1) and a modified still-face paradigm (“still-body”) (Study 2) to examine variation in the change in infant emotion expression (positive and negative affect) during the different episodes of dyadic interaction with caregivers. In Study 1, we conducted a three-culture comparison of the classic still-face paradigm. Our first research question was: do infants in proximal care populations (Bolivia) versus distal care populations (U.S., Fiji) respond differently to the change in the different episodes during the still-face paradigm? We predicted society-level differences in infant response to the classic still-face paradigm (interaction episode to still-face episode) with infants in Bolivia showing a different behavioral pattern (i.e., less negative affect during the still-face episode) from infants in the U.S. and Fiji. We measured the change in emotion and contact with caregivers among infants in the U.S., Bolivia, and Fiji from periods of interaction in a face-to-face context (interaction episode) to periods of non-interaction (still episode), during which the caregiver was instructed to maintain a completely neutral expression and refrain from talking to or touching the infant. In the current still-face literature – based on infants socialized in the Western, distal care pattern of

interaction – infant responses to the still episode are marked by high levels of negative emotional reactivity, including vocalizations, attempts to reengage the caregiver's attention, and demonstrations of distress (Adamson & Frick, 2003). Thus, the change from the interaction episode to the still episode is associated with a decrease in positive affect and attempted social engagement and an increase in negative affect (i.e., the still-face effect), which is what we predicted that U.S. infants would show here. We predicted that Bolivian infants would be less likely to engage in overt protesting or negative emotions in response to the still episode, based on the ethnographic and experimental work showing that negative emotions are less overt in proximal care contexts (Hunziker & Barr, 1986; St James-Roberts et al., 2006), either because infants are better able to self-soothe (and therefore less distressed) or because they have been socialized to not overtly express negative emotions. The caretaking pattern in Fiji – with regard to amount of infant-caregiver physical contact – falls somewhere in between the U.S. and Bolivia. We predicted that infants in Fiji would show some degree of negative affect and social disengagement from the interaction episode to the still-face episode. We also examined the change in self-soothing strategies by infants from the interaction to the still-face episode of Study 1. Our second research question for Study 1 was: do infants in proximal care populations (Bolivia) use non-visual strategies (i.e., tactile self-soothing and physical contact) for social engagement and emotion regulation during the still-face paradigm to a greater extent than infants in distal care populations (U.S.)? We examined whether infants in proximal care populations (Bolivia) use non-visual strategies (i.e., tactile self-soothing and physical contact) for attempted social engagement and emotion regulation during the still-face paradigm to a greater extent than infants in distal care populations (U.S.). We coded infant behavior in the U.S. and Bolivia for tactile self-stimulation and object stimulation. We also coded for a non-visual strategy for attempted social engagement with caregivers via touch. Given the contrasting amount of physical contact in the socialization experiences of these two populations, we chose to focus on the comparison between U.S. and Bolivia and did not include the Fijian infants in the additional analyses comprising Study 1. We predicted that infants in Bolivia would be better able to self-soothe and therefore would be more likely to increase tactile self-stimulation from the interaction episode to the still episode in comparison with infants in the U.S.

Study 2 measured behavior during a novel and culturally-appropriate version of the still-face paradigm designed to be more reflective of proximal care models of interaction (i.e., body-to-body contact rather than face-to-face contact). Though it is widely documented that physical contact is a more prevalent form of infant-caregiver interaction in many non-Western societies than face-to-face visual interaction (e.g., Hewlett, 1992; Hill & Hurtado, 1996; Konner, 2017; Little et al., 2016; Super & Harkness, 1986), this is the first known investigation to modify the still-face procedure to be sensitive to the interaction patterns of proximal care cultures. Touch has been incorporated into past still-face studies (e.g., Stack & Arnold, 1998; Stack & Muir, 1992), but this has primarily been with stimulating touch rather than sustained body contact, which is a more appropriate reflection of infant-caregiver interaction in proximal care communities. Infants interacted with caregivers in a body-to-body social orientation (interaction episode) before the caregiver was instructed to cease all interaction with the infant (still episode). If Bolivian infants did not have the same propensity for displaying emotional responses as infants in the current literature – regardless of the modality and orientation of the social interaction – we would not predict Bolivian infants to show a significant change in behavior from the interaction episode to the still episode. Our third research question was whether population-level variation in caregiving practices (distal and proximal) would reflect variation in infant response to a modified still face procedure where the interaction was based on physical contact rather than vocal and visual cues. We measured overall differences in emotion expression and attempted social engagement between this physical version of the still-face and the traditional visual still-face paradigm used in Study 1. In response to the modified still-face paradigm ("still-body"), which we conducted with only Bolivian and U.S. infants, we expected more negative affect by infants in Bolivia compared to U.S. in response to the still-body episode. We also expected social engagement (as measured by infant touch of the mother) to increase during the still-body episode in an attempt to restart the social interaction.

3. Procedure

All procedures were approved according to standards for research with Human Subjects by the Institutional Review Board at [institution- blinded] under the protocol "Culture and Infant-Caregiver Interactions," protocol number 130567. In the case of the international field sites, approval by health center directors (Bolivia) and village elders and chiefs (Fiji) was also obtained. Before starting any study procedures, the study was explained in detail and informed consent was obtained from each participant. In the U.S., participants signed informed consent forms and in Bolivia and Fiji, informed consent was obtained verbally.

3.1. Study 1

The experimental setup comprised two small camcorders (FlipCam or Sony HDR- CX405) on a tripod, with one camera facing the infant and one camera facing the caregiver, who were seated inside one of the rooms of the developmental psychology lab or the field site location. The infant and caregiver were seated in face-to-face position with the caregiver seated in a folding chair and the infant sitting across from the caregiver strapped into a car seat or high chair. In Fiji, the set-up was modified slightly to adjust to the local setting of the homes to ensure the infant was comfortable. The infants were placed on pillows and blankets on the floor facing the mother. The mother sat facing the infant. Traditionally, there is no furniture for sitting in the homes in this region therefore we did not use chairs or infant car seats as that would have been unusual in this setting.

The caregiver and infant were videotaped interacting with each other in a traditional still-face paradigm. The caregiver was instructed to interact with the infant however they would like while maintaining the face-to-face position for two minutes. The experimenter left the room during this interaction episode. After two minutes, the experimenter signaled to the caregiver to stop interacting with the infant. For this two minute still-face episode, the dyad maintained a face-to-face position during which the

caregiver maintained a neutral facial expression, gazed at the torso of the infant and refrained from interacting with the infant. If the caregiver did not comply with the still episode – by resuming normal interaction – they were excluded from the final sample ($n = 1$ from the U.S.). If the infant became too distressed during any episode of this procedure, the session ended early so the caregiver could comfort the infant. If the session was not at least 90 s, the dyads were excluded ($n = 4$ from Bolivia).

All the episodes in the FFSF paradigm are critical to understanding infant social and emotional development at the individual and group level. It is the change from one episode to the next that reveals critical information about the infant and the developmental process (Tronick, 1979). However, there have been several modifications and iterations of the FFSF paradigm and, as Tronick notes (1979), the FFSF must be modified and coded according to the specific hypothesis and to apply a more standardized procedure and coding method across different contexts would be problematic. In our exploratory study, we were interested in determining whether there were group-level differences in infants response moving from the interaction episode to the still face episode. The reunion episode was not consistently applied across contexts so we had only our episodes of interest (interaction and SF) available for coding.

3.2. Study 2

The experimental setup comprised a small FlipCam camcorder on a GorillaPod tripod facing the infant and caregiver. The caregiver and infant were videotaped interacting with each other in a body-to-body social orientation, with the caregiver seated in a folding chair and the infant sitting on the caregiver's lap facing out to prevent face-to-face visual contact. The caregiver was instructed to interact with the infant however they would like, without making face-to-face contact with the infant, for two minutes. The experimenter left the room during this interaction episode. After two minutes, the experimenter opened the door and signaled to the caregiver to stop interacting with the infant. The caregiver was instructed to stop all vocal and tactile interaction with the infant, but they were permitted to passively hold the infant's waist to keep them from falling off their lap. The experimenter exited the room again, and the infant and caregiver were videotaped for an additional two minutes during this still episode. If the infant became too distressed during any episode of this procedure, the session ended early so the caregiver could comfort the infant. If the caregiver did not comply with the instructions (i.e., did not maintain a neutral touch or began responding to the infant), the session ended early. There were no instances of the session being terminated early due to infant distress or caregiver non-compliance in the Bolivian sample. In the U.S. sample, one additional dyad participated in the study, but the video was cut off early due to infant distress and they were excluded from all analyses. Overall, the caregivers complied with the instructions.

4. Participants

4.1. Study 1

U.S. Twenty mothers and their 3- to 11-month-old infants (nine female) participated in Study 1 ($M = 7.99$, $SD = 2.39$). Participants were recruited from the lab database of interested parents. The caregiver scheduled a time to come into the lab and was given information about the purpose of the investigation, the procedure involved, and the potential risks and benefits. She was told that participation was completely voluntary and that she could withdraw from the study at any time. All U.S. data were collected in large urban centers in the area immediately surrounding a public research university, among an upper-middle class, predominantly white and English-speaking community. Parents are generally highly educated and have an interest in and understanding of research and developmental science. The U.S. is one of the only countries in the world that does not mandate paid leave for new parents, yet many mothers in this fairly affluent community have the means to be stay-at-home parents.

4.1.1. Bolivia

Nine mothers and their 4- to 14-month-old infants (three female) participated in this study from Bolivia ($M = 10.80$, $SD = 2.74$). All Bolivia data collection took place at two rural health clinics outside of the city of Cochabamba, in the *altiplano* (high plateau) region. Female caregivers and their infants were recruited at one of two health centers outside of the city of Cochabamba, either at Centro de Salud España or at Centro de Salud Lacma. Mothers were approached by the primary experimenter and first author, who was proficient in Spanish and was familiar to the participants as a volunteer at the health centers. The mother was given basic information about the purpose of the investigation and the procedure involved, and if she was interested, verbal consent to participate was obtained. All Bolivia data were collected outside of Cochabamba, the fourth largest city in Bolivia (population 630,587) and the citizens are primarily of indigenous origin (mostly Quechua or Aymara ethnicity). Though Spanish is the official national language, the indigenous communities of the rural highlands speak Quechua or Aymara, with Spanish as the secondary language. Mothers are the primary infant caregivers in addition to care provided by the infant's older siblings, which is common among indigenous families of the Andean highlands as well as many other non-Western cultural contexts (Lancy, 2012). Infant care is seamlessly woven into all other aspects of daily life, and infants generally accompany the mother everywhere and are always in close proximity.

4.1.2. Fiji

Seventeen mothers and their 2- to 8-month-old infants (seven female) participated in this study ($M = 4.88$, $SD = 2.11$). Mothers were all self-declared primary caregivers of the infants and were living in a small-scale, isolated, rural society in the Fijian archipelago. Mothers were recruited and tested in two regions of Fiji – a small-scale rural society on an island chain (Yasawas) ($n = 11$) and a village near the town of Lautoka on the main island ($n = 6$). All mothers in this study were born, raised and spent the majority of their adult life in the Yasawas (a rural society on the island chain). Dyads were recruited by word of mouth by the first author who lived on the island

and was familiar to the mothers. Fiji data were collected in the Yasawa island region as well as one Yasawa community on the mainland. Families living in the Yasawas typically practice a subsistence way of life, relying on marine foraging, fishing and small-scale family farming. Most adults attend school on the island until secondary school, at which point some select to the mainland to complete their formal education. Healthcare and childbirth also occur on the mainland as there is no permanent health clinic in the Yasawas (at the time of this research). This means that the women in this study have traveled to and from the mainland and had at least some access to Western caregiving ideals through various media, but it would not be pervasive in their life. Travel to and from islands is difficult and expensive. The villages do engage in religious practices and adhere to village norms and rules carefully.

4.2. Study 2

Nineteen participants were recruited for this study. In the US, we recruited ten female caregivers and their 8- to 11-month old infants ($M = 9.85$, $SD = 1.02$). In Bolivia, nine female caregivers and their 4- to 14-month-old infants participated in this study ($M = 9.31$, $SD = 3.12$). Recruitment methods were the same as Study 1.

4.3. Infant age

Given the nature of cross-cultural fieldwork, the ages of the infants in each sample showed some variation. We grouped infants according to standard age ranges used in past still-face studies: 0–3 months, 4–6 months, 7–9 months, and 10+ months (e.g., Mesman et al., 2009). Though most Western still-face studies measure infant emotion in the younger age groups (0–3 and 4–6 months, Mesman et al., 2009), we included all mothers and infants that wanted to participate, given the nature of the convenience sampling that is the reality of fieldwork in smaller societies. In all analyses, we control for the confounding effects of infant age by including infants age in all models as a fixed effect.

5. Coding

Videos were coded by two U.S. undergraduate research assistants for eight measures of infant emotion and social engagement: positive affect (facial and vocal), negative affect (facial and vocal), social engagement via gaze, social engagement via touch, tactile self-stimulation, object stimulation.

5.1. Positive affect

Positive affect was coded in two (non-mutually exclusive) categories: positive facial affect and positive vocal affect. Positive facial affect was coded whenever the infant smiled. A smile was defined as the corners of the infant's mouth being turned upward, with the mouth being either open or closed. Positive vocal affect was coded whenever the infant laughed or vocalized with an upward, happy intonation (i.e., not whining). For each break longer than one second, the vocalization was counted as a new vocalization.

5.2. Negative affect

Negative affect was coded in two (non-mutually exclusive) categories: negative facial affect and negative vocal affect. Negative facial affect was coded whenever the infant grimaced (i.e., furrowed brow), frowned (i.e., downward turn of the corners of the mouth), distressed face (i.e., open mouth, eyes closed). Bouts of negative vocalizations were coded with each bout being defined as a period of negative sounding vocalization that does not break for longer than one second, including crying (i.e., loud upset sounds), fussing (i.e., whiny quality, downward intonation).

5.3. Social engagement via gaze

Gaze was coded whenever the infant looked at the caregiver's face or torso or engaged in mutual eye contact with the caregiver.

5.4. Social engagement via touch

Social engagement via touch was coded whenever the infant touched the mother or directed any intentional motor activity toward the mother. This coding criteria excluded any movements that did not appear to be socially directed (e.g., leg swinging). Each infant was measured on proportion of time spent engaging in social engagement via touch from the interaction episode to the still episode.

5.5. Tactile self-stimulation

Tactile self-stimulation was coded whenever there was any instance of the baby touching their own body. Each infant was measured on proportion of time spent engaging in tactile self-stimulation from the interaction episode to the still episode.

5.6. Object stimulation

Object stimulation was coded whenever the infant touched anything besides themselves or the mother. Though there were not objects specifically available to explore, the object stimulation category was reflective of the infant exploring the chair, as well any movement of the arms or hands that is not direct self-stimulation or directed at the mother. Switching from one type of object-directed movement to another was coded as two separate occurrences. Each infant was measured on proportion of time spent engaging in object stimulation from the interaction episode to the still episode.

The coding scheme is based on the most commonly measured and most consistently replicated emotional behaviors displayed by infants during the still-face (Tronick et al., 1978; Mesman et al., 2009). For each behavior, two independent coders – blind to the hypotheses of the study – used video annotation software (i.e., Datavyu Team, 2014; or CowLog, Pastell, 2016) to indicate the exact start time and stop time of each behavior. This resulted in a measure of overall duration of each infant behavior, which was then converted into a proportion of time during each session that was spent engaging in each behavior. This allowed for standardization across the field sites, as there was slight variation – both within group and across groups – in exact time of each session. The coders were trained together by the primary experimenter on a small subset of videos and discrepancies were discussed and resolved on the spot. After this, 20% of the videos were coded by both coders until a sufficient level of agreement was reached (>80%) on each of the coding categories, after which they completed all coding independently. For each of the following behaviors, infants were measured on the proportion of time spent displaying each behavior during the two-minute behavior assessment period of non-interaction by the caregiver.

6. Analyses and results

6.1. Study 1

We conducted a linear mixed-effects model (Pinheiro & Bates, 2000) with each infant behavior as an outcome measure (positive facial affect, positive vocal affect, negative facial affect, negative vocal affect, and gaze) and infant age group (0–3 months, 4–6 months, 7–9 months, 10 + months), episode (interaction, still), and population (U.S., Bolivia, Fiji) as the fixed effects, while including subject (nested within population) as a random effect. We followed this with planned contrasts between the interaction episode and the still episode for each group. For the second set of questions regarding tactile self-stimulation and emotion regulation, we conducted a linear mixed-effects model (Pinheiro & Bates, 2000) with each infant behavior as an outcome measure (tactile self-stimulation, object stimulation, and social engagement via touch) and infant age group (0–3 months, 4–6 months, 7–9 months), episode (interaction, still), and population (U.S., Bolivia) as the fixed effects, while including subject (nested within population) as the random effect. We followed this with planned contrasts between the interaction episode and the still episode for each group. All analyses were completed in JMP®, Version 14. SAS Institute Inc., Cary, NC, 1989–2007.

All the descriptive statistics addressing cultural variation in response to the still-face paradigm are included in Table 1. All fixed

Table 1

Descriptive statistics for the proportion of time spent in each infant behavior from the interaction episode to the still episode (U.S., Bolivia, Fiji) in Study 1.

| Positive Facial Affect Interaction | | | | | Positive Facial Affect Still | | | | |
|-------------------------------------|----------|-----------|------------------|------------------|-------------------------------|----------|-----------|------------------|------------------|
| | <i>M</i> | <i>SE</i> | <i>Lower 95%</i> | <i>Upper 95%</i> | | <i>M</i> | <i>SE</i> | <i>Lower 95%</i> | <i>Upper 95%</i> |
| Bolivia | 0.12 | 0.09 | -0.07 | 0.30 | Bolivia | 0.09 | 0.09 | -0.09 | 0.28 |
| Fiji | 0.16 | 0.06 | 0.03 | 0.29 | Fiji | 0.23 | 0.06 | 0.10 | 0.35 |
| U.S. | 0.20 | 0.06 | 0.08 | 0.31 | U.S. | 0.13 | 0.06 | 0.02 | 0.24 |
| Positive Vocal Affect Interaction | | | | | Positive Vocal Affect Still | | | | |
| | <i>M</i> | <i>SE</i> | <i>Lower 95%</i> | <i>Upper 95%</i> | | <i>M</i> | <i>SE</i> | <i>Lower 95%</i> | <i>Upper 95%</i> |
| Bolivia | 0.00 | 0.05 | -0.10 | 0.10 | Bolivia | 0.06 | 0.05 | -0.04 | 0.15 |
| Fiji | 0.05 | 0.03 | -0.02 | 0.12 | Fiji | 0.10 | 0.03 | 0.03 | 0.17 |
| U.S. | 0.04 | 0.03 | -0.02 | 0.10 | U.S. | 0.05 | 0.03 | -0.01 | 0.11 |
| Negative Facial Affect Interaction | | | | | Negative Facial Affect Still | | | | |
| | <i>M</i> | <i>SE</i> | <i>Lower 95%</i> | <i>Upper 95%</i> | | <i>M</i> | <i>SE</i> | <i>Lower 95%</i> | <i>Upper 95%</i> |
| Bolivia | 0.03 | 0.11 | -0.19 | 0.25 | Bolivia | 0.06 | 0.11 | -0.15 | 0.28 |
| Fiji | 0.15 | 0.08 | 0.00 | 0.31 | Fiji | 0.51 | 0.08 | 0.35 | 0.66 |
| U.S. | 0.05 | 0.07 | -0.09 | 0.19 | U.S. | 0.33 | 0.07 | 0.19 | 0.47 |
| Negative Vocal Affect Interaction | | | | | Negative Vocal Affect Still | | | | |
| | <i>M</i> | <i>SE</i> | <i>Lower 95%</i> | <i>Upper 95%</i> | | <i>M</i> | <i>SE</i> | <i>Lower 95%</i> | <i>Upper 95%</i> |
| Bolivia | 0.04 | 0.10 | -0.16 | 0.25 | Bolivia | 0.07 | 0.10 | -0.13 | 0.28 |
| Fiji | 0.11 | 0.07 | -0.03 | 0.26 | Fiji | 0.60 | 0.07 | 0.46 | 0.75 |
| U.S. | 0.01 | 0.06 | -0.12 | 0.14 | U.S. | 0.47 | 0.06 | 0.34 | 0.60 |
| Social Engagement- Gaze Interaction | | | | | Social Engagement- Gaze Still | | | | |
| | <i>M</i> | <i>SE</i> | <i>Lower 95%</i> | <i>Upper 95%</i> | | <i>M</i> | <i>SE</i> | <i>Lower 95%</i> | <i>Upper 95%</i> |
| Bolivia | 0.41 | 0.09 | 0.24 | 0.59 | Bolivia | 0.26 | 0.09 | 0.08 | 0.44 |
| Fiji | 0.43 | 0.06 | 0.30 | 0.55 | Fiji | 0.22 | 0.06 | 0.09 | 0.34 |
| U.S. | 0.55 | 0.06 | 0.44 | 0.66 | U.S. | 0.33 | 0.07 | 0.19 | 0.47 |

Table 2

Fixed effects for the mixed-effects model predicting infant behavior by population and episode of the still-face paradigm (Study 1).

| | <i>Positive Facial Affect</i> | | | <i>Positive Vocal Affect</i> | | | <i>Negative Facial Affect</i> | | | <i>Negative Vocal Affect</i> | | | <i>Social Engagement - Gaze</i> | | |
|-----------------------------|-------------------------------|------|----------|------------------------------|------|------|-------------------------------|------|----------|------------------------------|------|----------|---------------------------------|------|----------|
| | β | SE | p | β | SE | p | β | SE | p | β | SE | p | β | SE | p |
| Intercept | 0.15 | 0.03 | < 0.0001 | 0.05 | 0.02 | 0.00 | 0.19 | 0.04 | < 0.0001 | 0.22 | 0.03 | < 0.0001 | 0.36 | 0.03 | < 0.0001 |
| Infant age | | | | | | | | | | | | | | | |
| 10 + (ref) | | | | | | | | | | | | | | | |
| 0–3 months | 0.00 | 0.06 | 0.97 | 0.06 | 0.03 | 0.04 | 0.09 | 0.07 | 0.22 | -0.07 | 0.07 | 0.32 | -0.03 | 0.06 | 0.64 |
| 4–6 months | 0.05 | 0.05 | 0.33 | 0.07 | 0.03 | 0.01 | 0.01 | 0.06 | 0.84 | 0.02 | 0.06 | 0.78 | 0.07 | 0.05 | 0.18 |
| 7–9 months | -0.01 | 0.05 | 0.86 | 0.01 | 0.02 | 0.81 | 0.00 | 0.06 | 0.96 | 0.03 | 0.05 | 0.61 | -0.06 | 0.05 | 0.18 |
| Population | | | | | | | | | | | | | | | |
| U.S. (ref) | | | | | | | | | | | | | | | |
| Bolivia | -0.05 | 0.05 | 0.38 | 0.02 | 0.03 | 0.46 | 0.14 | 0.07 | 0.03 | -0.16 | 0.06 | 0.01 | -0.02 | 0.05 | 0.68 |
| Fiji | 0.04 | 0.05 | 0.47 | 0.02 | 0.03 | 0.35 | 0.14 | 0.06 | 0.03 | 0.14 | 0.06 | 0.02 | -0.04 | 0.05 | 0.48 |
| Episode | | | | | | | | | | | | | | | |
| Still (ref) | | | | | | | | | | | | | | | |
| Interaction | 0.00 | 0.03 | 0.87 | 0.02 | 0.01 | 0.23 | 0.11 | 0.03 | 0.00 | -0.16 | 0.03 | < 0.0001 | 0.10 | 0.02 | < 0.0001 |
| Population * Episode | | | | | | | | | | | | | | | |
| Bolivia* Interaction | 0.01 | 0.04 | 0.85 | 0.01 | 0.02 | 0.71 | 0.09 | 0.05 | 0.06 | 0.15 | 0.05 | 0.00 | -0.03 | 0.04 | 0.51 |
| Fiji* Interaction | -0.04 | 0.03 | 0.25 | 0.00 | 0.02 | 0.82 | 0.07 | 0.04 | 0.10 | -0.08 | 0.04 | 0.03 | 0.00 | 0.03 | 0.97 |

effects for the mixed-effects model are included in Table 2. There was no difference across groups or episodes in positive facial affect or positive vocal affect. Episode predicted proportion of negative facial affect, see Fig. 1 (Hypothesis 1). U.S. infants spent more time in negative facial affect during the still episode ($M = 0.35$, $SE = 0.06$, 95% CIs [0.22,0.47]) in comparison with the interaction episode ($M = 0.07$, $SE = 0.06$, 95% CIs [-0.06,0.20]), $t(42) = -3.25$, $p = .0001$. Infants in Fiji also spent more time in negative facial affect during the still episode ($M = 0.47$, $SE = 0.07$, 95% CIs [0.32,0.61]) in comparison with the interaction episode ($M = 0.11$, $SE = 0.07$, 95% CIs [-0.02,0.26]), $t(42) = -4.15$, $p = .0002$. For negative facial affect, there was no difference between the still episode and the interaction episode in the Bolivian group ($p > .1$). Both population and episode predicted amount of negative vocal affect, see Fig. 1. U.S. infants spent more time making negative vocalizations during the still episode ($M = 0.47$, $SE = 0.07$, 95% CIs [0.34,0.60]) in comparison with the interaction episode ($M = 0.01$, $SE = 0.06$, 95% CIs [-0.12,0.14]), $t(42) = -5.83$, $p < .0001$. Fijian infants also spent more time making negative vocalizations during the still episode ($M = 0.60$, $SE = 0.07$, 95% CIs [0.46,0.75]) in comparison with the interaction episode ($M = 0.11$, $SE = 0.07$, 95% CIs [-0.03,0.26]), $t(42) = -6.06$, $p < .0001$. For negative vocal affect, there was no difference between the still episode and the interaction episode in the Bolivian group ($p > .1$). Episode of the still-face paradigm predicted amount of gaze toward the mother, see Fig. 1. U.S. infants showed decreased gaze during the still episode ($M = 0.29$, $SE = 0.06$, 95% CIs [0.18,0.40]) in comparison with the interaction episode ($M = 0.55$, $SE = 0.06$, 95% CIs [0.44,0.66]), $t(42) = 5.607$, $p < .0001$. Fijian infants also showed decreased gaze during the still episode ($M = 0.22$, $SE = 0.06$, 95% CIs [0.09,0.34]) in comparison with the interaction episode ($M = 0.43$, $SE = 0.06$, 95% CIs [0.30,0.55]), $t(42) = 4.01$, $p = .0002$. Infants in Bolivia showed no difference in amount of gaze from the interaction episode to the still episode ($p > .1$).

All the descriptive statistics regarding the additional coding of the Bolivian and U.S. data are included in Table 3 and all fixed effects

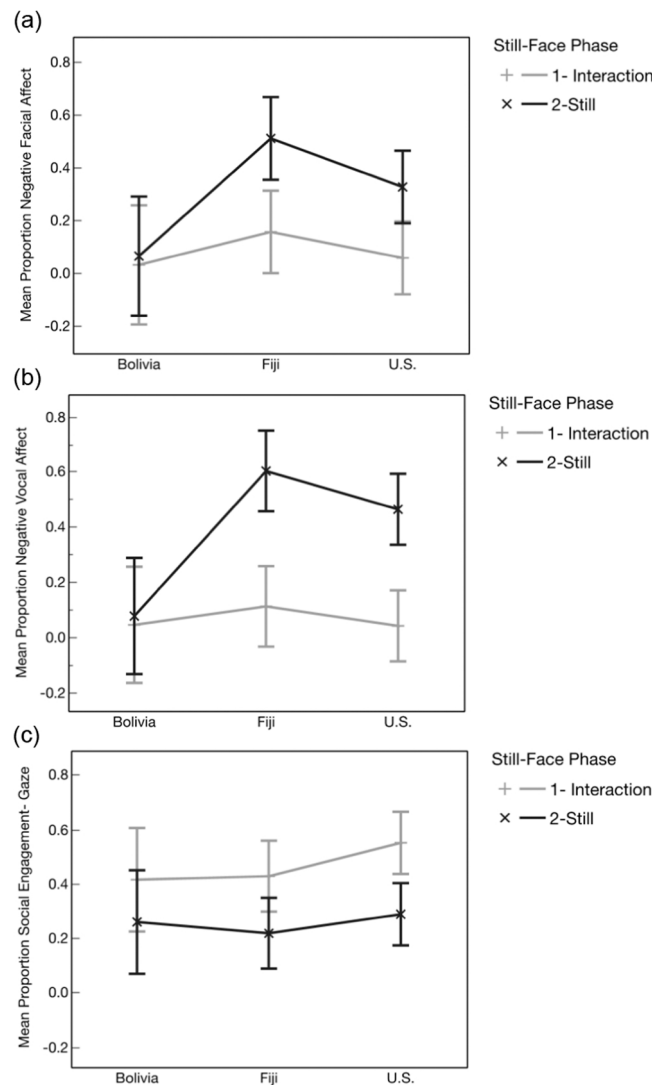


Fig. 1. Mean proportion of negative facial affect (1A), negative vocal affect (1B), and attempted social engagement via gaze (1C) in the U.S., Bolivia, and Fiji in Study 1 from the interaction episode to the still episode. Error bars represent 95% confidence intervals.

Table 3

Descriptive statistics for the proportion of time spent in each infant behavior from the interaction episode to the still episode (U.S., Bolivia) in Study 1.

| Tactile Self-Stimulation Interaction | | | | | Tactile Self-Stimulation Still | | | | |
|--------------------------------------|----------|-----------|-----------|-----------|--------------------------------|----------|-----------|-----------|-----------|
| | <i>M</i> | <i>SE</i> | Lower 95% | Upper 95% | | <i>M</i> | <i>SE</i> | Lower 95% | Upper 95% |
| Bolivia | 0.01 | 0.09 | -0.17 | 0.18 | Bolivia | 0.27 | 0.09 | 0.09 | 0.44 |
| U.S. | 0.18 | 0.09 | 0.00 | 0.36 | U.S. | 0.14 | 0.09 | -0.04 | 0.31 |
| Object Stimulation Interaction | | | | | Object Stimulation Still | | | | |
| | <i>M</i> | <i>SE</i> | Lower 95% | Upper 95% | | <i>M</i> | <i>SE</i> | Lower 95% | Upper 95% |
| Bolivia | 0.34 | 0.10 | 0.13 | 0.54 | Bolivia | 0.12 | 0.10 | -0.08 | 0.32 |
| U.S. | 0.26 | 0.10 | 0.05 | 0.46 | U.S. | 0.35 | 0.10 | 0.15 | 0.56 |
| Social Engagement- Touch Interaction | | | | | Social Engagement- Touch Still | | | | |
| | <i>M</i> | <i>SE</i> | Lower 95% | Upper 95% | | <i>M</i> | <i>SE</i> | Lower 95% | Upper 95% |
| Bolivia | 0.28 | 0.04 | 0.19 | 0.37 | Bolivia | 0.25 | 0.04 | 0.16 | 0.34 |
| U.S. | 0.21 | 0.05 | 0.11 | 0.30 | U.S. | 0.18 | 0.05 | 0.09 | 0.28 |

are included in Table 4. The model showed a population by episode interaction predicting amount of tactile self-stimulation, see Fig. 2. Bolivian infants showed an increase in tactile self-stimulation from the interaction episode ($M=0.01$, $SE=0.09$, 95% CIs [-0.17,0.18]) to the still episode ($M=0.27$, $SE=0.06$, 95% CIs [0.09,0.44]), $t(34) = -2.49$, $p = .02$. In the U.S. infants, there was no difference from the interaction episode to the still episode in amount of tactile self-stimulation ($p > .1$). There was no effect of episode or population for object stimulation or attempted social engagement via touch. Infant age predicted amount of both object stimulation and attempted social engagement via touch, accounting for any episode and population level differences in these two behaviors, see Table 4.

6.2. Study 2

We conducted a linear mixed-effects model (Pinheiro & Bates, 2000) with each infant behavior as an outcome measure (positive facial affect, negative facial affect, and attempted social engagement via touch) and infant age group (4–6 months, 7–9 months, 10 + months), episode (interaction, still), and population (U.S., Bolivia) as the fixed effects, while including subject (nested within population) as a random effect. We followed this with planned contrasts between the interaction episode and the still episode for each group. To address the question of differences in emotion between the “still-body” paradigm and the FFSF from Study 1, we conducted further analyses to compare group-level (e.g., country) behaviors of infants in both paradigms. We examined the data from Study 1 and 2 by performing a linear mixed-effects model with each infant behavior as an outcome measure (positive facial affect, negative facial affect, and attempted social engagement via touch) and infant age group (4–6 months, 7–9 months, 10 + months), episode (interaction, still), population (U.S., Bolivia), and version of the still-face (FFSF, Still-body) as the fixed effects, while including subject (nested within population) as the random effect. All analyses were completed in JMP®, Version 14. SAS Institute Inc., Cary, NC, 1989–2007.

All descriptive statistics are included in Table 5 and all model effects are included in Table 6.

6.2.1. Still-body

Episode and population both predicted amount of positive facial affect, and there was an episode by population interaction, see Fig. 3. U.S. infants showed a decrease in positive facial affect from the interaction episode ($M=0.11$, $SE=0.02$, 95% CIs [0.07,0.15]) to the still episode ($M=0.03$, $SE=0.02$, 95% CIs [-0.02,0.07]), $t(25) = 3.02$, $p = .01$. There was no difference in positive facial affect from the interaction to the still episode in the Bolivian group ($p = .16$). Episode and population both predicted amount of negative facial affect, and there was an episode by population interaction, see Fig. 3. U.S. infants showed an increase in negative facial affect from the interaction episode ($M=0.06$, $SE=0.05$, 95% CIs [-0.04,0.15]) to the still episode ($M=0.26$, $SE=0.05$, 95% CIs [0.16,0.35]),

Table 4

Fixed effects for the mixed-effects model predicting infant behavior by population and episode of the still-face paradigm (Study 1).

| | Tactile Self-Stimulation | | | Object Stimulation | | | Social Engagement- Touch | | |
|-----------------------------|--------------------------|-----------|----------|--------------------|-----------|----------|--------------------------|-----------|----------|
| | β | <i>SE</i> | <i>p</i> | β | <i>SE</i> | <i>p</i> | β | <i>SE</i> | <i>p</i> |
| Intercept | 0.15 | 0.06 | 0.02 | 0.27 | 0.07 | 0.00 | 0.23 | 0.03 | < 0.0001 |
| Infant age | | | | | | | | | |
| 0–3 months (ref) | | | | | | | | | |
| 4–6 months | 0.05 | 0.11 | 0.68 | 0.20 | 0.13 | 0.13 | 0.27 | 0.06 | < 0.0001 |
| 7–9 months | 0.05 | 0.08 | 0.50 | 0.19 | 0.09 | 0.03 | -0.13 | 0.04 | 0.00 |
| Population | | | | | | | | | |
| U.S. (ref) | | | | | | | | | |
| Bolivia | 0.01 | 0.04 | 0.80 | 0.04 | 0.05 | 0.42 | 0.03 | 0.02 | 0.12 |
| Episode | | | | | | | | | |
| Still (ref) | | | | | | | | | |
| Interaction | 0.05 | 0.04 | 0.14 | 0.03 | 0.04 | 0.48 | 0.01 | 0.02 | 0.50 |
| Population * Episode | | | | | | | | | |
| Bolivia*Interaction | 0.08 | 0.04 | 0.04 | 0.08 | 0.04 | 0.07 | 0.00 | 0.02 | 0.94 |

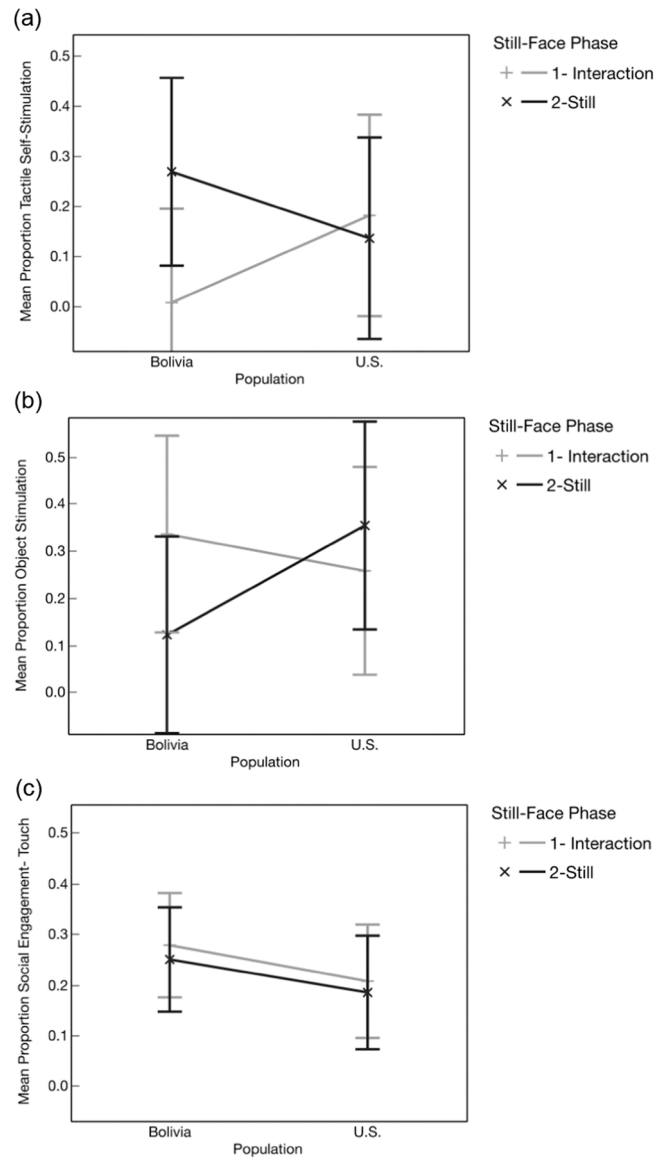


Fig. 2. Mean proportion of tactile self-stimulation (2A), object stimulation (2B), and attempted social engagement via touch (2C) in the U.S. and Bolivia in Study 1 from the interaction episode to the still episode. Error bars represent 95% confidence intervals.

Table 5

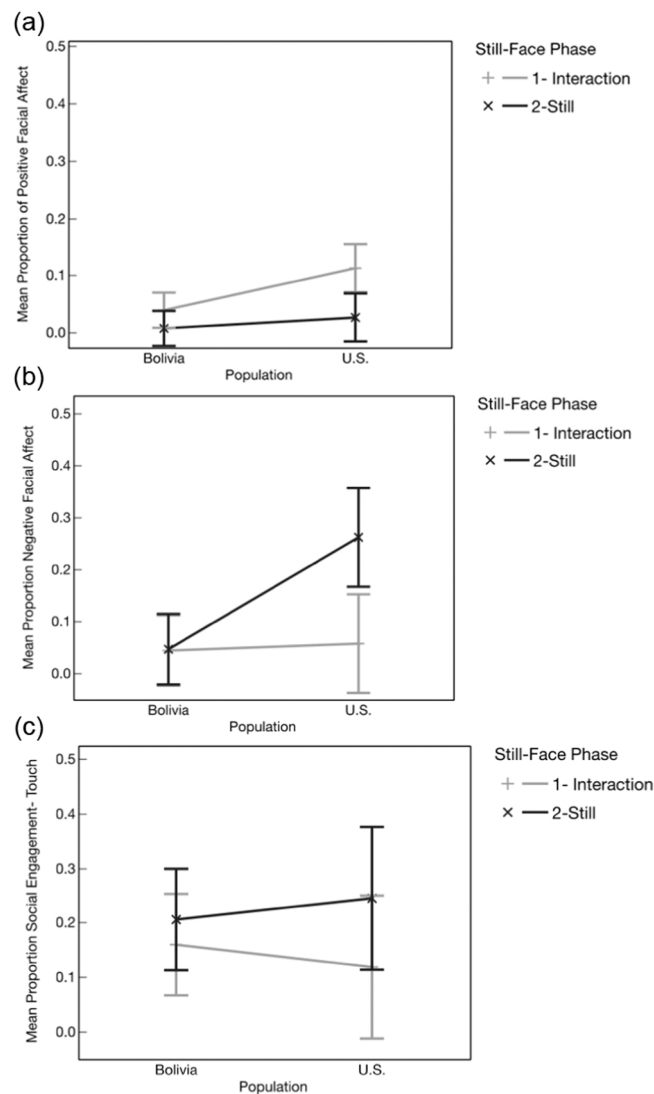
Descriptive statistics for each infant behavior from the interaction episode to the still episode (U.S., Bolivia) in Study 2.

| POSITIVE FACIAL AFFECT INTERACTION | | | | | POSITIVE FACIAL AFFECT STILL | | | |
|--------------------------------------|------|------|-----------|-----------|--------------------------------|------|------|-----------|
| | M | SE | Lower 95% | Upper 95% | | M | SE | UPPER 95% |
| Bolivia | 0.04 | 0.02 | 0.01 | 0.07 | Bolivia | 0.01 | 0.02 | 0.04 |
| U.S. | 0.11 | 0.02 | 0.07 | 0.15 | U.S. | 0.03 | 0.02 | 0.07 |
| NEGATIVE FACIAL AFFECT INTERACTION | | | | | NEGATIVE FACIAL AFFECT STILL | | | |
| | M | SE | Lower 95% | Upper 95% | | M | SE | Upper 95% |
| BOLIVIA | 0.04 | 0.03 | -0.02 | 0.11 | BOLIVIA | 0.05 | 0.03 | 0.11 |
| U.S. | 0.06 | 0.05 | -0.04 | 0.15 | U.S. | 0.26 | 0.05 | 0.36 |
| Social Engagement- Touch Interaction | | | | | Social Engagement- Touch Still | | | |
| | M | SE | Lower 95% | Upper 95% | | M | SE | Upper 95% |
| Bolivia | 0.16 | 0.05 | 0.07 | 0.25 | Bolivia | 0.21 | 0.05 | 0.30 |
| U.S. | 0.24 | 0.06 | -0.01 | 0.25 | U.S. | 0.12 | 0.06 | 0.25 |

Table 6

Fixed effects for the mixed-effects model predicting infant behavior by population and episode of the still-face paradigm (Study 2).

| | Positive Facial Affect | | | Negative Facial Affect | | | Social Engagement- Touch | | |
|-----------------------------|------------------------|------|----------|------------------------|------|--------|--------------------------|------|----------|
| | β | SE | p | β | SE | p | β | SE | p |
| Intercept | 0.05 | 0.01 | < 0.0001 | 0.10 | 0.02 | 0.0004 | 0.18 | 0.04 | < 0.0001 |
| Infant age | | | | | | | | | |
| 0–3 months (ref) | | | | | | | | | |
| 4–6 months | -0.01 | 0.02 | 0.52 | -0.02 | 0.04 | 0.60 | 0.09 | 0.06 | 0.16 |
| 7–9 months | 0.01 | 0.01 | 0.29 | 0.03 | 0.04 | 0.38 | -0.05 | 0.05 | 0.33 |
| Population | | | | | | | | | |
| U.S. (ref) | | | | | | | | | |
| Bolivia | -0.02 | 0.01 | 0.02 | -0.06 | 0.02 | 0.0303 | 0.00 | 0.04 | 0.99 |
| Episode | | | | | | | | | |
| Still (ref) | | | | | | | | | |
| Interaction | 0.03 | 0.01 | 0.00 | 0.03 | 0.03 | 0.00 | -0.04 | 0.02 | 0.01 |
| Population * Episode | | | | | | | | | |
| Bolivia*Interaction | -0.01 | 0.01 | 0.14 | 0.05 | 0.01 | 0.00 | 0.02 | 0.02 | 0.21 |

**Fig. 3.** Mean proportion of positive facial affect (3A), negative facial affect (3B), and attempted social engagement via touch (3C) in the U.S. and Bolivia in Study 2 from the interaction episode to the still episode. Error bars represent 95% confidence intervals.

$t(25) = -4.41, p = .0002$. There was no difference in negative facial affect from the interaction to the still episode in the Bolivian group ($p > .1$). Episode predicted amount of attempted social engagement via touch, see Fig. 3. U.S. infants showed an increase in social engagement via touch from the interaction episode ($M = 0.12, SE = 0.06, 95\% \text{ CIs } [-0.01, 0.25]$) to the still episode ($M = 0.24, SE = 0.06, 95\% \text{ CIs } [0.11, 0.38]$), $t(25) = -2.55, p = .017$. There was no difference in attempted social engagement via touch from the interaction ($M = 0.16, SE = 0.05, 95\% \text{ CIs } [0.07, 0.25]$) to the still episode ($M = 0.21, SE = 0.05, 95\% \text{ CIs } [0.11, 0.30]$) in the Bolivian group ($p > .1$).

6.2.2. Still-body vs FFSS

Condition and episode predicted amount of positive facial affect, and there was a population by episode interaction, see Fig. 4. Infants in Bolivia showed more overall positive facial affect during the visual still-face ($M = 0.08, SE = 0.02, 95\% \text{ CIs } [0.03, 0.12]$) than during the physical still-face ($M = 0.03, SE = 0.02, 95\% \text{ CIs } [-0.00, 0.06]$), $t(61) = -2.14, p = .035$. Infants in the U.S. showed more overall positive facial affect during the visual still-face ($M = 0.12, SE = 0.02, 95\% \text{ CIs } [0.07, 0.16]$) than during the physical still-face ($M = 0.06, SE = 0.02, 95\% \text{ CIs } [0.02, 0.11]$), $t(61) = -2.14, p = .036$. There was no difference between the physical still-face and the visual still-face in amount of negative facial affect or attempted social engagement via touch for U.S. infants or Bolivian infants (all $ps > 0.08$).

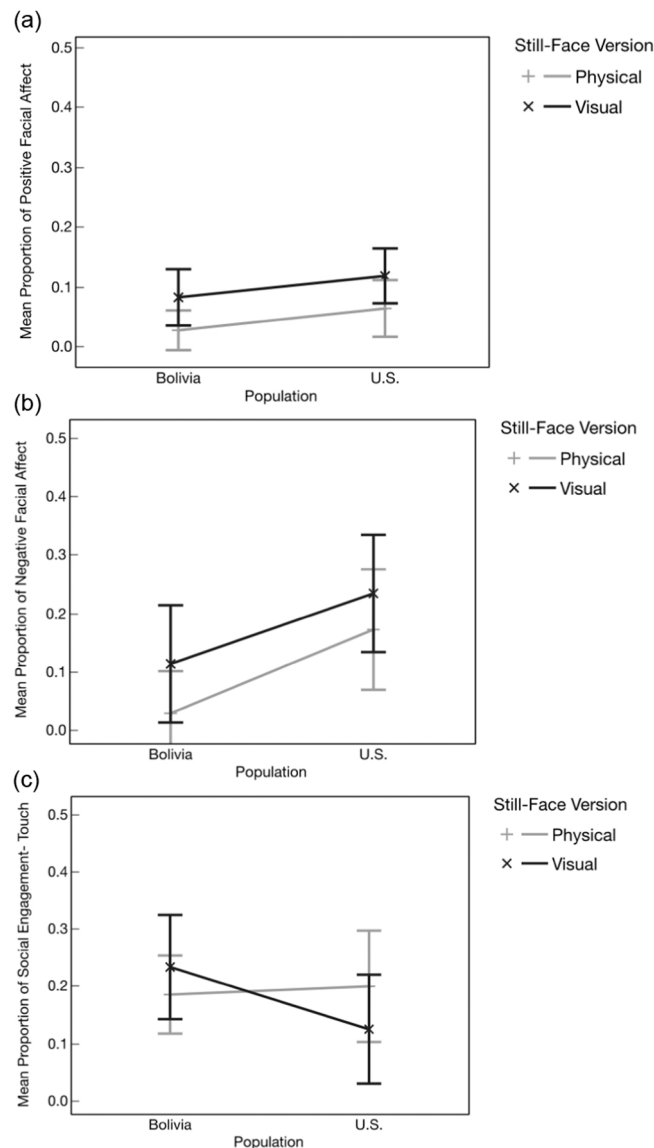


Fig. 4. Mean proportion of positive facial affect (4A), negative facial affect (4B), and attempted social engagement via touch (4C) in the U.S. and Bolivia in Study 2 between the physical still-face paradigm and the visual still-face paradigm. Error bars represent 95% confidence intervals.

7. Discussion

There is growing recognition that experimental paradigms designed to capture Western norms for communication (i.e., facial affect, eye gaze, vocalization) and infant-caregiver interaction (i.e., face-to-face interaction) are not adequate for assessing infant behavior and development in other cultural contexts (e.g., Kline et al., 2018; Mesman et al., 2017). Here we used a modified still-face procedure to be sensitive to non-Western, and specifically to proximal care, childrearing practices. First, we highlight key findings alongside our proposed explanation for these findings. Next, we explore potential alternate explanations for these results. Finally, we address limitations of these studies and propose future directions to build upon these preliminary findings.

7.1. Findings and proposed explanations

In Study 1, we examined whether infants in the U.S. and two distinct non-Western populations (Bolivia, Fiji) would show variation in emotion and attempted social engagement in response to the classic still-face paradigm. U.S. infants and Bolivian infants showed more variation in emotion expression than the difference between U.S. infants and Fijian infants. This reveals the need to assess infant development across a wide range of non-Western populations, as there is substantial variation within and across communities. Given the cultural contexts of socialization in the U.S. and Bolivia, one interesting distinction is the proximal caregiving style characteristic of Bolivian caregivers, in which caregivers practice constant body contact and nursing on-demand (Hewlett, Lamb, Shannon, Leyendecker & Schölmerich, 1998; Hunziker & Barr, 1986; St James-Roberts et al., 2006). Bolivian infants across the two studies did not show overt positive or negative affect, but they were more likely to self-soothe with tactile stimulation during a lack of interaction (Study 1). Infants in the U.S. and Fiji were more likely to protest or attempt to reengage the mother while Bolivian infants seemed to effectively manage their emotions without needing to solicit caregiver attention. We propose that emotional behavior in infancy is shaped by culture-specific socialization patterns, which is consistent with past work demonstrating variation in the timing of the emergence of emotional displays associated with proximal versus distal patterns of infant-caregiver interaction (Keller & Otto, 2009; Wörmann, Holodyskia, Kärtnner, & Keller, 2012).

We also examined whether infants in proximal care cultures use non-visual modalities (i.e., tactile engagement and physical contact) for attempted social engagement and emotion regulation during the still-face paradigm. Our data showed that touch was not used as a social engagement strategy, but rather as a self-soothing strategy by infants in Bolivia. This is consistent with past work showing that infants in proximal care cultures are socialized to self-soothe rather than overtly show negative emotions (Keller et al., 2004). Given that self-soothing ability during the still-face paradigm is associated with mother-infant attachment (e.g., Braungart-Rieker, Garwood, Powers, & Wang, 2001), this cross-cultural variation in tactile self-stimulation behavior warrants further investigation.

In Study 2 we examined whether infants in the U.S. and in a proximal care culture (Bolivia) display a change in emotions and attempted social engagement in response to a body-to-body modification of the still-face paradigm. Controlled studies outside of Western culture show that mothers (and others) in many places of the world not only use physical contact as a necessary means of transporting their infant (e.g., because strollers and other products are unavailable and impractical) or keeping their infant safe (e.g., from the hazards of the environment), but that physical contact plays a central role in both play-based and pedagogical interactions. For example, in a controlled object manipulation paradigm, mothers in Vanuatu – a remote island archipelago – were more likely to use physical contact and tactile interaction to teach their infant about a novel toy, in comparison with U.S. mothers who used visual shared attention to interact with and teach their infant about the object (Little et al., 2016). Physical contact is implicated in developmental processes – such as early social learning (Della Longa, Gliga, & Farroni, 2017) – to a degree that had previously not been recognized in the developmental psychology literature.

Though speculative, it is possible that our results reflect cultural variation in socialization of emotion, and more specifically, that the infant behavior documented here is a result of different experiences with infant-caregiver physical contact. Because we did not directly measure amount of mother-infant contact within the context of this study, documenting this will be an important addition for future work on this topic. Another improvement for future work will be to measure responses to the still-face paradigm physiologically. It is possible that infants in Bolivia were equally distressed by the lack of contingency in the still episode of Studies 1 and 2 but are simply not as explicitly expressive in their displays of emotion as U.S. infants. Previous studies have demonstrated that the still-face effect is not confined to overt behavior because underlying physiological responses change from the interaction episode to the still episode as well (e.g., increase in heart rate and respiration, Conradt & Ablow, 2010). Though physiological measures were not possible at the current field sites, future research should aim to incorporate additional measures of infant emotion besides just overt facial, vocal, and tactile behavior. As with differences in contingent responsivity, cultures differ with regard to the socialization of emotions (Keller & Otto, 2009), so it may be that infants in these studies have experienced a socialization pattern where they have learned to refrain from overt discomfort. It should also be noted, however, that there are several confounding factors (e.g., SES, years of formalized schooling) that may explain the cross-cultural differences we report here. The underlying physiology of cultural variation in infant responses to the still-face paradigm warrants further investigation to fully understand this developmental process.

7.2. Limitations and future directions

There are several limitations of this research that should inform the design of future research. First, the sample sizes are small, particularly the Bolivian mother-infant dyads. We argue that the lack of effect found in the Bolivian sample cannot be attributed exclusively to small sample size, however; the confidence intervals for the Bolivian group (between the interaction episode and the

still-face/body episode in Study 1 and Study 2) are almost entirely overlapping for almost every behavior, suggesting there is no difference to be found, irrespective of sample size. Another limitation related to the small sample size is the exclusion of a substantial portion of the already-small Bolivian sample due to the session ending early from infant distress. Because negative affect was one of the primary measures in this study, future work should better account for these differences in negative affect. We hope that this research can serve as a starting point from which other researchers can build on these preliminary findings. We also draw the reader's attention to recent arguments pointing to the flawed nature in counting only methods with experimental control as rigorous and meaningful (Dahl, 2017; Broesch et al., 2020; Amir & McAuliffe, 2020).

An additional limitation arising from the convenience-driven sampling required by the field sites was reflected in the substantial variation in infant age both within and between groups in these studies. We did not deem this a primary concern, given that the still-face effect has shown relative consistency across different groups, including across different genders (Abelkop & Frick, 2003) and ages (Moore, Cohn, & Campbell, 2001). However, we acknowledge that controlling for infant age in our models cannot adequately repair for unequal sampling, given our sample sizes. In addition, some of our measures such as infant touch were dependent on developmental milestones (i.e., reaching) that may have precluded some of the younger infants from engaging in this behavior. Future studies with larger sample sizes or longitudinal designs would provide additional insight into developmental differences across the age groups. A longitudinal design would further elucidate the potential connection between socialization with increased infant-caregiver physical contact and infant behavior during the still-face paradigm.

Another direction for future research is to concurrently evaluate differences in socialization goals, patterns of caregiving, and amount of infant-caregiver physical contact, in order to draw more concrete conclusions about the mechanisms underlying cultural variation in infant behavior during the still-face paradigm. Though evaluating maternal behavior was not the objective of the current study, past work shows that infant behavior during the still episode is influenced by the behavior of their social partner (Bigelow & Best, 2013; Bigelow, Power, Bulmer & Gerrior, 2017; Bigelow & Power, 2016; Bigelow & Rochat, 2006). Measuring this systematically would be an interesting addition to future cross-cultural still-face studies. Finally, testing modalities of emotion outside of just facial and vocal affect (e.g., physiological measures of emotion) will be an important future direction as our definition of infant emotion displays continues to expand with more diverse samples.

Finally, there are methodological limitations that have the potential to be improved in subsequent work. For example, the body-to-body orientation in Study 2 included the caregiver holding onto the infant's waist throughout both the interaction episode and the still episode. It would make sense that infants accustomed to a proximal care style of interaction would find this passive contact soothing, making this an imperfect equivalent to the visual still-face procedure. In the interest of being respectful of local community customs and subsistence constraints of the mothers in the study, we attempted to keep sessions as short as possible and therefore were not able to include the reunion episode in all locations (Bolivia) and therefore decided not to include the Fijian reunion data here. Future work should assess the reunion episode as well to provide a more comprehensive cross-cultural comparison of the still-face paradigm. Furthermore, we also recognize the testing locations varied both within and across locations. Future research will be required to systematically examine the impact of testing location and set up on outcomes.

8. Conclusions

The emotions displayed in response to the still-face paradigm are used as a proxy for normal functioning and variation from the expected response is often considered on the spectrum of psychopathology (Peláez-Nogueras et al., 1996), which is problematic when data are limited to certain populations and certain modalities of emotion expression. Testing infant response to the still-face paradigm with different modalities of emotion and social engagement strategies (i.e., non-visual and non-vocal) is important for understanding whether infants use variation in early social experience to construct culture-specific patterns of emotion expression. Our modified version of the still-face paradigm is a methodological innovation in culturally sensitive still-face research. The data presented demonstrate that the development of emotion is not fixed and universal, but rather shaped by the modality and contingency of interactions experienced by the infant within their early social and cultural context. This suggests that the still-face effect is a reflection not of inborn preferences for social interaction, but rather of general learning mechanisms (i.e., contingency detection and multi-modal perception) that have allowed infants to develop preferences for the social contingencies they experience most. This research emphasizes the need for more diverse and theoretically-motivated cultural comparisons within the study of infant emotion and infant-caregiver interaction. We hope these studies motivate further rigorous examination of the impact of cultural context on early social development Legare, 2017.

CRedit authorship contribution statement

Tanya Broesch: Conceptualization, Methodology, Writing – original draft, Investigation, Project administration, Writing – review & editing, Funding acquisition, Resources. **Emily E. Little:** Conceptualization, Methodology, Writing – original draft, Investigation, Data curation, Formal analysis; **Leslie J. Carver:** Conceptualization, Methodology, Writing – original draft, Supervision, Project administration. **Cristine H. Legare:** Conceptualization, Methodology, Writing – original draft, Supervision, Writing – review & editing, Funding acquisition, Resources.

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References

- Abelkop, B. S., & Frick, J. E. (2003). Cross-task stability in infant attention: New perspectives using the still-face procedure. *Infancy*, 4(4), 567–588. <https://doi.org/10.1207/S15327078IN0404.09>
- Abney, D. H., daSilva, E. B., & Bertenthal, B. I. (2021). Associations between infant–mother physiological synchrony and 4-and 6-month-old infants' emotion regulation. *Developmental Psychobiology*, 63(6), Article e22161.
- Adamson, L. B., & Frick, J. E. (2003). The still face: A history of a shared experimental paradigm. *Infancy*, 4(4), 451–473. <https://doi.org/10.1207/s15327078in0404.01>
- Akhtar, N., & Gernsbacher, M. A. (2008). On privileging the role of gaze in infant social cognition. *Child Development Perspectives*, 2(2), 59–65. <https://doi.org/10.1111/j.1750-8606.2008.00044.x>
- Amir, D., & McAuliffe, K. (2020). Cross-cultural, developmental psychology: Integrating approaches and key insights. *Evolution and Human Behavior*, 41(5), 430–444. <https://doi.org/10.1016/j.evolhumbehav.2020.06.006>
- Bigelow, A., Power, M., MacLellan-Peters, J., Alex, M., & McDonald, C. (2012). Effect of mother/infant skin-to-skin contact on postpartum depressive symptoms and maternal physiological stress. *Journal of Obstetric, Gynecologic & Neonatal Nursing*, 41(3), 369–382.
- Bigelow, A. E. (1998). Infants' sensitivity to familiar imperfect contingencies in social interaction. *Infant Behavior and Development*, 21(1), 149–162. [https://doi.org/10.1016/S0163-6383\(98\)90060-1](https://doi.org/10.1016/S0163-6383(98)90060-1)
- Bigelow, A. E., & Best, C. (2013). Peek-a-what? Infants' response to the still-face task after normal and interrupted peek-a-boo. *Infancy*, 18(3), 400–413. <https://doi.org/10.1111/j.1532-7078.2012.00124.x>
- Bigelow, A. E., Littlejohn, M., Bergman, N., & McDonald, C. (2010). The relation between early mother–infant skin-to-skin contact and later maternal sensitivity in South African mothers of low birth weight infants. *Infant Mental Health Journal*, 31(3), 358–377.
- Bigelow, A. E., & Power, M. (2016). Effect of maternal responsiveness on young infants' social bidding-like behavior during the still face task. *Infant and Child Development*, 25(3), 256–276. <https://doi.org/10.1002/icd.1974>
- Bigelow, A. E., Power, M., Bulmer, M., & Gerrior, K. (2017). The effect of maternal mirroring behavior on infants' early social bidding during the still-face task. *Infancy*. <https://doi.org/10.1111/infia.12221>
- Bigelow, A. E., Power, M., Gillis, D. E., MacLellan-Peters, J., Alex, M., & McDonald, C. (2014). Breastfeeding, skin-to-skin contact, and mother-infant interactions over infants' first three months. *Infant Mental Health Journal*, 35(1), 51–62.
- Bigelow, A. E., & Rochat, P. (2006). Two-month-old infants' sensitivity to social contingency in mother-infant and stranger-infant interaction. *Infancy*, 9(3), 313–325. <https://doi.org/10.1207/s15327078in0903.3>
- Braungart-Rieker, J. M., Garwood, M. M., Powers, B. P., & Wang, X. (2001). Parental sensitivity, infant affect, and affect regulation: Predictors of later attachment. *Child Development*, 72(1), 252–270. <https://doi.org/10.1111/1467-8624.00277>
- Broesch, T., Crittenden, A. N., Beheim, B., Blackwell, A. D., Bunce, J., Colleran, H., ... Borgerhoff Mulder, M. (2020). Navigating cross-cultural research: Methodological and ethical considerations. *Proceedings of the Royal Society B*, 287(1935). <https://doi.org/10.1098/rspb.2020.1245>
- Broesch, T., Rochat, P., Olah, K., Broesch, J., & Henrich, J. (2016). Similarities and differences in maternal responsiveness in three societies: Evidence from Fiji, Kenya and US. *Child Development*, 87(3), 700–711. <https://doi.org/10.1111/cdev.12501>
- Carpenter, M., Nagell, K., Tomasello, M., Butterworth, G., & Moore, C. (1998). Social cognition, joint attention, and communicative competence from 9 to 15 months of age. *Monographs of the Society for Research in Child Development*, 174. <https://doi.org/10.2307/1166214>
- Cavagnoud, R. (2011). Primera infancia: Experiencias y políticas públicas en Bolivia. *Aporte a la educación actual. Tinkazos*, 14(29), 152–154.
- Cohn, J. F., Campbell, S. B., & Ross, S. (1991). Infant response in the still-face paradigm at 6 months predicts avoidant and secure attachment at 12 months. *Development and Psychopathology*, 3, 367–376. <https://doi.org/10.1017/S0954579400007574>
- Conradt, E., & Ablow, J. (2010). Infant physiological response to the still-face paradigm: Contributions of maternal sensitivity and infants' early regulatory behavior. *Infant Behavior and Development*, 33(3), 251–265.
- Dahl, A. (2017). Ecological commitments: Why developmental science needs naturalistic methods. *Child Development Perspectives*, 11, 79–84. <https://doi.org/10.1111/cdep.12217>
- Datavyu Team. (2014). Datavyu: A video coding tool. *Datavary project*. New York University. (<http://datavyu.org>).
- Della Longa, L., Gliga, T., & Farroni, T. (2017). Tune to touch: Affective touch enhances learning of face. *Infancy*, 4(4), 451–473. <https://doi.org/10.1016/j.dcn.2017.11.002>
- Field, T. (1995). Massage therapy for infants and children. *Journal of Developmental & Behavioral Pediatrics*, 16(2), 105–111. <https://doi.org/10.1097/00004703-199504000-00008>
- Field, T. (2010). Touch for socioemotional and physical well-being: A review. *Developmental Review*, 30(4), 367–383. <https://doi.org/10.1016/j.dr.2011.01.001>
- Field, T., Hernandez-Reif, M., Diego, M., Feijo, L., Vera, Y., & Gil, K. (2007). Still-face and separation effects on depressed mother–infant interactions. *Infant Mental Health Journal*, 28, 314–323.
- Fouts, H. N., Hewlett, B. S., & Lamb, M. E. (2012). A biocultural approach to breastfeeding interactions in Central Africa. *American Anthropologist*, 114(1), 123–136.
- Fuertes, M., da Costa Ribeiro, C., Barbosa, M., Gonçalves, J., Teodoro, A. T., Almeida, R., & Lamônica, D. A. C. (2021). Patterns of regulatory behavior in the still-face paradigm at 3 months: A comparison of Brazilian and Portuguese infants. *PLoS One*, 16(6), Article e0252562.
- Gerlach, A., Browne, A., & Suto, M. (2014). A critical reframing of play in relation to Indigenous children in Canada. *Journal of Occupational Science*, 21(3), 243–258.
- Henrich, J., Heine, S. J., & Norenzayan, A. (2010). The weirdest people in the world? *Behavioral and Brain Sciences*, 33(2–3), 61–83. <https://doi.org/10.1017/S0140525X0999152x>
- Hertenstein, M. J. (2002). Touch: Its communicative functions in infancy. *Human Development*, 45(2), 70–94. <https://doi.org/10.1159/000048154>
- Hewlett, B. S. (1989). Multiple caretaking among African pygmies. *American Anthropologist*, 91(1), 186–191. <https://doi.org/10.1525/aa.1989.91.1.02a00190>
- Hewlett, B. S. (1992). The parent-infant relationship and social-emotional development among Aka Pygmies. *Parent-Child Socialization in Diverse Cultures*, 223–243.
- Hewlett, B. S., Lamb, M. E., Shannon, D., Leyendecker, B., & Schölmerich, A. (1998). Culture and early infancy among central African foragers and farmers. *Developmental Psychology*, 34(4), 653–661. <https://doi.org/10.1037/0012-1649.34.4.653>
- Hill, K. R., & Hurtado, A. M. (1996). *Ache life history: The ecology and demography of a foraging people*. Transaction Publishers.
- Hsu, H., & Jeng, S. (2008). Two-month-olds' attention and affective response to maternal still face: A comparison between term and preterm infants in Taiwan. *Infant Behavior and Development*, 31(2), 194–206. <https://doi.org/10.1016/j.infbeh.2007.10.008>
- Hunziker, U. A., & Barr, R. G. (1986). Increased carrying reduces infant crying: A randomized controlled trial. *Pediatrics*, 77(5), 641–648.
- Kärtnner, J., Keller, H., & Yovsi, R. D. (2010). Mother-infant interaction during the first 3 months: The emergence of culture-specific contingency patterns. *Child Development*, 81(2), 540–554. <https://doi.org/10.1111/j.1467-8624.2009.01414.x>
- Kasari, C., Freeman, S., & Paparella, T. (2006). Joint attention and symbolic play in young children with autism: A randomized controlled intervention study. *Journal of Child Psychology and Psychiatry*, 47(6), 611–620. <https://doi.org/10.1111/j.1469-7610.2005.01567.x>
- Keller, H. (2002). Development as the interface between biology and culture: A conceptualization of early ontogenetic experiences. *Between Culture and Biology*, 215–240. <https://doi.org/10.1017/cbo9780511489853.011>

- Keller, H., Borke, J., Staufienbiel, T., Yovsi, R. D., Abels, M., Papaligoura, Z., & Su, Y. (2009). Distal and proximal parenting as alternative parenting strategies during infants' early months of life: A cross-cultural study. *International Journal of Behavioral Development*, 33(5), 412–420. <https://doi.org/10.1177/0165025409338441>
- Keller, H., & Otto, H. (2009). The cultural socialization of emotion regulation during infancy. *Journal of Cross-Cultural Psychology*, 40(6), 996–1011. <https://doi.org/10.1177/0022022109348576>
- Keller, H., Yovsi, R., Borke, J., Kärtner, J., Jensen, H., & Papaligoura, Z. (2004). Developmental consequences of early parenting experiences: Self-recognition and self-regulation in three cultural communities. *Child Development*, 75(6), 1745–1760. <https://doi.org/10.1111/j.1467-8624.2004.00814.x>
- Kirberg, B. A. (2006). La salud del niño aymara. *Rev Child Pediatrics*, 77(6). <https://doi.org/10.4067/s0370-41062006000600009>
- Kisilevsky, B. S., Hains, S. M., Lee, K., Muir, D. W., Xu, F., Fu, G., & Yang, R. L. (1998). The still-face effect in Chinese and Canadian 3- to 6-month-old infants. *Developmental Psychology*, 34(4), 629–639. <https://doi.org/10.1037/0012-1649.34.4.629>
- Kline, M., Shamsudeen, R., & Broesch, T. (2018). Variation is the universal: Making cultural evolution work in developmental psychology. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 373(1743). <https://doi.org/10.1098/rstb.2017.0059>
- Konner, M. (2017). Hunter-gatherer infancy and childhood: The Kung and others. *Hunter-Gatherer childhoods* (pp. 19–64). Routledge.
- Lancy, D. F. (2012). The chore curriculum. *African Children at Work: Working and Learning in Growing Up*, 23.
- Legare, C. H. (2017). Cumulative cultural learning: Development and diversity. *Proceedings of the National Academy of Sciences*, 7877–7883.
- Legare, C. H., & Harris, P. L. (2016). Introduction to the ontogeny of cultural learning. In C. H. Legare, & P. L. Harris (Eds.), *The ontogeny of cultural learning*. [Special section]. Child development.
- LeVine, R. A., Dixon, S., LeVine, S., Richman, A., Leiderman, P. H., Keefer, C. H., & Brazelton, T. B. (1994). *Child care and culture: Lessons from Africa*. Cambridge University Press.
- Little, E. E., Carver, L. J., & Legare, C. H. (2016). Cultural variation in triadic infant-caregiver object exploration. *Child Development*, 87(4), 1130–1145. <https://doi.org/10.1111/cdev.12513>
- Little, E. E., Cioffi, C. C., Bain, L., Legare, C. H., & Hahn-Holbrook, J. (2021). An infant carrier intervention and breastfeeding duration: A randomized controlled trial. *Pediatrics*, 148, 1.
- Mantis, I., Mercuri, M., Stack, D. M., & Field, T. M. (2019). Depressed and non-depressed mothers' touching during social interactions with their infants. *Developmental Cognitive Neuroscience*, 35, 57–65.
- McKenna, J. J., & McDade, T. (2005). Why babies should never sleep alone: A review of the co-sleeping controversy in relation to SIDS, bedsharing and breast feeding. *Paediatric Respiratory Reviews*, 6(2), 134–152.
- Mesman, J., Minter, T., Angged, A., Cissé, I. A., Salali, G. D., & Migliano, A. B. (2017). Universality without uniformity: A culturally inclusive approach to sensitive responsiveness in infant caregiving. *Child Development*. <https://doi.org/10.1111/cdev.12795>
- Mesman, J., van Ijzendoorn, M. H., & Bakermans-Kranenburg, M. J. (2009). The many faces of the still-face paradigm: A review and meta-analysis. *Developmental Review*, 29(2), 120–162. <https://doi.org/10.1016/j.dr.2009.02.001>
- Moore, C. (2008). The development of gaze following. *Child Development Perspectives*, 2(2), 66–70. <https://doi.org/10.1111/j.1750-8606.2008.00052.x>
- Moore, C. E., & Dunham, P. J. (1995). *Joint attention: Its origins and role in development*. Lawrence Erlbaum Associates, Inc.
- Moore, G. A., Cohn, J. F., & Campbell, S. B. (2001). Infant affective responses to mother's still face at 6 months differentially predict externalizing and internalizing behaviors at 18 months. *Developmental Psychology*, 37(5), 706.
- Muir, N., & Bohr, Y. (2019). Contemporary practice of traditional Aboriginal child rearing: A review. *First Peoples Child & Family Review: An Interdisciplinary Journal Honouring the Voices, Perspectives, and Knowledge of First Peoples through Research, Critical Analyses, Stories, Standpoints and Media Reviews*, 14(1), 153–165.
- Nielsen, M., Haun, D., Kärtner, J., & Legare, C. H. (2017). The persistent sampling bias in developmental psychology: A call to action. *Journal of Experimental Child Psychology*, 162, 31–38. <https://doi.org/10.1016/j.jecp.2017.04.017>
- Owusu-Ansah, F. E., Bigelow, A. E., & Power, M. (2019). The effect of mother-infant skin-to-skin contact on Ghanaian infants' response to the still face task: Comparison between Ghanaian and Canadian mother-infant dyads. *Infant Behavior and Development*, 57.
- Peláez-Nogueras, M., Gewirtz, J. L., Field, T., Cigales, M., Malphurs, J., Clasky, S., & Sanchez, A. (1996). Infants' preference for touch stimulation in face-to-face interactions. *Journal of Applied Developmental Psychology*, 17(2), 199–213. [https://doi.org/10.1016/s0193-3973\(96\)90025-8](https://doi.org/10.1016/s0193-3973(96)90025-8)
- Peláez-Nogueras, M., Field, T. M., Hossain, Z., & Pickens, J. (1996). Depressed mothers' touching increases infants' positive affect and attention in still-face interactions. *Child Development*, 67(4), 1780–1792. <https://doi.org/10.1111/j.1467-8624.1996.tb01827.x>
- Pinheiro, J. C., & Bates, D. M. (2000). Linear mixed-effects models: basic concepts and examples. *Mixed-effects models in S and S-Plus*, 3–56. *Statistics and computing*. New York, NY: Springer.
- Richman, A. L., Miller, P. M., & LeVine, R. A. (1992). Cultural and educational variations in maternal responsiveness. *Developmental Psychology*, 28(4), 614–621. <https://doi.org/10.1037/0012-1649.28.4.614>
- St James-Roberts, I., Alvarez, M., Csipke, E., Abramsky, T., Goodwin, J., & Sorgenfrei, E. (2006). Infant crying and sleeping in London, Copenhagen and when parents adopt a "proximal" form of care. *Pediatrics*, 117(6), e1146–e1155.
- Stack, D. M., & Arnold, S. L. (1998). Changes in mothers' touch and hand gestures influence infant behavior during face-to-face interchanges. *Infant Behavior and Development*, 21(3), 451–468. [https://doi.org/10.1016/s0163-6383\(98\)90019-4](https://doi.org/10.1016/s0163-6383(98)90019-4)
- Stack, D. M., & Muir, D. W. (1992). Adult tactile stimulation during face-to-face interactions modulates five-month-olds' affect and attention. *Child Development*, 63(6), 1509. <https://doi.org/10.2307/1131572>
- Stack, D. M., & Muir, D. W. (1990). Tactile stimulation as a component of social interchange: New interpretations for the still-face effect. *British Journal of Developmental Psychology*, 8(2), 131–145. <https://doi.org/10.1111/j.2044-835X.1990.tb00828>
- Super, C. M., & Harkness, S. (1986). The developmental niche: A conceptualization at the interface of child and culture. *International Journal of Behavioral Development*, 9(4), 545–569.
- Trevarthen, C., & Aitken, K. J. (2001). Infant intersubjectivity: Research, theory, and clinical applications. *Journal of Child Psychology and Psychiatry*, 42(1), 3–48. <https://doi.org/10.1017/s0021963001006552>
- Tronick, E., Als, H., Adamson, L., Wise, S., & Brazelton, T. B. (1978). The infant's response to entrapment between contradictory messages in face-to-face interaction. *Journal of the American Academy of Child Psychiatry*, 17(1), 1–13. [https://doi.org/10.1016/s0002-7138\(09\)62273-1](https://doi.org/10.1016/s0002-7138(09)62273-1)
- Wörmann, V., Holodyski, M., Kärtner, J., & Keller, H. (2012). A cross-cultural comparison of the development of the social smile. *Infant Behavior and Development*, 35(3), 335–347. <https://doi.org/10.1016/j.infbeh.2012.03.002>
- Yato, Y., Kawai, M., Negayama, K., Sogon, S., Tomiwa, K., & Yamamoto, H. (2008). Infant responses to maternal still-face at 4 and 9 months. *Infant Behavior and Development*, 31(4), 570–577. <https://doi.org/10.1016/j.infbeh.2008.07.008>