



A cross-cultural comparison of the development of the social smile A longitudinal study of maternal and infant imitation in 6- and 12-week-old infants

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ABSTRACT

Social smiling is universally regarded as being an infant's first facial expression of pleasure. Underlying co-constructivist emotion theories are the assumptions that the emergence of social smiling is bound to experiences of face-to-face interactions with caregivers and the impact of two developmental mechanisms – maternal and infant imitation. We analyzed mother–infant interactions from two different socio-cultural contexts and hypothesized that cross-cultural differences in face-to-face interactions determine the occurrence of both of these mechanisms and of the frequency of social smiling by 12-week-old infants. Twenty mother–infant dyads from a socio-cultural community with many face-to-face interactions (German families, Münster) were compared with 24 mother–infant dyads from a socio-cultural community with few such interactions (rural Nso families, Cameroon) when the infants were aged 6 and 12 weeks. When infants were 6 weeks old, mothers and their infants from both cultural communities smiled at each other for similar (albeit very short) amounts of time and used imitated each other's smiling similarly rarely. In contrast, when infants were 12 weeks old, mothers and their infants from Münster smiled at and imitated each other more often than did Nso mothers and their infants.

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1. Introduction

1.1. Evidence for the emergence of smiling in the first three months

An infant social smile is usually interpreted as the first positive expression that is directed towards a cause: “It occurs when an infant with an initially expressionless face examines the face of another person, his face and eyes then light up, and the corners of his mouth pull upward” (Anisfeld, 1982, p. 387). Previous findings on the development of social smiling were obtained mainly from face-to-face interactions between mothers or caregivers and infants in industrial societies and western cultures. From this research, two main factors have been identified as potential explanations for the development of social smiling.

First, an important role is ascribed to neurophysiological maturation processes in regard to the 2-month shift. At this age infants show increased alertness (Emde & Buchsbaum, 1989; Kärtner, Keller, & Yovsi, 2010; Wolff, 1987), improved control of their head and improved gaze direction (Stern, 1974; van Wulfften Palthe & Hopkins, 1993), as well as an increasing ability to maintain their visual attention for longer periods of time (Lavelli & Fogel, 2002, 2005; Wolff, 1963) and to explore the internal

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features of their mother's face systematically (Haith, Bergman, & Moore, 1977). This gaze behavior can be interpreted as a readiness to engage in social interaction with their caregivers (Adamson, 1995) that promotes more face-to-face interactions, in which infants start to smile at their caregivers (Messinger, 2008; Stern, 1974; Trevarthen, 1979).

Second, interaction between infants and their caregivers greatly contributes to the emergence of infant smiling. Co-constructivist approaches consider the maturation processes associated with the 2-month shift as a *necessary*, but not *sufficient*, precondition for the emergence of social smiling. In order to meet a *sufficient* condition, the infant must experience specific social interactions with his or her mother or caregiver (Camras, 2000; Fogel et al., 1992; Gergely & Watson, 1999; Holodynski & Friedlmeier, 2006; Messinger, Fogel, & Dickson, 1997; Stern, 1996). In general, social smiling is elicited by contingent imitation during face-to-face interactions with caregivers, building on the neural maturation processes described above (Adamson, 1995; Lavelli & Fogel, 2002, 2005; Messinger, 2008; Messinger & Fogel, 2007; van Wulfften Palthe & Hopkins, 1993).

1.2. Contingent maternal imitation of infant smiles

With respect to the 2-month shift, Lavelli and Fogel (2002, 2005) have demonstrated that there are significant changes in interactional behavior between mothers and infants (from North-Italy). During the second month, mothers started to reflect contingently the increasing number of smiles that their infants gave in terms of an answer-smile with accompanying speech and then gave the infants an opportunity to "answer". Gergely and Watson (1999) defined such contingent imitation of infant smiles as affect mirroring.

In a recent cross-cultural study, Kärtner et al. (2010) found that there are culture-specific contingency patterns towards infants' vocalizations that emerge during the second and third month of life. Between the 6th and the 8th week, the duration of mutual gaze sharply increased in the urban German middle-class sample from Münster, leading to significant differences in postnatal weeks 8–12 as compared to dyads from the rural Cameroonian Nso sample where the duration of mutual gaze was continuous at a comparatively low level. As a consequence, mothers in the Münster sample showed significantly more visual contingent responses and less proximal contingent responses to infants' nondistress vocalizations as infants got older. Cultural differences in maternal visual contingencies are important because even 2-month-old infants seem able to perceive this contingent maternal interaction behavior as studies of the modified still-face paradigm (originally from Tronick, Als, Adamson, Wise, & Brazelton, 1978) have shown (Fogel, 1982; Murray & Trevarthen, 1985; Nadel, Carchon, Kervella, Marcelli, & Rtserbat-Plantey, 1999). For example, Legerstee and Varghese (2001) found that 2- to 3-month-olds whose mothers showed a high degree of imitation behavior in their daily interactions with their infants were able to perceive the difference between life and replay interactions with their mothers. In contrast, infants whose mothers imitated their infants less in their daily interactions were unable to perceive this difference. Soussignan, Nadel, Canet, and Geradin (2006) obtained similar results; in their sample, only the 2-month-olds who recognized the distinction between life and replay settings exhibited significantly more smiling.

1.3. Learning by infants through imitation of maternal smile

Contingent imitation by caregivers does not seem to be the only mechanism that increases both the duration and frequency of infant smiles. In this way, maternal imitation is limited by the fact that caregivers have to wait for the appearance of their infant's first smile before they can respond to it contingently. On the other hand, there seems to be a second mechanism by which a self-perpetuating cycle is developed through maternal imitation: infants' learning through imitation behavior. Infants are able to precisely imitate the facial expressions of caregivers from very early on. Note that this imitation is not deliberate imitation, but a kind of motor mimicry (Meltzoff & Moore, 1988). Until now, the focus in the imitation literature has been particularly on such facial expressions as opening the mouth, sticking out the tongue, closing the eyes (Heimann, 1998; Kugiumutzakis, 1998; Kugiumutzakis, Kokkinaki, Makrodimitraki, & Vitalaki, 2005). Importantly, it seems like both newborns (Field, Woodson, Greenberg, & Cohen, 1982) and 2- to 3-month-olds (Haviland & Lelwica, 1987) are able to imitate the maternal smile. Although further studies on the neonates' ability to imitate facial emotional expressions (Bertin & Striano, 2006; Kaitz, Meschulach-Sarfaty, Auerbach, & Eidelman, 1988) failed to replicate the results of Field et al. (1982), there is evidence that newborns are able to distinguish facial expressions: They are able to show preferences on certain facial movements in the peripheral visual field (De Haan, 2001) as well as to discriminate at least some facial expressions (happy and fear) which they favor over other expressions (Farroni, Menon, Rigato, & Jonson, 2007). Bertin and Striano (2006) demonstrated that even 6-week-old infants are able to imitate maternal smiling and respond sensitive to the still-face periods with decreasing of positive affect.

In two longitudinal studies of infants aged 2–6 months, Kokkinaki (2003), in addition to the facial imitation patterns mentioned above, observed the smiles of caregivers and their infants before and during imitation. Infants responded to the preceding smiles of their parents mainly with smiles that could be regarded as imitation. Lavelli and Fogel (2005) also demonstrated that 2-month-olds respond to the maternal smile with their own smile, in a more systematically frequent, rather than a random pattern. It remains unclear, however, whether this contingent infant "answering" smile represents *only* imitation or if it is an expression of pleasure.

Moreover, mothers or caregivers in western socio-cultural contexts do not wait for their infant to start smiling; they smile at the infant during self-initiated face-to-face interactions, either because of the joy of visual contact or as a social welcoming

signal. By smiling, caregivers provide their infant with more opportunities to smile in response (through imitation). In turn, caregivers interpret their infant's imitation as a welcome occasion to respond contingently with their own smile, thereby triggering maternal imitation of the infant's smile. In this way, the infant's and the caregiver's imitation behaviors interact with one another; this mutual interaction intensifies the smiling process and contributes to the emergence of the infant's social smile in future face-to-face interactions. The interplay of these two mechanisms is referred to in the Internalization Model of Emotional Development (Holodynski & Friedlmeier, 2006) with respect to the differentiation of joy and other positive emotions in ontogenesis.

1.4. *The emergence of emotions in a cultural context*

The findings regarding the reciprocal interaction of infants' and maternal imitation behaviors are exclusively based on samples from western, industrialized societies. In this way, it is impossible for us to infer a universal behavioral process. If caregivers establish few face-to-face interactions with their infants and imitate their infants' smiles inconsistently, then their infants receive minimal feedback that their smile is important. Accordingly, the emergence of social smiling in these infants should be delayed.

Parents from different socio-cultural contexts value different socialization goals and strategies. These strategies, in turn, depend on culture-specific parenting ethnotheories regarding appropriate contact with their infants (Keller et al., 2006; Keller, Völker, & Yovsi, 2005; Lamm, Keller, Yovsi, & Chaudhary, 2008), which also effect the interactional parenting practices that parents apply towards their infants (Keller & Otto, 2009). Because of co-regulation of infant emotions by caregivers, the newborn infant becomes a toddler with differentiated, culture-specific emotions (Holodynski & Friedlmeier, 2006).

The emergence of social smiling provides us with a perfect opportunity to test these assumptions and explore the culture-specific development of social smiling. If infant's and maternal facial imitations are considered as key factors for the development of social smiling, then patterns of mother–infant interactions that differ between cultures should lead to differential courses of the development of social smiling in different socio-cultural contexts. In order to test this hypothesis, it is necessary to observe the development of social smiling in two cultural contexts that embrace contrasting patterns of social interaction during the first three months of life.

1.5. *The selection of contrasting culture-specific patterns of interaction*

There is some, albeit little, research regarding social smiling across different socio-cultural contexts (Anisfeld, 1982; Fogel, Toda, & Kawai, 1988; Landau, 1977; Wolff, 1963). For example, Anisfeld (1982) found that Israeli infants (of Asiatic or north-African origin, ethnic subgroup Sephardim) from families of low socio-economic status began to smile socially one month earlier than did Israeli infants (of northern and central European or American origin, ethnic subgroup Ashkenazim) from families of average socio-economic status. Anisfeld discussed these results with respect to different living environments and parenting patterns in the home. Note, however, that the interaction behaviors and ethnotheories of the mothers were not examined closely.

The first evidence of a possible link between maternal interactional behavior and the emergence of the infant smile was provided by Fogel et al. (1988). These authors examined socio-cultural differences in mothers' contingent responses to their infants and found that 3-month-old American infants from middle-class families smiled three times as often as Japanese infants of the same age, who were also from middle class families. With respect to maternal interactional behavior, Fogel et al. reported that American mothers responded to their infants' signals by using facial expressions and vocalizations, whereas Japanese mothers responded by initiating body contact and body stimulations (touch, stroke, tap and reposition of infant) with their infants. Again, however, the nature of parenting ethnotheories was not examined.

Keller and her colleagues (Kärtner et al., 2007; Keller et al., 2006; Keller & Otto, 2009) have compared socio-cultural contexts, which can be described as either independent or interdependent with regard to their predominant socio-cultural orientation (see also Kağitçibasi, 1996, 2005). In their studies, the authors contrast different socio-cultural contexts with regard to parenting ethnotheories and practices. The most important differences between these cultural contexts with respect to parenting behavior are represented in Table 1.

Table 1
Relevant parenting features of independent and interdependent socio-cultural contexts.

Elements of parenting	Independent socio-cultural contexts	Interdependent socio-cultural contexts
Parenting socialization goals	Learn to be different from others, to be assertive, to offer one's own ideas	Learn to share with others, to obey parents, to facilitate social harmony
Parenting ethnotheories	Autonomy: self-actualizing, emotional expressiveness	Relatedness: regulation of negative emotions
Parental behavioral strategies	Distal regulation: face-to-face contact, object stimulation, mutual gaze, undivided attention	Proximal regulation: body contact, body stimulation, primary care
Effect on emergence of infants' emotions	Expression and maintenance of positive emotions are reinforced	Fostering a calm infant, who does not express negative emotions

Note. According to Keller (2007).

An *independent socio-cultural orientation* is typical of urban, middle-class families from western, industrialized societies who have comparatively high levels of formal education (see Keller, 2007). Mothers from independent socio-cultural contexts socialize their children towards autonomy, which is reflected in empirical findings on the socialization goals of urban, middle-class families in Germany, the USA, and Greece (Keller, 2007). Face-to-face interactions with infants along with object-stimulation predominate in these countries. Mothers expect expression of their infant's positive emotions (e.g., the first smile) as early as the age of about two months and respond and reinforce these occurrences with joyful smiling in return (Kärtner et al., 2007; Keller et al., 2006; Keller & Otto, 2009).

Interdependent socio-cultural orientation is typical of traditional families from non-western, rural communities with predominantly agricultural backgrounds who have relatively low levels of formal education (Keller, 2007). Such prototypical interdependent orientations are evident, for example in the ethnic Nso group from rural village communities in Cameroon (Kärtner et al., 2007; Keller et al., 2006; Keller & Otto, 2009). Duties towards and co-operation with others, as well as the avoidance and suppression of negative emotions, are all very important in interdependent socio-cultural contexts. Infant smiling, in contrast, is not considered to be an important communicative signal (Keller, 2007). As a result, mothers from these contexts only expect expressions of pleasure from their infants at the age of about seven months (Keller & Otto, 2009).

Based on these considerations, we assume that there are different developmental pathways of smiling according to the different socio-cultural contexts. In order to test these assumptions, we used two samples representing both of these socio-cultural orientations: Münster, Germany (independent orientation) and Nso, Cameroon (interdependent orientation). These samples were the same samples as those recruited by Kärtner et al. (2010). The difference between this earlier study and the study is that Kärtner and his colleagues focused only maternal contingent responses to infants' non-distress vocalizations, while, in the present study, we focus on maternal and infants' smiling and gazing behavior within mother–infant interactions and the imitations of smiles by mothers and infants. As Kärtner et al. (2010) have shown, the Münster and the Nso sample differ in how often caregivers establish face-to-face interactions with their infants. They also differ with respect to infant gaze behavior during face-to-face interactions. Accordingly, we hypothesize that mothers from these socio-cultural contexts will differ regarding the amount of smiling that is directed at their infants and the degree to which they engage in imitation.

Based on these considerations we formulated three hypotheses concerning maternal and infant responses in both prototypical contexts.

1. *Culture-specific emergence of smiling*

The duration and intensity of both maternal and infant smiles during mutual gazing increase substantially in the Münster sample, but not in the Nso sample, from the 6th to the 12th week of life.

2. *Maternal imitation of infant smiling as the first-term factor of the social smile*

By the time their infants are 12 weeks old, mothers from the Münster sample imitate smiles of their infants more frequently than mothers from the Nso sample.

3. *Infant imitation of maternal smiling as the second-term factor of the social smile*

The frequency of infants' imitation of their mother's smile will be greater for 12-week-olds from the Münster sample compared to 12-week-olds from the Nso sample.

In the present study, mother–infant interaction was observed when infants were 6 and 12 weeks old. We selected the 6-week time point because it is prior to the 2-month shift and exogenous smiling is seldom observed before this age (Emde & Buchsbaum, 1989). It was our aim to select the time point that is proximately prior to the initial onset of social smile (Lavelli & Fogel, 2005) in order to analyze the developmental “baseline” before maternal behavior may start to change with regard to the 2-month shift. Kärtner et al. (2010) have shown that between the ages of 6 and 8 weeks, there is a significant increase in infants' alertness in both socio-cultural contexts. While in the 6th week, Nso infants were alert for 71% (SD = 41%) and infants from Münster were alert for 62% (SD = 35%) of the time, proportions of time significantly increased in week 8, 10, and 12 (Nso: smallest $M = 94%$, $SD = 20%$; Münster: smallest $M = 92%$, $SD = 16%$). If the 2-month shift encourages the emergence of social smiling through maturational processes alone, then interactive behavior (i.e., mutual gazing and smiling) of the 6-week-old infants should not (yet) differ between the two socio-cultural contexts.

We selected the 12-week time point because it is after the 2-month shift and infants of this age from western cultures show social smiling in a reliable and clearly observable way (Emde & Buchsbaum, 1989; Sroufe & Waters, 1976) and are able to be engaged in stable face-to-face interactions (Lavelli & Fogel, 2005; Messinger & Fogel, 2007). We were particularly interested in specific features of the appearance of social smiling in the Nso sample compared to the Münster sample at this time point.

2. Method

2.1. Participants

We examined the videos of 44 freely-occurring mother–infant interactions when the infants were aged 6 and 12 weeks. Families belonged to two different socio-cultural contexts. There were 24 mother–infant pairs from the rural region around Kumbo, in the northwest province of Cameroon. These families belong to the ethnic Nso group and live in the village of Kikakelaki. There were also 20 mother–infant pairs from middle-class families from the northern German city of Münster.

Both samples were drawn from a wider study in which the families were visited weekly during the first 12 postnatal weeks. A precise description of the sample ($N=44$) can be found in Kärtner et al. (2010).¹

The average age of the mothers in the Münster sample was 30.70 years ($SD=3.76$ years) and the average age of the mothers from the Nso sample was 27.40 years ($SD=8.15$ years). The Nso mothers were significantly younger than were the mothers from Münster, $t(42)=1.67$, $p<.10$, $d=.51$. The mothers from Münster had a higher degree of formal education ($M=14.35$ years, $SD=3.23$) than did the Nso mothers ($M=8.00$ years, $SD=1.91$), $t(42)=8.09$, $p<.01$, $d=2.45$. In both socio-cultural contexts, infant gender was distributed more or less equally. The mothers in both samples were the primary caregivers to their infants. All mothers from Münster and only seven of the Nso mothers were first-time mothers (see Kärtner et al., 2010).

Based on our conception of culture, these patterns of socio-demographic differences are constitutive of the different socio-cultural environments (Keller, 2007). In this sense, our sampling strategy was to recruit homogeneous groups with respect to the socio-demographic marker variables that can be regarded as prototypical for the respective socio-cultural contexts. The exposure to formal education and the families' economic resources are inextricably interwoven with the shared systems of meaning and actions and thus with the practices of everyday life within the family. Because these differences in socio-demographic variables are constitutive of culture, we do not control for them statistically. As a further consequence, this approach does not allow generalizations about countries or societies as a whole.

2.2. Procedure

The mother–infant interactions were videotaped for 10 min. The mothers were asked to interact freely with their infants as they would in their normal daily interactions. Researchers ensured that all infants were awake, calm, and fed before the videotaping (see Kärtner et al., 2010). From each of the 10-min free-play interaction videos, we selected a 3-min sequence that began during the second minute of the film. The first minute was not used because it served as an opportunity for the mothers and their infants to get used to the recording process. The coders ensured that, within these sequences, no essential or systematic interruptions (e.g., feeding, sleeping, etc.) of the interaction occurred. This checking ensured that we were observing the contingent gazing and smiling behavior accurately.

2.3. Coding scheme and behavioral definition

2.3.1. Gazing and smiling behavior

The gazing direction and maternal and infant smile behaviors were coded from the video sequences with the aid of INTERACT 9.0.7 software. The exact time at the beginning (*onset*) and end (*offset*) of these behaviors were coded. We used the following categories to code gazing behavior: (1) gazing at mother/gazing at infant (gaze is focused on the mother's/infant's face for a minimum of 1 s), (2) not gazing at mother/not gazing at infant (gaze is not focused on the mother's/infant's face (e.g., gaze away, swivel gaze, for a minimum of 1 s), and (3) gazing could not be coded (impossible to identify the gaze due to insufficient film quality, face being hidden, etc.).

We used the following categories to code the duration of mothers' and infants' smiles: (1) smile, (2) non-smile (other facial expressions, except smiling) and (3) smile could not be coded (impossible to identify smiling expressions due to insufficient film quality, face being hidden, etc.). We also rated the intensity of infants' and mothers' smiles with regard to the ratings of infants' smile intensities by naïve adult raters: in their study, Bolzani Dinehart et al. (2005) found that greater smiling lip corner movement (Action Unit 12A-E of the BabyFACS (Oster, 2000), eye constriction (AU6) by which the cheeks are raised, and mouth opening (AU25A-E) were rated as more intensive positive emotion. We combined these results to a 5-point intensity scale from 1 = very low-intensity smile (only low raising or sideways movement of lip corners without eye constriction, cheeks not raised, mouth closed) to 3 = middle intensity (raising or sideways movement of lip corners is clearly distinctive, mouth can be slightly open, eye constriction, cheeks are clearly raised) to 5 = very high-intensity smile (maximum constriction of eyes with highly-raised cheeks, mouth opened, and a very high raising or sideways movement of lip corners).

2.3.2. Maternal and infant imitation behavior

With the aid of an integrated design environment (IDE) application in Visual Studio 2010, we developed software to score the variables in question. We coded the *maternal* and *infant imitation* variables separately for onsets and offsets of smiling. Other expressions (gestures, vocal, etc.) were not considered. We calculated the frequency of appearance of the maternal and infant imitation variables. Such analysis represents a combination between *event* and *time analysis* because our question was whether the maternal or infant imitation occurred within a certain time frame as well as whether it occurred as the very next behavior following the determined criteria (Barratt, Roach, & Leavitt, 1992; Sackett, 1979).

2.3.2.1. Maternal imitation. In order to code *maternal imitation*, we identified the onset and offset during mutual gazing when mothers responded within 3 s to the intensification (onset) or reduction (offset) of their infant's smile by

¹ The videotaped interactions were funded by the German Research Foundation and form part of a larger project headed by Prof. Dr. Heidi Keller (University of Osnabrück) and Prof. Dr. Arnold Lohaus (University of Bielefeld).

intensifying or reducing their own smile. In order to count the frequency of all possible occasions of maternal imitation, the non-implemented instances of imitation by the mother, as well as reciprocal maternal smiling were also coded as potential situations in which maternal imitation could have occurred, but did not. These instances were coded as *missed maternal imitation* if the infant intensified or reduced his or her smile and the mother did not respond (within 3 s) by intensifying or reducing, her own smile, respectively. We also coded instances for *reciprocal maternal smiles* by identifying instances in which at onset the infant started/intensified his or her smile and the mother responded (within 3 s) by ending/reducing the intensity of her own smile, respectively and vice versa at offset. The frequencies of all possible occasions for maternal imitation did not differ at 6 weeks neither for onset ($M_{\text{Münster}} = 1.0$, $SD_{\text{Münster}} = 2.31$, $M_{\text{Nso}} = .58$, $SD_{\text{Nso}} = 2.45$) nor for offset ($M_{\text{Münster}} = .65$, $SD_{\text{Münster}} = 1.84$, $M_{\text{Nso}} = .79$, $SD_{\text{Nso}} = 3.67$). However, it differed at 12 weeks for onset ($M_{\text{Münster}} = 4.20$, $SD_{\text{Münster}} = 4.98$, $M_{\text{Nso}} = .62$, $SD_{\text{Nso}} = 1.15$) and for offset ($M_{\text{Münster}} = 3.30$, $SD_{\text{Münster}} = 4.18$, $M_{\text{Nso}} = .67$, $SD_{\text{Nso}} = 2.11$), smallest $t(42) = -2.556$, $p < .05$, $d = -.21$.

2.3.2.2. Response window of maternal imitation, missed maternal imitation, and reciprocal maternal smile. We imposed a 3 s response window, during which mutual gazing had to maintain and should be constant (no further codes (except for the smiling codes) should occur within this window (e.g., mother's *not gazing at infant* or infant's *smile could not be coded*) and mothers either did or did not respond to their infants' smile by smiling themselves. In this way we assured, that maternal responses were to the previous infant's behavior.

Our choice of a 3 s response window differs from some previous studies in which latency windows for maternal reactions were e.g. 1 s (Kärtner et al., 2010; Keller, Lohaus, Völker, Cappenberg, & Chasiotis, 1999; Papoušek & Papoušek, 1991). Van Egeren, Barratt, and Roach (2001), however, showed that response windows within mother–infant interactions differ for different categories of behavior: vocalizations revealed the shortest response windows (2 s). In contrast, contingencies for smile signals and responses regularly accrued in a linear fashion for at least 3 s and even longer. In their longitudinal study of 3, 9, and 24-month-old infants conducted by Feldman, Greenbaum, and Yirmiya (1999), the time it took mothers to commence affect-synchronous behavior with their 3-month-old infants (time lag to synchrony) amounted to 2.8 s on average. Therefore, we decided to use a 3 s latency window.

2.3.2.3. Infant imitation. We coded the onsets and offsets of *infant imitation* during mutual gazing each time when the infant responded within 6 s to the intensification (onset) or reduction (offset) of maternal smiling by intensifying or reducing his or her own smile, respectively. In order to count the frequency of all possible occasions of infant imitation, the non-implemented occasions of infant imitation as well as infants' reciprocal smiling responses were also coded as possible situations in which infant imitation could have occurred. These responses were coded either for onset or offset, as *missed infant imitation* (e.g., at onset: if the mother starts or intensifies her smiling and infant does not respond within 6 s by starting or intensifying his or her own smiling and vice versa at offset) or *reciprocal infant smile* (e.g., at offset: mother ends or reduces intensity of her smiling and infant responds within 6 s by starting or intensifying his or her own smiling and vice versa at onset). The frequencies of all possible occasions of infant imitation didn't differ at 6 weeks neither for onset ($M_{\text{Münster}} = 2.9$, $SD_{\text{Münster}} = 4.29$, $M_{\text{Nso}} = 3.3$, $SD_{\text{Nso}} = 5.48$) nor for offset ($M_{\text{Münster}} = .35$, $SD_{\text{Münster}} = 1.09$, $M_{\text{Nso}} = .33$, $SD_{\text{Nso}} = 1.63$). However, it differed at 12 weeks for onset ($M_{\text{Münster}} = 6.75$, $SD_{\text{Münster}} = 5.13$, $M_{\text{Nso}} = 1.75$, $SD_{\text{Nso}} = 2.99$) and for offset ($M_{\text{Münster}} = 1.65$, $SD_{\text{Münster}} = 2.23$, $M_{\text{Nso}} = .25$, $SD_{\text{Nso}} = .74$), smallest $t(42) = -2.687$, $p < .05$, $d = -.39$.

2.3.2.4. Response window for infant imitation, missed infant imitation, and reciprocal infant smile. We defined a response window of at most 6 s, during which mutual gazing had to maintain and should be constant (no further codes (except for the smiling codes) should occur within this window (e.g., infant's *not gazing at infant* or infant's *smile could not be coded*) and the infant either did or did not respond to his or her mother's smile with an own smile. In this way, we interpreted the beginning/intensification or ending/reduction of the infant smile as responses to previous maternal smiling behavior. Several empirical results support this approach to use a longer response window for infants than for mothers. In the abovementioned study of Van Egeren et al. (2001), the amount of infants' smiling responses to maternal smiling signals decreased only after 4 s, and these infants were already 4-month old. Brock, Rothbart, and Derryberry (1986) analyzed smiling responses of 3-month-old infants to social stimulation. Smiling occurred after a heart-rate deceleration that lasted for 3.6 s on average ($SD = 2.6$) which is similar to the results of Sroufe and Waters (1976) as well as of Beebe and Lachmann (1994) (5 s). This result would reveal a response window up to 6 s in order to get most of the infants' smiling responses. This can also take into account individual differences in the typical response windows of mother–infant dyads² (see Fox, 1998).

2.4. Inter-rater reliability

In order to calculate inter-rater reliability, 22% of the video sequences were coded by two coders. Socio-cultural contexts and the ages of the infants were equally distributed within this subset (five of each context and each age). Each coding category

² If we would have used a response window of only 3 s, 33% of the infants' onset responses in our Münster sample and 27% in our Nso sample would have been excluded. However, all infants' offset responses were observed within 3 s. In addition, infants' and mothers' latency of responses were highly correlated (from $r = .63$ to $r = .85$) in both samples.

(gazing, smiling, and smiling intensity) was coded in each case by two different coders. Cohen's kappa was calculated using the Interact evaluation tool for each mother–infant pair in each category. The onset of each event recorded by both coders occurred within a time tolerance of 1 s and there was an overlap of 85% between the events. From a total of 120 kappa values (20 pairs \times 6 categories), 73 kappa exceeded .8, 21 kappa were between .6 and .8, and only 3 kappa were between .5 and .6. Therefore, 75% of the codes reached a very good interrater reliability and 20% of the codes a good reliability.

2.5. Final scores and dependent variables

Because the “could not be coded” category for the smiling as well as for the gazing behavior was unequal in each mother–infant interaction, we calculated adjusted percentage value of each category. For example, for the adjusted duration of smiling: percentage adjusted value of smiling duration = (total smile duration / (duration of the total interaction (180 s) – duration of non-coded smiling in s) \times 100.

Subsequently, the following variables were treated as dependent variables for analysis:

1. Duration and (b) intensity of maternal smiling during mutual gazing
2. Duration and (b) intensity of infant smiling during mutual gazing.

All *duration* variables represent adjusted percentage values with regard to the calculation outlined above. In order to calculate the average value of *intensity* of a maternal/infant smile during mutual gazing, only those mothers and infants for whom there was at least one smile event during mutual gazing were included in the analysis.

3. Frequencies of maternal imitation for (a) onsets and (b) offsets.
4. Frequencies of infant imitation for (a) onsets and (b) offsets.

The *frequency* (separately for onset and offset) reflects the absolute number of all of the maternal/infant imitations which occurred during the 3 min of mother–infant interaction.

3. Statistical analyses

For duration and frequency variables, we conducted a repeated measure analysis of variance (ANOVA) with age (6 or 12 weeks) as the within-subjects factor and cultural context (Münster or Nso) as the between-subjects factor. When significant interactions between age and cultural context occurred, we conducted separate one-way (age) ANOVAs for each cultural context. Post hoc *t*-tests were conducted for any significant effects of age. Because of the variable number of participants who received a smile-intensity value during mutual gazing as well as the robustness of the inequality of variances, we calculated the group differences with regard to intensity using Mann–Whitney *U* tests (two-tailed) for both time points (6 and 12 weeks).

4. Results

4.1. Preliminary analysis

The descriptive statistics for both adjusted maternal and infant gazing and smiling variables for both socio-cultural contexts are presented in Table 2.

There few significant differences occurred in these variables. First, there were significant effects of socio-cultural context on the *duration of maternal gazing at infant* at both time points: Mothers from the Münster sample gazed at their infants for longer than did mothers from the Nso sample. Second, there were significant effects of socio-cultural context on the *duration of infant gazing at mother* and on the *duration of infant smile at mother* at the age of 12 weeks but not of 6 weeks: 12-week-old infants from Münster gazed and smiled at their mothers for longer than did infants from the Nso sample. There were also some marginally-significant effects of socio-cultural context on: (1) the *duration of maternal smile at infant* (at 12 weeks only) and (2) the *duration of infant gazing at mother* (at 12 weeks only). In each of these cases, mothers and infants from Münster showed the behaviors for longer durations than did mothers and infants from the Nso sample.

4.2. The culture-specific emergence of smiling

The descriptive statistics are displayed in Table 3.

4.2.1. Duration and intensity of maternal smiling during mutual gazing

There was a significant main effect of cultural context on duration of maternal smiling during mutual gazing, $F(1, 42) = 4.56$, $p < .05$, $\eta^2 = .09$; mothers from Münster smiled significantly more at their infants than did Nso mothers. There was no main effect of age, $F(1, 42) = .66$, $p > .10$, $\eta^2 = .05$, and no interaction ($F(1, 42) = .13$, $p > .10$, $\eta^2 = .01$).

There was no difference between mothers in the two socio-cultural contexts with respect to smile intensity at either the age of 6 weeks, $U = 69.500$, $Z = -.463$, $p > .10$, or 12 weeks, $U = 64.500$, $Z = -1.845$, $p > .10$, weeks. On the basis of these results, our hypothesis concerning the duration and intensity of maternal smiling during mutual gazing is only partially

Table 2

Variable scores of maternal and infant gazing and smiling behavior in both socio-cultural contexts.

	Münster (N = 20)		Nso (N = 24)		$F_{(1,d.f)}$	p	η^2
	M (n%) ^a	SD	M (n%) ^a	SD			
Duration ^b on of maternal smile at infant							
Week 6	21.20 (100)	24.98	29.12 (96)	25.38	1.08 _(1,42)	.30	.02
Week 12	39.61 (100)	17.71	29.22 (100)	20.10	3.25 _(1,42)	.08	.07
Intensity ^c of maternal smile at infant							
Week 6	1.89 (100)	.51	1.75 (96)	.56	.74 _(1,41)	.40	.02
Week 12	2.10 (100)	.51	1.91 (100)	.65	1.07 _(1,42)	.31	.02
Duration of maternal gazing at infant							
Week 6	83.55 (100)	18.90	65.16 (100)	24.07	7.70 _(1,42)	<.01	.15
Week 12	93.30 (100)	6.28	57.26 (100)	19.90	60.37 _(1,42)	<.01	.59
Duration of infant smile at mother							
Week 6	1.76 (15)	5.32	1.34 (17)	5.82	.06 _(1,42)	.80	.001
Week 12	10.04 (70)	11.91	1.56 (25)	3.95	10.79 _(1,42)	<.01	.20
Intensity of infant smile at mother							
Week 6	1.86 (15)	.67	1.29 (17)	.59	1.39 _(1,5)	.29	.21
Week 12	2.03 (70)	.45	2.24 (25)	.44	.93 _(1,18)	.35	.05
Duration of infant gazing at mother							
Week 6	31.27 (80)	33.62	16.29 (58)	26.38	2.74 _(1,42)	.10	.06
Week 12	40.34 (90)	31.62	10.34 (54)	20.30	14.48 _(1,42)	<.01	.26

^a Percentage of participants who exhibited the appropriate behaviors.

^b Scales for “duration” represent the percentage of observed durations.

^c Scales for “intensity” represent the average intensity value of smiling (ranging from 1 (very low-intensity smile) to 5 (very high-intensity smile)) of mothers and infants with inclusion criterion of at least one smile event.

confirmed. Our results showed the expected cross-cultural differences only for duration, but not for intensity, of maternal smiling during mutual gazing.

4.2.2. Duration and intensity of infant smiling during mutual gazing

There was a significant socio-cultural context \times age interaction, $F(1, 42) = 6.55$, $p < .05$, $\eta^2 = .13$, as well significant main effects of age, $F(1, 42) = 6.50$, $p < .05$, $\eta^2 = .13$, and socio-cultural context, $F(1, 42) = 10.19$, $p < .01$, $\eta^2 = .19$, on the duration of infant smiling during mutual gazing. Subsequent post hoc t -tests indicated that there were no differences between the socio-cultural contexts at the age of 6 weeks, $t(42) = -.245$, $p = .81$, $d = -.07$, but there was a significant difference at the age of 12 weeks, $t(21) = -3.172$, $p = .005$, $d = -.96$. Thus, infant smiling during mutual gazing increases substantially in the Münster sample from the age of 6–12 weeks, whereas there was no change in Nso infants' smiling during this period.

There were no differences between the infants from the two socio-cultural contexts with respect to the intensity of smiling during mutual gazing at either the age of 6 weeks, $U = 2.000$, $Z = -1.468$, $p > .01$, or 12 weeks, $U = 32.000$, $Z = -.828$, $p > .01$. Thus, there was no support for the hypothesis that the intensity of the infant smiling during mutual gazing is higher in the Münster sample than in the Nso sample.

Table 3

Maternal and infant gazing and smiling combination variables (AVs) in both socio-cultural contexts.

	Münster (N = 20)		Nso (N = 24)	
	Mean (n%) ^a [Mdn]	SD [Iqr]	Mean (n%) ^a [Mdn]	SD [Iqr]
Duration ^b of maternal smile during mutual gazing				
Week 6	11.67 (60)	22.43	8.90 (54)	18.44
Week 12	20.48 (90)	18.17	6.15 (50)	12.80
Intensity ^c of maternal smile during mutual gazing				
Week 6	[1.78] (60)	[1.69]	[1.99] (54)	[2.64]
Week 12	[2.36] (90)	[1.69]	[2.72] (50)	[1.59]
Duration of infant smile during mutual gazing				
Week 6	1.75 (15)	5.29	1.34 (17)	5.82
Week 12	9.95 (70)	11.81	1.32 (25)	3.23
Intensity of infant smile during mutual gazing				
Week 6	[1.63] (15)	[1.28]	[1.00] (17)	[1.18]
Week 12	[2.00] (70)	[1.63]	[2.23] (25)	[1.05]

^a Percentage of participants who exhibited the appropriate behaviors.

^b Scales for “duration” are expressed in percentages.

^c Scales for “intensity” represent the average value of smile intensity of mothers and infants with inclusion criterion of at least one smile event; medians [Mdn] and interquartile ranges [Iqr] are displayed.

Table 4
Maternal and infant imitation in both socio-cultural contexts.

Age	Münster (N = 20)		Nso (N = 24)	
	Mean (n%) ^a	SD	Mean (n%) ^a	SD
Frequency of maternal imitations of infant smiles (number) ^b				
6 weeks				
Onset	.35 (15)	.99	.17 (4)	.82
Offset	.30 (15)	.80	.37 (4)	1.84
12 weeks				
Onset	1.75 (55)	2.05	.12 (13)	.34
Offset	1.60 (65)	1.76	.21 (8)	.72
Frequency of infant imitations of maternal smiles (number)				
6 weeks				
Onset	.50 (15)	1.39	.25 (4)	1.22
Offset	.20 (10)	.61	.17 (4)	.82
12 weeks				
Onset	1.80 (70)	1.79	.37 (21)	.87
Offset	1.40 (50)	1.93	.25 (13)	.74

^a Percentage of participants who exhibited the appropriate behaviors.

^b For the “frequency” scales we used an inclusion criterion of at least one episodes of mutual gazing.

4.3. Maternal imitation of infant smiling as the first-term factor of the social smile

The descriptive statistics are displayed in Table 4.

4.3.1. Frequency of maternal imitation for onset and offset

There was a significant disordinal interaction between age and socio-cultural context on the onset, $F(1, 42) = 7.57, p < .05, \eta^2 = .15$, and on the offset of maternal imitation, $F(1, 42) = 5.81, p < .05, \eta^2 = .12$. Subsequent one-way ANOVAs at the age of 6 weeks yielded no significant main effects of cultural contexts on either the onset, $F(1, 42) = .45, p > .10, \eta^2 = .01$, or the offset of maternal imitation, $F(1, 42) = .03, p > .10, \eta^2 = .001$. At the age of 12 weeks, however, maternal imitation was higher in the Münster sample than the Nso sample for onset, $F(1, 42) = 14.69, p < .001, \eta^2 = .26$, as well as offset, $F(1, 42) = 12.54, p < .01, \eta^2 = .23$. Because of these results, the significant main effects of age (for onset of maternal imitation, $F(1, 42) = 6.72, p < .01, \eta^2 = .14$), and of socio-cultural context (for onset, $F(1, 42) = 14.03, p < .01, \eta^2 = .25$, and offset, $F(1, 42) = 5.24, p < .05, \eta^2 = .11$) cannot be interpreted on its own.

These results confirm our hypothesis: at the age of 12 weeks, frequency of maternal imitation of infant smiling (for onset as well as offset) was greater for the Münster sample than it was for the Nso sample. There were no differences at the age of 6 weeks.

4.4. Infant imitation of maternal smiling as the second-term factor of the social smile

The descriptive statistics are displayed in Table 4.

4.4.1. Frequency of infant imitation for onset and offset

There was no significant interaction for onset, $F(1, 42) = 3.62, p > .05, \eta^2 = .08$, but there were significant main effects of age, $F(1, 42) = 5.32, p < .05, \eta^2 = .11$, and socio-cultural context, $F(1, 42) = 10.22, p < .01, \eta^2 = .20$. Subsequent post hoc *t*-tests indicated that there was no difference in the frequency of infant imitation for onset at the age of 6 weeks, $t(42) = -.633, p = .53, d = -.19$, but there was a significant difference at the age of 12 weeks, $t(26) = -3.244, p = .003, d = -.98$.

There was a significant interaction for offset, $F(1, 42) = 4.97, p < .05, \eta^2 = .11$. Subsequent one-way ANOVAs at the age of 6 weeks indicated no significant effect of socio-cultural context, $F(1, 42) = .02, p > .10, \eta^2 = .001$, but at the age of 12 weeks, $F(1, 42) = 7.27, p < .05, \eta^2 = .15$. Because of these results, the significant main effects of age, $F(1, 42) = 6.56, p < .05, \eta^2 = .13$, and socio-cultural context, $F(1, 42) = 6.64, p < .05, \eta^2 = .14$, cannot be interpreted on its own.

These results confirm our hypothesis: at the age of 12 weeks, frequency of infant imitation of maternal smiling (in terms of infant smiling) was greater for the Münster infants than for the Nso infants for onset as well as offset. There were no differences at the age of 6 weeks.

5. Discussion

The overarching aim of the present study was to observe differences in social smiling in 6 and 12-week-old infants from different socio-cultural contexts. Specifically, we aimed to examine the emergence of two-term factors related to social smiling: maternal imitation of infant smiles and infant imitation of maternal smiling as outlined in the Internalization Model of Emotional Development (Holodynski & Friedlmeier, 2006).

5.1. Culture-specific development of maternal and infant smiling

Our hypotheses regarding the duration and intensity of maternal and infant smiling during mutual gazing were partly supported by our findings. Although there were no age-related differences in the duration of maternal smiling during mutual gazing as a function of socio-cultural context, there was a main effect of socio-cultural context; the mothers from Münster (independent socio-cultural context) smiled at their infants for longer during mutual gazing (at both 6 and 12 weeks) than did the Nso mothers (interdependent socio-cultural context). With respect to the intensity of maternal smiling during mutual gazing, there were no differences between the two socio-cultural contexts at either of these ages.

With respect to the duration of infant smiling during mutual gazing, we found that 12-week-old infants from Münster smiled at their mothers for longer than did same-aged Nso infants. At the age of 6 weeks, there were no differences in infant smiling between the two socio-cultural contexts. On the basis of these results, it seems that the duration of infant smiling during mutual gazing increased more in the Münster sample from 6 to 12 weeks than it did in the Nso sample. This finding is consistent with [Lavelli and Fogel's \(2005\)](#) finding that Italian infants smiled at their mothers significantly more after the 2-month shift than they had beforehand. Nonetheless, we did not find any differences in the intensity of either infant or maternal smiling during mutual gazing at either age (6 or 12 weeks), which is consistent with [Kärtner et al.'s \(2010\)](#) finding that, although there were differences in mutual gaze and visual contingency between the Münster and Nso sample, the differences in visual contingency were no longer significant if mutual gaze was controlled for statistically. In the present study we obtained a similar result with regard to the intensity of maternal and infant smiling during the mutual gaze. Specifically, although there were differences in the duration of maternal and infant smiling during mutual gazing at the age of 12 weeks, mothers and infants from both socio-cultural groups smiled at their interaction partner with similar intensity during mutual gaze episodes.

Our analysis also demonstrated that infants and mothers from Münster smile and gaze at each other longer with 12 weeks as with 6 weeks which is similar to the results of [Lavelli and Fogel \(2005\)](#) who found an increasing of mutual influence between the infant's and the mother's smile at each other in face-to-face communication through the 3rd month. Similar results found [Kärtner et al. \(2010\)](#) with respect to the duration of mutual gazing as well as smiling of 12-week-old infants and their mothers at each other in Münster sample. In addition, the assessed duration of 12-week-old infants' smile at their mothers in the Münster sample (10.4% of interaction) are very similar to those of [Bertin and Striano \(2006\)](#) who also analyzed the interaction of mothers with their 3-month-old infants and found a comparable percentage of smiling about ca. 11% of the whole time of interaction.

5.2. Culture-specific development of maternal and infant imitation behaviors

In addition to determining the temporal dimension of both maternal and infant smiling during mutual gazing (in terms of duration), we determined the frequency with which two developmental mechanisms occurred: maternal and infant imitations in terms of smiles. The use of these mechanisms amplifies social-acquisition processes of social smiling. In the present study, we examined the *total* frequency of both these mechanisms. We also examined both of these mechanisms for onsets and offsets separately for maternal and infant smiling behavior. As such, we believe that not only does the onset of the maternal/infant smile lead to learning about social smiling, but so too does the offset of the smile. The end of the caregiver's smile shows behavioral changes and leads to setting down the infant smile (or vice versa). Thus, on one hand, infants can learn the constraints of new contingent experiences and, on the other hand, the infants can learn the setting down of emotions.

Our hypotheses concerning the frequencies of both of these mechanisms in two different socio-cultural contexts were fully supported. The mothers from the Münster sample used imitation for onset as well as for offset of infant smiling to a greater extent than did the Nso mothers. There were similar results concerning infants' behavior: 12-week-old infants from the Münster sample responded to maternal smiling more often with imitative behavior (for onset and offset of maternal smiling), than did same-aged Nso infants. There were, however, no differences at the age of 6 weeks; mothers and infants from both socio-cultural contexts exhibited both mechanisms equally rarely.

To sum, the results of the present study demonstrate that the nature of mother–infant interaction influences the emergence of social smiling during the first 12 postnatal weeks. The increasing alertness of the infants, as well as the maturational processes accompanying the 2-month shift, would not, in isolation, explain the phenomenon of social smiling ([Emde & Buchsbaum, 1989](#); [van Wulfften Palthe & Hopkins, 1993](#)) because infants in both socio-cultural groups increased in terms of alertness after the 8th postnatal week to comparable degrees ([Kärtner et al., 2010](#)). In the present study, different socio-cultural contexts were represented by two samples, one from an independent socio-cultural context and one from an interdependent socio-cultural context. We have shown that both mechanisms (maternal and infant imitation behavior in terms of smiles) occurred more frequently in the independent socio-cultural context compared to the interdependent socio-cultural context when infants were 12 weeks old. In the independent socio-cultural context, face-to-face interaction encourages the maternal imitation of an infant's smile. The ethnotheories of such cultural contexts regard the infant social smile as an important communicative tool; mothers wish to elicit it as soon as possible after giving birth ([Keller, 2007](#); [Keller & Otto, 2009](#)). They then respond contingently to their infants' smiles. Frequent maternal smiling at the infant offers him or her more frequent opportunities for imitative learning in terms of motor mimicry. The infant imitates the maternal smile, which, in turn, gives the mother more frequent opportunities to respond contingently with affect mirroring.

In contrast to the Münster sample, face-to-face interactions occurred much less frequently in the Nso sample, which, in turn, led to fewer opportunities for mutual gazing. According to the parenting ethnotheories for socio-cultural contexts such as this, the meaning of infant smiling is of only marginal importance. Accordingly, mothers in these cultures rarely imitate smiles of their infants and seldom spontaneously smile at them. Consequently, the Nso infants had fewer opportunities to respond with imitation of the smiles of their mothers, which could lead to shorter smile durations from these 12-week-old infants (compared to the 12-week-old infants from Münster). Taking these findings into account, it seems that both, maternal and infant imitations interact as *amplifying mechanisms*.

5.3. Intentionality of imitation: maternal affect mirroring and infant motor mimicry

The abovementioned mechanisms of maternal and infant imitation could be differentiated with respect to their intentionality: maternal imitation is a deliberate imitation with intent to mirror the expression of her infant and in this way to intensify and elicit it. [Gergely and Watson \(1999\)](#) classified such mechanism as *affect mirroring*. In contrast, infant's imitation is not deliberate imitation (at least at this developmental stage). [Meltzoff and Moore \(1988\)](#) classified such imitation as motor mimicry and suggest that innate amodal representational system (active intermodal mapping) represent its underlying mechanism. Based on this consideration and in light of the results of our study we assume that the emergence of social smile in different socio-cultural contexts could proceed as follows:

Face-to-face interactions. Mothers from independent socio-cultural contexts with a pedagogical ethnotheory of early child care ([LeVine et al., 1994](#)) offer their infants various opportunities for mutual gazing, and will interpret this activity on the basis of their parenting ethnotheories as an important occasion. In contrast, mothers from interdependent socio-cultural contexts with a pediatric ethnotheory of early child care ([LeVine et al., 1994](#)) offer fewer opportunities for mutual gazing during mother–infant interactions because this behavior is not important in their parenting ethnotheories.

Infant motor mimicry. Mutual gaze creates considerable pleasure for mothers from independent socio-cultural contexts. This sense of pleasure leads them to smile frequently, offering their infant frequent opportunities for motor mimicry of the maternal smile. Their infants, therefore, exhibit more frequent motor mimicry of smiling and smiling back at their mothers. On the other hand, mutual gaze creates less pleasure for mothers from interdependent socio-cultural contexts and their infants, therefore, seldom return smiles in response during mutual gazing. In this way, these infants rarely have opportunities to respond to their mothers' smiles with motor mimicry; they seldom return the smiles of their mothers and, thus, generally smile less frequently.

Maternal affect mirroring. Mothers from independent socio-cultural contexts perceive smiling by their infants as especially joyful occasions, which frequently leads to a maternal smile in response (affect mirroring). In contrast, an infant's smile at his or her mother is interpreted by mothers from interdependent socio-cultural contexts as not being a particularly special occasion. Relatively little joy is gleaned from these occasions leading to no smile being returned to the infant by affect mirroring.

At last, it is important to keep in mind that these results do not imply that the Nso mothers are less sensitive towards their infants. In fact, [Kärtner et al. \(2010\)](#) have shown that Nso parents respond contingently to the vocalizations of their infants. This makes sense given that early infant vocalizations provide the basis for acquiring the phonetic structure of the mother tongue. The sensitivity of Nso mothers relates to another form of contingent response, namely proximal parenting strategies (e.g., body contact, body stimulation). Finally, the Nso culture attaches very little importance to dialogic communication between mother and infant, and to infant smiling, as [Keller and Otto \(2009\)](#) have demonstrated.

It is important to note that the result of the present study do not allow generalizations about countries or societies as a whole. Rather, we describe patterns of mother–infant interaction that are typical for very specific socio-cultural contexts, namely Western urban middle-class families and families with very basic levels of formal education living in subsistence-based farming ecologies. Questions of how differences in the degree of formal education or socio-economic status might affect mother–infant interaction need to be explicitly addressed by further research. The potential influence of this and other socio-demographic factors on the emergence and interactional dynamics of social smile should be investigated in further studies with respect to the differences within a given socio-cultural context as well as between different contexts.

6. Limitations of the study and future directions

Unfortunately, there remain several ongoing questions that we could not answer using the data from the present study. The first time point of 6 weeks was deliberately chosen in order to identify a kind of starting point for the developmental process of social smiling. Indeed, it was the case that mothers and infants from both socio-cultural contexts smiled at each other similarly infrequently at the 6-week time point. For this reason, calculating the longitudinal cross-lag panel was not possible, which inhibited any examination of the causal direction and interaction of the developmental mechanisms (maternal and infant imitations). Thus, it would be useful to start a further study at the 2-month shift in order to have the most applicable time point for the onset of exogenous smile, e.g. the 8th postnatal week. A longitudinal analysis, e.g. till the 12th postnatal week, may enable to clarify whether these mechanisms represent two mutually-increasing, cross-cultural developmental paths. It would also be interesting to examine how the cultural specificity of social interaction patterns between

caregivers and their infants during the 2-month shift can contribute to the culture-specific differentiation of emotions. The extent to which both of these mechanisms are also responsible for the differentiation of other emotions or expressions, including smiling, should be examined in further studies. Such longitudinal studies with time-series analysis (e.g. Lavelli & Fogel, 2002, 2005; Pomerleau, Scuccimarrì, & Malcuit, 2003, etc.) provide the perfect basis for tracing developmental paths and examining causal relations among variables.

With the exception of maternal smiling, we did not examine any other precursor mechanisms, which could also contribute to the emergence of infant social smiling. As such, the exact mechanism underlying infant smiling remains unknown. According to Sroufe's (1996) tension modulation hypothesis, the emergence of social smiling should be triggered by contingency experiences not only in face-to-face contexts, but also in the contexts of other modalities. Further cross-cultural analysis of other contingencies experienced by infants (e.g., body contact, body stimulation, vocalizations, etc.) with regard to the social smile is necessary in order to answer this question. Such an analysis would be informative, because the Nso infants also start to smile, and in their further development the smile becomes a common form of expression.

Finally, the question arises as to whether infant smiling represents only motoric imitation or whether it is also associated with a feeling of pleasure. We believe that smiling with a certain degree of intensity results in a feeling of pleasure (induced emotion). It is difficult to specify when the transition from a marginal smile (which may not reflect pleasure) to a genuinely joyful smile occurs. If mothers subscribe to the parenting ethnotheory that a smile expresses feelings of pleasure and that their infant should experience this feeling, they may interpret the smallest signs of a smile as a first step in this direction. Thus, the reinforcing mechanisms of affect mirroring and motor mimicry may be set in motion and, sooner or later, they will release a genuine feeling of pleasure on the part of the infant.

In conclusion, we wish to point out that the results of the present study are based on prototypical samples of independent and interdependent socio-cultural orientations with a pedagogical and pediatric model of early child care. Hence, these results can only be generalized to similar socio-cultural contexts if they are replicated in other samples from such contexts. Research with other socio-cultural contexts, such as those that represent a socio-cultural model of autonomy-relatedness (e.g., China, India) (Keller et al., 2009) would further our knowledge regarding the emergence of social smiling with respect to both cross-cultural and culture-specific mechanisms.

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