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Similarities and differences in contingency experiences of 3-month-olds across sociocultural contexts

Joscha Kärtner [a,*], Heidi Keller [a], Bettina Lamm [a], Monika Abels [a], Relindis D. Yovsi [a], Nandita Chaudhary [b], Yanjie Su [c]

[a] *University of Osnabrück, Germany*
[b] *Lady Irwin College, University of Delhi, India*
[c] *Peking University, China*

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Abstract

In this study we analyzed similarities and differences in the contingency experiences of 159 three-month-olds from 6 sociocultural contexts. Across contexts, caretakers responded with similar overall contingency levels, vocalizations provided the dominant response as well as the most salient signal, and there was a relative signal-response correspondence. With two exceptions, infants in all samples most often got responses addressing their sense of hearing, followed by the sense of touch and then sight. In response to nondistress vocalizations, infants from independent contexts (Berlin, Los Angeles) experienced more contingent responses addressing their sense of sight than infants from autonomous-related (Beijing, Delhi, urban Nso from Cameroon) or interdependent contexts (rural Nso). Rural Nso infants experienced more contingent responses addressing their sense of touch than infants from all other but the Los Angeles sample. These results support the interpretation of contingent responsiveness as a part of the intuitive parenting program that manifests differentially depending on culture-specific emphases on distal and proximal caretaking.

Keywords: Contingency; Responsiveness; Culture; Signal-response correspondence; Infants' senses

From early on, social communication takes place in a "format" (Bruner, 1982) that organizes the timing of early caretaker–infant interaction (Jaffe, Beatrice, Stanley, Crown, & Jasnow, 2001; Stern, 1985). One interaction mechanism that is constitutive of this format is contingent responsiveness defined as the presence of a temporal relationship between two communicative signals. By definition, a caretaker's response follows an infant's signal in time. Furthermore, in order to be perceived as a response by the infant, a caretaker's behavior has to occur within a specific latency window. After this latency window has elapsed, the infant cannot relate the caretaker's to his or her own behavior. Contingent responsiveness allows infants to experience themselves as causal agents whose behavior has effects on the environment, i.e., to detect their own efficacy in producing social events in ways that become predictable (Tarabulsy, Tessier, & Kappas, 1996). These developmental patterns are fundamental to subsequent cognitive and socioemotional developmental processes (cf. Bigelow, 1998; Keller, Kärtner, Borke, Yovsi, & Kleis, 2005).

* Corresponding author at: University of Osnabrück, Faculty of Human Sciences, Culture and Development, Seminarstr. 20, 49069 Osnabrück, Germany. Tel.: +49 541 969 4056; fax: +49 541 969 4770.
E-mail address: joscha.kaertner@uni-osnabrueck.de (J. Kärtner).

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Since it is early parenting behavior that lays the foundation for later development, the mechanism of contingent responsiveness is an essential component of major theories of parenting. The behavioral readiness to respond promptly towards infants' signals is conceptualized as part of an intuitive parenting program by Papoušek and Papoušek (1987, 1991). According to these authors this program has been shaped by evolution and, thus, is a universal component of parenting. Moreover, prompt responsiveness is a crucial element of sensitivity which is the central quality of parenting in attachment theory (Ainsworth, Blehar, Waters, & Wall, 1978).

Meanwhile, there is substantial evidence that universal, evolutionarily shaped components of parenting are realized in context-sensitive ways (Greenfield, Keller, Fuligni, & Maynard, 2003; Kärtner et al., 2007; Keller, 2007). In contexts with a predominantly interdependent sociocultural orientation, proximal components of parenting (body contact and body stimulation) play a central role, whereas distal components of parenting (face-to-face context and object play) are emphasized more often in contexts with a predominantly independent sociocultural orientation. Parenting behavior of caretakers from contexts with a predominantly autonomous-related sociocultural orientation that are prevalent in urban settings of "traditional" societies can best be described as being intermediate (Keller, 2007). Keller et al. (2004) found empirical support for their assumption that these differences in early parenting foster later developmental outcomes that are appreciated in the respective sociocultural context. In their study the authors found that proximal caretaking lead to an earlier development of compliance and obedience while distal parenting lead to an earlier development of the toddlers' autonomy. One aim of this study therefore is to analyze supposedly culture-specific and universal aspects of contingent responsiveness.

Given the significance of contingent responsiveness for infants' development, we expected little cultural variation in the overall level of contingent responsiveness (Keller, 2007). Although most of the few cross-cultural studies on contingent responsiveness share this assumption, none of them provided empirical evidence for it (Bornstein et al., 1992; Fogel, Toda, & Kawai, 1988; Richman, Miller, & LeVine, 1992). To our knowledge, there is only one study that found that mothers from Berlin showed higher levels of contingent responsiveness than did mothers from rural Nso families (Keller et al., 2005). However, the study by Keller et al. analyzed only a very specific type of contingent responsiveness, i.e., distal nonverbal reactions to nonverbal infant signals. Since we are assuming that contingent responsiveness manifests in context-sensitive ways, the scope of analysis in this study is too narrow to claim cross-cultural validity.

Generally, the sensory channels through which infants receive contingent responses are the sense of hearing, touch, and sight. There is some evidence that for both mother and infant, vocalizations constitute the primary response tendency as well as the most salient signal, thus reinforcing the prominence of vocal behaviors relative to other actions across cultures (Bornstein et al., 1992; Hsu & Fogel, 2003; Van Egeren, Barratt, & Roach, 2001). Several other studies reported evidence for culture-specific differences in these patterns of contingent responsiveness. Fogel et al. (1988) provided a descriptive account along with a cautious interpretation of cross-cultural differences. In this study, Euro-American mothers from Lafayette, Indiana, displayed facial expressions and vocalizations in response to infants' gaze, smile, and vocalization, whereas Japanese mothers from Nagoya reacted more by leaning close to and touching the infant. The authors interpreted these differences with reference to culturally appropriate means of expressing affect—nonverbally for the Japanese and verbally for the Euro-American mothers. Another cross-cultural study, comparing middle-class mothers from Tokyo with mothers from Paris and New York found that mothers from New York more often responded extradyadically – directing their infant's attention to properties, objects, or events in the environment – while mothers from Tokyo responded more dyadically to their infant's social looking (Bornstein et al., 1992). Unfortunately, the authors did not differentiate between proximal and distal responses. In one study on contingent responsiveness going beyond urban middle-class families, Richman et al. (1992) found that West Kenyan Gusii were predominantly physically responsive and Bostonian mothers were predominantly verbally and visually responsive. They speculated that where reciprocal vocalization is rare in mother–infant interaction, tactile or other forms of responsiveness may play an equivalent role.

The conclusions drawn from these studies differ considerably. Fogel et al. (1988), as well as Bornstein et al. (1992) assume rather similar processes with only minor differences while Richman et al. (1992) infer considerable differences between samples. In part, these different views can be explained by the selection of samples. The more distant the cultural samples were, the bigger the differences found. Furthermore, there are a number of systematic differences concerning procedure and methodology. First, the studies differ with regards to the setting chosen, reaching from completely standardized scenarios, e.g., mother–infant face-to-face interactions in a laboratory setting with the infant being seated in an infant seat mounted on a table in Fogel et al.'s (1988) study, to naturalistic observations where

mothers were free to follow daily routines in Richman et al.'s study (1992). Second, the studies differ with regards to the instruction given. Mothers in one study were asked to play with their infant while mothers in another study were asked to carry on with their usual activities. Third, the studies differ with regards to the latency window chosen (2–9 s). Fourth, the studies differ with regards to how data were aggregated and further analyzed. Taken together, it is hard to tell whether the different results found can be ascribed to the sociocultural environments or whether they rather go back to any of the procedural or methodological differences. It is the main aim of this study to analyze differences and similarities in the contingency experiences of infants that come from samples whose selection was theoretically driven and which were analyzed using the same procedure and methodology. Since the majority of studies found that vocalizations were the dominant response as well as the most salient infant signal, we hypothesized that, across cultural samples, caretakers most often address the infant's sense of hearing and respond more contingently to infant vocalizations than to nonverbal signals. In cultures where conventions of conversational interaction differ, caretakers may address the infant's sense of hearing by clicking one's tongue or producing other sounds (Demuth, in preparation). Furthermore, in line with the culture-specific contingency patterns identified so far, we expected differences in the contingency pattern for the other senses that are in line with the cultural emphasis on distal and proximal parenting style.

Recent monocultural and cross-cultural studies have demonstrated a relative signal-response correspondence between infants' and mothers' modalities (Bornstein et al., 1992). Besides vocalization as the most frequent response, the second most frequent response corresponded to the type of signal that the infant initiated, e.g., mothers responded dyadically to the infants gazing at them or they responded with object play to an infant's object play (Van Egeren et al., 2001). Again, the data of Richman et al. (1992), comparing a traditional rural with an urban middle-class sample, do not support this preliminary evidence. Both, Bostonian and Gusii mothers reacted with the same dominant response regardless of whether the 4-month-old infants vocalized or gazed at them. However, the authors provided only descriptive information and did not test for the signal-response correspondence of contingent responses directly. Therefore, in line with the above-mentioned studies, we expected a relative signal-response correspondence between infant signals and caregivers' responses. More specifically, we expected that caretakers address the infants' sense of sight relatively more often in response to nonverbal infant signals than infant vocalizations.

The present study characterizes contingency experiences of 3-month-old infants during the natural flow of social interaction between mothers and infants across six, considerably different, sociocultural contexts. In order to grasp the infants' actual experiences we shifted our attention away from what the mother did to what the infant actually experienced. We assessed data from two prototypically independent samples of urban middle- to upper-middle-class families with a high degree of formal education: a Euro-American sample from Los Angeles (USA) and a sample from Berlin (Germany). Furthermore, there are three samples that can be characterized as representing an autonomous-related orientation defined as high on both autonomy and relatedness (Kağitçibaşi, 2005). All three are urban middle- to upper-middle-class families with an intermediate to high degree of formal education from so-called traditional societies: one sample of families from Beijing, one sample of Indian Hindu families from Delhi, and one sample of families from the ethnic group of the Nso living in various bigger cities in Cameroon. Finally, we included a rural Nso sample from Cameroon, consisting of families in which parents received only basic formal education, representing a prototypical interdependent sociocultural orientation. These families lived in small villages scattered on the hills around Kumbo, in houses mainly built of mud bricks. Their livelihood primarily depended on farming on a subsidiary basis (Keller, 2007).

The hypotheses tested in this paper refer to the universal and culture-specific aspects of contingent responsiveness. First, the overall contingency level should be similar across cultural contexts. Second, we hypothesized that vocalizations provide the dominant response, i.e., infants most often experience a contingent response they can hear. Third, we hypothesized that vocalizations provide the most salient signal, i.e., contingency levels should be generally higher in response to infants' vocalizations than nonverbal signals. Fourth, we hypothesized that the relative frequency of contingent responses that the child can feel or see depends on the sociocultural environment. Infants in independent environments should experience more contingent responses that they can see, whereas infants in interdependent sociocultural environments should experience more contingent responses that they can feel than infants in the other samples. The contingency experience of infants with an autonomous-related sociocultural orientation should be intermediate. Finally, we hypothesized a relative signal-response correspondence. Infants should receive a higher rate of contingent responses addressing their sense of sight in response to nonverbal as compared to vocal infant signals.

1. Method

1.1. Sample

One hundred and sixty-five families with 3-month-old babies from six cultural communities volunteered to participate in this study. The recruitment of participants depended on the local customs of the respective cultural community. In Berlin, Beijing, and Delhi local research assistants collected the data in cooperation with pediatricians and hospitals. In Los Angeles, local and bilingual German assistants collected the data in cooperation with UCLA. In the rural Nso community, mothers were informed during prenatal and welfare classes after the lineage heads approved participation. Interested mothers participated if their family heads consented. The urban Nso sample was recruited through local research assistants who announced the study at the monthly cultural meetings of the Nso in various cities in Cameroon (Yaoundé, Kumbo, Bamenda, Buea, and Douala).

Age and gender distribution was held equal in all samples. On average, infants were 3-month-old ($M = 94.31$ days, S.D. = 9.27 days) and 56.7% of the infants were girls. Other parameters varied across the samples as a consequence of the respective sociodemographic context. The fertility rate in Germany (1.39), the USA (2.07), China (1.82), and India (2.98) is lower than the fertility rate in Cameroon (4.72; data separate for urban and rural areas were not available) leading to more firstborns than laterborns in the former samples (73.7%, 71.4%, 100%, 38.9%, 26.9% for urban and 38.5% for rural Nso, respectively), $\chi^2 = 36.55$, $p < .001$ (CIA, 2002). China's one-child policy – the enforced limit of one child per couple in urban areas – is clearly reflected in the data. The mothers' degree of formal education, assessed by years spent in formal schools, was higher in the Berlin ($M = 15.2$, S.D. = 3.5), Los Angeles ($M = 17.0$, S.D. = 1.6), Beijing ($M = 15.2$, S.D. = 3.0), and Delhi ($M = 15.6$, S.D. = 1.4) samples than in the Nso samples, especially the rural Nso sample (urban Nso: $M = 12.9$, S.D. = 1.8; rural Nso: $M = 6.6$, S.D. = 1.9), $F(5,159) = 62.92$, $p < .001$, $\eta_p^2 = .67$.[1] Furthermore, mothers from Berlin ($M = 34.0$, S.D. = 4.0) and Los Angeles ($M = 34.5$, S.D. = 3.0) were significantly older than mothers from Beijing ($M = 27.9$, S.D. = 2.8), Delhi ($M = 29.0$, S.D. = 3.3), or the Nso samples (urban Nso: $M = 30.2$, S.D. = 6.2; rural Nso: $M = 29.0$, S.D. = 8.4), $F(5,159) = 8.12$, $p < .001$, $\eta_p^2 = .21$.

1.2. Procedure

When infants were 3 months (±7 days) old, local research assistants visited the families at home. After the assistant had introduced the project, mothers, who were the primary caretakers in all cases, were asked to interact with their infants as they would normally do. Caretakers were free to choose a typical setting and the following interaction was videotaped for 10 min. Since we were interested in the infant's everyday experiences, we allowed for settings with multiple caretakers. In such cases, there was either one (Berlin 0% of the families, LA 9.5%; Beijing 5.6%; Delhi 25.0%, urban Nso 11.5%, rural Nso 15.4%, total 11.5%) or two to three (Delhi 11.1%, urban Nso 15.4%, all other 0%, total 4.8%) other persons present besides the mother. The fact, that there was more than only one person interacting with the infant was not related to any of the dependent measures.

Socialization goals and relevant background information were assessed in order to validate the a priori classification of the samples with respect to the sociocultural orientations. The socialization goals questionnaire consisted of 12 items that assess the importance given to autonomy (for example, "during the first three years of life, children should become assertive") and relatedness (for example, "during the first three years of life, children should learn to obey the parents") as socialization goals for the first 3 years of an infant's life (Keller et al., 2006). Participants rated each item on a 6-point Likert scale. Due to organizational problems, we received data from only 23 of the 37 Delhi mothers. However, there were no significant differences regarding the sociodemographic data between mothers for whom we do have information and mothers for whom we do not have the socialization goals data. The autonomous and relational socialization goal scores were defined as the mean scores of the respective six items for each dimension. The reliability of the relatedness scale was assessed using Cronbach's α and the scores ranged between .64 and .83 per cultural group[2] with an overall reliability of .82. For the autonomy scale the scores ranged between .66 and .92 with an overall

[1] Partial eta-square (η^2) was used as an index of the strength of association between an independent variable and a dependent variable. We followed Cohen's (1988) guidelines and interpreted η^2s of .01, .09, and .25 as small, medium, and large effect size, respectively.

[2] For the rural Nso sample the reliability for the relatedness scale was not computed separately since all participants fully agreed except for one person on two items.

reliability score of .92. However, the mean scores of the scales should be interpreted cautiously. To avoid fallacies based on culture-specific response styles, we decided to divide the autonomy score by the relatedness score and to use the natural logarithm of this ratio score as the central score for the final analyses. This metric score is corrected for individual and cultural response styles and indicates, on the group level, the samples' sociocultural orientation. Scores above zero indicate a relative preference for autonomous socialization goals, scores around zero indicate that autonomous and relational socialization goals are of equal importance, and scores below zero indicate a preference for relational socialization goals.

1.3. Coding

For analyzing the caretakers' levels and patterns of contingent responsiveness we applied an event coding approach. In a first step, two pairs of trained students coded the infant nonverbal signals and the infant sounds. One pair of coders identified the on- and offsets of infant sounds for the whole 10 min episode. A new vocalization was coded when there was a pause of more than 1 s. The identification was followed by an evaluation of sounds according to type (vocalization, vegetative, or effort sound), intensity (low, middle, or high), and, in the case of vocalizations, valence (negative, neutral, or positive). In the main analysis, we focused on the infants' *nondistress vocalizations* (on- and offsets) defined as neutral vocalizations of low or middle intensity. All other sounds were excluded for one of two reasons. First, vegetative and effort sounds cannot be attributed to the infant's initiative. Therefore, these sounds do not provide the child with an opportunity to perceive him- or herself as a causal agent. Second, including negative, positive, and highly intense vocalizations affects contingency levels. As a, clearly undesirable, consequence, differences in the contingency patterns between families or cultural samples would, in part, be caused by differential distributions of the valence and intensity of infant vocalizations. The other pair of coders identified the nonverbal infant signals in those sequences of the 10 min episode where the primary caretaker was facing the child while the latter was in a neutral or positive mood. Furthermore, coders excluded those sequences where the primary caretaker or the child could not be seen clearly on the video. In the main analysis, we focused on the infants' nonverbal signals *gaze at mother* (onsets) and *smile at mother* (onsets and increases, i.e., a new smile began before the precendent smile abated completely).

Based on the fact that maternal responses are most likely to occur in the first second after the infants' signal (Bloom, Russell, & Wassenberg, 1987; Keller, Lohaus, Völker, Cappenberg, & Chasiotis, 1999; Papoušek & Papoušek, 1987) and following other authors (Bigelow, 1998; Hsu and Fogel, 2003; Keller et al., 2004) we defined a latency window of 1 s. For the nonverbal signals we used a leading edge trigger. This means that the caretakers' response had to occur within the second of the onset of the antecedent infant signal. For the infant vocalizations, we chose a different latency window. The caretakers' response had to occur within the latency window that begins with the onset and ends 1 s after the offset of the vocalization. We did so because caretakers may respond with a nonverbal modality (e.g., touching or smiling) while the child vocalizes but normally withhold verbal responses until the infant's vocalization terminated. Also Bornstein et al. (1992) found that maternal responsiveness was predominantly co-occurring when the infant looked at objects or at the mother, whereas maternal responses to infant nondistress vocalizations were predominantly lagged. By the latency window chosen, any response the infants received during or up to 1 s after their vocalizations was coded as contingent.

In a second step, we analyzed which of the infants' senses the caretakers' contingent response addressed: (1) the infants' *sense of hearing* was addressed by the caretakers' verbalization, vocalization, and others sounds like, e.g., clicking one's tongue; (2) their *sense of touch* by body stimulation defined as touching or stimulating the infant with hands (e.g., fondling or patting) or the face (e.g., kissing) or by body contact; (3) their *sense of sight* by the caretakers' gaze, smile or facial expression (raised eyebrows and/or mouth wide open) or via the caretaker using an object (e.g., a toy).

A caretaker's action was coded as a contingent response if the caretaker either began an action that was not shown before (*addition*) or if the caretaker changed the rhythm or the intensity of an ongoing action (*modification*) (cf. Hsu & Fogel, 2003; Keller & Schölmerich, 1987). In all other cases, we coded *no reaction*. The 1 s before the onset of the infants' signal served as the baseline against which the caretakers' behavior was evaluated. For the final analysis, we computed proportional scores that describe the contingency experience of the infants. If not all modalities a caretaker may use to respond could be coded (e.g., face covered by hair), the infant signals were excluded from further analyses. Aggregate scores were computed separately for the two types of infant signals (nondistress vocalization and nonverbal signal) and separately for the infant's sense the caretakers' contingent response addressed (sense of hearing, touch

Table 1
Socialization goals

	Cultural sample (M (S.D.))							$F(5,153)$	η^2_p
	Berlin $N=37$	LA $N=21$	Beijing $N=17$	Delhi $N=22$	u. Nso $N=26$	r. Nso $N=26$	Total $N=149$		
Autonomy	4.56_a (.99)	5.00_a (.59)	5.18_a (.63)	4.21_a (.99)	4.76_a (1.63)	1.47_b (.84)	4.14 (1.62)	43.97^{***}	.61
Relatedness	3.86_a (.89)	4.62_b (1.03)	$4.10_{a/b}$ (.81)	4.70_b (.80)	5.88_c (.36)	5.96_c (.20)	4.84 (1.12)	39.25^{***}	.58
Ratio ln(A/R)	$.17_a$ (.23)	$.10_a$ (.20)	$.25_a$ (.17)	$-.12_b$ (.20)	$-.30_b$ (.47)	-1.51_c (.44)	−.25 (.68)	108.61^{***}	.79

Note: 1-Factorial (cultural group) ANOVAs. Subscripts indicate results of simple main effects testing (with Bonferroni adjustment). η^2_p = partial eta-square. *u.* = urban; *r.* = rural. $^{+}p<.10$, $^{*}p<.05$, $^{**}p<.01$, $^{***}p<.001$.

or sight).[3] Each of the six scores ranges between 0 and 100 and indicates the percentage of infant events that was followed by a contingent response. Furthermore, we computed two proportional scores (one for infants' nondistress vocalizations and one for nonverbal signals) that indicate the overall contingency experience, i.e., the percentage of events in which the infant experienced a contingent response that he could either hear, see or feel.

1.4. Inter-rater reliability

For the reliability of the identification of the infants' sounds and nonverbal signals, about 20% of all participants were rated by both codes. We used a rather conservative measure by dividing the number of matches by the number of matches plus the number of deviant codes for each rater. Reliabilities were .77 for infant sounds, .63 for infant gazes and .64 for infant smiles.

Reliabilities were medium to high for the infants' sounds (type: Cohen's $\kappa = .78$, valence: $\kappa = .57$, intensity $\kappa = .60$) and the caretakers' contingent responses separate for each modality (body stimulation: $\kappa = .78$, body contact: $\kappa = .83$, gaze: $\kappa = .80$, smile: $\kappa = .74$, facial expression: $\kappa = .88$, vocalization: $\kappa = .78$, and object stimulation: $\kappa = .61$).

2. Results

2.1. Socialization goals

The a priori classification of cultural samples into different sociocultural orientations was tested by analyzing the emphasis mothers put on autonomy and relatedness as socialization goals for their infants. As hypothesized, Berlin, Los Angeles, Beijing, Delhi and urban Nso mothers valued autonomous socialization goals significantly higher than rural Nso mothers did (see Table 1). Furthermore, there were no significant differences between the former samples. With regards to relatedness, Nso mothers in general attached a higher importance to relational socialization goals than did mothers from Berlin and Los Angeles. Unexpectedly, Beijing and Delhi mothers valued relational socialization goals significantly less than did urban Nso mothers and did not differ significantly from Los Angeles mothers. Looking at the ratio scores, a clear picture emerged with Berlin, Los Angeles, and Beijing mothers having values above zero, indicating a prevalence of autonomous goals, Delhi and urban Nso mothers with values below zero, indicating a prevalence of relational socialization goals and rural Nso mothers with a value far below zero, indicating a clear preference for relational socialization goals. Within these three groups, samples did not differ significantly from each other but from each sample of the other two groups as indicated by the pairwise comparisons. As indicated by one-sample t-tests, all mean scores differed significantly from zero. Partial eta-squares for all three analyses (autonomy, relatedness, and ratio score) indicate large effects. Unexpectedly, the mothers from Beijing fell into the group of samples with an independent sociocultural orientation showing a preference for socialization goals related to autonomy. Apart from this, the results support our assumptions concerning the selection of samples.

[3] In 32.4% of all contingent responses to nondistress vocalizations and in 25.6% of all contingent responses to nonverbal infant signals, caretakers addressed more than one of the infant's senses. As indicated by Yule's Q, there were no culture-specific differences in the co-occurrences of contingent responses for each pair of addressed senses. Therefore, we do only report contingency levels for each of the infant's senses separately.

2.2. Preliminary analyses

The recorded sequences had a mean duration of 10.03 min (S.D. = 1.50) and infants expressed an average of 27.6 (S.D. = 16.9) nondistress vocalizations per 10 min. Nondistress vocalizations had a mean duration of 1.05 s (S.D. = .64) and accounted for 59.7% of all sounds produced by the infant. Across cultural groups, there were no differences for the mean duration of the sequence, or the number and mean duration of nondistress vocalizations. The percentage of infant sounds that were nondistress vocalizations, however, was lower in Berlin ($M = 50.68$, S.D. = 16.14) and LA ($M = 50.72$, S.D. = 20.30) than in Beijing ($M = 71.75$, S.D. = 19.38) and urban Nso families ($M = 70.38$, S.D. = 13.80), with Delhi ($M = 59.95$, S.D. = 21.34) and rural Nso ($M = 61.96$, S.D. = 59.74) moving in between, $F(5,155) = 6.07$, $p < .001$, $\eta_p^2 = .16$. Cases in which an infant sound and a nonverbal signal occurred in the same second (4.7% of all events, similar in all samples) were excluded from further analysis.

There was a significant difference in the relative frequency of nonverbal infant signals (smile and gaze) per 10 min between cultural samples, $F(5,158) = 5.43$, $p < .001$, $\eta_p^2 = .15$. Infants from Berlin initiated more ($M = 31.2$, S.D. = 19.3) nonverbal signals than infants from all other samples (Los Angeles: $M = 14.8$, S.D. = 11.8; Beijing: $M = 14.6$, S.D. = 13.5; urban Nso: $M = 19.2$, S.D. = 9.5; rural Nso: $M = 19.2$, S.D. = 13.1) except for infants from Delhi ($M = 21.6$, S.D. = 14.0). On average, 29.5% of these nonverbal signals were smiles and in .3% of all events the infant started gazing and smiling simultaneously, i.e., onsets were coded less than 1 s apart, similarly in all cultural samples. These differences in the relative frequencies of nonverbal infant signals were not related – neither in a linear nor in a nonlinear way – to the contingency rates of caretakers within or across cultural groups.

In some dyads, there were hardly any nonverbal infant signals. Therefore, we defined an inclusion criterion: all analyses including both types of infant signals are based on contingency scores that were derived from a minimum of three infant signals that could be coded for all the caretakers' modalities as defined above.[4] According to this criterion we excluded 8 (21%) families from the Berlin sample, 11 (52%) families from the LA, 12 (67%) families from the Beijing, 14 (39%) families from the Delhi, 5 (19%) families from the urban Nso, and 14 (52%) families from the rural Nso sample, leaving five samples with at least 10 families.

2.3. Plan of analysis

To test our hypotheses, we computed mixed ANOVAs with follow-up univariate analyses and *t*-tests at the level of the infant's sense that the response addressed. Furthermore, we used simple main effects with Bonferroni-adjustments for pairwise comparisons of cultural samples. The dependent variable in all analyses was the percentage of infant signals in which the infant experienced a contingent response. Independent variables were either defined as between-subject (cultural group, gender, birth rank) or within-subject (addressed sense, type of infant signal) factors. There were no effects of gender or birth rank (first- vs. later born) in any of the analyses and therefore the data were collapsed across these factors.

There are two sets of analyses, each addressing parts of the hypotheses formulated above. In the first analysis, we focused on contingent responses to nondistress vocalizations. Therefore, we specified a mixed ANOVA with infants' sense (hearing, touch, sight) as within-subjects factor and cultural group as between-subjects factor. The dependent variable was the percentage of nondistress vocalizations to which the infant received a contingent response. The hypotheses tested in this analyses were that (1) the overall contingency level is similar in all cultural contexts, (2) that vocalizations addressing the infant's sense of hearing are the caretakers' dominant response (main effect sense), and, furthermore, that (3) there are culture-specific contingency patterns that lead to differences in the order in which senses are addressed in the different cultural contexts (interaction sense × cultural sample).

In the second analysis we looked at contingent responses to both types of infant signals. We specified a mixed ANOVA with type (nondistress vocalization, nonverbal signal) and sense (hearing, touch, sight) as within-subject factors and cultural sample (Berlin, LA, Delhi, urban and rural Nso) as between-subject factor. The Beijing sample was excluded, because the inclusion criterion was met in only six cases. The hypotheses tested in this analyses were that (1) vocalizations are the most salient signal (main effect type), that (2) there is a relative signal-response correspondence

[4] We decided for a cut-off criterion of $N \geq 3$, because the standard deviations of mean scores based on fewer events were substantially bigger. Additionally, computing analyses with alternative cut-off criteria ($N \geq 5$, 7 or 10) yielded identical patterns of results.

Table 2
Contingency patterns by sense addressed

	Cultural sample (*M* (S.D.))						
	Berlin *N* = 38	LA *N* = 20	Beijing *N* = 16	Delhi *N* = 35	u. Nso *N* = 24	r. Nso *N* = 26	Total *N* = 159
Nondistress vocalizations							
Sense of hearing	45.10 (19.92)	51.03 (20.37)	56.71 (16.76)	48.97 (19.87)	45.10 (21.34)	46.74 (15.85)	48.13 (19.31)
Sense of touch	21.20_{a} (13.45)	$36.36_{b/c}$ (20.08)	$31.68_{a/b}$ (13.01)	$25.26_{a/b}$ (11.63)	22.88_{a} (10.68)	47.43_{c} (18.64)	29.60 (17.15)
Sense of sight	14.78_{a} (13.13)	16.38_{a} (15.38)	8.45 (9.05)	6.95_{b} (7.63)	11.07 (9.71)	10.96 (9.26)	11.44 (11.30)
Overall	60.29 (19.75)	71.80 (15.97)	67.10 (20.74)	62.08 (17.44)	57.54 (16.66)	69.57 (16.17)	63.92 (18.28)
	Cultural sample (*M* (S.D.))						
	Berlin *N* = 30	LA *N* = 10	Beijing *N* = 6	Delhi *N* = 22	u. Nso *N* = 21	r. Nso *N* = 13	Total *N* = 96
Nonverbal signals							
Sense of hearing	30.81 (17.62)	26.61 (17.79)	30.86 (22.96)	31.58 (18.10)	31.11 (17.77)	35.36 (19.55)	31.23 (17.79)
Sense of touch	10.70 (10.70)	23.50 (23.90)	12.27 (22.07)	15.93 (14.67)	12.33 (12.30)	29.36 (19.03)	16.12 (16.01)
Sense of sight	17.46 (16.35)	26.89 (21.08)	25.36 (26.79)	10.90 (12.86)	17.04 (15.97)	16.15 (19.57)	16.67 (16.77)
Overall	47.54 (18.87)	55.48 (29.05)	52.78 (24.53)	48.22 (15.28)	46.34 (23.32)	59.24 (19.55)	49.84 (20.58)

Note: 1-Factorial (cultural group) ANOVAs. Subscripts indicate results of simple main effects testing (with Bonferroni adjustment). There were contingency data on only six infants' nonverbal signals in Beijing. Consequently, we do only report descriptive information here. Beijing was excluded from all statistical analyses. η_p^2 = partial eta-square. u. = urban; r. = rural. $^{+}p < .10$, $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$.

(interaction type × sense) while (3) vocalizations addressing the infant's sense of hearing still are the dominant response (main effect sense).

2.4. Overall contingency levels, dominant responses and culture-specific contingency patterns

In the first analysis, we excluded six families (1 LA, 2 Beijing, 1 Delhi, and 2 urban Nso families) that failed the inclusion criterion defined above. The 2-factorial ANOVA yielded a significant main effect for cultural group, $F(5,153) = 5.01$, $p < .001$, $\eta_p^2 = .14$, and the infants' sense, $F_{GG}(2, 306) = 225.55$, $p < .001$, $\eta_p^2 = .60$.[5] Furthermore, there was a significant interaction effect for sense and cultural group, $F_{GG}(10, 306) = 4.89$, $p < .001$, $\eta_p^2 = .14$ (see Table 2).

The significant main effect for cultural sample indicates that, based on the estimated marginal means, there were differences between the cultural samples. However, in the case of contingency levels, estimated marginal means are hard to interpret, because they equal the mean scores of contingency rates across the infant's senses. Since we were interested whether there are differences in the overall contingency rate, i.e., the percentage of contingent responses addressing at least one of the infant's senses, we entered the overall contingency score as an independent variable in a one-factorial (cultural sample) ANOVA. Again, we got a significant main effect for cultural sample, $F(5,153) = 2.39$, $p < .05$, $\eta_p^2 = .07$. However, the effect was rather small and none of the pairwise comparisons was significant.

Pairwise comparisons among estimated marginal means revealed that the main effect of sense was ascribable to a clear order in which senses were addressed. The sense of hearing was addressed most often, followed by the sense of touch which, in turn, was addressed significantly more often than the sense of sight, $ps < .001$. The significant interaction between sense and cultural sample indicated that the infant's senses were not addressed equally in the different cultural groups. To see whether there were differences regarding the dominant responses, we computed 1-factorial (sense) within-subjects ANOVAs separate for each cultural group. Main effects for sense were significant for all cultural groups, $Fs = 17.53$ to 81.93, $ps < .001$, $\eta_p^2 s = .48$ to $.81$. All pairwise comparisons between the infant's

[5] Whenever there was violation of sphericity in mixed ANOVAs, we used the conservative Greenhouse-Geisser significance test (indicated by F_{GG}) that is adjusted for this violation and results in a lower η_p^2.

senses were significant with two exceptions. First, infants in Berlin experienced contingent responses they could feel not more often than responses they could see. Second, rural Nso infants experienced contingent responses addressing their sense of touch as often as their sense of hearing.

To test whether there were differences in the percentage of contingent responses addressing a specific sense across cultural samples, we computed 1-factorial (cultural sample) ANOVAs separate for each of the infant's senses. There were no effects of cultural group on the infant's sense of hearing. There was a significant main effect of cultural group on the infant's sense of touch, $F(5,153) = 12.75$, $p < .001$, $\eta_p^2 = .29$. Caretakers from rural Nso families addressed the infant's sense of touch significantly more often than caretakers from all other cultural groups except LA. Caretakers from LA, in turn, addressed the infant's sense of touch significantly more often than caretakers from urban Nso and Berlin families. Finally, there was a significant main effect of cultural group on the infant's sense of sight, $F(5,153) = 2.95$, $p < .05$, $\eta_p^2 = .09$. Caretakers from Berlin and LA addressed the sense of sight most often and significantly more often than mothers from Delhi. Since the pattern of means was in line with our hypothesis, we tested a specific contrast comparing the Berlin and LA sample to all other samples, $F(1,153) = 10.82$, $p < .01$, $\eta_p^2 = .07$.

Theoretically, the culture-specific contingency pattern should be, at least in part, caused by the differential emphasis on autonomous and relational socialization goals. To test for this idea empirically, we computed a 2-factorial ANOVA (sense, cultural sample) in which the dependent variable was the contingency rate corrected for the ratio score of the socialization goals, i.e., the residual of the regression of the socialization goals ratio score on each of the three contingency scores. If the socialization goals account for the culture-specific contingency pattern, the effect size of the cultural sample × sense interaction should be reduced considerably. The sense × cultural sample interaction effect for the residual scores still was significant, $F(10,274) = 2.07$, $p < .05$. However, the effects size was reduced by 50% from a medium to a small effect ($\eta_p^2 = .07$). Therefore, we can conclude that the differential emphasis on autonomous and relational socialization goals accounts for a good proportion of differences in the contingency patterns across cultural contexts.

2.5. Signal-response correspondence

The 3-factorial ANOVA of the second analysis yielded a significant main effect for type of infant signal, $F(1,91) = 37.88$, $p < .001$, $\eta_p^2 = .29$, sense, $F(2,182) = 78.01$, $p < .001$, $\eta_p^2 = .46$, and cultural sample, $F(4,91) = 5.67$, $p < .001$, $\eta_p^2 = .20$. Furthermore, there were significant interaction effects of sense × type, $F(2,182) = 19.69$, $p < .001$, $\eta_p^2 = .18$, and sense × cultural sample, $F(8,182) = 3.10$, $p < .001$, $\eta_p^2 = .12$.[6] To interpret the significant main effect for cultural sample, we entered the overall contingency scores for nondistress vocalizations and nonverbal infant signals as independent variables in separate one-factorial (cultural sample) ANOVAs. As above, the main effect for nondistress vocalizations got significant, $F(4,91) = 5.67$, $p < .05$, $\eta_p^2 = .12$ while none of the pairwise comparisons reached significance. The main effect for nonverbal signals did not reach significance, $F(4,91) = 1.15$, n.s., $\eta_p^2 = .05$.

2.6. Vocalizations as dominant response and salient signal

The significant main effect for sense and the pairwise comparisons among estimated marginal means indicated that, as in response to nondistress vocalizations alone, infants most often experienced a contingent response addressing their sense of hearing, followed by touch and then sight, $ps < .001$. The main effect for type is based on estimated marginal means that are, as argued above, difficult to interpret in the case of contingency rates. Therefore, we additionally compared the overall contingency levels between the two types of infant signals, $t(95) = 4.82$, $p < .001$, $d = .49$. In line with our hypothesis nondistress vocalizations turned out to be the more salient signal: infants experienced more contingencies in response to nondistress vocalizations as compared to nonverbal infant signals (see Table 2).

[6] Additionally, we did the same analysis with a different inclusion criterion ($N \geq 20$: Berlin, Delhi, urban Nso). The analysis yielded a significant main effect for type of infant signal, $F(1,70) = 27.09$, $p < .001$, $\eta_p^2 = .28$, and for sense, $F(2,140) = 105.36$, $p < .001$, $\eta_p^2 = .60$, and a significant type × sense interaction, $F(2,140) = 15.56$, $p < .001$, $\eta_p^2 = .18$. Different from the analysis reported above, there were no main or interaction effects involving cultural group, indicating that the signal-response correspondence had a very similar pattern in all three cultural groups. This was related to the fact that the two cultural samples that differed most (rural Nso and LA) were excluded from this analysis.

2.7. Relative signal-response correspondence

The significant interactions indicate that the infants' senses were addressed differently depending on the type of infant signal and depending on the cultural sample. To interpret the interactions, we computed mixed ANOVAs with type (nondistress vocalization, nonverbal signal) as within-subject factor and cultural sample as between-subject factor separate for the infant's senses.

With regards to type we found that the contingency rates addressing the sense of hearing and touch decreased when responding to nonverbal signals, $F(1,91) = 31.23$, $p < .001$, $\eta_p^2 = .26$ and $F(1,91) = 41.13$, $p < .001$, $\eta_p^2 = .31$, respectively, while the contingency rate addressing the sense of sight did not change significantly, $F(1,91) = 1.91$, n.s., $\eta_p^2 = .02$.

The interpretation of the sense × cultural sample interaction generally supports the results reported earlier. As for responses to nondistress vocalizations alone, there were no differences between cultural samples for contingent responses the infants could hear, $F(4,91) = .59$, n.s., $\eta_p^2 = .02$. The contingency experiences the infants could see or feel differed between the cultural samples, $F(4,91) = 4.91$, $p < .05$, $\eta_p^2 = .13$ and $F(4,91) = 8.49$, $p < .001$, $\eta_p^2 = .27$, respectively. Pairwise comparisons indicated that infants from LA more often experienced contingent responses that they could see than infants from the Delhi sample, while infants from the rural Nso sample more often got contingent responses they could feel than infants from all other samples except the LA sample, $ps < .01$. Unexpectedly, infants from LA got more contingent responses addressing their sense of touch than infants from Berlin, $p < .01$, or infants from the urban Nso sample, $p < .05$.

3. Discussion

The main purpose of this study was to analyze similarities and differences in the contingency patterns and dominant responses of caretakers to nondistress vocalizations and nonverbal infant signals in different sociocultural environments. We found a distinct pattern for the socialization goals that supports the a priori classification of cultural samples as prototypic for specific sociocultural orientations. Mothers from all samples with predominantly highly educated middle-class families evaluated autonomous socialization goals as more important than interdependent, i.e., rural Nso, mothers did. With regards to relational socialization goals, the Nso mothers, urban and rural alike, valued these goals higher than the participants with an independent sociocultural orientation did. The urban Nso mothers scored higher on relatedness than the Beijing and Delhi mothers, although all three cultural communities are considered to represent the autonomous-related orientation. There may be various reasons that account for this finding. First, urban Nso mothers received less formal education than did mothers from Beijing and Delhi and it has convincingly been argued before that it is formal education that drives the development of autonomy (Kağitçibaşi, 1996). Most often, urban Nso mothers completed high school but – unlike most mothers from Beijing and Delhi – did not receive a university degree. Second, as data from the grandmothers of these families demonstrate (Lamm, Keller, Yovsi, & Chaudhary, in press), most of the grandmothers from Delhi and Beijing lived in similar urban contexts as their daughters do, whereas the urban Nso mothers migrated to the urban environments when they were children or young adults. As a consequence, urban Nso mothers became exposed to the urban context only later and had less time to adapt. If one looks at the relative importance attached to autonomy vs. relatedness, autonomy dominates in the samples with an independent sociocultural orientation, the ratio is slightly in favor of relatedness in the samples with an autonomous-related sociocultural orientation and relatedness clearly dominates in the samples with an interdependent sociocultural orientation. Only the Beijing mothers were more in favor of autonomous socialization goals than expected. Possibly, having only one child and living in a rapidly developing and very modern metropolis might have driven mothers to focus on the infant's autonomy.

These differences in the sociocultural orientation across samples affected some but not all aspects of contingent responsiveness. The results point to several areas of cultural similarity in contingent responsiveness. Vocalizations constituted the primary response tendency of caretakers as well as the most frequent and salient signal of infants across all sociocultural contexts. Furthermore, a relative signal-response correspondence emerged in all six cultural contexts. Across all sociocultural contexts, caretakers addressed the infants' sense of hearing more often in response to vocalizations than in response to nonverbal signals. Furthermore, caretakers addressed the sense of sight equally often in response to verbal and nonverbal infant signals. Because generally the overall rate of contingent responsiveness was lower in response to nonverbal than vocal infant signals, it was rather a relative increase of the contingency rate

addressing the infants' sense of sight in response to nonverbal signals than an increase in absolute terms as initially hypothesized.

One could argue that the fact that caretakers have more time to react to nondistress vocalizations than to nonverbal signals might be an alternative explanation for this finding. As reported above, the average duration of a vocalization is approximately 1s and adds to the latency window. However, using a different methodological approach with identical latency windows, Van Egeren et al. (2001) found similar results. Also in their study vocalizations clearly constituted the most salient signal for the majority of responses. However, this general finding might be limited to 3-month-olds since other research could show that in younger infants smiles are as salient as infant vocalizations (Lavelli and Fogel, 2005).

Generally, our results support the idea of Hsu and Fogel (2001) that the social regulatory function of infant signals is modality-specific and, furthermore, their speculation that the modality-specific function may be further moderated by culture. The differences in the sociocultural orientations manifested most clearly in the caretakers' contingency pattern, i.e., the pattern in which the caretakers contingently addressed the infants' senses of hearing, touch and sight. Despite the rather stable hierarchy concerning the relative frequency with which the infants' senses were addressed (sense of hearing, followed by touch and then sight), there were two exceptions. In the rural Nso sample caretakers addressed the sense of touch as often as the sense of hearing. This divergence was in line with our hypotheses that proximal modalities should be central to the interdependent sociocultural orientation of the rural Nso families. The other discrepancy pertained to the Berlin sample. Berlin caretakers addressed the senses of touch and sight similarly often. Again, this was in line with our hypotheses, since we expected caretakers from the Berlin and the LA sample to emphasize the face-to-face context more than caretakers from the other samples. Taken together, the results indicate that, across a number of considerably different sociocultural environments, there was a notably stable order in which senses were addressed. However, where this order did not emerge, it was in line with our hypotheses. We did not find full support for Richman et al.'s (1992) hypothesis that the order of dominant responses may be reversed in sociocultural environments that differ substantially from the Western model. However, it was in the interdependent rural Nso families that the primacy of the sense of hearing was challenged by the equal rates in which the senses of hearing and touch were addressed.

Looking at the infants' senses separately, we found that there were no differences in the contingency levels addressing the infants' dominant sense of hearing. The sense of touch was addressed more often in the rural Nso sample than in all other but the LA sample. Concerning the sense of sight, the effect was smaller. However, the significant contrast allows for the interpretation that the sense of sight was addressed more often by caretakers of the two samples with an independent cultural orientation than all other samples. These results again, indicate that proximal modalities are central to interdependent sociocultural environments, whereas distal modalities, especially the face-to-face interaction format, are central to independent sociocultural environments. Unexpectedly, we found a rather high contingency level for responses addressing the infants' sense of touch in the LA sample. To find an explanation for this unexpected finding, it would be important to further analyze the duration, intensity, and type of body contact established.

In general, our results imply that contingency experiences rely less on the face-to-face format than is implicit in previous research that focused exclusively on the face-to-face context (Jaffe et al., 2001; Keller et al., 1999; Stern, 1985). Furthermore, there is evidence for predictable culture-specific differences in the contingency patterns and dominant responses. The reasons for these differences might be different norms of interaction (Richman et al., 1992) or differences in cultural beliefs (Fogel et al., 1988). Thus, caretakers in different cultural contexts follow different cultural scripts that lead to different developmental outcomes. We furthermore assume that these different developmental outcomes have an adaptive value within the specific sociocultural context within which the culture-specific script developed. It does not seem as if it was one factor alone, e.g., the mothers' level of formal education, which accounts for the culture-specific differences found. It rather seems to be a whole pattern – what Triandis (1993) called cultural syndrome – that is responsible for these differences.

Though there were culture-specific contingency patterns, the overall contingency levels were rather similar. This finding, along with the dominance and salience of vocalizations and the relative signal-response correspondence, supports our general assumption that the basic process of social contingency in caretaker–infant interaction is based in an evolved, intuitive parenting program that differs according to culture-specific beliefs, ethnotheories, and socializations goals. Since there are huge differences concerning families' sociodemographic profiles, structural differences in dwellings, and geographical location between samples, the findings of cultural universals are more compelling than earlier studies focusing on urban middle-class.

Our study has several limitations. Generally, it would be important to have more than only one sample with an interdependent sociocultural orientation. However, collecting data in rural traditional environments is especially challenging. Another shortcoming are the relatively small sample sizes and the relatively high and variable exclusion rates. As described above, the second set of analyses was based on only parts of the samples that were assessed. Trying to maximize ecological validity and to be as unobtrusive as possible apparently led to different data exclusion rates across cultures that were due to unusable sequences. Furthermore, there were differences in the degree to which mothers established contexts that were favorable for face-to-face interactions. All these factors reduced the duration of the interaction that could be analyzed for nonverbal infant signals which could be avoided by recording interactions either repeatedly or for a longer duration.

Besides, it seems worthwhile to bring in more systematic variation with regards to the number of caretakers interacting with the infant. In our study, multi-party interactions occurred in about 15% of the total sample. Looking through the recordings we had the impression that mothers reduced their rate of contingent responses and actively promoted the participation of the other parties present. It seemed as if they concertedly met a contingency target value. However, we could not do in-depth analyses on this issue because multi-party interactions occurred rather rarely and were distributed unequally across samples. It would be interesting to see in which way mothers' behavior changes in exclusive vs. multi-party interactions. Up to this point, we can only say that the contingency levels and patterns did not differ between exclusive mother–infant interactions and multi-party settings within cultural samples.

Finally, future research should analyze these developmental processes longitudinally in order to see whether the infants' behavior can be conceived of as a developmental outcome of earlier contingency experiences. A study by Tamis-LeMonda, Bornstein, and Baumwell (2001) suggests that certain types of maternal responsiveness are specifically associated with certain child outcomes at specific periods in development. Also Hsu and Fogel (2001) speculated that certain types of infant signals are more likely to elicit certain types of maternal responsive actions, which, in turn, are more likely to affect certain areas of child development at certain developmental periods. We would like to add that it is not only the type of infant signal that is more likely to elicit specific responsive actions in caretakers but also the caretakers' broader sociocultural orientation and "cultural embeddedness" that leads to modal differences in contingent responsiveness. Future research should aim to demonstrate the significance of different contingency experiences for later developmental outcomes.

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