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A Prelinguistic Gestural Universal of Human Communication

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Abstract

Several cognitive accounts of human communication argue for a language-independent, prelinguistic basis of human communication and language. The current study provides evidence for the universality of a prelinguistic gestural basis for human communication. We used a standardized, semi-natural elicitation procedure in seven very different cultures around the world to test for the existence of preverbal pointing in infants and their caregivers. Results were that by 10–14 months of age, infants and their caregivers pointed in all cultures in the same basic situation with similar frequencies and the same proto-typical morphology of the extended index finger. Infants' pointing was best predicted by age and caregiver pointing, but not by cultural group. Further analyses revealed a strong relation between the temporal unfolding of caregivers' and infants' pointing events, uncovering a structure of early prelinguistic gestural conversation. Findings support the existence of a gestural, language-independent universal of human communication that forms a culturally shared, prelinguistic basis for diversified linguistic communication.

Keywords: Pointing; Caregiver–infant interaction; Social development; Infant communication; Cross-cultural; Deictic

Language is a universal feature of human communication. However, language is not a unitary phenomenon and is arguably best characterized by cultural diversity (Evans & Levinson, 2009). Regarding universal aspects of human communication, one view is that language is based on universal forms of non-linguistic, species-specific cognition and

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interaction skills, which enable and shape language in the first place (Bates, 1979; Bruner, 1981; Levinson, 2006; Macnamara, 1972; Tomasello, 2008). A hypothesis arising from this view is that there are language-independent universal forms of human-specific communication already before language has emerged.

One of the most characteristic means of human prelinguistic communication is the pointing gesture, emerging around 12 months of age. In the modern context, Bates (1979) was one of the first to attribute ''cosmic importance'' to infant pointing in the construction of language and meaning (see also Werner & Kaplan, 1963). Research since then has provided direct empirical evidence for a close relationship between prelinguistic pointing and language development (for a recent meta-analysis, see Colonnesi, Stams, Koster, & Noom, 2010). For example, the onset of pointing predicts first words (Carpenter, Nagell, & Tomasello, 1998; Fenson et al., 1994; Harris, Barlow-Brown, & Chasin, 1995), the frequency of pointing increases with the vocabulary spurt (Iverson, Capirci, & Caselli, 1994; Lock, Young, Service, & Chandler, 1990), and the combination of points and words predicts the onset of syntactic two-word combinations (Iverson & Goldin-Meadow, 2005). Indeed, pointing remains a crucial accompaniment of adults' deictic speech in many languages. Delayed development of pointing gestures after brain injury predicts delayed language acquisition (Sauer, Levine, Rowe, & Goldin-Meadow, 2010), and aberrant development of pointing is both symptom and source of autism (Baron-Cohen et al., 2000). The uniqueness of pointing is further corroborated by the fact that humans are the only primate species who communicate with each other through pointing gestures (Povinelli, Bering, & Giambrone, 2003; Tomasello, 2006).

Further research has established that prelinguistic infants of 12 months of age point in meaningful ways, based on social-cognitive skills and motivations that run much deeper than language alone. For example, 12-month-olds point to communicate about specific entities and events, even when these are absent from the perceptual scene (Liszkowski, Carpenter, & Tomasello, 2007; Liszkowski, Schafer, Carpenter, & Tomasello, 2009). They point with cooperative motives such as aligning interest with others and helpfully providing relevant information for others (Liszkowski, Carpenter, Henning, Striano, & Tomasello, 2004; Liszkowski, Carpenter, & Tomasello, 2008), and they use pointing within a shared background of mutual knowledge (Liebal, Behne, Carpenter, & Tomasello, 2009; Liebal, Carpenter, & Tomasello, 2010). Further, before infants produce point-word combinations they comprehend the underlying referential nature of these combinations (Gliga & Csibra, 2009), and it is the specific canonical form of index-finger pointing (as opposed to whole-hand pointing) that first embodies a bidirectional understanding of the underlying communicative intentions of the act (Liszkowski & Tomasello, 2011; Behne, Liszkowski, Carpenter, & Tomasello, 2011). These studies provide support for a non-linguistic primacy of social-cognitive and motivational skills for shared intentionality in the specific case of deictic pointing, upon which language usage must rest (Tomasello, Carpenter, & Liszkowski, 2007).

However, the vast majority of the reviewed studies are based on participants with a Euro-American cultural background. Researchers have rightly cautioned about the biased and unrepresentative characteristics of these samples (Henrich, Heine, & Norenzayan, 2010), which pose a serious methodological problem for theories of universal prelinguistic communication. Further, research has shown that culture and linguistic diversity have

profound effects on differences in core cognitive domains like spatial cognition (Haun, Rapold, Call, Janzen, & Levinson, 2006; Levinson, 2003), perception (Winawer et al., 2007), abstract representations (Boroditsky & Gaby, 2010), numerical knowledge (Frank, Everett, Fedorenko, & Gibson, 2008), and perspective taking (Wu & Keysar, 2007). One could easily imagine that cultural diversity runs deep down in ontogeny, beyond language, without ever running up against specific universal forms of prelinguistic communication, or fundamental social cognition and interaction skills. Sociocultural theories of development indeed suggest that infants' social understanding and interaction skills are socially constructed from the beginning (Carpendale & Lewis, 2004; Werner & Kaplan, 1963), especially in the case of pointing (Carpendale & Carpendale, 2010). This would render prelinguistic communication susceptible to shaping by cultural practices and cast doubt on any a priori claims of universality.

Modes and frequency of interaction with infants indeed vary substantially across cultures (Gaskins, 2006), as also indicated by studies of children's language socialization (Schieffelin & Ochs, 1986) and early dyadic face-to-face interactions (Field, Sostek, Vietze, & Leiderman, 1981; Kärtner, Keller, & Yovsi, in press; LeVine et al., 1994; see also Masataka, 2003). Different social environments might thus differentially promote the emergence or usage of prelinguistic pointing. Culturally informed research indeed suggests considerable variability in adults' use of pointing across cultures. Wilkins (2003) summarizes anthropological studies and linguists' reports and concludes that there is no universal alignment of form and functions of pointing across cultures. According to Wilkins, in several cultures around the world people predominantly point with pursed lips or with the chin instead of using the canonical index-finger point (''lip-pointing,'' Sherzer, 1973; Enfield, 2001), and in other cultures certain forms of pointing are absent or socially inhibited (e.g., taboos against left hand pointing, index-finger pointing, or pointing at people). This raises the possibility that pointing is conventionalized and shaped through sociocultural practices from the beginning rather than starting from a universal base. Further, Wilkins describes different cultural functions and contexts within which index-finger pointing is used (2003, p. 194). For example, in some cultures pointing seems to serve predominantly spatial indicating, often based on absolute, cardinal directions (Le Guen, 2011; Levinson, 2003), rather than indicating interesting objects as in the case of interactions with preverbal infants in Euro-American contexts. Finally, members of different cultures have varying meta-theories of how to point, and there is some indication that certain forms of pointing may be learned through explicit teaching (Wilkins, 2003).

In the current study, we sought to provide evidence for a broad cultural distribution of infant pointing as a species-specific and fundamental form of prelinguistic human communication. One might well imagine that cultural diversity in linguistic communication pertains equally to forms of gestural communication, including pointing, as some of the evidence may suggest. However, it is also possible that pointing becomes diversified only later in development and starts out universal in form and function as a prelinguistic foundation of human communication, as some other evidence may suggest. We tested the existence and practice of pointing in infants and caregivers across seven very different cultural settings around the world, some of which were small scale and rural, others large scale and urban,

some of which may be described along socialization dimensions as independent or as interdependent, and all of which varied substantially in socioeconomic and educational levels.

We used a semi-natural elicitation procedure in which we video-recorded caregivers' and their infants' spontaneous interactions in a room decorated with various items potentially interesting to infants, broadly analogous to a visit to an exhibit or museum. This method has previously been used successfully to elicit uninstructed, spontaneous pointing (Liszkowski & Tomasello, 2011). Of interest was whether the same situation, that is one of looking at objects together, including the same sets of objects, would elicit the same gestural pointing in infants of similar ages across very different cultural settings. Apart from documenting the spontaneous use of pointing in the same situation, we were specifically interested in the form of index-finger pointing, since index-finger pointing has been described as non-universal among adults but foundational to linguistic communication in ontogeny. To provide further evidence for the social-communicative usage of pointing, we investigated the sequential unfolding of pointing events between caregivers and infants as an early manifestation of a coordinated gestural-referential conversation format (following Puccini & Liszkowski, 2009). Further, we investigated whether caregivers integrated their pointing with vocalizations, providing a stepping stone into language, and whether infants accompanied their pointing with vocalizations, providing additional communicative cues.

2. Method

2.1. Participants

Infants were accompanied by their main caregivers (in almost all cases their mothers; $n = 96$). Dyads were from seven different cultural settings (''cultures,'' for short) and tested once in their respective regions of residence. The cultures were chosen based on the available field sites of researchers who had expressed interest in participating in our research project (Liszkowski & Brown, 2007), with the aim of maximizing diversity between cultures. Table 1 displays the ages and main sample characteristics. Our focus was on the age range between 9 and 15 months in which pointing and other joint attention behaviors develop (Carpenter et al., 1998). Infants were included if they were not fussing, sleeping, or otherwise disrupting the intended recording. Six dyads had to be excluded because caregivers did not look at the decoration items, other siblings entered the room, or the cameras ran out of batteries. Data collection yielded infants between 7 and 17 months, with the majority of infants across all samples falling into the age range between 10 and 14 months ($n = 68$; see Table 2). For further information about the field sites, see Supporting Information.

2.2. Materials and procedure

A portable field kit was compiled, containing a tool-kit with glue, tape, string, clips, nails, task instructions, and 20 stimulus items, (Liszkowski & Brown, 2007). The stimuli were composed of novel and familiar items, including both depictions of objects and real objects.

Table 1
Description of the sample

Region (Field Researcher)	*N* (male)	Mean Age (range) in Days	Average Family Size Estimate	Language Environment	Socialization Goal	Rural/Urban	Economy
Papua New Guinea, Rossel Island (PB)	13 (6)	396 (282–531)	Four children; extended family	Monolingual Yélî Dnye	Interdependent	Rural	Subsistence farming/fishing
Indonesia, Bali (CdV)	9 (5)	361 (257–461)	Three to four children; extended family	Multilingual, including indigenous sign language	Interdependent	Rural	Agriculture, local businesses
Japan, Kyoto (AT)	16 (5)	394 (363–424)	One to two children; nuclear family	Monolingual Japanese	Interdependent	Urban	Industrialized
Peru, Montaro Valley, Central Highlands (TC)	27 (13)	363 (167–534)	Four to five children; extended family	MonolingualSpanish	Interdependent	Rural	Subsistence farming, migrant labor, craft production
Mexico, Tzeltal Mayans (PB)	12 (9)	413 (316–489)	Four to five children; extended family	Monolingual Tzeltal	Interdependent	Rural	Subsistence farming
Mexico,Yucatec Mayans (Dorothe Salomo; Laura Shneidman)	8 (4)	376 (312–435)	About six children; extended family	Monolingual Yucatec	Interdependent	Rural	Slash and burn subsistence farming
Canada, Nova Scotia (TC)	11 (4)	395 (313–435)	Two children; nuclear family	Monolingual English	Independent	Rural	Industrialized

Table 2
The distribution of infants sampled across cultures and three independent age ranges

	Number of Infants in Each Age Range		
Region	7–9 Months: n = 12	10–14 Months: n = 68	15–17 Months: n = 16
PNG (Rossel)	1/1	7/10	2/2
Indonesia, Bali	1/2	5/6	1/1
Japan, Kyoto	–	14/16	–
Peru, Montaro Valley	2/9	7/10	8/8
Mexico, Tzeltal Mayan	–	7/7	5/5
Mexico, Yucatec Mayan	–	5/8	–
Canada, Nova Scotia	–	8/11	–
Total	**33.3%**	**77.9%**	**100%**

Note. Denominators indicate the number of infants in each age range for each culture. Nominators indicate the number of index-finger pointers in that age range and culture. The bottom line (bold) summarizes the proportions of index-finger pointers in the three independent age ranges across cultures.

These were laminated color pictures of animals, plants, and vehicles, and objects like a ball, balloon, doll, feather boa, blinking light, and so forth (see Fig. 1), and a cup from the local field site.

The researcher in each cultural setting set up the decoration items depending on the local possibilities either in one specific room, in different rooms, or outside, such that the items would hang down from or be attached to a wall or ceiling or a rope, or be placed on chairs or tables. At least two cameras recorded the entire scene from two opposing angles. Caregivers were asked to carry their infants on their hips and look together the items in the room without removing them from their positions. The researcher left the participants alone in the room for about 5 min (varying across participants and cultures). There was no mentioning of pointing at any time during the entire data collection to any of the participants. Most field researchers were well known to their participants or to the community through previous field work, and the current study accompanied other investigations.

Fig. 1. Stimulus material.

2.3. Coding

Video recordings were digitized, synchronized, and then all analyzed by one trained assistant using ELAN, a free video annotation program developed by the Max-Planck-Institute for Psycholinguistics, which allows for time-locked coding of multiple events, with the option of watching both combined and individual camera recordings, thus not losing any quality of the camera resolution. Points were coded when the participant extended her arm and hand either fully or half into a discernable direction or toward an object with a corresponding look during or just before. If the configuration resembled that of the definition of a point but was not as pronounced, for example, it lacked accompanying gaze in the direction or could have resulted from another movement, like swinging the arm through the air, or from scratching the head or simply from the caregiver's movement of the infant's body, it was coded as an unclear act and later omitted from the analyses. The morphological definition of pointing was further distinguished from touching or grabbing objects, or attempts to do so, which were usually also accompanied by leaning forward and/or grasping movements. Points were coded as index-finger point if the index finger was clearly extended relative to all other fingers, and as whole-hand point if it was not—the latter including a broader range of possible hand configurations. In few cases when the hand configuration could not be determined because of lighting conditions or camera angles, it was coded as ''unclear'' and later omitted from the analyses. We were also careful to identify possible other, idiosyncratic or culture-specific forms of deictic attention directing. These forms could not be defined a priori other than being directed at some specific object and were described by the coder and counted separately. There were very few of these instances. The first author agreed with all of the descriptions.

In addition, we coded for the temporal order of pointing events. Points were coded as *following* if they occurred within 10 s of the partner's points and as *initiating* if they were not preceded within 10 s by the partner's point. Vocalizations were coded when they occurred within 2–3 s before or after a point and were not fussing or involuntary (e.g., hiccups, coughs).

Reliability was coded on 30% of the recordings of each culture by a second trained assistant. Reliability coding on the number of all points, index-finger points, and point-accompanying vocalizations for caregivers and for infants correlated significantly with the main coding (all rs > .933, ps < .001). For comparisons, continuous data were relativized on the amount of time spent in the decorated room and subsequently square-root transformed to fit the normal distribution. Age was analyzed as zero-centered covariate by subtracting the mean age from each age value (see Delaney & Maxwell, 1981).

3. Results

We found evidence for infant pointing across all of the different cultures under investigation. Infants pointed more than once from about 9 months of age. As shown in Table 2, data collection in all cultures included infants between 10 and 14 months of age. The cultural

comparison in this age range revealed that in each of the cultures the majority of infants began to point with the index finger between 10 and 14 months of age, with no significant differences between cultures, $\chi 2(n = 68, df = 6) = 4.95, p = .550$.

Infants pointed about equally often across all cultures as revealed by a 2 (pointing: whole-hand, index finger) × 7 (culture) ANCOVA with age as covariate. The analysis yielded no significant main or interaction effects for culture ($F(1, 88) = 0.56$, $p = .760$; $F(6, 88) = 1.12$, $p = .358$, respectively). Only the form of pointing interacted significantly with age, $F(1, 88) = 7.85$, $p = .006$, partial $\eta^2 = .082$. Fig. 2 shows that younger infants pointed more with the hand than the index finger, while this pattern reversed at around 12 months of age ($F(1, 88) = 3.870$, $p = .052$, partial $\eta = .042$).

For caregivers, a 2 (pointing: whole-hand, index finger) × 7 (culture) ANCOVA with infant age as covariate revealed that caregivers pointed across all seven cultures predominantly with the index finger ($F(1, 88) = 315.16$, $p < .001$, partial $\eta^2 = .782$), with a marginal effect of infant age. Fig. 3 shows that Rossel caregivers pointed significantly more than caregivers

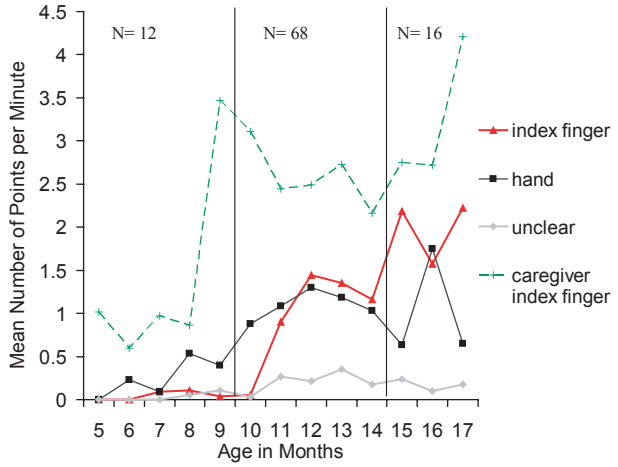

Fig. 2. Infant pointing as a function of hand shape and age, and caregiver index-finger pointing.

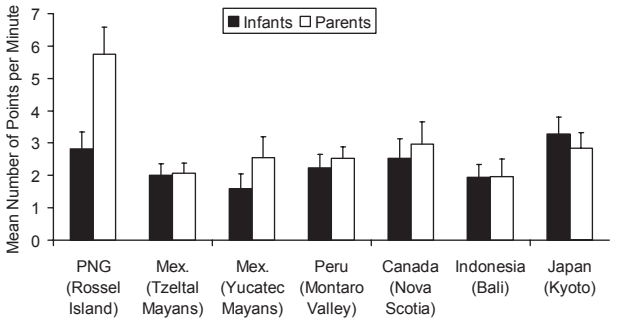

Fig. 3. Infant and parent pointing in different cultural settings.

of all other cultures (main effect: $F(6, 88) = 4.11$, $p = .001$, partial $\eta^2 = .219$; all single comparisons, $p < .005$), with no significant differences between the other groups.

We tested with a hierarchical linear regression analysis whether infants' index-finger pointing was predicted by culture (dummy-coded), caregiver index-finger pointing, and age. There was no predictive effect for culture, but a significant increase in the explanation of variance when adding caregiver pointing to the model ($R^2 = .153$; significant change of R^2: $F(1, 88) = 8.82$, $p = .004$), with a further increase when adding age to the model ($R^2 = .183$; significant change of R^2: $F(1, 87) = 23.96$, $p < .001$). In the final model, infant pointing was predicted by caregiver pointing ($\beta = .218$, $p = .029$) and by age ($\beta = .452$, $p < .001$). When controlling for age, the partial correlation between caregiver and infant pointing remained significant, r*par* = .209, $p = .021$.

To further analyze this relation, we looked at the sequential structure of each other's pointing events. We tested whether pointing was more closely related within a temporally narrower defined conversation format. Fig. 4 shows a highly positive correlation between infants' and caregivers' points which followed each other within 10 s, $r(n = 96) = .953$, $p < .001$. This relation was not influenced by culture or age (linear regression, all βs < .04, *p*s > .556). In contrast, the correlation for the numbers of initiating points was weaker and negative, and only approached significance, $r(n = 96) = -.174$, $p = .090$. The relation between caregiver and infant pointing was thus carried by the points within a temporally narrower defined interaction frame, revealing a conversation-like structure in prelinguistic gestural communication.

To address the directionality underlying the relation, we ran additional analyses on the primacy of caregivers' versus infants' pointing events. Caregivers pointed overall significantly more than infants ($F(1, 89) = 64.41$, $p < .001$, partial $\eta^2 = .420$) with no significant differences between cultures. However, as the dashed line in Fig. 2 shows, there was an interaction with age ($F(1, 88) = 8.90$, $p = .004$, partial $\eta^2 = .092$), suggesting that caregivers begin to point with the index finger about 2–3 months earlier than infants. When looking

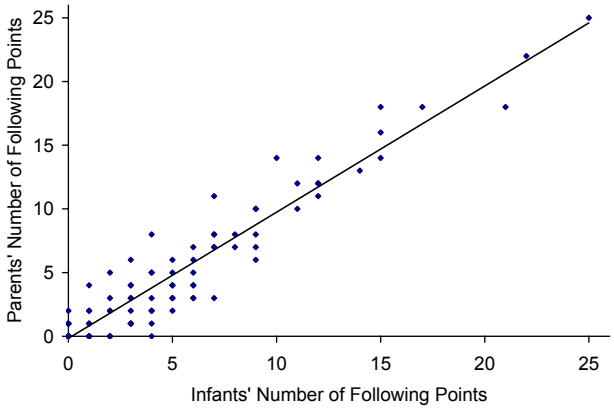

Fig. 4. The relation between parents' and infants' number of following points (points within 10 s of each other's points).

at the sequential structure of initiating and following points, there was overall a greater proportion of initiating than following points for both caregivers and infants (76.5% of caregivers' points and 69.4% of infants' points were initiating; one-sample *t* tests both *p*s < .001). Caregivers proportion of initiating points was slightly higher compared to infants (2 (infant, caregiver) × 7 (culture) ANOVA, $F(1, 81) = 5.09$, $p = .027$, partial $\eta^2 = .059$). Culture did not interact and produced only a marginally significant main effect, $F(6, 81) = 2.12$, $p < .060$, partial $\eta^2 = .135$. Finally, when looking at the proportion of a participant's points to which the other responded, as an index of uptake, a 2 (infant, caregiver) × 7(culture) ANOVA revealed no significant differences between infants and caregivers (30.5% of infants' points were followed by caregivers' points; 26.6% of caregivers' points were followed by infants' points), no interaction, and only a main effect of culture, $F(6, 81) = 4.59$, $p < .001$, partial $\eta^2 = .254$. Unadjusted direct comparisons suggested that the proportion of both infants' and caregivers' points to which the other responded was greater in the Rossel, Japan, and Canada settings compared to the Tzeltal, Yucatan, and Bali settings (all *p*s < .016), and greater in the Peruvian compared to the Yucatan setting ($p = .015$).

Infants accompanied on average 51% of their points with vocalizations. A one-factorial ANCOVA on the proportion of point-accompanying vocalizations revealed a significant effect of culture ($F(6, 77) = 3.26$, $p = .007$, partial $\eta^2 = .202$) and a positive relation with age $F(1, 77) = 10.78$, $p = .002$, partial $\eta^2 = .123$). Unadjusted post hoc comparisons (LSD) suggested that infants in Rossel accompanied more points with vocalizations than in all other groups (*p*s < .05) except for Canada, where they vocalized more than in Peru and Yucatan (*p*s < .017). Caregivers accompanied the majority of their points (88.8%) with vocalizations. There was a significant difference between cultures ($F(6, 85) = 3.97$, $p = .002$, partial $\eta^2 = .219$) suggesting that Yucatec Mayan caregivers accompanied fewer points with vocalizations (62.5%) compared to all other groups.

Other ways of gestural attention directing than the pointing we coded were absent in infants, and infrequent, idiosyncratic, and not culture-specific in caregivers. These included hand gestures with extended, wiggling fingers, hand waving to the objects, finger snapping next to objects, or an up and down moving index finger.

4. Discussion

We found evidence for infant pointing across all of the different cultures under investigation. All infants and caregivers used pointing in one and the same situation which afforded looking together at objects that were the same across all settings. In all settings the majority of infants and caregivers used the specific form of index-finger pointing. Index-finger pointing emerged in all cultures within the same age range as reported previously for Euro-American samples. Even the frequency of infants' pointing did not differ across cultures. The study provides the first coherent and systematic evidence of a universal form and usage of human gestural communication before language.

Previous research had questioned the universality of prelinguistic communication skills and means, alluding to vast cultural differences in socialization practices and the role of

social interaction in development (e.g., Gaskins, 2006; Göncü, Mistry, & Mosier, 2000; Masataka, 2003; Schieffelin & Ochs, 1986). However, many of these reports either did not directly address pointing or may have suffered from methodological problems in the scope and systematicity of the observations. Our method was presumably especially apt for eliciting pointing gestures. Pointing facilitates joint attention, and the test situation was modeled after naturally occurring formats of looking together at objects and events. Our study provided participants with a relatively natural context that induced pointing within minutes (for a direct comparison to a less point-inducing context of joint acting, see Puccini, Hassemer, Salomo, & Liszkowski, 2010). It may well be that the natural occurrence of this specific interaction format varies across cultures (Salomo & Liszkowski, 2010). A lower occurrence of such point-inducing formats in some cultures could make it more difficult to observe infant pointing, and possibly give rise to the impression of a relative absence of pointing compared to Euro-American cultural practices.

Although we compared caregiver–infant interactions in only a very limited set of cultures, and so any claims about universality must be treated with caution, the cultures were not only distinct in their geographic spread but also in other social, demographic, and economic aspects, thus making it unlikely that they presented a biased sample. For example, although socialization goals of independence versus interdependence seem to influence some of the early face-to-face interaction patterns among caregivers and infants (Keller, 2007), this variable did not affect the presence of infant pointing. Further, although urban and rural environments may certainly promote different socialization practices, this did not affect infant pointing either. Also the number of siblings varied substantially, for example, from 0 to 1 sibling in the Japanese sample to six or more siblings in the Yucatec Mayan sample, and the socioeconomic and educational levels were very different within and between nations and families (e.g., subsistence farming vs. industrialized societies). Further, qualitative (Brown, in press; Gaskins, 1999) and quantitative (Salomo & Liszkowski, 2010) differences in infant interactions in some of the field sites, or even the fact of being immersed in a naturally signing community (the Balinese field site) did not seem to impact the presence of pointing either. Finally, although lip-pointing is apparently widespread across the indigenous Americas (Enfield, 2009, p. 68), we did not observe it either in infants' or in caregivers' infant-directed pointing. Only one culture to date has been reported to lack index-finger pointing altogether among adult interactors (Barai speakers of Papua New Guinea; see Wilkins, 2003), but this report provides no empirical evidence and is based on personal communication with a missionary, who we were not able to trace. Other cultures have been reported to refrain from index-finger pointing (Hewes, 1996), often with regard to specific situations, like not pointing with the left hand (Kita & Essegbey, 2001), not pointing to the rainbow (Lee & Fraser, 2001, p. 28) or not pointing at people (a taboo common, e.g., in Europe, the Americas, Japan). But all of these taboos are explicitly represented in folk theories of conduct and politeness, which can only mean that the behavior must exist in the first place for it to be tabooed. Further, we would find it likely that infants under 1 year of age are generally exempted from pointing rules and taboos, although this has not been tested.

Although culture had no influence on infant pointing in the current context, there was a relation between infant and caregiver pointing that held even when controlled for infant age. This reveals a social function and usage of pointing between infants and caregivers from the beginning. The causality of this relationship is currently still unknown. It is a reasonable speculation that culture shapes infants' usage of pointing later in development, resulting in such things as taboos, culture-specific morphologies, or even culture-specific motives to point. But our data are also compatible with social origin accounts of pointing, in which pointing not only promotes but originates through social interaction (e.g., Werner & Kaplan, 1963). Most revealing in this respect are our findings from the temporal structure of pointing events. The majority of both caregivers' and infants' points were initiating, suggesting that participants were not simply mimicking each other. Despite an overall relation between caregiver and infant pointing, the initiating points were not related. Instead, however, there was a very strong positive relation between the numbers of points that followed into each other's points. These findings reveal an early conversational structure in prelinguistic gestural exchange and support the deeply social, communicative usage of pointing from early on. Regarding the directionality of this relation, infants appear to follow more often into caregivers' pointing than the other way around, suggesting that caregivers initially take the lead. This is supported by our finding that caregivers appear to increase pointing a few months before infants point (for a similar cross-sectional finding, see Lock et al., 1990). One possibility is that infants first begin to follow into the pointing of caregivers, who then follow into infants', leading to the temporally structured, shared activity of a gestural conversation.

Our study did not address finer grained age differences in the emergence of pointing across cultures. Differences in the quantity of point-eliciting interaction formats and gestural responsivity could well account for minor cultural variability in the onset of pointing. For example, a recent study shows that the time 8- to 15-month-olds spend in object-related social interaction differs systematically between Yucatec Mayan, Dutch, and Shanghai-Chinese infants and is predictive of infants' gesture use (Salomo & Liszkowski, 2010). Our data further suggest that parents interact and gesture in some cultures (e.g., Rossel) more than in others, with varying degrees of responsivity. While the causes of these quantitative differences are unknown, these findings could indicate some general social influence on the emergence of pointing, albeit not culture-specific, as our findings of main effects and a universal outcome must suggest.

Infants and caregivers coordinated their pointing and accompanied it with vocalizations, providing additional cues for a communicative usage of pointing. The integration of caregivers' pointing with the vocal modality in all the cultural settings provides further support for pointing as a stepping stone into language. The slight cultural differences in the extent of this integration, especially on behalf of infants, and a positive relation with age presumably reflect the ontogenetic primacy of pointing over multimodal communicative acts.

Communication is a complex and pervasive phenomenon of human cognitive and social life. Much research has investigated the uniqueness of language. Irrespective of the success or failure to provide direct, uncontested evidence for language-specific universals, there must be some universal form of communication to get language off the ground. Philosophical

analyses suggest that language usage is underlain by a specific intentional and cooperative structure of human communciation (Grice, 1957; Searle, 1969). Recent accounts of linguistic diversity and the origins of human communication argue and have provided some evidence for a universal ''stable engineering solution satisfying multiple design constraints'' (Evans & Levinson, 2009) or a ''social-cognitive and cooperative infrastructure'' (Tomasello, 2008) that forms the basis for language acquisition and usage. Although these claims are in theory modality-unspecific, some researchers have specifically argued for gestural origins of language, alluding to intriguing phylogenetic, ontogenetic, and neuroscientific evidence (e.g., Arbib, 2005; Armstrong & Wilcox, 2007; Call & Tomasello, 2007; Capirci, Contaldo, Caselli, & Volterra, 2005; Corballis, 2002; Tomasello, 2008). In support of these approaches the current study demonstrates a language-independent gestural universal of human communication in the quotidian prelinguistic act of infant pointing.

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