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Places and postures: A cross-cultural comparison of sitting in 5-month-olds

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Abstract

Motor development—traditionally described in terms of age-related stages—is typically studied in the laboratory with participants of Western European descent. Cross-cultural studies typically focus on group differences in age-related stages relative to Western norms. We adopted a less traditional approach: We observed 5-month-olds and their mothers from six cultural groups around the world during one hour at home while they engaged in natural daily activities. We examined group differences in infants' sitting proficiency, everyday opportunities to practice sitting, the surfaces on which sitting took place, and mothers' proximity to sitting infants. Infants had opportunities to practice sitting in varied contexts—including ground, infant chairs, and raised surfaces. Proficiency varied considerably within and between cultural groups: 64% of the sample sat only with support from mother or furniture and 36% sat independently. Some infants sat unsupported for 20+ minutes, in some cases so securely that mothers moved beyond arms' reach of their infants even while infants sat on raised surfaces. Our observations of infant sitting across cultures provide new insights into the striking range of ability, varied opportunities for practice, and contextual factors that influence the proficiency of infant motor skills.

Keywords

sitting; infants; motor development; cross-cultural

Motor development—perhaps more than any other area of developmental science—falls victim to assumptions of universality (Adolph, Karasik, & Tamis-LeMonda, 2010a; Adolph & Robinson, 2015; Karasik, Adolph, Tamis-LeMonda, & Bornstein, 2010). Children are expected to display postural, manual, and locomotor skills in an invariant sequence regardless of cultural or contextual influences. This assumption can be traced to the standardization of motor skills in the 1930s and 1940s. Based on observations from homogeneous samples of U.S. middle-class infants of European descent, Shirley (1931),

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McGraw (1945), and Gesell (1946) identified a series of motor accomplishments during infants' first two postnatal years and established a corresponding set of developmental norms. These motor skills became standard items on screening tests, and the norms provided the basis for developmental assessment tools, including the Bayley (1969, 1993), AIMS (Piper & Darrah, 1994), and Denver (Frankenburg, Dodds, Archer, Bresnick, et al., 1992; Frankenburg & Dodds, 1967) scales of motor development. In fact, the classic motor milestone chart with accompanying onset ages has become the gold standard of motor development and is prominently displayed in developmental textbooks, pediatrician's offices, and parenting books. Infants from other cultures are typically described as "precocious" or "delayed" relative to norms established with Western infants (Adolph & Robinson, 2015; Werner, 1972, for review).

Contemporary developmental science has come a long way since the standardization of motor skills. Researchers today focus on the *proficiency* of infants' skills at sitting, crawling, and walking and the *adaptability* of their actions in response to local conditions. For example, infants' postural sway and limit of stability reveal proficiency at keeping balance in a sitting position (Harbourne & Stergiou, 2003; Woollacott, 1986), and gait characteristics reflect speed, amplitude, and consistency of movements while crawling or walking (Hallemans, De Clercq, Otten, & Aerts, 2005; Ivanenko, Dominici, Cappellini, & Lacquaniti, 2005; Patrick, Noah, & Yang, 2009). Adaptability is assessed by infants' ability to select and modify actions to navigate slopes, cliffs, and other obstacles or to cope with changes in their bodies induced by carrying loads or wearing platform or slippery-soled shoes (Adolph, 1997; Adolph & Avolio, 2000; Adolph, Karasik, & Tamis-LeMonda, 2010b; Cole, Gill, Vereijken, & Adolph, in press; Kretch & Adolph, 2013). This work highlights the striking intra- and inter-individual variability that characterizes motor development in infants of the same age, as first described by the early pioneers yet soon overshadowed by the focus on developmental norms (Adolph, Cole, & Vereijken, in press).

Across contemporary research studies (Adolph & Robinson, 2015), the primary predictor of individual differences in infant motor skills is experience, defined as the number of days between skill onset age and test date. Days of experience predict infants' ability to control posture and to make adaptive decisions for action in sitting, crawling, and walking (Adolph & Robinson, 2015). But, experience so defined is not an explanatory mechanism: What is missing in studies of motor development is a description of infants' everyday opportunities to practice specific skills in *natural contexts* (Adolph et al., 2012; Adolph & Robinson, 2015).

Cross-Cultural Research on Sitting

Like most research on motor development, research on infant sitting falls prey to over-reliance on estimates of onset ages and lack of focus on infants' natural opportunities to practice sitting. To establish onset ages, researchers rely on maternal reports or elicit sitting in the laboratory; both methods use an arbitrary "pass/fail" criterion such as 5, 10, or 30 seconds of sitting with or without support (Adolph, 2000; Fishkind & Haley, 1986; Wijnhoven et al., 2004). However, reliance on onset ages obscures the day-to-day variability of infant skills in natural settings (Adolph, Robinson, Young, & Gill-Alvarez, 2008), such as

how long infants typically sit and under what conditions. Moreover, the contextual opportunities for sitting are ignored.

Cross-cultural research offers a unique window into inter-individual variability in sitting skills and the social contexts of infant sitting. Early cross-cultural studies documented variability in sitting onset ages by assessing group differences relative to Western norms. Infants in some African and Caribbean cultures showed accelerated onset ages relative to Western infants (Brazelton, 1973; Capute, Shapiro, Palmer, Ross, & Wachtel, 1985; Hopkins & Westra, 1989, 1990; Iloeje, Obiekwe, & Kaine, 1991; Keefer, Tronick, Dixon, & Brazelton, 1982; Kilbride, Robbins, & Kilbride, 1970; Leiderman, Babu, Kagia, Kraemer, & Leiderman, 1973; Lohaus, et al., 2011; Vierhaus et al., 2011). Whereas Western norms report that 25% of infants achieve independent sitting by 5.5 months and 90% by 7 months (Frankenburg, Dodds, Archer, Shapiro, & Bresnick, 1992), infants in Uganda sat independently at 4 months (Geber & Dean, 1957) and infants from the West Indies sat at 5 months (Hopkins & Westra, 1989); sitting was delayed by months for infants in Brazil (Lopes, de Lima, & Tudella, 2009), Taiwan (Wu et al., 2008), and Japan (Ooki, 2006) relative to Western norms. A cross-cultural investigation by the World Health Organization (Martorell et al., 2006) indicated that infants from India, Ghana, Norway, Oman and the United States sat, on average, at 5.9 months, but sitting onset ages ranged from 3.8 months (1^{st} percentile) to 9.2 months (99^{th} percentile).

In terms of social context, motor skills emerge in the natural settings of infants' lives. For example, cross-cultural differences in sitting onset ages are linked with differences in childrearing practices (e.g., Bril & Sabatier, 1986; Hopkins & Westra, 1990; Lohaus et al., 2011; Super, 1976; Vierhaus et al., 2011). Augmentation of infants' movements can facilitate the acquisition of sitting. Jamaican infants whose mothers massaged and exercised their limbs and put them into sitting positions sat at earlier ages than did Jamaican infants whose mothers did not engage in these practices (Hopkins & Westra, 1990).

Striking variability in onset ages across different cultural groups begs for examination of the range of proficiency in infant sitting skills and contextual factors that influence the development of those skills. However, cross-cultural research continues to compare infants on onset ages or against standardized Western norms and consequently describes infants as "precocious" or "delayed" (Adolph & Robinson, 2015; Werner, 1972, for review) despite the limited value of standard methods of motor assessment for non-Western children (e.g., Lohaus et al., 2011; Vierhaus et al., 2011). Naturalistic contexts of everyday life can determine the opportunities infants have to practice specific motor skills, which in turn, have implications for when skills emerge and the proficiency of infants' skills.

Current Study

Here, we move beyond onset ages and standardized norms to consider infants' sitting skill and practice with sitting in an everyday home setting. Sitting, one of the most important skills in early infancy is associated with advanced forms of object exploration and facilitates infants' perception and cognition (Kretch, Franchak, & Adolph, 2014; Soska, Adolph, & Johnson, 2010). Rather than reforming developmental norms, which would require a large

representative sample, this demonstration study analyzed naturalistic observations from targeted samples. We considered the everyday opportunities for infants to practice sitting, infants' sitting proficiency, and the surfaces on which sitting takes place (e.g., strapped in a baby chair with postural support or on the floor dealing with challenges of maintaining balance).

We had three aims. First, we describe and compare the relative prevalence and proficiency of independent sitting in 5-month-olds from six cultural communities around the world during everyday routines at home. Rather than limiting sitting skill to a dichotomous measure of absence/presence, we report skill proficiency based on the duration of infants' natural bouts of sitting. In typical laboratory studies of proficiency, sitting bouts end when infant topple over, when an experimenter repositions infants into another posture, or when infants spontaneously transition from sitting into a prone posture. However, previous work cannot speak to how sitting bouts end in the course of everyday life. Spontaneous transitions would suggest greater proficiency than falling. Second, we characterize natural opportunities for sitting by calculating the time infants spend in supported and unsupported sitting positions, thus moving beyond the laboratory standard of eliciting independent sitting with a 10- or 30-second criterion. In principle, prior to independent sitting, infants can practice sitting for extended periods with various supports (e.g., in specialized furniture, in mother's arms, propped on their hands in a "tripod" position). Thus, our third aim was to describe the context of sitting in terms of the various surfaces on which infants sat and mothers' location relative to their sitting infants.

We focused on 5-month-olds because, according to Western developmental norms, most infants do not yet sit independently but begin to sit in the coming months. On the WHO standards (Martorell et al., 2006), fewer than 25% of infants sit independently at 5 months. Because infants are still unable to sit independently, their placement and postures largely depend on opportunities provided by their caregivers.

Methods

Participants and Procedure

Video records of 72 mother-infant pairs, 12 dyads from each of six countries (Argentina, Cameroon, Italy, Kenya, South Korea, and the U.S.) were randomly selected from a large archival dataset (Bornstein, Putnick, Suwalsky, & Park, 2014.). We aimed to maximize inter-group variability by including families from urban and rural settings and industrialized and developing nations. South Korean and U.S. families were recruited from metropolitan areas (Seoul, Washington DC). Argentinian families were from a rural indigenous (Mestizos) population from the outskirts of Córdoba. Nso infants (the largest ethnic group in Cameroon) included both rural and urban communities. The sample from South Italy was from a farming community. Kenyan families from the Kamba tribe were from the Bantu region, from both rural and urban areas.

All infants were firstborn, healthy, and born at term. Infants averaged 5 months (+/− 1 week) at the time of observation. Approximately equal numbers of girls and boys were recruited from each country (33 boys and 39 girls). The average age of mothers was 25 years (*SD* =

4.79). Table 1 presents sociodemographic characteristics of infants and mothers in the six cultures.

A researcher local to the host culture video recorded mother-infant pairs for 1 hour in the natural setting of their homes at a time most convenient for families. Mother-infant pairs were unrestricted in terms of where they could be in their homes. In fact, many dyads across the culture groups spent time outside of their home (i.e., in the yard) during the observation hour. During observations, the researcher remained in the background and interacted minimally with infants and mothers. Mothers were told that the purpose of the study was to document infants' daily routines and were instructed to go about their normal activities. Mothers were unaware that infants' placement or postures would be the focus of study. After the observation, mothers reported that they were comfortable during the observation and rated their behaviors and their infants' behaviors to be typical (Bornstein et al., 2014).

Coding Places and Postures

Behavioral data were coded from video files using a computerized video coding system, Datavyu (www.Datavyu.org) that records the frequencies and durations of specific behaviors. A primary coder scored every variable. A second coder scored 30% of the data to ensure inter-rater reliability. Inter-rater reliability on categorical measures ranged from 95.1% to 99.5% and κs ranged from .80 to .98 (*p*s < .001). The correlation between primary and reliability coders for durations was .96 ($p < .001$). Disagreements between coders were resolved through discussion.

Video files were coded in separate passes. In the first pass, coders accounted for every video frame reflecting 4 types of places where mothers situated their sitting infants: *ground* (foot area of a residence or outside space), *adult furniture* (furnishing that is several feet off the ground, such as couch, bed, stool, table), *child furniture* (furnishing designed to support infants' posture and limit independent movement such as a belted highchair or stroller, or makeshift baby gear such as a cardboard box lined with towels), or held in mothers' *arms* (completely supporting infants' posture and limbs). Infants' body contact with the surface of support (i.e., ground, furniture, mother) denoted the onset; interrupted contact with the supporting surface for 1 s or more signaled offset.

In a second pass, coders scored two types of infants' sitting positions: *sitting independently* (infants' bottom resting on a flat surface with torso upright without external support) and *sitting with support* (infants' bottom resting on a flat surface with torso held upright with aid of external support of adults' arms or furniture). Coders also counted "tripod" sitting (infants' back inclined 45° forward, balance supported on infants' hands). By definition, child furniture and mothers' arms fully support infants' posture and limbs; thus, infants could not demonstrate independent sitting when placed in child furniture or when held in mothers' arms. When on the ground or on adult furniture, infants could demonstrate independent sitting without support or sitting with support (e.g., sitting on the flat surface while resting against cushioning or supported by mothers' hands). The onset of a sitting bout marked the video frame when infants were first placed into a sitting position. The offset of a sitting bout marked the video frame when infants began transitioning out of sitting. To count as a separate sitting bout, infants had to maintain the sitting posture for at least 1 s. Figure 1

illustrates infant sitting across the 4 places found around the home. The coders also noted how sitting bouts ended: *fall* (loss of balance forward, backward or sideways with torso contacting the floor or mothers' rescuing arms), *transition* (controlled movement from a sitting posture to prone), or *mother* (mothers repositioned infants).

In a third pass, coders examined whether sitting infants were out of their mothers' reach and for how long. We coded the duration of time mothers were *proximal* (within arms' reach of infants) and *distal* (out of reach) while infants were in supported and independent sitting positions.

Infant Sitting

Although laboratory assessments and standardized tests suggested that tripod sitting would be prevalent, tripod sitting constituted only 0.9% of all postural bouts in the dataset, with most bouts limited to 1 U.S. infant, who leaned onto his hands to play with toys and who also demonstrated multiple bouts of independent sitting. Thus, it appears that mothers across our sample did not put their pre-sitting infants into a sitting position without external supports for balance. None of the infants independently transitioned into a sitting position from a prone or supine position, so mothers decided when infants should sit up. None of the infants demonstrated independent mobility (e.g., crawling, cruising), so their experience with surfaces depended on mothers' decisions about placements. Because of its low frequency, tripod sitting was not considered in the subsequent analyses of independent and supported sitting.

Infants were classified as *sitters* if they demonstrated independent sitting for at least 1 s at least once during the 1-hour observation. Frequencies of both supported and independent sitting bouts were tallied to obtain an accumulated *number of sit bouts* over the session. *Accumulated time sitting* with support and sitting independently indicated the total amount of time infants spent sitting upright over the entire session. *Proficiency of independent sitting* was computed by considering the longest bout of independent sitting. We differentiated the longest single bout of independent sitting from accumulated sitting time to establish the extent of infants' sitting proficiency. Accumulated time in sitting due to shorter sitting bouts (e.g., 10 bouts of 30 s would yield 5 min of accumulated sitting time) is not the same as a protracted period of sitting (e.g., 1 bout of 5 min).

Results

Moving Beyond Onset Ages: Sitting at 5 months

Independent Sitting—In the context of everyday naturalistic interactions, mothers placed infants in a sitting position and infants sometimes sat independently. In fact, 36% of infants (n = 26) demonstrated independent sitting at least once during the observation.

The number of independent sitters varied across the six culture groups, $\chi 2(5) = 32.27$, $p < .001$ (Figure 2). Only 2 (17%) U.S. infants, 2 (17%) South Korean infants, and 3 (25%) Argentinian infants demonstrated independent sitting. None of the Italian infants displayed independent sitting. In contrast, 8 (67%) Kenyan infants and 11 Cameroonian infants (92% of Cameroon sample) demonstrated independent sitting (Table 2).

Proficiency of independent sitting—Sitting proficiency—the longest bout of independent sitting—ranged from 2.4 s to 28 min (*M* = 7.72 min, *SD* = 8.32). All but one infant labeled as an independent sitter demonstrated sitting bouts of 5 s or more, aligning with lab-based definitions of sitting. Figure 2 shows the enormous variation in sitting proficiency within and across cultural groups. Although only 2 U.S. infants demonstrated independent sitting, one infant sat for about 1 min (57 s) and one infant sat for almost 5 min. Kenyan and Cameroonian infants showed the most variability. One Kenyan infant exhibited one of the shortest bouts of independent sitting (5.40 s) of all 26 independent sitters; another Kenyan infant exhibited one of the longest bouts in the sample (25.37 min). Cameroonian infants matched Kenyan infants in sitting proficiency, and included the infant whose sitting bout approached half of the observation period (27.79 min).

How bouts ended—Infants rarely fell while in a supported sitting position. Most supported bouts ended with mothers changing infants' position (96%). Independent sitting bouts had more heterogeneous endings: 55% ended when mothers lifted infants into a new position, 34% ended when infants fell, and 10% ended when infants spontaneously transitioned from sitting to prone.

Opportunities for Sitting

Accumulated time—All infants had experience sitting upright. Over the observation hour, infants spent about one-third of their time in a sitting posture (*M* = 19.50 min, *SD* = 15.37), and most of that time was spent in a supported sitting posture (*M* = 13.28 min, *SD* = 10.87). Supported sitting time did not differ for sitters and non-sitters. However, the 26 infants who displayed independent sitting averaged an *additional* 17.22 min of independent sitting (*SD* = 15.64) accumulated over the session. Therefore, overall accumulated sitting time was longer for sitters (*M* = 28.54 min, *SD* = 16.09) compared to non-sitters (*M* = 14.39 min, *SD* = 12.56), $t(70) = 4.16$, $p < .001$.

Opportunities for sitting varied widely across the sample. Accumulated sitting duration (with and without support) ranged from 30 s for one infant to 52 min—nearly the entire session—for another infant. Accumulated duration of independent sitting ranged from approximately 30 s (4 infants) to over 30 min (4 infants) paralleling the findings above on sitting proficiency. The time that infants were not in a sitting position was spent lying, usually on their backs.

Time spent in accumulated sitting differed by culture group. Italian infants spent the least amount of time sitting upright (*M* = 7.68 min, *SD* = 4.71), whereas Kenyan and Cameroonian infants spent the most amount of time in an upright posture (*M*s = 25.19, 33.45 min and *SD*s = 19.21, 12.80, respectively). Infants from United States, South Korea, and Argentina were comparable on their accumulated sitting duration (*M*s = 17.06, 13.73, 19.89 min and *SD*s = 10.16, 11.41, 17.16, respectively).

U.S., South Korean, Argentinian, and Italian infants spent more time in supported sitting (*M*s = 15.23, 11.92, 19.72, 7.68 min and *SD*s = 7.88, 10.58, 17.02, 4.71, respectively) than unsupported sitting (*M*s = 1.82, 1.81, 0.17, 0 min and *SD*s = 5.97, 5.28, 0.48, 0, respectively), whereas Kenyan and Cameroonian infants spent equivalent times in supported

(*M*s = 12.50, 12.63 min and *SD*s = 6.92, 11.93, respectively) and unsupported sitting (*M*s = 12.69, 20.82 min and *SD*s = 18.31, 14.25, respectively). A 6(group) × 2(sit type: independent and supported) mixed-measures ANOVA on duration of sitting confirmed the main effect for sitting duration, $F(5, 66) = 5.40$, $p < .001$, partial $\eta^2 = .29$; sitting type, $F(1, 66) = 14.62$, $p < .01$, partial $\eta^2 = .18$; and Group by Sit type interaction, $F(5, 66) = 4.80$, $p < .01$, partial $\eta^2 = .27$. Post-hoc, Sidak-corrected pairwise comparisons confirmed these differences, *p*s < .05.

Sitting bouts—Sitting episodes were brief and distributed over time. The frequency of bouts of supported and independent sitting ranged from 2 to 62 (*M* =15.07 bouts, *SD* =12.79).

Not surprising, independent sitters had more sitting bouts overall (*M* = 25.31 bouts, *SD* = 15.40) than did non-sitters (*M* = 9.28, *SD* = 5.60), $t(70) = 6.38$, $p < .001$, even when comparing only supported sitting bouts (*Ms* = 18.42 and 9.28, *SDs* = 11.76 and 5.60, for sitters and non-sitters respectively), $t(70) = 4.47$, $p < .001$. All culture groups were comparable on the number of sitting bouts except for Kenya. Kenyan infants accumulated 27.42 (*SD* = 14.49) bouts of independent and supported sitting, which is double that of the other groups (*M*s = 11.33, 12.92, 11.58, 7.83, 19.33 and *SD*s = 8.40, 14.16, 9.81, 4.64, 13.39, for U.S., South Korea, Argentina, Italy, and Cameroon, respectively), $F(5, 66) = 4.69$, $p < .01$.

Most supported sitting bouts were short: 77% of supported sitting bouts lasted less than 1 min, with no differences between sitters and non-sitters. In contrast, 40% of independent sitting bouts were 1 min or *longer* and 10% of independent sitting bouts were over 7 min. Although non-sitters had opportunities to sit while supported, their mothers left them in a supported sitting position for brief periods; therefore, the bouts of sitting seen in non-sitters never reached the durations seen for independent sitters.

Contexts of Sitting

Although infants had opportunities to spend time in all 4 places, only 17% of infants spent time on the ground, adult and child furniture, and in mothers' arms. Of their observation hour, approximately one-third was spent in mothers' arms (*M* = 22.63 min, *SD* = 10.68; ranging from *M* = 15.21 min for Argentinians to *M* = 28.51 min for Italians).

Places infants sit—Infants sat on many surfaces, enabling them to practice postural control across different contexts. Where mothers situated their infants for sitting differed by group (Figure 3). Infants from U.S., Argentina, South Korea, and Italy spent most of their sitting time in places that offered postural support: child furniture for U.S. (*M* = 9.77 min, *SD* = 7.60) and Argentinian infants (*M* = 14.45 min, *SD* = 16.01); and mothers' arms for South Korean (*M* = 6.61 min in arms, *SD* = 5.20) and Italian infants (*M* = 5.76 min in arms, *SD* = 3.70). In contrast, infants from Kenya and Cameroon spent most of their sitting time in places that offered little postural support, requiring infants to manage the challenges of gravity to stay upright. Kenyan infants spent most of their sitting time on the ground (*M* = 12.16 min, *SD* = 16.11) and Cameroonian infants spent most of their sitting time on adult

furniture (*M* = 13.14 min, *SD* = 14.66). These differences were confirmed by a Group × Place interaction, $F(15, 198) = 3.72$, $p < .001$.

Places and types of sitting—Infants across the six groups differed in where they sat when supported and unsupported, as revealed in the 3-way interaction, $F(15,198) = 3.94$ $p < .001$. Of the 26 sitters, infants from the U.S., South Korea, and Kenya sat unsupported on the floor (*M* = 10.98, 10.87, and 16.18 min, *SD*s = 13.82, 10.46, 17.34) rather than on adult furniture (*M*s = 0, 0, and 2.81 min, for U.S., South Korea, and Kenya, respectively). Argentinian and Cameroonian infants divided their independent sitting time between the ground and adult furniture. The three sitters from Argentina, on average, spent 0.13 min (*SD* = 0.23) sitting on the ground and 0.56 min (*SD* = 0.94) sitting on adult furniture. In comparison, the 11 Cameroonian independent sitters, on average, spent 9.29 min (*SD* = 16.05) sitting on the ground and 13.17 min (*SD* = 14.0) sitting on adult furniture. Compared to independent sitting on the ground, sitting on adult furniture is potentially more challenging and the consequences of falling are more severe.

The places where mothers situated their infants were related to infants' sitting proficiency, controlling for maternal age and education. Mothers who placed their infants on the ground, floor, or adult furniture had infants who demonstrated the longest bouts of independent sitting, $r(23) = .86$, $p < .001$.

Mothers' location—Mothers' willingness to leave their sitting infants on adult furniture was related to infants' sitting skill. For the 26 sitters, the more proficient the sitter, the longer mothers tended to stay out of reach of their sitting infants, $r(26) = .34$, $p = .05$. These results were not carried by one or two mothers; 10 of 26 mothers (38%) of sitters spent time out of their infants' reach while infants sat independently on adult furniture.

The differences in mothers' location were most pronounced for infants in Cameroon and Kenya. When Cameroonian infants were sitting independently on high adult furniture, their mothers were just as likely to be near their infants (51% of time sitting independently on adult furniture) as out of reach of their infants (49% of time).

Kenyan mothers maintained comparable distances from their infants: When their infants sat independently on adult furniture, mothers spent 38% of the time away and 62% of the time near their infants. In fact, one Kenyan mother spent a stretch of 13 minutes away from her infant as he sat independently on adult furniture: This infant was one of the more proficient sitters (17.4 min of sitting in a single bout). In contrast, when infants of other cultural communities were placed sitting independently or supported on adult furniture, mothers hovered near their infants (100%, 100%, 91%, and 78% of sitting time for U.S., South Korea, Argentina, and Italy, respectively).

Discussion

The study of motor development has been limited in terms of *how* motor skills are depicted, *where* motor development is studied, and *who* is studied. Previous work has been confined largely to the study of Western, White, middle-class populations in laboratory settings.

Based on laboratory research on sitting proficiency, we would expect infants to sit for short periods, with bouts ending in falls or transitions to prone. Cross-cultural research—studies involving the other 95% of the population (Henrich, Heine, & Norenzayan, 2010)—is limited primarily to comparisons of milestone onset ages to Western norms. The implementation of these limited methods has led to a gross misrepresentation of motor development (Adolph et al., 2010a; Adolph & Robinson, 2015).

How: Conceptualizing Sitting Skill

Here, rather than focusing on onset ages and imposing arbitrary criteria for success, we focused on variability in infants' sitting proficiency. At 5 months, approximately one third of infants sat independently, with 92% of infants in Cameroon and 67% of infants in Kenya being independent sitters. These findings align with the accelerated sitting onset ages observed in some African and Caribbean cultures (e.g., Adolph et al., 2010a, for review; Hopkins & Westra, 1990). However, unlike other researchers (e.g., Keller, Yovsi, & Voelker, 2002; Lamm, Keller, Yovsi, & Chaudhary, 2008; Carra, Lavelli, Keller, & Kartner, 2013), we did not collect data on parental expectations or specific childrearing practices outside the observation hour.

We also found considerable overlap in sitting proficiency across the six cultures: Approximately half of the independent sitting bouts in each sample were under 10 minutes. Ranges of sitting were most pronounced in the Kenyan and Cameroonian samples. Infants' sitting bouts ranged from a few seconds to half of the observation period. Some U.S. infants sat longer than some of the Kenyan and Cameroonian infants. These ranges highlight a frequent misattribution in comparative studies. Cultures cannot be characterized as uniformly "advanced" or "delayed"; rather, within-group variability nearly always surpasses between-group differences. In addition to the between-group differences, variability within-groups was striking.

The upper range in the duration of single sitting bouts is particularly remarkable because in the laboratory when researchers attempt to elicit sitting, they typically adopt a 5-second, 10-second, or 30-second criterion to demonstrate sitting ability (McGraw, 1945; Fishkind & Haley, 1986; Martorell et al., 2006). At home, in the context of spontaneous activity, one infant sat for almost half an hour in a single episode of uninterrupted independent sitting.

Sitting for extended periods might have far-reaching implications for developing skills in other domains. While sitting upright, the infants' world comes into view (Kretch et al., 2014), allowing them to visually scan interesting objects and people. While sitting independently, infants' hands are freed from supportive functions to explore objects and interact with caregivers. Sitting for prolonged periods provides ample opportunity to explore and learn about objects. In fact, independent sitters are more likely to demonstrate more advanced object manipulation skills and better performance on a 3D object completion task compared to non-sitters (Soska et al., 2010). Long-term effects, beyond infancy, have been documented: Motor-exploratory behaviors in infancy predicted cognitive function in childhood and academic achievement in adolescence (Bornstein, Hahn, & Suwalsky, 2013).

Where: Sitting in Natural Settings

The study of motor development is typically confined to the laboratory. In contrast, we observed infants' spontaneous real-time experiences with sitting in the home. Cultural routines and expectations about the ages at which infants should display various skills guide caregivers' childrearing practices including when and how to allow infants to practice skills, and what is safe and appropriate for infants to do (Carra, Lavelli, Keller, & Kartner, 2013; Carra, Lavelli, & Keller, 2014). Caregivers determine opportunities for sitting; they situate infants in certain places (stroller or dirt floor) and place them in particular postures (lying or sitting), thereby restricting or broadening infants' opportunities to practice sitting. Caregivers rarely leave pre-sitters in a tripod position, and they—not infants—most frequently decide when sitting bouts should end.

Infants had extensive experiences with sitting across a variety of places—floor, infant and adult furniture, mothers' arms. These surfaces provided different constraints on balance and offered different opportunities for learning. For example, although independent sitting occurred on the ground or floor and adult furniture, the consequences of keeping balance on these two surfaces differ. When sitting independently, there is a possibility of falling, but falling from high adult furniture has potentially dire consequences. Thus, sitting independently or while supported on adult furniture provides a more demanding learning context than sitting on the floor, strapped into infant furniture, or in mothers' arms.

We found no group differences in infants spending time in mothers' arms, although others have shown that mothers from West Africa spend more time in body contact with their infants than do mothers from Italy (e.g., Carra et al., 2013; Carra et al., 2014). Infants across the six cultures, on average, spent one third of the observation hour held in mothers' arms. It is possible that while in mothers' arms engaging in typical daily activities (i.e., face-to-face interactions, grooming, feeding, carrying), infants experience forms of handling that may emphasize different postural positions (Bril & Sabatier, 1986; Lamm et al., 2008) and may in turn affect development of various skills. For example, when in body contact, West African mothers showed longer durations of rhythmic motor behaviors by repeatedly shaking or moving infants' bodies than Italian mothers (Carra et al., 2014). Future investigations of the different postural positions and activities that mothers engage in while holding their infants would shed light on whether and how patterns of holding relate to infant sitting.

These findings challenge current definitions of sitting. Why is sitting on the floor with legs outstretched (termed "long sit" or "v-sit") considered the benchmark of independent sitting? Infants have opportunities to practice sitting on many surfaces under varying balance constraints. Yet, sitting on a high surface, which poses more risk and potentially requires more balance control, is not assessed on standard developmental screening tests. Similarly, the "short sit," with legs bent over the edge of a chair or bench, "w-sitting" with legs bent backward at the knee, deep crouching with buttocks near heels, and other forms of sitting that are prevalent in many cultures (Hewes, 1955) are missing from most assessment tests. Indeed, the short sit is the most prevalent form of sitting among Western children and adults, and many older children and adults cannot perform the "long sit" that typifies sitting on Western assessment instruments for infants.

Who: Sitting Across Cultures

What is known about motor development, similar to other areas of psychology, is predominantly based on infants from Western countries, which precludes a full appreciation of social and cultural influences (Bornstein, 2010; Bornstein et al., 2014; Tomlinson, Bornstein, Marlow, & Swartz, 2014). The few cross-cultural studies of infant motor development are limited to group comparisons of onset ages (e.g., Hopkins & Westra, 1990). Cross-cultural studies of natural, everyday experiences with motor action are rare.

Our observations of infant sitting across six cultural groups uncovered possibilities in human development previously unimagined. In terms of sitting proficiency, half-hour sitting bouts could only be documented with an eye toward cultural variability. In terms of where infants sit, the common mandate is for 5-month-olds to be strapped into infant seats or held in mothers' arms. Most U.S. parents, pediatricians, and even researchers could not imagine leaving an infant seated unattended on a high bed or bench. Our culture promotes implicit expectations that mothers should be nearby when infants are sitting independently. This was indeed the case for infants from the U.S., South Korea, Argentina, and Italy. However, mothers from Kenya and Cameroon spent substantial time out of the vicinity of their sitting infants. One of the most proficient sitters in the Cameroonian sample demonstrated a bout of independent sitting that lasted 28 min. At the start of the visit, her mother sat on the bench nearby and periodically glanced over and smiled/vocalized to her infant. On several occasions she left the room for minutes at a time. Upon her return, she casually checked in with her infant and continued her work. The routine of mother leaving and reuniting with her infant lasted the entire half hour; all the while the infant contentedly remained seated without falling out of her sitting posture. This finding was not due to lack of care for infants' safety. In fact, none of the infants who sat independently on adult furniture experienced a fall.

Conclusions

Conclusions about the bounds of infant motor development are the product of our methods —whom we study, where we conduct studies, and how we assess developmental changes in skills. Had we not looked beyond onset ages, ventured outside the laboratory, and studied samples of infants from six cultures across the globe, we would never have known that at 5 months, some infants can safely sit on high benches for extended periods without the support of adults nearby. The sort of phenomena we observed could only be revealed through the lens of cross-cultural inquiry and the use of ecologically valid methods and measures.

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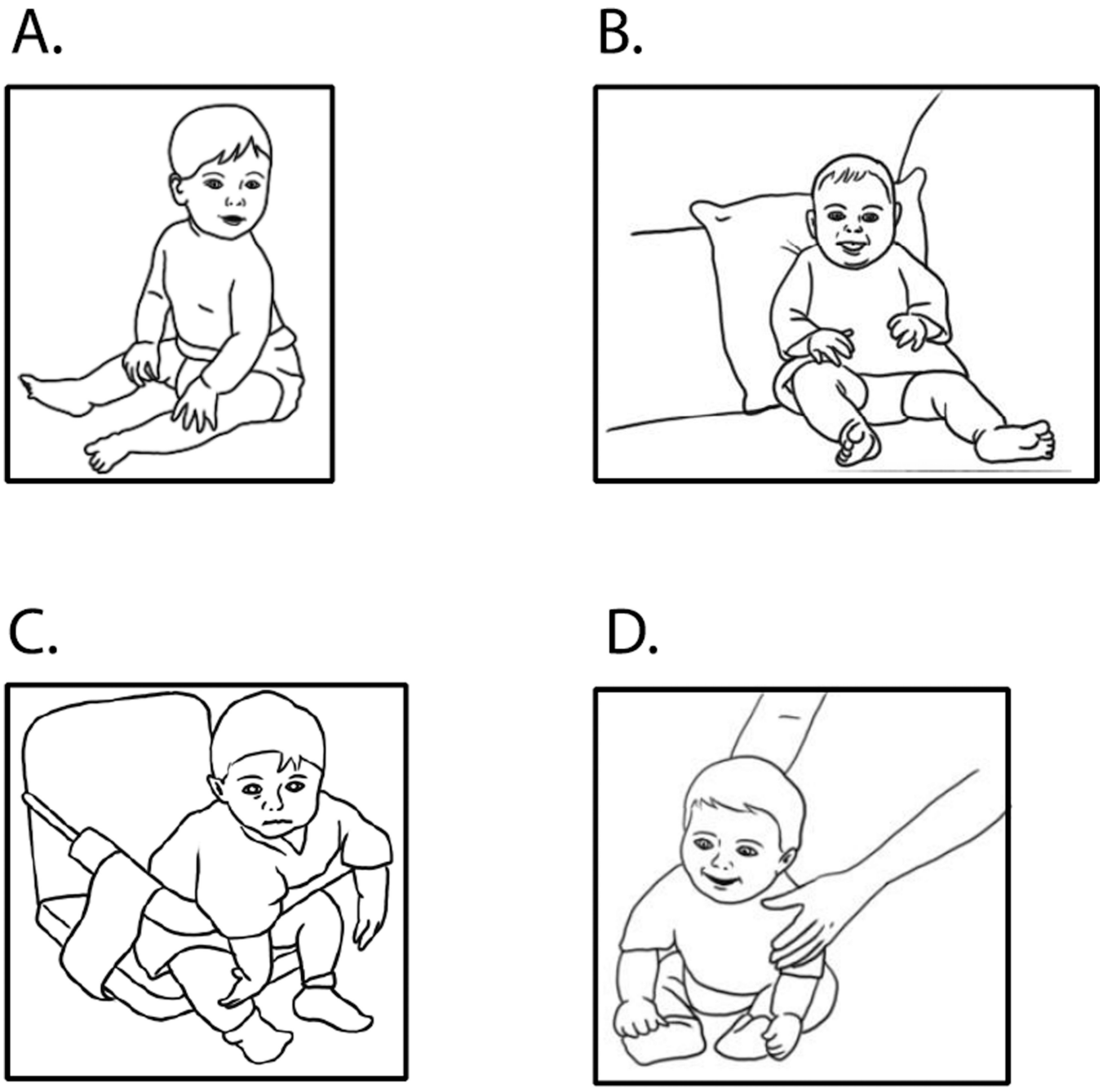

Figure 1.

Line drawings from video files illustrating 4 types of places where mothers situated their infants for sitting. (A) Infant sitting on the ground or floor of residence; (B) infant sitting on adult furniture several feet from the floor; (C) infant sitting in child furniture, which supports the body and posture; and (D) infant sitting supported in mother's arms.

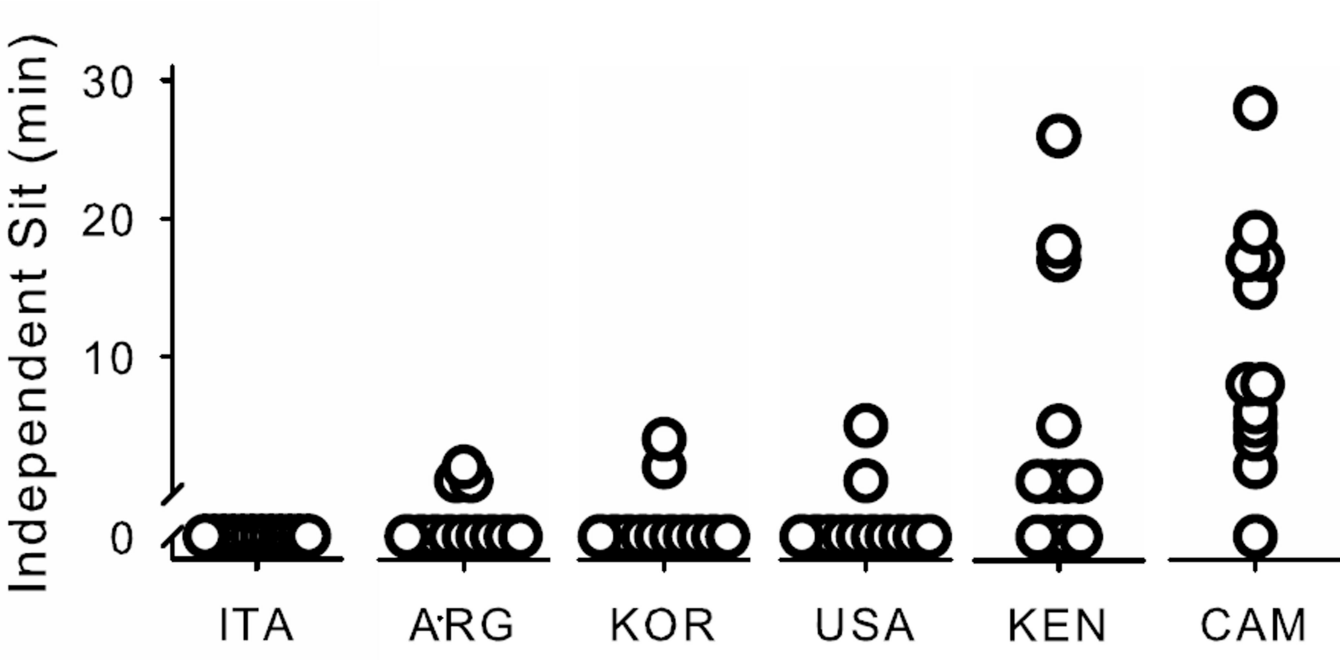

Figure 2.

Proficiency of independent sitting as measured by the longest single bout of sitting (in min) for infants in Argentina (ARG), Cameroon (CAM), Italy (ITA), Kenya (KEN), South Korea (KOR), and United States (USA). Symbols represent individual infants who demonstrated independent sitting during the session. Broken y-axis highlights the infants at 0 who never sat independently.

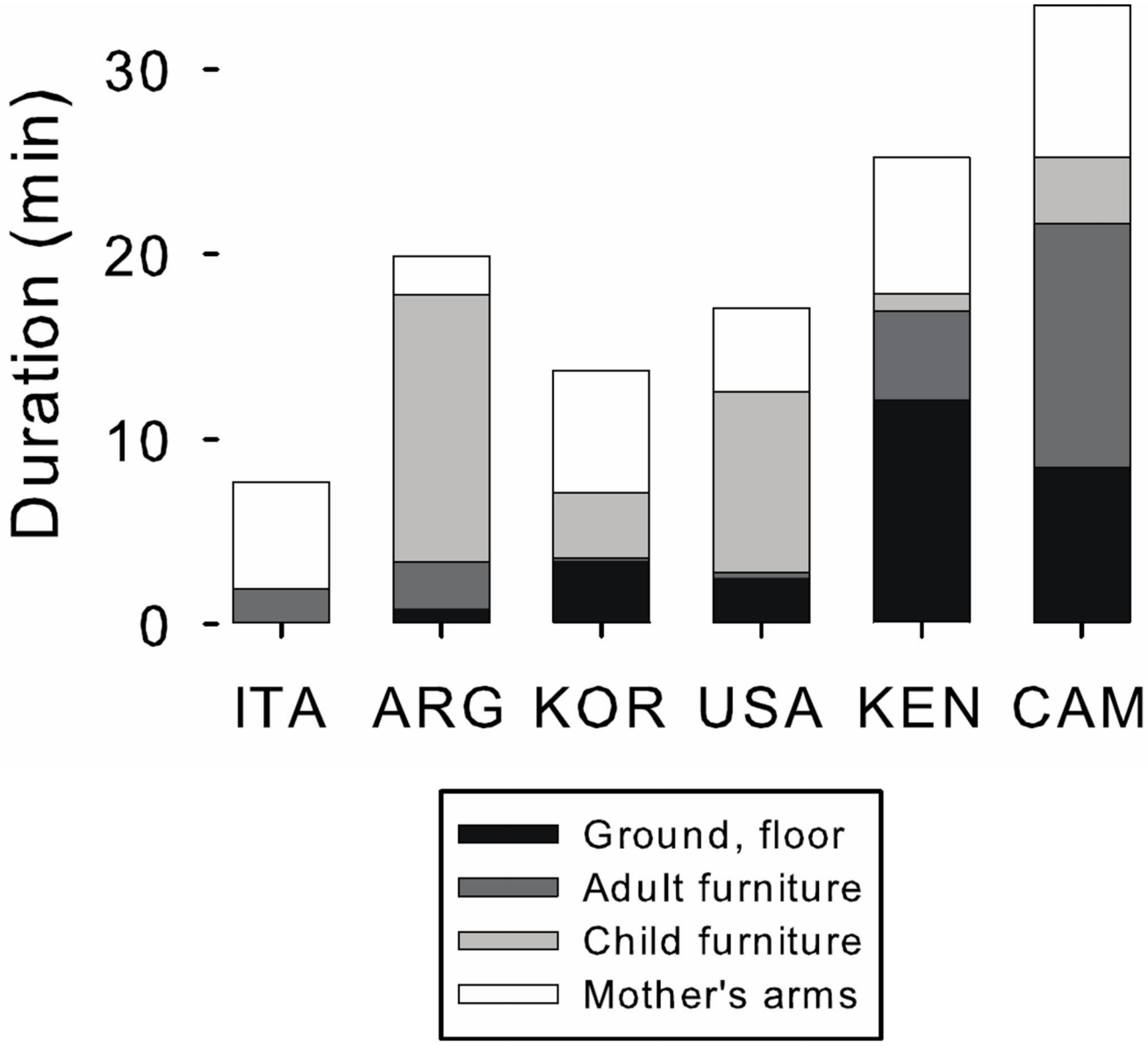

Figure 3.
Sitting across 4 places represented as duration in minutes: ground/floor, adult furniture, child furniture, and mother's arms.

Table 1

Sociodemographic characteristics of samples.

	Infant		Mother	
	Age (months)	**Gender (% girls)**	**Age (years)**	**Education***
ARG	5.24 (0.33)	66.7	21.83 (2.52)	3.58 (1.08)
CAM	5.04 (0.14)	50.0	22.17 (1.64)	2.50 (1.09)
ITA	5.15 (0.20)	50.0	24.25 (6.55)	2.92 (1.31)
KEN	5.27 (0.42)	50.0	21.75 (3.14)	2.83 (1.70)
KOR	5.25 (0.16)	58.3	29.00 (2.41)	5.92 (0.79)
USA	5.33 (0.20)	50.0	30.25 (4.00)	6.17 (0.83)

Note. The numbers shown are means (with standard deviations in parentheses).

*Hollingshead Index Education Scale (1: Less than 7^{th} grade; 2: 7^{th}, 8^{th}, 9^{th} grade; 3: 10^{th}, 11^{th} grade; 4: High school graduate/GED; 5: Partial college; 6: College graduate; 7: Graduate/professional. Differences in mothers' age and education existed between U.S./S. Korean mothers and mothers from Argentina, Cameroon, Italy, and Kenya, F (5, 58) = 17.50, $p < .01$ and F (5, 66) = 23.20, $p = .01$, respectively.

Table 2

Descriptive statistics.

		Sit Prof (min)	Supp Sit (min)	Unsupp Sit (min)	Unsupp & Supp Sit Bouts	Grnd Sit (min)	Adt Furn Sit (min)	Chi Furn Sit (min)	Arms Sit (min)	Accumul Sit (min)
ARG	*M*	0.53	19.72	0.17	11.58	0.88	2.47	14.45	2.09	19.89
	SD	0.78	17.02	0.48	9.81	1.90	4.70	16.01	2.67	17.16
CAM	*M*	11.26	12.63	20.82	19.33	8.53	13.14	3.58	8.20	33.45
	SD	7.85	11.93	14.25	13.39	15.55	14.66	9.74	4.47	12.80
ITA	*M*	0.00	7.68	0.00	7.83	0.00	1.92	0.00	5.76	7.68
	SD	0.00	4.71	0.00	4.64	0.00	2.90	0.00	3.70	4.71
KEN	*M*	8.10	12.50	12.69	27.42	12.16	4.77	0.94	7.32	25.19
	SD	10.05	6.92	18.31	14.49	16.11	7.65	1.41	3.98	19.21
KOR	*M*	2.31	11.92	1.81	12.92	3.44	0.14	3.54	6.61	13.73
	SD	1.02	10.58	5.28	14.16	7.46	0.26	8.86	5.20	11.41
USA	*M*	2.89	15.23	1.82	11.33	2.53	0.28	9.77	4.48	17.06
	SD	2.74	7.88	5.97	8.40	5.96	0.46	7.60	2.61	10.16

Note. Sitting proficiency averages (in minutes) are shown for independent sitters. Supported plus unsupported sitting (in minutes) equal to accumulated sitting (in minutes) across the four places (ground, adult and child furniture, and mother's arms). Frequency of supported and unsupported sitting bouts were distributed over the hour with sitters accumulating more sitting bouts overall than non-sitters. Maternal age and education did not predict duration of sitting in the four places. Places where mothers situated infants related to infant sitting proficiency after controlling for maternal age and education.