Does Travel Broaden the Communicative Mind? The Influence of Crawling on the Development of Communication in the First Year of Life

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Abstract

Previous research suggests that the development of early communicative behavior is linked to the onset of independent locomotion. We examined parent reports of communicative behaviors in infants before crawling, and two and six weeks after crawling onset. The findings support a relationship between parent-reported communication behaviors and crawling onset.

Introduction

Infancy marks a crucial stage of development in which both physical and psychological changes rapidly occur. It has been suggested that these changes may be contingent upon one another in order for an infant to develop normally across a number of early milestones. The current study was concerned with the onset of crawling in infants and the communicative behaviors that seem to arise as. Does the acquisition of locomotion in infancy facilitate the development of communication? How profound is this influence?

Locomotor acquisition has even been referred to as the “psychological birth” of the human infant (Mahler, Pine, and Bergman, 1975). Previous research has elucidated locomotor acquisition as a milestone of infancy in which psychological development arises and behavioral clues proliferate (for a review, see Campos, Anderson, Barbu-Roth, Hubbard, Hertenstein, & Withington, 2000). The specific posture in locomotion (for example, the prone position for crawling, as compared to the upright position for walking) has been debated by researchers as to which seems to have a larger influence on psychological development. Mahler and colleagues (1975) proposed that the upright posture and the advent of walking facilitate psychological development, but recent research tends to support the earlier occurrence of crawling as more influential.

The idea that the advent of crawling drives psychological development has been more recently supported by the literature. An interview study by Campos, Kermolian, and Zumbahlen (1992) presented parental reports of large increases in emotional expression (i.e. anger), separation anxiety, attention to distal objects, and checking back to the mother in locomotor infants as compared to those who were pre-locomotor (both conditions included infants with and without experience in a walker). The changes in the infants had brought about changes in the parents as well, including but not limited to an increase in vocal volume to communicate prohibitions and to enforce discipline, as well as an increase in emotional expression and affection. It is important to note that the results from the infants with and without walker experience were comparable, and that they were later coupled together (Campos et al., 1992). In addition to the socio-emotional developments reported in locomotor infants, they also show noted increases in referential gestural communication following the onset of crawling (Campos et al., 2000). Findings that support this notion were reported in studies examining normal infant populations (Campos, Kermoian, Witherington, Chen, & Dong, 1997), as well as infants experiencing locomotor delay due to spina bifida (Telzrow, 1990; Telzrow Campos, Kermoian, & Bertenthal, 1999; Telzrow, Campos, Shepard, Bertenthal, & Atwater, 1987) and Chinese infants experiencing locomotor delay due to cultural lifestyle pressures (Tao & Dong, 1997). Each study employed similar paradigms in that they examined prelocomotor and locomotor infants' abilities to respond correctly to a point and gaze gesture initiated by an experimenter. The study by Campos and colleagues (1997) reported increases in correct responsiveness to the experimenter's point and gaze in locomotor infants as compared to those who were prelocomotor. The studies examining infants experiencing locomotor delay found increases in responsiveness to point and gaze gestures only after the delayed locomotor abilities were attained. These studies provide a preliminary foundation for the notion that locomotor experience is a driving force for the development of communicative behavior in infancy, as they provide evidence of a relationship between these two developmental trajectories in both normal and delayed conditions.

Referential gestural communication may also be phrased as an infant's responsiveness to another's attempt to engage in joint attention behavior. Joint attention is considered a major milestone in the development of communication, as it provides evidence that the child understands an individual's state of attention whereby the individual can then effectively communicate a distal object or event to the child. Things get even more interesting when a child develops the ability to turn this around and communicate by means of joint attention, as well. Also called initiated joint attention (IJA; Seibert, Hogan, & Mundy, 1982), this newly attained ability opens new doors for early communication in infancy without necessarily using sounds, or later, words.

When an infant attains the ability to move independently, it begins a more independent experience with the environment that surrounds it. These new experiences warrant the need to express interests and emotions with others, typically the mother or caregiver initially. The current study was concerned with a further investigation of the likely influence of crawling experience on these communicative developments, and to provide empirical evidence on the nature of this crucial period of infancy. Based on previous research, we hypothesized that as infants increase in age, the frequency of their communicative behaviors will increase as well. We also predicted that as infants transition through various crawling milestones, the frequency of their communicative behaviors will increase correspondingly.

Methods

Participants

Twenty-three infants (12 female, all European American) and their mothers participated in a study of change in multiple domains of development (e.g., motor, cognitive, social, emotional) during infants' transition to independent locomotion. The current report focuses on communicative development. Infants were born between 37 and 42 weeks gestational age, with a birth weight greater than 2500g, and without major birth complications. Three infants were already crawling at the baseline pre-crawling assessment and were thus not included in analyses. Of the 20 remaining infants, 17 completed all three assessments (baseline, 2 weeks post-crawling, six weeks post-crawling), two completed two assessments, and one infant completed one assessment. All missed assessments were due to mothers having other commitments. Infants ranged from 25 to 28 weeks of age at baseline (M = 26.10, SD = 0.91), 27 to 44 weeks at 2 weeks post-crawling (M = 36.71, SD = 4.16), and 30 to 48 weeks (M = 40.71, SD = 4.11) at 6 weeks post-crawling.

Procedure

The larger study consisted of three phases of data collection, each of which included home and lab visits: a baseline pre-crawling phase at approximately infant age 25 weeks, an early crawling phase, and an experienced crawling phase. The early and experienced crawling phases were yoked to each infant's onset of crawling. All infants, except for those three that crawled at baseline, participated in a total of three lab and three home visits, one home and one lab visit at each crawling phase. The first home visit (Baseline Home) took place at 25 weeks plus or minus 2 weeks, with the first lab visit occurring one week later (Baseline Lab, pre-crawling). At the first lab visit the parents were given a diary to be completed daily, monitoring their infants' motor activities. An experimenter called weekly to collect parents' recorded information and to determine if the child had begun crawling. Infants were considered to crawl if they could independently move at least 10 feet, regardless of whether they engaged in hands and knees crawling, belly crawling, hitching, or some other variation of independent movement. Once the parents reported crawling, a home visit was scheduled within one week of crawl onset followed by a lab visit one week later (novice crawling: 2 weeks post-crawling). A home visit was scheduled for the fifth week post crawling and a lab visit the following week (experienced crawling: 6 weeks post-crawling). This longitudinal design, therefore, was based on stages of crawling, not infant age. By design, infants were the same age at the baseline assessment but varied in age at the novice (2 week) and experienced (6 week) post-crawling assessments because infants began to crawl at different ages.

At each home visit, mothers were given questionnaires to be completed for that week, which were returned the following week at the lab visit. Of these, the Communication and Symbolic Behavior Scale – Developmental Profile (CSBS-DP; Wetherby & Prizant, 2002) was the measure of choice for the current study. At each lab visit, infants were first given several minutes to acclimate to the surroundings. Anthropometric measurements and a crawling assessment in which the experimenter verified crawling status were also conducted.

The CSBS-DP is a three-part evaluation tool used to assess the development of communication in infants ranging in ages six to 24 months, primarily used in clinical and research applications to identify developmental deficits that may lead to later disorders (Wetherby, Allen, Cleary, Kublin, & Goldstein, 2002). It is a tool for determining the stage of communicative development of the infant. The entire assessment consists of an initial screening, a caregiver questionnaire, and a face-to-face behavioral evaluation. The caregiver questionnaire is comprised of 41 multiple choice items and four open ended questions organized over three distinct composites: social, speech, and symbolic. The social composite measures aspects of early social expression, including emotion and eye gaze, communication, and gestures. The speech and symbolic composites measure increasingly complex expressions including sound and word production, as well as evidence of understanding and object use. The sub-scales of the symbolic composite were excluded from our analyses because the measured behaviors of these sub-scales are not seen in infants of our observed age range. In addition, we included only one sub-scale of the speech composite ('Sounds', but not 'Words').

Typical employment of the CSBS-DP involves an initial screening of the infant subject in order to identify their developmental "age." If the infant performs at the level of their chronological age or higher, they can be additionally screened every three months, so long as the infant remains within the age range of six and 24 months. However, if the infant does not perform at the level of their chronological age, then further evaluation is recommended to fully assess the developmental condition. For the current study, the caregiver questionnaire was used to collect data at each time period of interest. The behavioral evaluation was excluded because the infant subjects were thought to be too young to produce any meaningful results.

The two-part hypothesis of the study stated that communication should develop rapidly during the observed ages of 23-48 weeks, and that crawling acquisition and experience will influence the rate of development. We used sub-scales within the CSBS-DP Caregiver Questionnaire as measures of communicative behaviors across three periods of crawling status: pre-locomotion (before), 1-2 weeks post-locomotion (early), and 5-6 weeks post-locomotion (late). One-way ANOVA tests with Tukey Honestly Significant Differences post hoc analyses ($p<.05$ significance level) and linear regression analyses were applied to the various sub-scales. The data collected from the CQ, as well as the demographics and anthropometrics, were analyzed using R statistical computing and analysis software (R Development Core Team, 2011; Fletcher, 2010; Pinheiro, Bates, DebRoy, Sarkar, & R Development Core Team, 2011).

Results

Emotion and Eye Gaze Sub-scale

A linear regression analysis on the Emotion and Eye Gaze sub-scale reported that age in weeks was a significant predictor of scores, $\beta = 0.38$, $p = 0.004$, $R2 = 0.13$. Figure 1 provides a scatter-plot of individual scores by age. The figure also shows crawling status at each assessment point. The sub-scale score means were not found to be significantly different across crawling status conditions, $F(2, 54) = 2.38$, $p = 0.102$.

Communication Sub-scale

A linear regression analysis conducted on the Communication sub-scale also revealed age as a predictor of sub-scale scores, $\beta = 0.49$, $p = 0.000$, $R2 = 0.23$. Figure 2 provides a scatter-plot of individual scores by age in weeks. Unlike the Emotion and Eye Gaze sub-scale score means, the Communication sub-scale score means were found to be significantly different across crawling status conditions after an analysis of variance was applied, $F(2, 54) = 7.12$, $p = 0.002$. The mean scores for the before condition ($M = 4.82$, $SD = 3.52$, $N = 21$) were not significantly different from the mean scores of the early condition ($M = 7.57$, $SD = 3.49$, $N = 21$), but were significantly lower than the mean scores of the late condition ($M = 9.32$, $SD = 3.74$, $N = 21$).

Gestures Sub-scale

The Gestures sub-scale scores were found to positively correlate significantly with infant age, $\beta = 0.80$, $p = 0.000$, $R2 = 0.63$. Figure 3 provides a scatter-plot of individual scores by age in weeks. The sub-scale score means were additionally found to be significantly different across crawling status conditions after an analysis of variance was applied, $F(2, 54) = 13.79$, $p = 0.000$. The mean score for the before condition ($M = 1.88$, $SD = 0.99$, $N = 21$) was significantly lower than the mean scores of both the early ($M = 4.95$, $SD = 2.38$, $N = 21$) and late ($M = 6.00$, $SD = 3.25$, $N = 21$) conditions. The mean score for the early condition was not significantly lower than the mean score for the late condition.

Sounds Sub-scale

The Sounds sub-scale was the only component of the Speech Composite measure included in the data collection. A linear regression analysis also found that age predicts Sounds sub-scale scores, $\beta = 0.63$, $p = 0.000$, $R2 = 0.39$. Figure 4 shows the graphical representation of this trend. The mean scores of the sub-scale were found to be significantly different across crawling status, $F(2, 54) = 12.01$, $p = 0.000$. The mean score for the before condition ($M = 6.59$, $SD = 1.54$, $N = 21$) was significantly lower than both the mean scores of the early ($M = 9.57$, $SD = 2.48$, $N = 21$) and late ($M = 10.26$, $SD = 2.83$, $N = 21$) conditions. The mean scores of the early and late conditions were not found to be significantly different.

Discussion

The linear regression analysis of the function of scores across age for the Emotion and Eye Gaze sub-scale resulted in a positively significant correlation between the ages of 25-48 weeks and test scores. This provides evidence that behaviors measured by this sub-scale are developing within this age range. However, results from the ANOVA on the Emotion and Eye Gaze sub-scale did not yield significance between the before and early crawling conditions. Crawling may not play an influential role in the development of such behaviors as self-generated eye gaze shifts between objects and individuals, positive emotional expression paired with gazes toward individuals, and the responsiveness to another individual’s joint attention behavior. The scores were also relatively high compared to the other sub-scales, suggesting that the development of these behaviors has already been established preceding locomotor acquisition.

The observed age range was also found to be significantly correlated with scores on the Communication sub-scale. Therefore, the represented behavioral measurements of this sub-scale seem to be developing rapidly as well. In addition, the means from the Communication sub-scale were statistically significant between the pre- and early crawling conditions, in which the early condition mean score was significantly higher than the pre-crawling condition. This may suggest that crawling acquisition plays an influential role in the development of behavioral regulation, communicative acts to draw attention to oneself, and IJA behaviors. The frequency of deliberate communicative acts may also be included as well. Rapid developments in social referencing communication have been demonstrated in children transitioning from crawling to walking (Clearfield, Osborne & Mullen, 2008). Although we were chiefly interested in crawling acquisition, Clearfield and colleagues’ results, as well as the results from the current study, present support for the role of locomotor acquisition in the development of communication as considerably influential.

The Gestures sub-scale scores were also found to be positively correlated with the observed age range. This may be evidence of a rapid development of gestural communication during this period of infancy. Results were significant between the mean scores of the pre- and early crawling conditions as well. Compared to the other sub-scales, the Gestures sub-scale yielded the most significant results from both the linear regression analyses and the ANOVA, providing strong support that the development and use of both conventional and distal gestures may be influenced by crawling experience.

The Sounds sub-scale produced significant results, in which scores were positively correlated with age. Just like the other three sub-scales, this suggests that the production of rudimentary sounds is rapidly increasing during the observed age range. As with both the Communication and Gestures sub-scales, the Sounds sub-scale mean scores were also significantly different between the before and early crawling conditions as well. This may suggest that crawling experience even plays a role in the ability to produce consonant sounds, as well as the size of the inventory of consonant syllables in which an infant can access.

There were some inherent limitations in the current study. Although the sub-scales were designed to measure and predict communicative behaviors in infants, the scores are ultimately a representation of the mother or caregiver's subjective evaluation of their child. Infants cannot simply be asked questions and be expected to give thorough, scientifically acceptable answers. Therefore, our data is an indirect measurement of infant communicative behaviors, filtered through the interpretation of the parent or caregiver. We encourage the further study of a larger age range using non-linear analyses to more accurately predict the influence of crawling on developmental trajectories.

Overall, our hypotheses were largely supported by the results of the CQ. Crawling acquisition and experience seem to be providing new opportunities for the use of a number of communicative behaviors and facilitating their development. Although behaviors like alternating eye gaze shifts and the responsiveness to joint attention were not significantly affected by crawling, these behaviors may serve as developmental precursors to behaviors that develop after the onset of crawling, where crawling provides the necessary opportunities for these precursor behaviors to evolve.

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Appendix

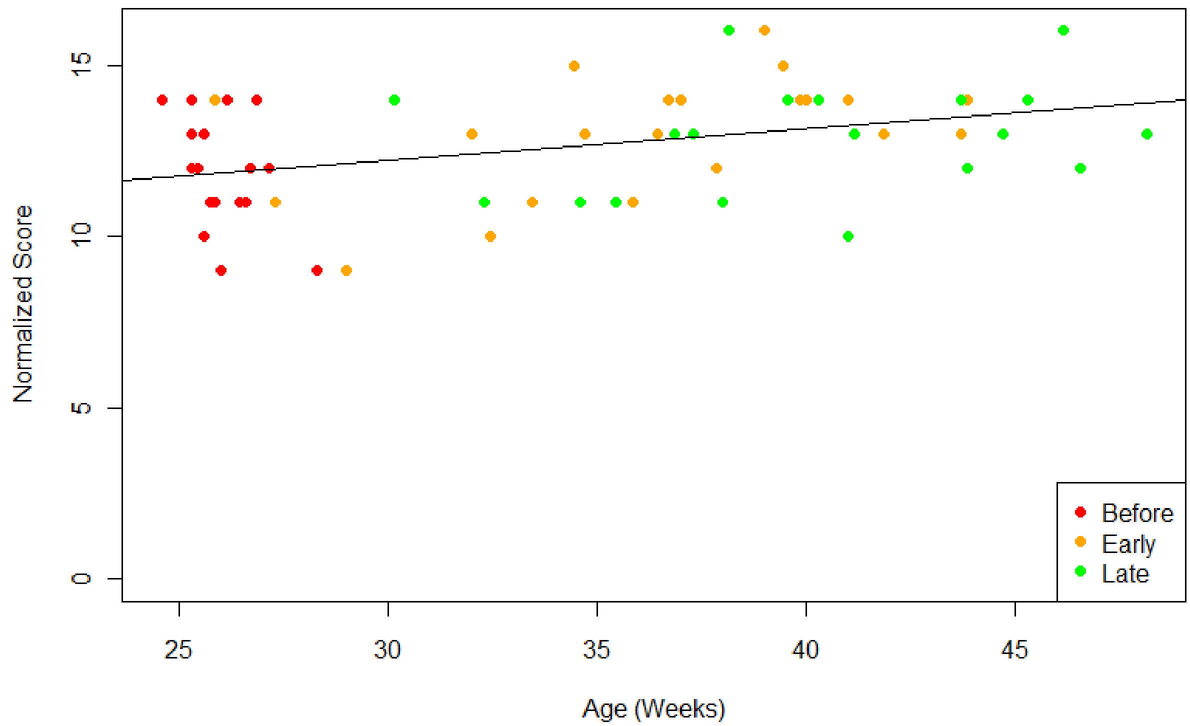

Figure 1. Emotion and Eye Gaze Sub-scale Scores across Infant Age in Weeks.

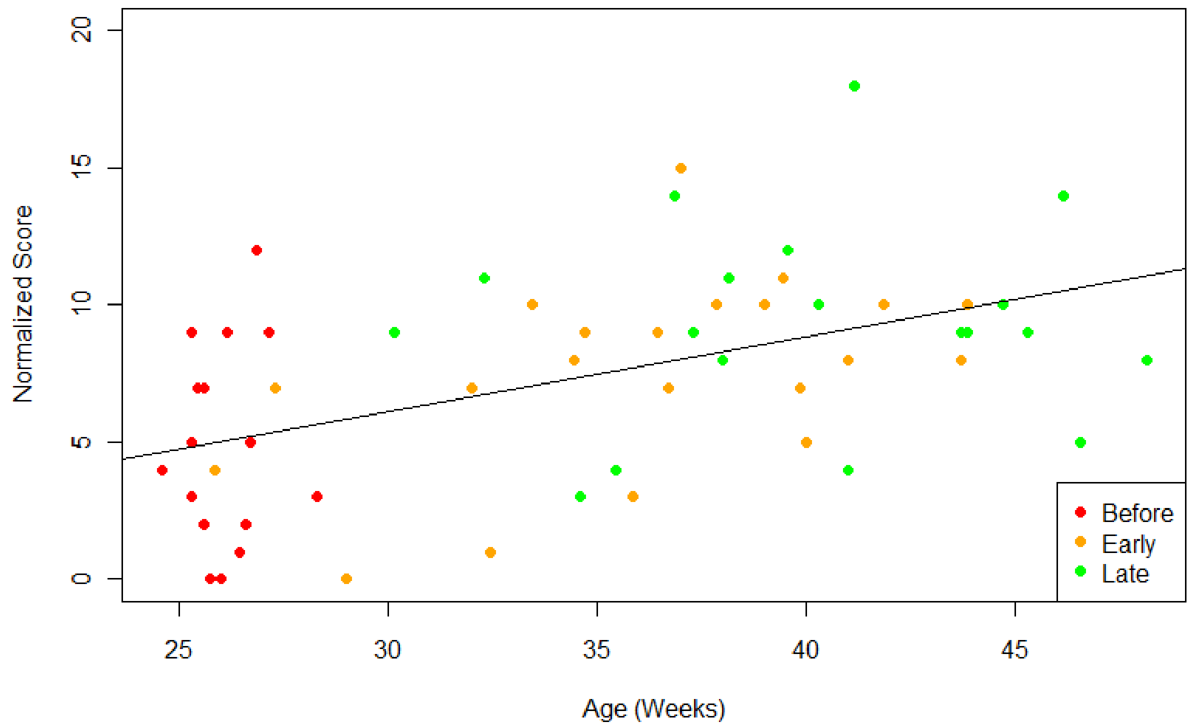

Figure 2. Communication Sub-scale Scores across Infant Age in Weeks.

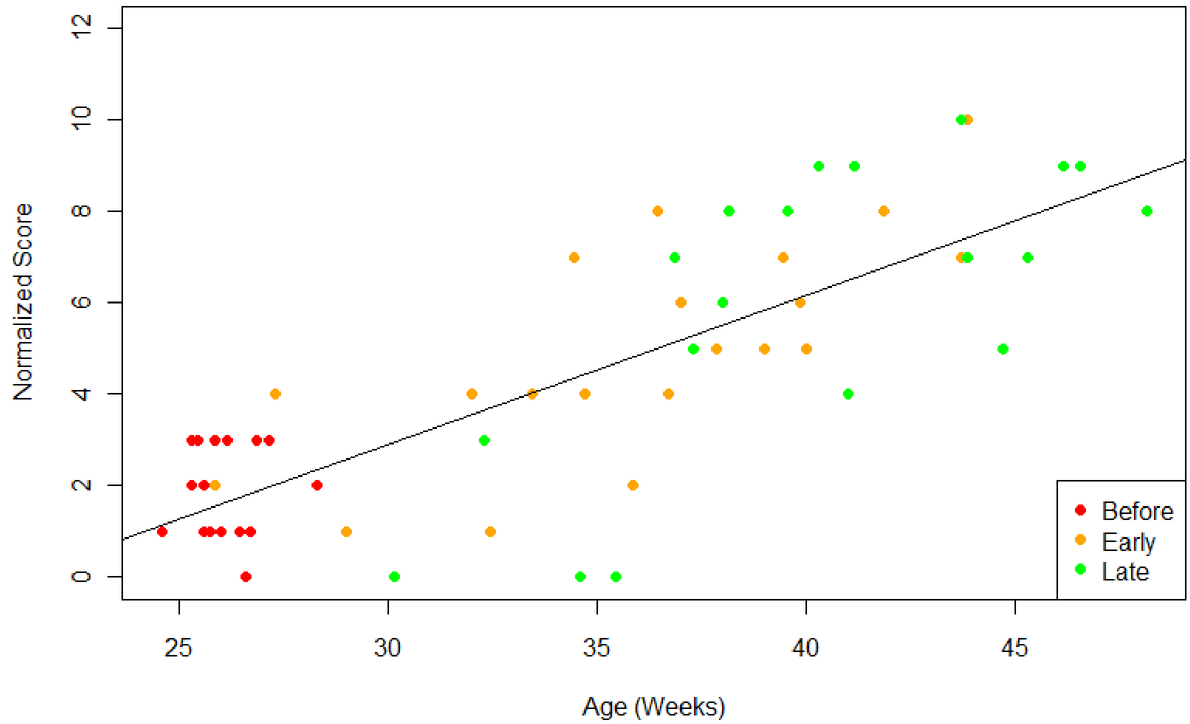

Figure 3. Gestures Sub-scale Scores across Infant Age in Weeks.

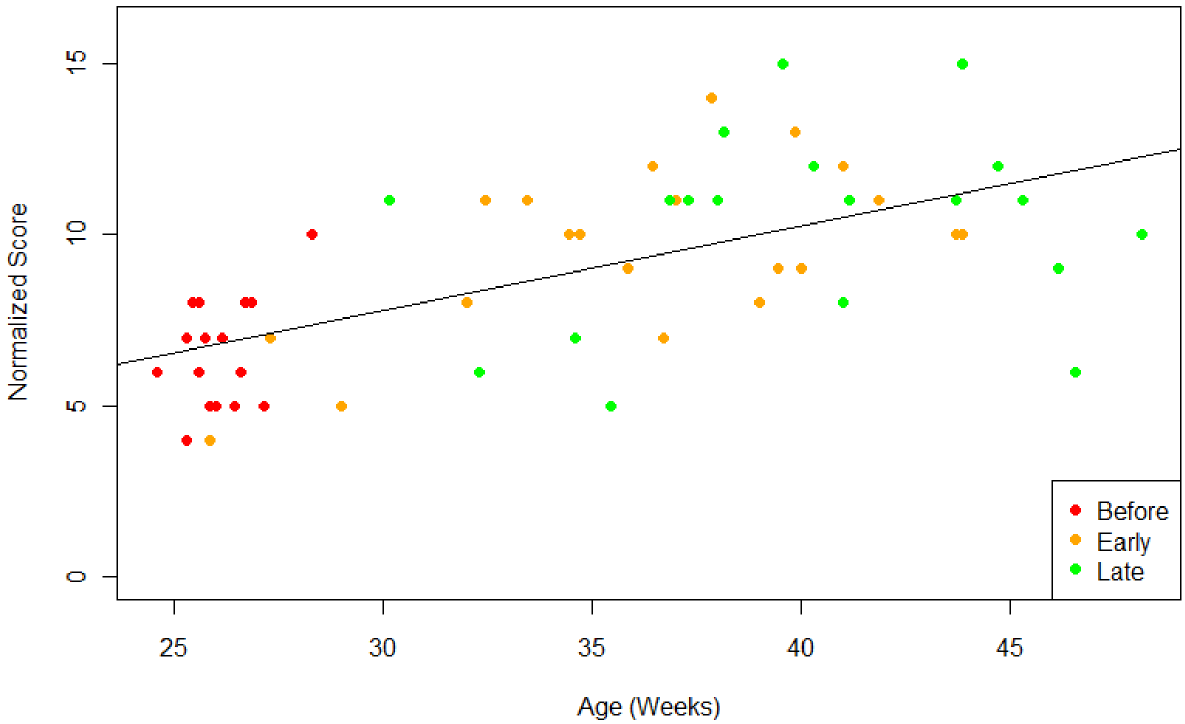

Figure 4. Sounds Sub-scale Scores across Infant Age in Weeks.

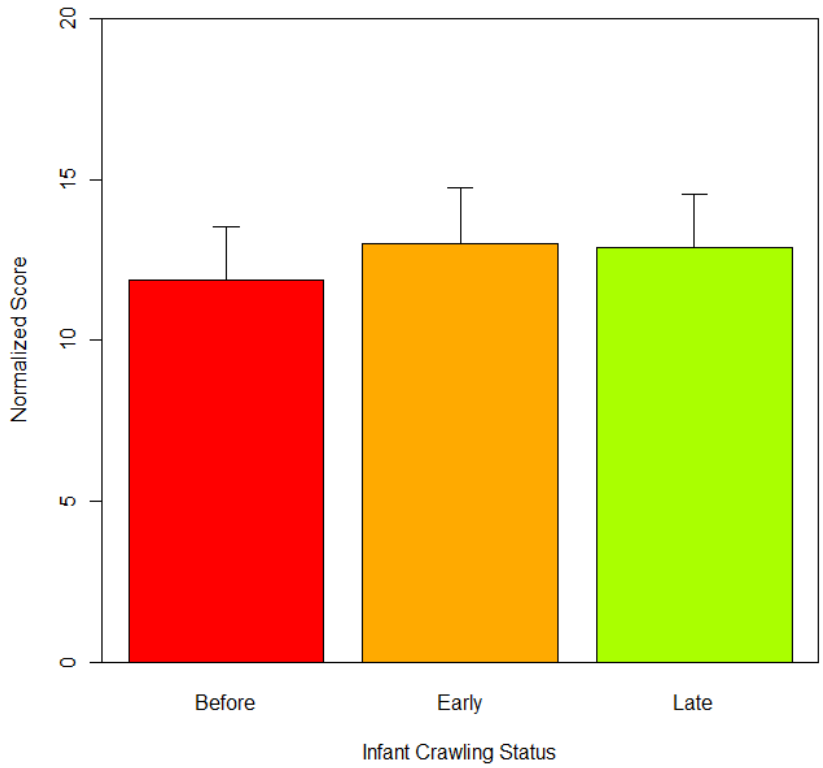

Figure 5. Emotion and Eye Gaze Sub-scale Mean Scores for Crawling Status Periods.

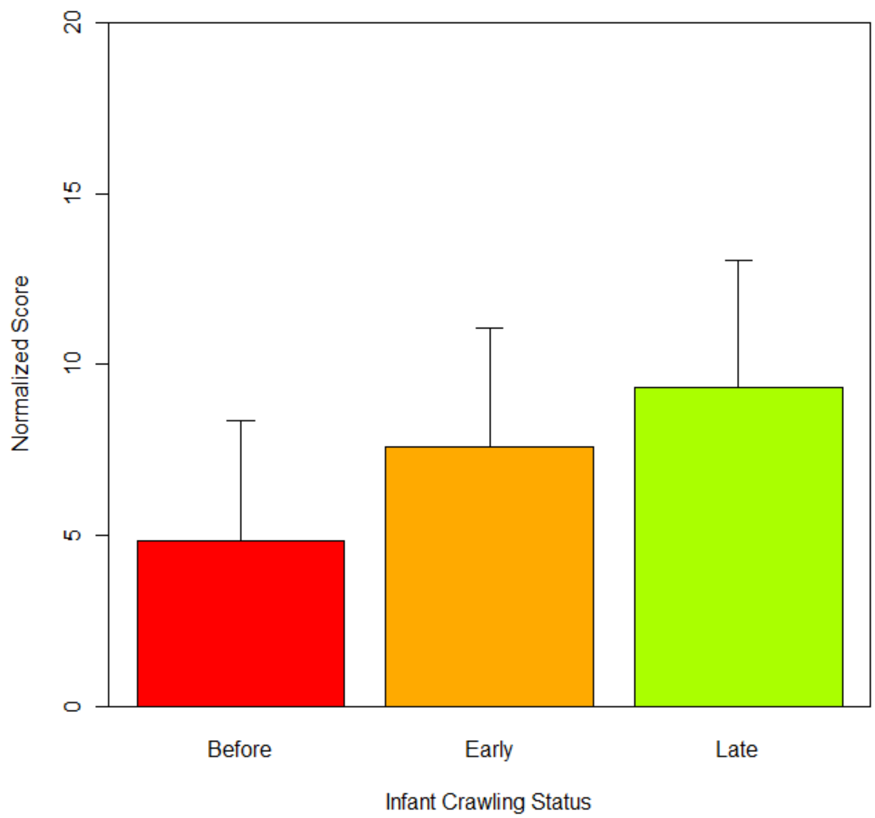

Figure 6. Communication Sub-scale Mean Scores for Crawling Status Periods.

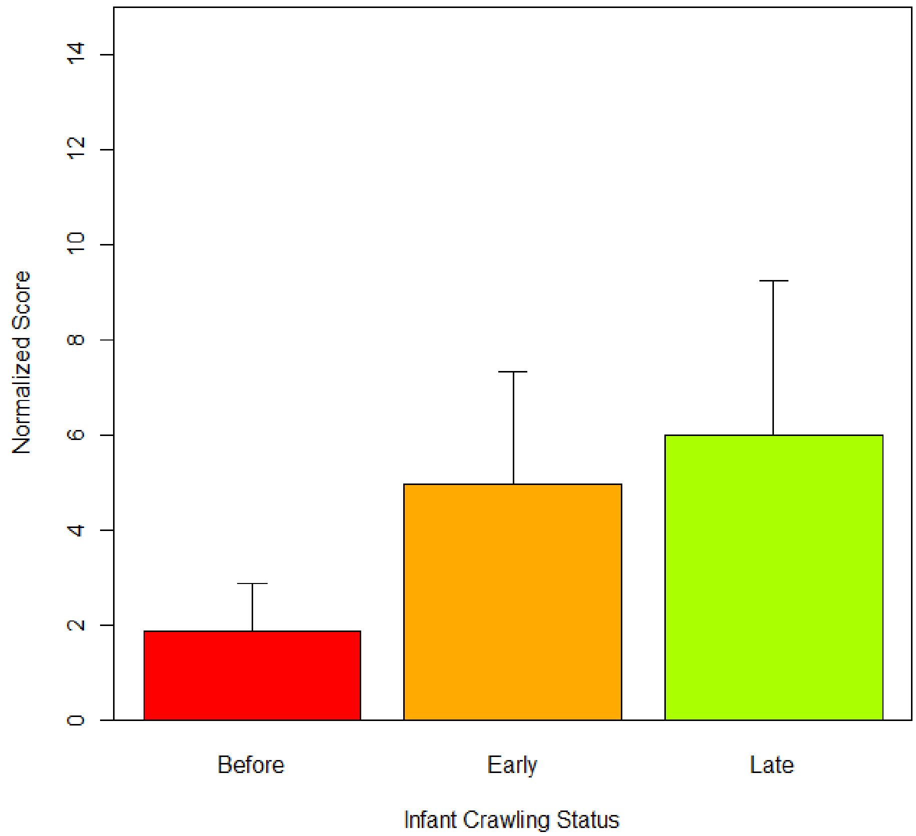

Figure 7. Gestures Sub-scale Mean Scores for Crawling Status Period.

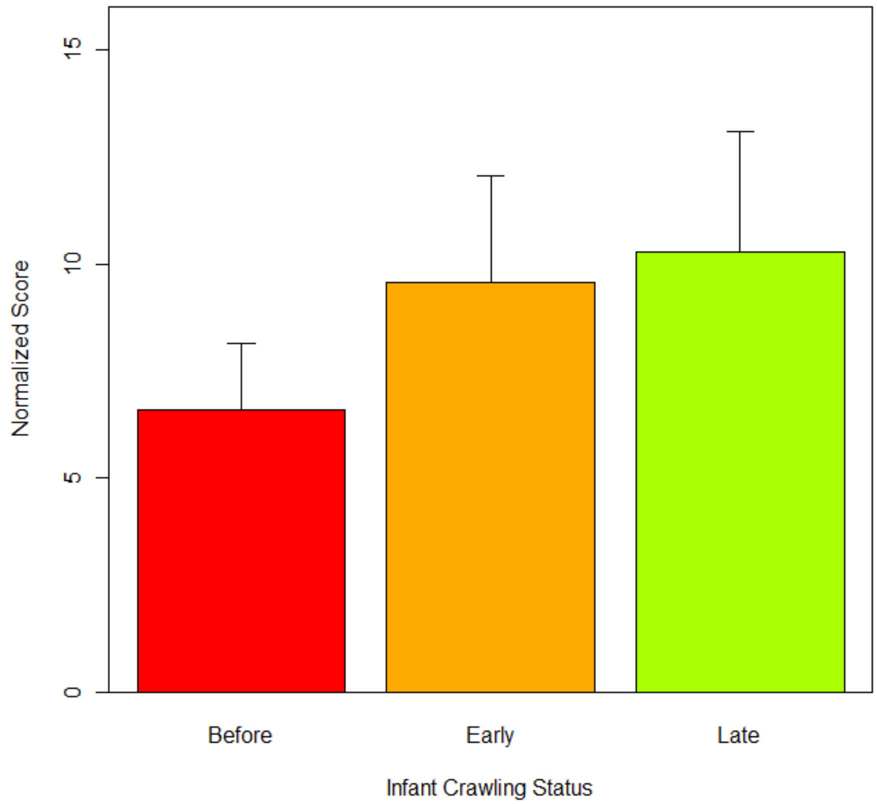

Figure 8. Sounds Sub-scale Mean Scores for Crawling Status Periods.