

Assessing the Developmental Trajectory of Infants' Lateralized Hand-Use Without Using Age

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Introduction

Lateralized hand use is the preference to use one hand (right or left) vs. both hands during the performance of a set of manual actions (e.g., reaching) in a particular situation (e.g., obtaining toys). Previous research has demonstrated frequent fluctuations in infants' lateralized hand-use development (Corbetta & Thelen, 1999; Corbetta & Thelen, 2002; Fagard & Lockman, 2005; Piek, 2002).

Some researchers have explained the apparent fluctuations using a dynamic systems perspective (Thelen, 1986) in which the emergence of new motor skills such as sitting, crawling or walking can modify established patterns of infant handedness (Corbetta & Bojczyk, 2002; Corbetta & Thelen, 1996; Corbetta & Thelen, 2002).

A key tenet of the dynamic systems theory is that "patterns of change can only be understood as a function of time" (Corbetta, & Thelen, 2002). Consequently, researchers typically map the developmental transformations of any trait as a function of time (age).

In contrast, Wohlwill (1973) argued that chronological age is a poor metric for developmental transformations. Transitions in neuromotor status, not age, may relate better to the developmental transitions observed in infant handedness (Corbetta & Thelen, 1999; Michel, 1988).

Touwen's neuromotor development assessment scale provides an alternative metric to age, because it includes a comprehensive evaluation of developmental change without ascribing age as a mechanism of this change (Touwen, 1976).

Thus, the goal of the current study was to examine the development of lateralized hand-use in relation to the forms of neuromotor development assessed by the Touwen's scale, independent of age.

Method

Participants:

- 171 infants (98 males, 73 females)
- tested monthly from 6- to 14-months of age (9 visits)

Apparatus:

- 34 common infant toys

Procedure:

- Touwen's neuromotor development assessment scale (Touwen, 1976) – patterns of sitting, crawling and walking
- A validated handedness assessment task (Michel et al., 1986) – number of toys acquired by right, left, or both hands by each infant at each visit

$$\text{Lateralization Index} = \frac{(\text{Right} + \text{Left})}{(\text{Right} + \text{Left} + \text{Both})}$$

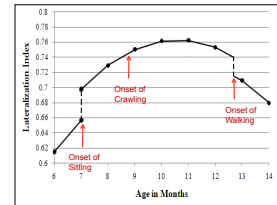
Building the Model Using Age

$$\begin{aligned} \text{LATERALIZATION}_{ij} &= \pi_{0i} + \epsilon_{ij} && 28.78\% \\ \text{LATERALIZATION}_{ij} &= \pi_{0i} + \pi_{1i} * \text{AGE}_{ij} + \pi_{2i} * \text{AGE}_{ij}^2 + \epsilon_{ij} && 8.78\% \\ \text{LATERALIZATION}_{ij} &= \pi_{0i} + \pi_{1i} * \text{AGE}_{ij} + \pi_{2i} * \text{AGE}_{ij}^2 + \pi_{3i} * \text{SIT}_{ij} + \pi_{4i} * \text{CRW}_{ij} + \pi_{5i} * \text{WLK}_{ij} + \epsilon_{ij} \\ \text{LATERALIZATION}_{ij} &= \pi_{0i} + \epsilon_{ij} && 28.62\% \\ \text{LATERALIZATION}_{ij} &= \pi_{0i} + \pi_{1i} * \text{SIT}_{ij} + \pi_{2i} * \text{CRW}_{ij} + \pi_{3i} * \text{WLK}_{ij} + \epsilon_{ij} && 8.98\% \\ \text{LATERALIZATION}_{ij} &= \pi_{0i} + \pi_{1i} * \text{SIT}_{ij} + \pi_{2i} * \text{CRW}_{ij} + \pi_{3i} * \text{WLK}_{ij} + \pi_{4i} * \text{AGE}_{ij} + \pi_{5i} * \text{AGE}_{ij}^2 + \epsilon_{ij} \end{aligned}$$

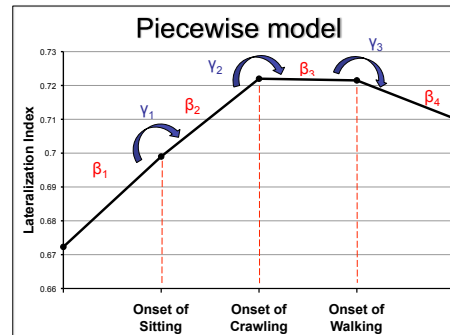
Correlations:

	Age	Sitting	Crawling	Walking
Age	1.00			
Sitting	0.46**	1.00		
Crawling	0.71**	0.54**	1.00	
Walking	0.81**	0.28**	0.54**	1.00

** $p < 0.01$



Building the Model Without Age



* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

$$\begin{aligned} \beta_1 &= 0.0267^{**} \\ \beta_2 &= 0.0230^{***} \\ \beta_3 &= -0.0005 \\ \beta_4 &= -0.0113^{*} \end{aligned}$$

$$\begin{aligned} \gamma_1 &= -0.0100 \\ \gamma_2 &= -0.0148^{**} \\ \gamma_3 &= -0.0148^{*} \end{aligned}$$

Results

In the process of model building, if we first add age to the one-way ANOVA model predicting change in infants' lateralized hand-use, age accounts for about 28.78% of the within-subject variance in the lateralized hand-use. When we enter markers of neuromotor development to the model that already contains age, they add only 8.78% to the explained portion of variance in the outcome.

However, if the markers of neuromotor development are first entered in the model, followed by age, the reversed pattern is observed. The onsets of sitting, crawling and walking add significantly to the explanation of subject-level variance, whereas age explains only a modest proportion of variability because age correlates highly with the markers of neuromotor development.

Our original model incorporating age described the step-like change in the trajectory of lateralized hand-use with the onset of sitting increasing the lateralization of hand-use, and the onset of walking decreasing lateralization. In contrast, the onset of crawling did not influence the trajectory of lateralized hand-use.

In this study, we used a piecewise model to estimate the developmental trajectory of infants' lateralized hand-use without using age. The model revealed: 1) a significant increase in lateralized hand-use before and after the onset of sitting; 2) the slope after the onset of crawling was not significantly different from zero; 3) a significant decrease in lateralized hand-use after the onset of walking.

The piecewise model also provides an opportunity to test the significance of change in trajectory of lateralized hand-use at the onset of sitting, crawling, and walking. At the onset of sitting, we do not observe a significant change in the trajectory. However, the onsets of crawling and walking do coincide with the decrease in lateralized hand-use.

Discussion

Please note that lateralized hand-use is not the same concept as handedness. Whereas handedness is a person's relatively consistent preference to use one hand or another (right vs. left) across a wide variety of actions and tasks, lateralized hand-use defines a person's preference to act unimanually (by using right or left hand) vs. acting bimanually (by using both hands) for a particular action at a particular time.

Since age is only a convenient marker of development, it is a poor predictor of developmental change. In the process of model building, age may seem to explain much of within-subject variability; however, if a better measure of individual development (onsets of sitting, crawling and walking) is added in the model first, age loses both predictive and explanatory power.

The current study using the piecewise model shows that markers of neuromotor development are powerful predictors of change in the developmental trajectory of lateralized hand-use.