

Age and Neuromotor Developmental Predictors of Infant Handedness

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Introduction

Handedness is usually defined as a preference to use one hand over the other, or that one hand performs faster or more skillfully on manual tasks. For humans, there is a remarkable asymmetry in the distribution of handedness with no more than 12% of the population manifesting a left hand preference. The majority of infants develop a consistent hand preference during the 6 to 14 month period with most using their right hand (Michel et al., 2006). However, a good proportion of infants fail to exhibit a preference during this period. In the current study, we explored differences in group trajectories of handedness development between those infants with and without hand-use preference.

Some researchers have reported frequent fluctuations in infant handedness development (Corbetta & Thelen, 1999; Corbetta & Thelen, 2002; Fagard & Lockman, 2005; Piek, 2002). From one observation to another, infants may change their preferences in hand use for reaching and manipulation of objects as well as the choice of one-handed versus two-handed strategy for reaching and acquisition. Some researchers have explained the observed fluctuations using a dynamic systems perspective (Thelen, 1986). From this perspective, 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).

For example, Rochat (1992) and Goldfield (1993) note that both the mastery of sitting and the emergence of crawling are associated with an increased handedness and a decrease in the proportion of bilateral two-handed responses. Corbetta and Bojczyk (2002) propose that infants might become less lateralized in their hand use as they establish an upright posture. Their report that infants return to two-handed reaching pattern toward the end of their first year and this decrease in handedness coincides with the onset of walking. Corbetta and Bojczyk (2002) propose that upright locomotion imposes new constraints on balance control, bimanual coordination, and head and arm control that might disrupt the established reaching preferences.

In the current study, we examined whether infant handedness for object acquisition is related to the development of locomotor skills of crawling and walking.

Method

Participants:

- 139 infants (73 males, 66 females) from full-term pregnancies with uncomplicated births - for the assessment of handedness patterns
- From above sample, 55 infants (30 males, 25 females) were included in the analysis of the relationship between handedness and locomotion development

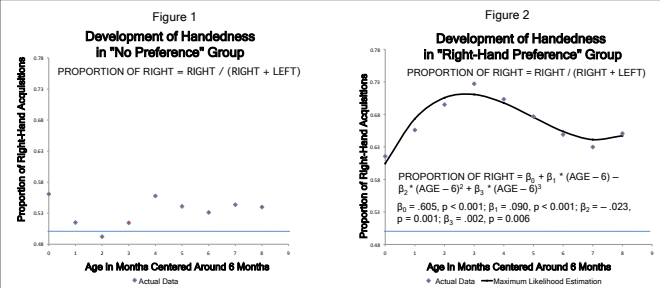
Apparatus:

- 34 common infant toys were presented one at a time at midline in the air or on the table directly in front of the infant (double toys were presented in line with infant's shoulders)

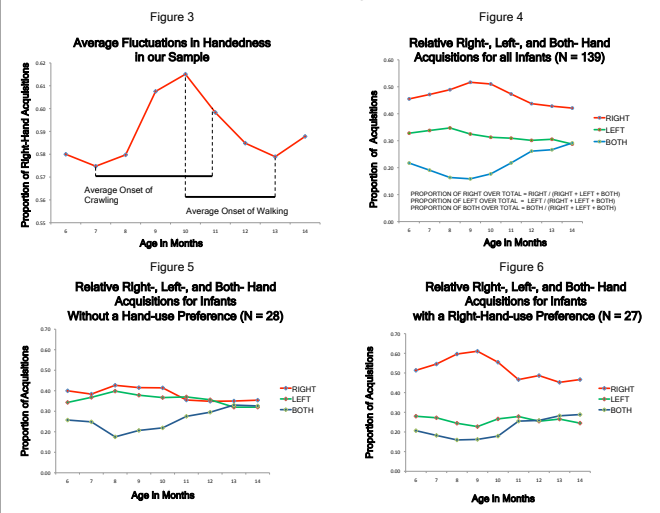
Procedure:

- A validated handedness assessment (Michel et al., 1986) was administered monthly from 6- to 14-months of age. During the assessment, infants were seated on their mothers' laps at navel level to a table.
- All of infants' manual actions were recorded by two cameras located one overhead and one on the right-hand side of the infant.
- The software program Noldus Observer was used to code observations. An acquisition was defined as the point at which infant's fingers closed around an edge of a toy. 25% of videos were re-coded for inter-rater reliability which reached a minimum Cohen's Kappa of 90%.
- The development of locomotor skills was assessed monthly with Touwen's neuromotor development assessment scale that examines patterns of sitting, crawling and walking (Touwen, 1976).

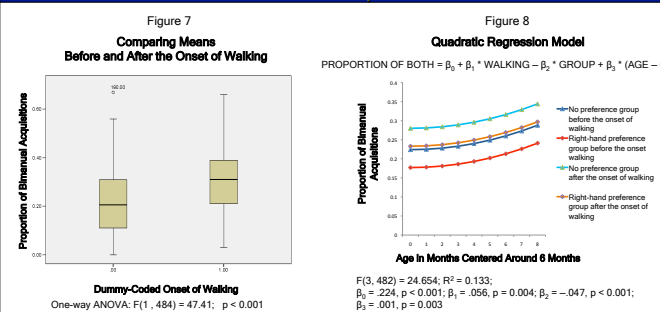
Handedness Development Trajectories



Fluctuations in the Development of Handedness



Locomotion and the Development of Handedness



Results

Figures 1 and 2 illustrate the type of fluctuations in handedness development typical of those infants with no hand-use preference and those with a right-hand-use preference. The repeated measures analysis showed that cubic function is appropriate for the description of handedness development in the right-hand preference group while the development of handedness in no-preference group does not have a significant linear or curvilinear pattern. Thus, the right-hand-use preference group exhibits a hidden developmental transformation from a stage of less handedness at 6 months of age to a maximum increase at 9 months followed by a decrease again to 13-14 months.

Figure 3 shows average development of handedness in our sample collapsing across two groups. We also marked the interval of average onset of crawling and walking in our sample. From this graph, we can suspect that the increase in handedness coincides with the onset of crawling, and the decrease in handedness follows the onset of walking which would confirm previous research.

To investigate the relation of the development of handedness to locomotion, we first analyzed the proportion of right-, left-, and both-hand acquisitions over the total number of acquisitions. On figure 4, we see the change in the proportion of right-hand, left-hand, and both-hand acquisitions over time on average in our sample (figures 5 and 6 show this change separately for no preference and right-hand preference groups respectively). These graphs show that the proportion of right-hand acquisitions is complementary to the proportion of both-hand acquisitions. Thus, the proportion of right-hand acquisitions decreases as bimanual acquisitions increase. Does the onset of crawling and walking relate to this change?

Regression analysis showed that the onset of crawling does not significantly predict the change in the proportion of bimanual acquisitions while the onset of walking is a significant predictor. In order to compare the proportion of bimanual reaches before and after the onset of walking, we performed one-way analysis of variance and confirmed that the proportion of bimanual reaches increases significantly after the onset of walking (figure 7). Figure 8 illustrates a quadratic model that describes expected change in the proportion of bimanual acquisitions after the onset of walking controlling for age and grouping variable (no preference group versus right-hand preference group). Although the overall model is highly significant, it explains only about 13% of variability in our data.

Conclusion

Regression analysis showed that the onset of crawling is not a significant predictor of the proportion of bimanual acquisitions which we have used as a measure of handedness lateralization. In contrast, the onset of walking significantly predicts an increase in the proportion of bimanual acquisitions and a corresponding decrease in handedness. Moreover, age and the affiliation with a right-hand preference group versus no preference group should be controlled for since these two variables affect the relation of locomotor development to the pattern of exhibited handedness. Although overall our model is highly significant, it explains only 13% of the variability of handedness in our sample. We conclude that if the onset of walking is the constraint on the development of infant handedness, it's rather minor constraint. Examination of other factors constraining the expression of lateralization is therefore needed.

One of the possible explanations for the increase in bimanual reaching observed toward the end of the first year is an increase in handedness for role-differentiated bimanual manipulation (RDBM). RDBM requires each hand to perform different, but complementary, actions on one or more objects. In this case, an infant may be reaching with both hands in order to hold the object with non-preferred hand and actively manipulate it with the preferred one. This would lead to an increase in bimanual acquisitions but it ought to predict an increase in handedness in RDBM at this time.

