



# Different assessment tasks produce different estimates of handedness stability during the eight to 14 month age period



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## ABSTRACT

Using 150 infants (57% males), two common tasks for assessing infant hand-use preferences for acquiring objects were compared for their ability to detect stable preferences during the age period of eight to 14 months. One task assesses the preference using nine presentations of objects; the other uses 32 presentations. Monthly classifications of hand preference for each task were determined by either a commonly used a decision criterion in which one hand is used 50% more often than the other or a criterion based on proportion of hand-use difference that exceeds a conventional alpha probability of 0.05. The seven monthly assessments provided by the two tasks also were examined for latent classes in their developmental trajectories. The two tasks were significantly different for both their identification of latent classes and their monthly classification of the infant's hand-use preference. The 32 presentations yielded three developmental trajectories (45% right preferring, 5% left preferring, and 50% no clear preference) whereas the nine presentations revealed only two trajectories (70% right, 30% no preference). The nine presentations task, with the 50% proportion decision criterion, was very generous in classifying right and left-preferring infants at each month but produced greater fluctuations across months compared to the 32 presentation task with an alpha decision criterion. Both tasks revealed that a large proportion of infants are still developing a hand-use preference during this age period. Recommendations are made for examining the development of hand-use preferences and their relation to the development of other neuropsychological functions.

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## 1. Introduction

The primary goal of this study was to compare two common tasks for assessing infant hand-use preferences for their ability to identify stable preferences. Many investigators have considered handedness to be an unstable trait during its early development with some proposing that handedness cannot be identified reliably until the ages of four to seven years (McManus et al., 1988) or as late as six to 10 years of age (Fennell, Satz, & Morris, 1983; Gesell & Ames, 1947). Consider this recent summary statement: "Infants initially use both hands indifferently (Corbetta & Thelen, 1999; Rönqvist & Domellöf, 2006), then preference for one hand becomes clear generally from 18 months of age on (Fagard & Marks, 2000) and is more

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and more pronounced during the following years (Ingram, 1975)" (Dubois et al., 2009, p. 414). Thus, a general consensus has arisen that restricts reliable handedness assessment to the period beyond infancy (Corbetta & Thelen, 1999, 2002; Fagard, 1998; Fagard & Lockman, 2005; McCormick & Maurer, 1988; Piek, Gasson, Barrett, & Case, 2002; Thelen, 1995; Thelen, Corbetta, & Spencer, 1996). Indeed, most longitudinal studies beginning during infancy have revealed much within-individual variability across age (Corbetta & Thelen, 1999, 2002; Fagard, 1998; Ferre, Babik, & Michel, 2010; Michel, Babik, Sheu, & Campbell, 2013; Piek et al., 2002; Thelen et al., 1996).

However, some evidence indicates that infant hand-use preferences for a skill such as the acquisition of objects are relatively stable across assessment periods for a majority of infants during the age range of seven to 13 months (Michel, Sheu, & Brumley, 2002; Michel, Tyler, Ferre, & Sheu, 2006). Using a reliable and valid procedure capable of identifying significant differences in the frequency of use of each hand at each monthly assessment during the 6- to 14-month period, Michel et al. (2013) assessed the longitudinal character of the hand-use preference for acquiring objects for a large sample of 328 infants (182 males). This large sample size permitted the use of a group based trajectory model which revealed three potential latent classes in these nonlinear, somewhat fluctuating, individual developmental trajectories. The three groups represented those with a right hand-use preference (38%), those with a left hand-use preference (14%) and those without a clear preference (48%) but whose trajectories were significantly trending toward a right hand-use preference.

Thus, although the actual preference scores of hand-use varied across the months for the left-hand and right-hand preferring infants, the pattern was consistent enough to reveal distinct trajectories. These trajectories demonstrated that right-hand preferring and left-hand preferring infants increased and maintained their hand preference for acquiring objects across the 6 to 14 month age period. Consequently, fluctuations in scores may indicate less about fluctuations in handedness development and more about the influence of transitory factors in a rapidly developing nervous system (cf., Babik, Campbell, & Michel, 2014). Only the large sample size with frequent longitudinal assessments enabled the identification of the three groups as distinguished by the developmental trajectory of their hand-use preferences.

Indeed, when infant hand-use preferences were classified for each month (across the six to 14 month age period) using a z-score decision criterion ( $p < 0.05$ ), Michel et al. (2013) found that the 12 month assessment was the best at identifying left-handed and right-handed infants who were identified also by the latent class analysis as having the that same handedness (less than 1% of 328 infants had their latent class hand-use preference misclassified by the z-score decision criterion). Nevertheless, even at 12 months, nearly 40% are likely to be classified differently between the latent class and z-score decision criteria, with most shifting between the hand preference and no preference categories across the two techniques. Thus, a single assessment at any month during infancy is likely to miss the important trajectory aspects of infant handedness development and the nature of that error is likely to vary greatly according to the age at assessment. This raises important problems for assessment of infant hand-use preference, especially for cross-sectional designs.

If infant hand-use preference reflects the consequences of a markedly immature but rapidly developing nervous system, then it may be sensitive to differences in assessment procedures and conditions. It is likely that hand-use preferences may be described as unstable and variable during infancy because of variation across studies in sample sizes, longitudinal sampling rates, and the types of skills being assessed (e.g., swiping at objects, grasping and acquiring them, engaging in role-differentiated bimanual manipulation). Given the wide array of assessment methods and decision criteria used for classifying hand-use preferences, a meta-analysis on the development of infant hand-use preferences or the relation of these preferences to other infant or childhood functions would be misleading and inappropriate.

Since some of the variability in infant hand-use preferences likely derives, in part, from variability in the developmental succession of different kinds of manual skills within which a hand preference may be expressed, the type of manual skill assessed and timing of the assessment becomes critical. We propose that object acquisition skills should be the focus of studies designed to assess the trajectory of the development of hand-use preferences during the period from 6 to 14 months of age for the following reasons. Object acquisition is a prevalent (and sufficiently challenging) manual skill in the infant's repertoire during this period. Also, object acquisition develops after establishment of the skills of reaching for and contacting objects (Michel & Harkins, 1986) and it is incorporated into all other manual skills involving object manipulation (e.g., tool use and artifact construction). Hand-use preference for acquiring objects is related to and predicts the later development (at about 11–12 months) of a hand-use preference for unimanual object manipulation (Hinojosa, Sheu, & Michel, 2003; Campbell, Marcinowski, Babik, & Michel, *accepted*) and a hand-use preference for role differentiated bimanual manipulation, which appears at about 13–14 months (Babik & Michel, *submitted for publication*). Similarly, Fagard and colleagues have used object grasping (similar to object acquisition) to characterize infant hand-use preferences during the first year and its relation to tool-using and gesturing (e.g., Esseily, Jacquet, & Fagard, 2011; Fagard & Marks, 2000; Jacquet, Esseily, Rider, & Fagard, 2012; Sacco, Moutard, & Fagard, 2006). Therefore, acquisition of objects seems pivotal for investigating the early development of hand-use preferences and will be the focus of this study.

Michel (1991, 2002) has argued that the criteria used to define a preference can affect its apparent stability (Michel et al., 2002). For example, calculating a hand-use preference using a laterality index (i.e., the relative difference between hands divided by the total frequency of hand use, Ramsay, 1980) and classifying the infant's preference with a subjective decision criterion (e.g., proportions greater than +50% or less than –50% identify right and left preferences, respectively) may show less stable preferences across assessment ages than a preference defined by statistical estimates of whether the inter-manual differences are likely to have occurred by chance (Michel et al., 2002, 2006). Although a laterality index exhibits a continuous distribution across individuals with a "right shift" skew similar to that observed in adult handedness (Annett, 1972), there is no common agreement about how to classify individuals into relatively discrete handedness groups.

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