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Examining the Development of Handedness in Rhesus Monkey and Human Infants Using Behavioral and Kinematic Measures

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Abstract
Handedness is a widely studied behavioral asymmetry that is commonly measured as a preference for using one hand over the other. Right hand preference in humans occurs at a ratio of 9:1, whereas left hand preference in rhesus monkeys has been estimated at 2:1. Despite differences in the direction and degree of hand preference, this dissertation investigated whether primates share common underlying factors for the development of handedness. Previous work in human infants has identified a predictive relationship between rightward supine head orientation and later right hand preference. Experiment 1 examined the relationship between neonatal head orientation and later hand use in rhesus monkey infants (N=16). A leftward supine head orientation bias was found that corresponded to greater left hand activity for hand-to-face movements while supine; however, neonatal head positioning did not

predict later hand use preference for reaching or manipulation on a coordinated bimanual task. A supine posture is common for human infants, but not for rhesus monkey infants, indicating that differences in early posture experience may differentially shape the development of hand use preference. Movement quality is an additional factor that may affect how the hands are used in addition to neonatal experience. 2-D and 3-D kinematic analyses were used to examine the quality of reaching movements in rhesus monkey infants (N=16), human infants (N=73) and human adults (N=12). In rhesus monkey infants, left hand reaches were characterized as ballistic as compared to right hand reaches independent of hand use preference (Experiment 2). Left hand ballistic reaching in rhesus monkeys may be a carryover from earlier primates that relied on very fast reaches to capture insect prey. Unlike monkey infants, reach quality was a function of hand preference in human infants (Experiment 3). By contrast, a right hand advantage for reaching was observed in human adults regardless of left or right hand preference (Experiment 4). Differential hand experience due to hand preference in early infancy may in part be responsible for the hand preference effects on movement quality observed in human infants but not monkey infants. Motor control may become increasingly lateralized to the left hemisphere over human development leading to the right hand advantage for reaching observed in human adults, as well as over primate evolution leading to right hand use preferences in higher primates like chimpanzees. An underlying mechanism such as a right shift factor in humans and a left shift factor in rhesus monkeys may be a common basis for primate handedness. Environmental and experiential factors then differentially shape this mechanism, including species-typical development. Further work examining the ontogeny of hand preference and hemispheric specialization in various primate infants will lead to a greater understanding of how different factors interact in the development of hand use across primate species.