Reaching kinematics in infant rhesus monkeys *(Macaca mulatta)*

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Background and Aims

- The structure of reaching has been well characterized in human infants using motion analysis. Over the first year of life, reaches become smoother, straighter, and decrease in average speed. Reach kinematics have also been used to examine laterality in motor control, or differences between hands.
- Comparable data in nonhuman primates are limited, particularly in infant samples. Our aim was to conduct the earliest assessment of reach kinematics in the rhesus monkey. The rhesus monkey was chosen because it is one of the most widely studied nonhuman primate species.
- Given prior work in 4.5-month-old rhesus monkeys that found that left hand reaches were smoother than right hand reaches, we hypothesized that there would be a difference between hands in 3-week-old monkeys, and we predicted that any differences would favor the left hand.

Methods and Data Analysis

- *Subjects:* 45 nursery-reared 3-week-old rhesus monkeys. All testing occurred at NICHD.
- *Procedure*: Monkeys were presented with a ball on a stick and encouraged to reach for it (**Fig 1**). Balls varied in size (small: 5 cm, large: 21 mm) and distance from infant (near: 5 cm; far: 14 cm) in a 2 x 2 design. Each trial type was presented twice for a total of 8 trials. All trials were videotaped.
- Reaches were digitized offline with the software program MaxTRAQ 2D using a single point on the wrist. Kinematic data were extracted and processed with Matlab using custom programs.

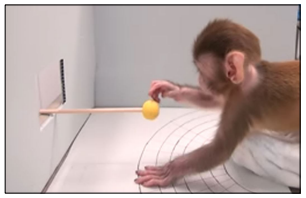

Fig 1. Example of a large ball far trial.

- A three-point differentiation technique was used to calculate speed. Average speed was the mean speed of the hand during the reach.
- Reach straightness was computed by the ratio of path length to straight-line distance. Values closer to 1 indicated straighter reaches.
- Reach smoothness was calculated by examining the number of peaks in the hand-speed profile. Values closer to 1 indicated smoother reaches.

- Linear mixed effects models were used to examine the effects of hand, ball size, and distance from infant on average reach speed, reach smoothness, and reach straightness using the software program R. Satterthwaite approximation for degrees of freedom was used to calculate p-values.

Results and Discussion

- There was a significant effect of hand on reach straightness (β=-0.095, SE=0.036, *t*(165.91)=-2.627, *p*<.01; **Fig. 2**).

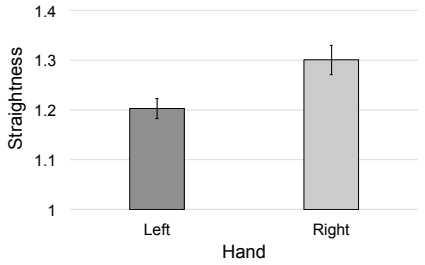

Fig. 2. Reaches made by the left hand were straighter than reaches made by the right hand.

- There was a significant interaction between ball size and distance on reach smoothness (β=-0.477, SE=0.191, *t*(166.87)=-2.491, *p*<.05; **Fig. 3**).

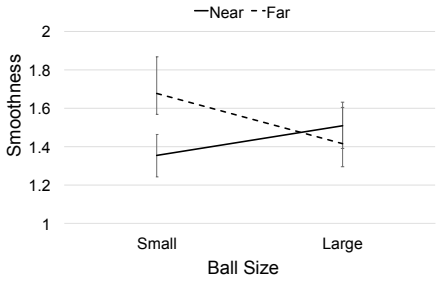

Fig. 3. Reaches to the small ball were smoother at the near distance, whereas reaches to the large ball were smoother at the far distance.

- These findings may provide insight into the evolution of reaching and grasping, as well as the evolution of laterality in motor control in nonhuman primates.

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