Development of reaching and grasping in infant and adult Colombian spider monkeys

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How does prehension develop in humans?
Prehension\(^1\) = (1) Reaching brings the hand to the target
(2) Grasping shapes the hand around the target
The onset of successful reaching and grasping is around 4 months\(^2\)
Timing grasping during object approach resembles adults at 13 months\(^3\)
Reach kinematics change dramatically, but have not reached adult levels by 2 years\(^4\) → Reach Smoothness → Reach Straightness

Why study motor skills in spider monkeys?
Reaching and grasping may have different evolutionary origins\(^1\)
Unlike most primates, spider monkeys do not have a thumb
Adult spider monkeys can execute independent digit movements\(^5\)
How does reaching improve quantitatively in spider monkeys?
How does grasping develop in the spider monkey without a thumb?

Method
Z01: 5 sessions from 2 to 5 months old (N = 40 trials)
  2 sessions at 18 months old (N = 101 trials)
Z03: 1 session at 6 years old (N = 30 trials)
Z02: 1 session at 8 years old (N = 20 trials)
Reaching: left x right counterbalanced presentation
  Onset → First frame movement towards object
  Offset → First frame contact with object
2-D Digitization: MaxTRAQ, 100 frames/s, left and right wrist
Values closer to 1 indicate smoother and straighter reaches

Longitudinal Infant Results
Linear Model
Reach Smoothness (p = .04)
Reach Straightness (p = .22)

Cross-Sectional Juvenile and Adult Results
Fig. 2. Reach smoothness and reach straightness improve with age

Grasp Sequence: Contact hand orientation → Adjusted hand orientation
  Flat: hand parallel to surface; fingers extended
  Palmer: hand parallel to surface; fingers flexed
  Partial Ulnar: digit 5 contact; hand angled; fingers extended
  Partial Radial: digit 2 contact; hand angled; fingers extended
  Radial: digit 2 contact; hand perpendicular to surface; fingers flexed

Fig. 3. Distribution of commonly observed grasp sequences

Conclusion
Improvement in reach smoothness from infancy through adulthood
Improvement in reach straightness only after 18 mos → Floor effect?
Decrease in flat hand contacts with objects → Increase in preshaping during approach

References
Decrease
Improvement
Increase
Floor effect?
Right hand bias

Protracted development of prehension in spider monkeys
Reaching and grasping as distinct processes?
Laterality in motor control?

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