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

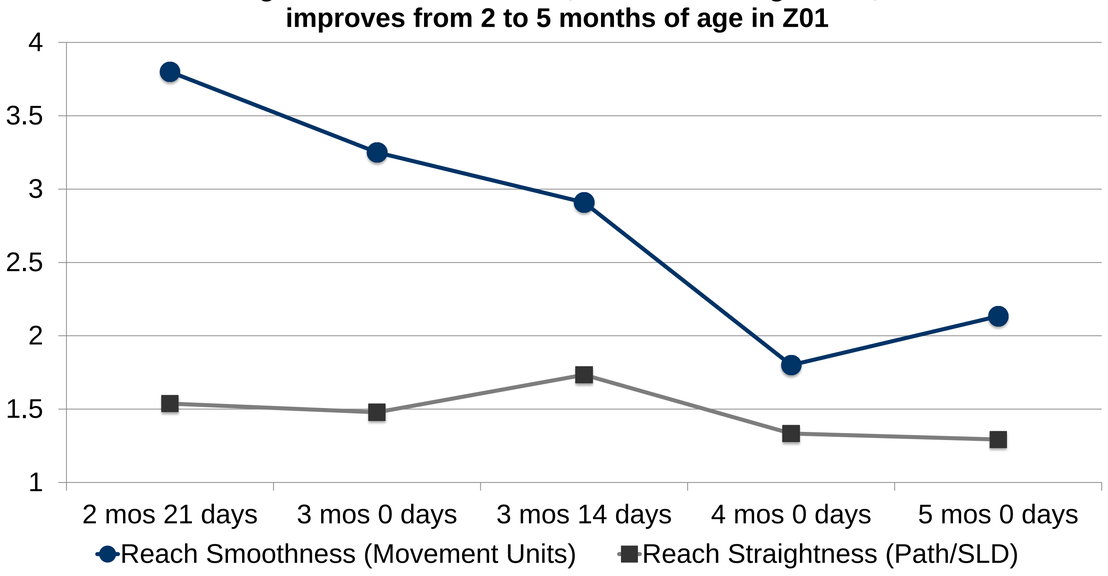
2-D Digitization: MaxTRAQ, 100 frames/s, left and right wrist

Values closer to 1 indicate smoother and straighter reaches

Longitudinal Infant Results

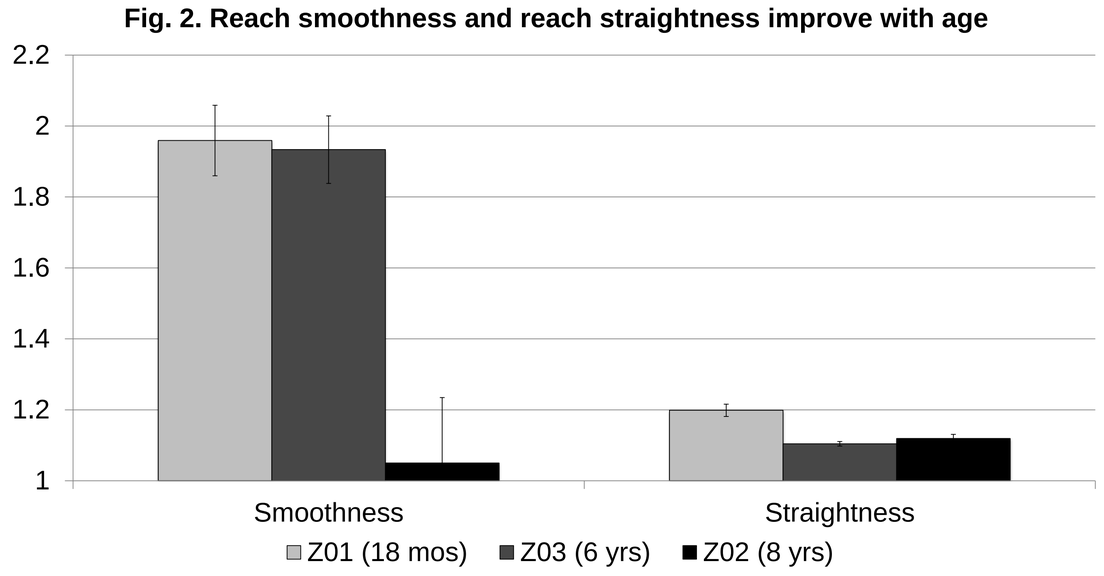
Linear Model Reach Smoothness (p = .04)
Reach Straightness (p = .22)

Fig. 1. Reach smoothness, not reach straightness, improves from 2 to 5 months of age in Z01



Cross-Sectional Juvenile and Adult Results

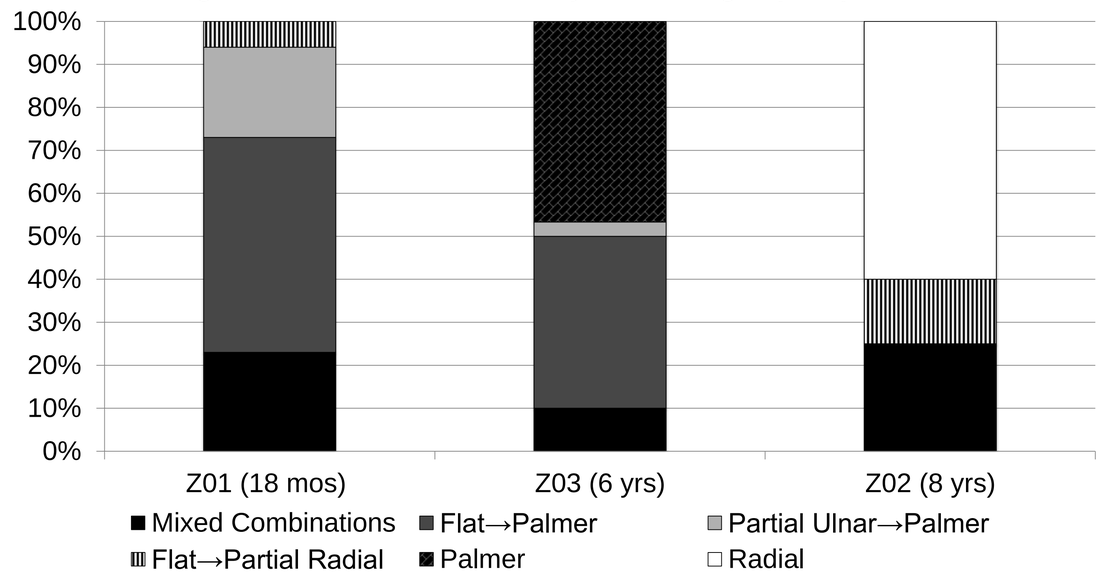
Fig. 2. Reach smoothness and reach straightness improve with age



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

Protracted development of prehension in spider monkeys

Reaching and grasping as **distinct processes?**

Laterality in motor control? → Right hand bias

References

[1]Karl, J.M., & Wishaw, I.Q. (2013). DOI: 10.3389/fneur.2013.00208.
[2]Berthier, N.E., & Keen, R. (2006). DOI: 10.1007/s00221-005-0169-9.
[3]von Hofsten, C., & Rönnqvist, L. (1988). DOI: 10.1037/0096-1523.14.4.610.
[4]Berthier, N.E. (2011). The syntax of human infant reaching. In *8th International Conference on Complex Systems* (pp. 1477-1487).
[5]Nelson, E.L., & Boeving, E.R. (2015). DOI: 10.1002/ajp.22478.

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