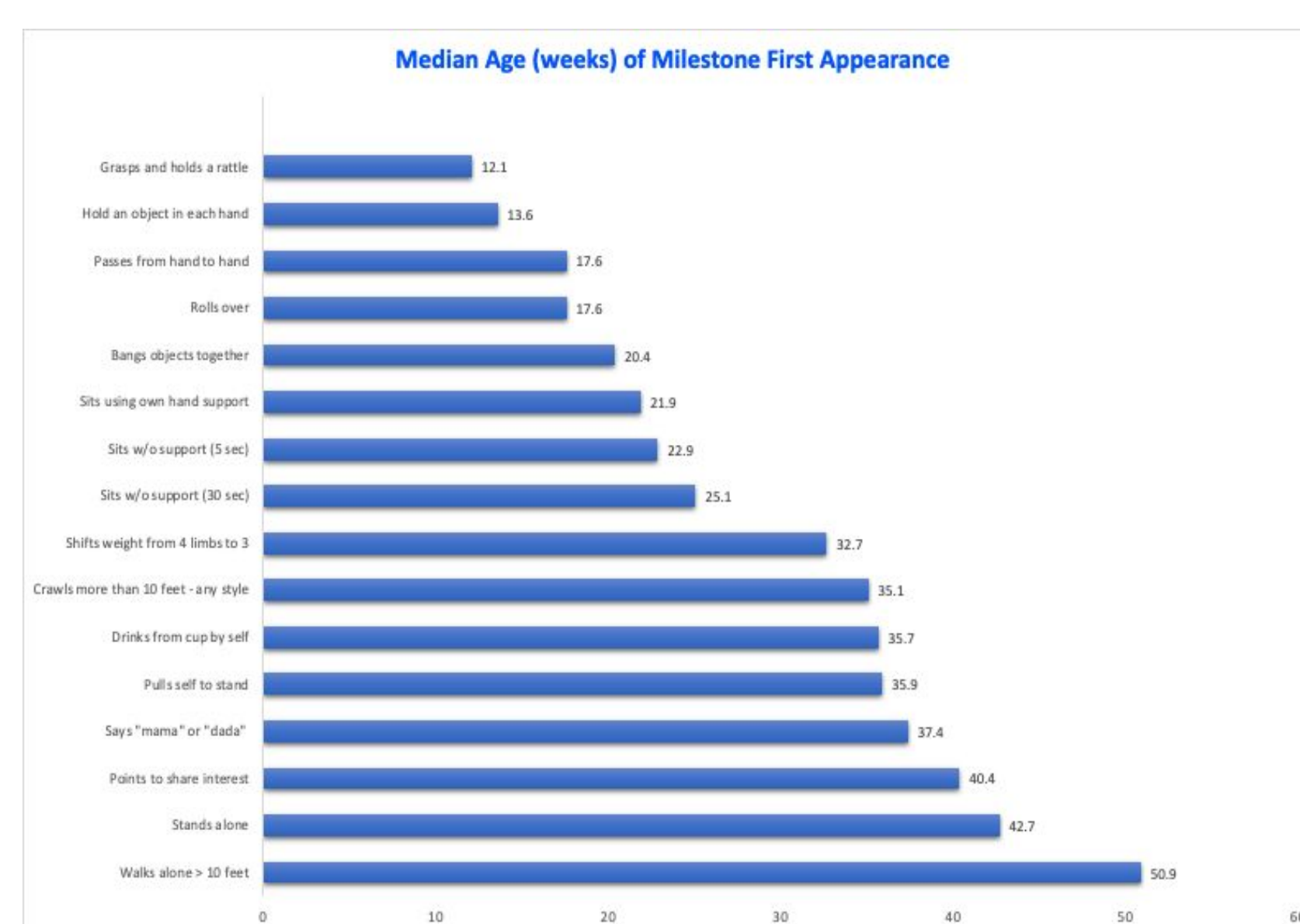


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### Cross-sectional vs. longitudinal data

- Infant developmental science largely rests on cross-sectional data, & most age plots in developmental textbooks are cross-sectional.
- For example, the cross-sectional graph shown below plots the median ages of the first appearance of some familiar infant milestones.



- When viewing a cross-sectional display, we tend to assume that a random baby would traverse the milestones in the *implied* longitudinal sequence.
- That said, developmental methodology courses have long reminded us not to casually conflate longitudinal and cross-sectional patterns.
- We received a similar reminder about conflation dangers from the research we were doing, which examined the role of crawling on the development of joint attention.

### Joint attention and crawling

- Being able to share attention with an adult is an important developmental achievement in infancy. Shared attention helps babies learn about their world through their experienced caregiver.
- Campos and colleagues inferred from cross-sectional studies that babies with crawling experience become better at joint attention than their late-crawling and non-crawling agemates.
- Campos et al concluded that *self-locomotion* supported the crucial underlying experiential basis for the development of joint attention.
- Here we test the self-locomotion hypothesis using our large database of multiple baby milestone attainments (the bar chart above is drawn from this database).



### Milestone Age-of-Attainment Study

- Parents and their infants were recruited during birth delivery stays in two hospitals in Winnipeg, Canada.
- Two months later we mailed parents monthly checklists for recording the presence of easily observable milestones that first appear during the first 18 months of life.
- For each milestone, the parent indicated whether or not it had been observed on a given day. Completed checklists were mailed back to the researchers.

### Sample Milestone Recording Form

Milestones	Each day, mark every item with one of the following
Grasps and holds a rattle or toy	
Reaches for object	
Passes from hand to hand	
Sits using own hand support	
Sits without support (10 sec)	
Sits without support (30 sec)	
Rolls over	
Rocks on hands and knees	
Shifts weight from 4 limbs to 3	
Feeds self finger food	
Crawls less than 10ft (3m):	
belly crawl	
other crawl	
hands-and-knees crawl	
Crawls more than 10ft (3m):	
belly crawl	
other crawl	
hands-and-knees crawl	
Drinks from cup by self	

- An *Age of First Attainment* (AoF) was calculated for each of a baby's milestones. AoF is the time in weeks between the date of the 1st observation of a milestone and the baby's birthdate. AoFs had excellent split-half reliabilities (high .90's), calculated from intraclass *r*'s based on odd vs even days of the month.
- **Pointing**, a form of joint attention, and crawling were defined for the parent observers as follows:

**Points** or reaches to make you notice something. Baby points or reaches toward an object or event they're interested in and want you to notice (baby wants to share interest or enjoyment).

**Crawling** more than 10 ft (3 m). Using a consistent crawling style, baby can really move forward across a room without breaking stride or needing a long rest break. Only check this skill if you see your baby continuously go 10 feet or more (this will involve several consecutive crawling steps).



### Does crawling predict pointing?

- **Sample.** We looked at the longitudinal sequences of 304 babies in our dataset who had started crawling. 141 of them left the study before they were seen to point.
- **Survival Analysis (SA) advantage.** In customary analyses, such as multiple regression, one would not include those dropouts. In contrast, SA includes such cases because the information about their age when they drop out is informative about pointing.
- **Pointing Results.** The SA revealed that babies who crawled early also pointed early. ( $X^2=8.88$ ,  $p<.01$ ) even after the effects of 8 covariates (gender, gestational age, delivery type, ponderal index, parent smoking, parent drinking, SES, children in household) had been removed.
- **Implication.** Campos et al's key findings are replicated with a large longitudinal study. However, this replication only establishes that self-locomotion associated with crawling is one *possible* explanation for pointing onset.
- **The Big If.** Ages of milestone attainment are often positively correlated. Babies who reach one milestone at a young age tend to reach other motor milestones relatively early as well. A different, pre-crawling milestone could also predict the onset of pointing. If that other milestone did not involve self-locomotion, the case for the self-locomotion hypothesis would be weakened.



- **Unsupported sitting** is a milestone that precedes crawling and does *not* entail self-locomotion. If early sitters point sooner than late sitters, the difference in pointing onset could not be attributable solely to *self-locomotion*. We could test this possibility.

### Does sitting onset predict point onset?

- **Unsupported sitting** was defined for the parent as follows:  
**Sits without support** (30 seconds). Sits up alone (not propped on pillows or a chair) without using hands for support for at least 30 seconds. Back is straight. Baby often uses hands to play with a toy.
- **Sitting Analysis and Results.** The SA was conducted on the 304 babies, except sitting replaced crawling as a predictor. Sitting was a significant ( $X^2=5.61$ ,  $p<.02$ ) positive predictor of pointing, even after the effects of the 8 covariates had been removed. Early sitting positively predicted earlier pointing onset.
- **Obvious Implication.** *Self-locomotion* can *not* be the only plausible facilitator of pointing because sitting onset predicts the appearance of the much later pointing onset.

### Sequence problem

- We had assumed that the age-related Sit < Crawl < Point sequence was universal. It's found in cross-sectional data and seems reasonable. But is it?
- Could some babies point before they crawl? We tallied the number of babies for each possible pattern of attainment for sit, crawl, and point.
- We were surprised that 25% of babies pointed before they crawled! How could self locomotion be a crucial influence on pointing for them?

Sequence	Frequency	% sample
Sit-Crawl-Point	107	65.6
Sit-Point-Crawl	41	25.2
Crawl-Sit-Point	6	3.7
Point-Sit-Crawl	8	4.9
Point-Crawl-Sit	1	0.6
Crawl-Point-Sit	0	0.0

### Conclusion

Self locomotion is an important organizer of development, including referential pointing. However, it is unlikely to play the sole *critical* role in the development of pointing for two reasons: Individual differences in sitting is predictive of individual differences in pointing onset, and 25% of babies pointed *before* they crawled.

Cross-sectional sequences sometimes look more universal than they actually are, highlighting the importance of longitudinal studies in developmental psychology.