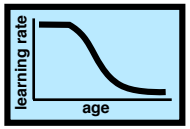
A critical period for acquisition of second language syntax
Evidence from 669,498 English speakers

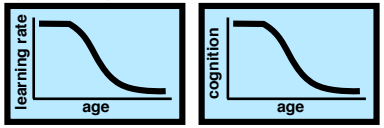
Joshua K. Hartshorne (Boston College) Joshua B. Tenenbaum (MIT) Steven Pinker (Harvard University)

Why are children more successful at learning new languages?

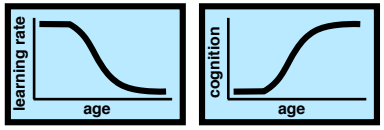
1. Language-specific critical period? (Lenneberg, 1967; Johnson & Newport, 1989)



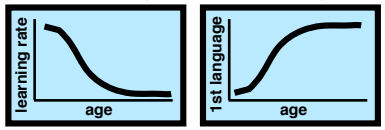
2. General cognitive decline? (Hakuta et al., 2003)



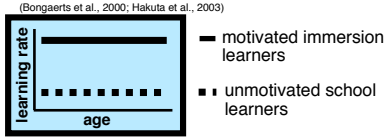
3. Less is more? (Newport, 1988)



4. Interference from 1st language? (Hernandez, Li, & MacWhinney, 2005; Sebastián-Gallés et al., 2005)

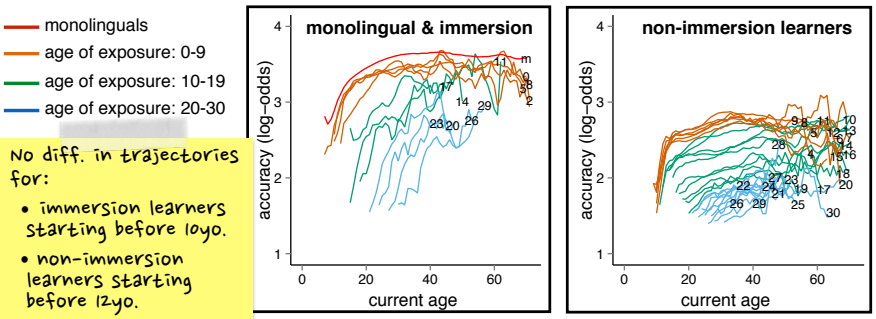


5. Environment / motivation? (Bongaerts et al., 2000; Hakuta et al., 2003)



To compare theories:
- Measure developmental change in learning rate
- compare with other processes

Primary analyses: How does learning rate change with age?



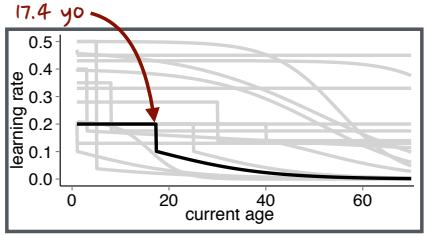
No diff. in trajectories for:
- immersion learners starting before 10yo.
- non-immersion learners starting before 12yo.

analytic model (ELSD)

$$g(t) = 1 - e^{\int_{t_e}^{t} -Er\,dt}$$

$$r(t) = \begin{cases} r_0, & t \le t_c \\ r_0\left(1 - \frac{1}{1 + e^{-\alpha(t - t_c - \delta)}}\right), & t > t_c \end{cases}$$

g(t) = gramm. knowledge at age t
r(t) = learning rate at age t
t = current age
t_c = critical age
t_e = age of exposure
α, δ = rate of decline
r_0 = initial learning rate
E = rate of exposure

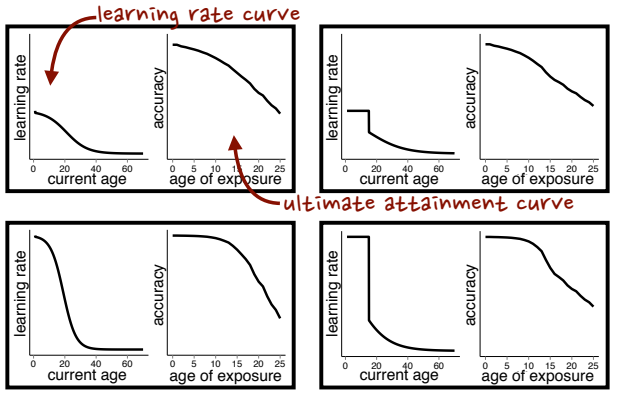


pdf: l3atbc.org/Publications.html

Previous attempts unsuccessful

Strategy #1: Measure learning rate in real time
Problem: Adults always learn faster. (Krashen, Long, & Scarcella, 1979; Snow & Hoefnagel-Hohle, 1978)
- superior attention
- explicit strategies

Strategy #2: Compare learners' ultimate attainment
Problem: Mapping from ultimate attainment curves to learning ability curves is many-to-many

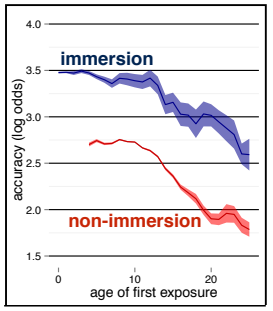


Note: Quantitative predictions based on ELSD model, but the basic point is model-independent.

Ultimate Attainment Curves

Inconsistent prior findings:
- last chance for native-like prof: 0-17yo
- Floor in curve by puberty or never

Probably due to low power
- cf. Vanhove (2013)
- Confirmed by bootstrap simulation (ask me)



learners with >29 yrs. experience

Conclusions

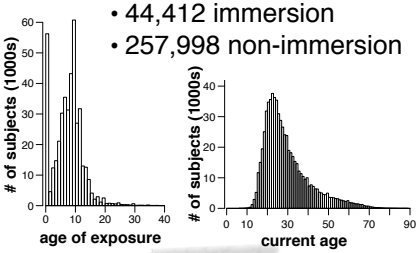
- Learning rate falls at 17-18 yo
- Calls for new theories (old theories focused on much earlier ages)

Method: Internet Quiz

www.gameswithwords.org/WhichEnglish

Items:
- 95 critical items (+ 37 filler)
- grammaticality judgment
- sentence-picture matching
- Chronbach's alpha: 0.86

Subjects:
- 244,840 monolinguals
- 44,412 immersion
- 257,998 non-immersion

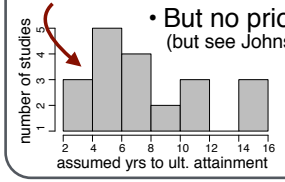


Features
- Adequate sample size
- Internet data is high quality
- Diverse 1st langs
- Diverse stimuli

Limitations
- Relatively few items
- cross-sectional
- cannot choose subjects
- Diverse 1st langs
- Diverse stimuli

Does Learning Take 30 years?

- Frequently claimed that 5yos have mastered L1
  - i.e., above-chance performance
  - BUT above-chance ≠ adult-like
  - No prior measure of asymptote
- Debate about when L2 learning ends
  - But no prior measurement (but see Johnson & Newport, 1989)



Future Directions

- Other L2s
- Phonology & semantics
- production