Robust heterogeneity in cognitive development: A large-scale investigation

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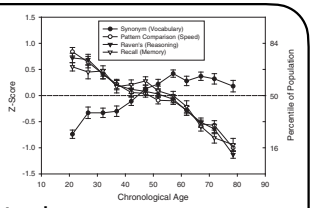
Background

- Classic distinction between early-peaking "fluid intelligence" and late-peaking "crystalized intelligence" [1, 2]
- BUT based on limited range of tasks
- More recent findings that don't fit dichotomy [3-6]



(Salthouse, 2004)

Present Study

Q: How well does fluid/crystalized dichotomy account for wide range of cognitive tasks?

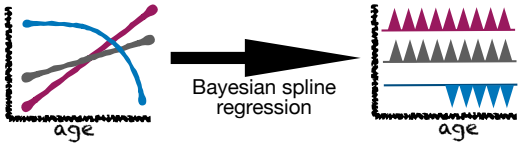
Data: Massive online experiments [3,5,7-10]

References

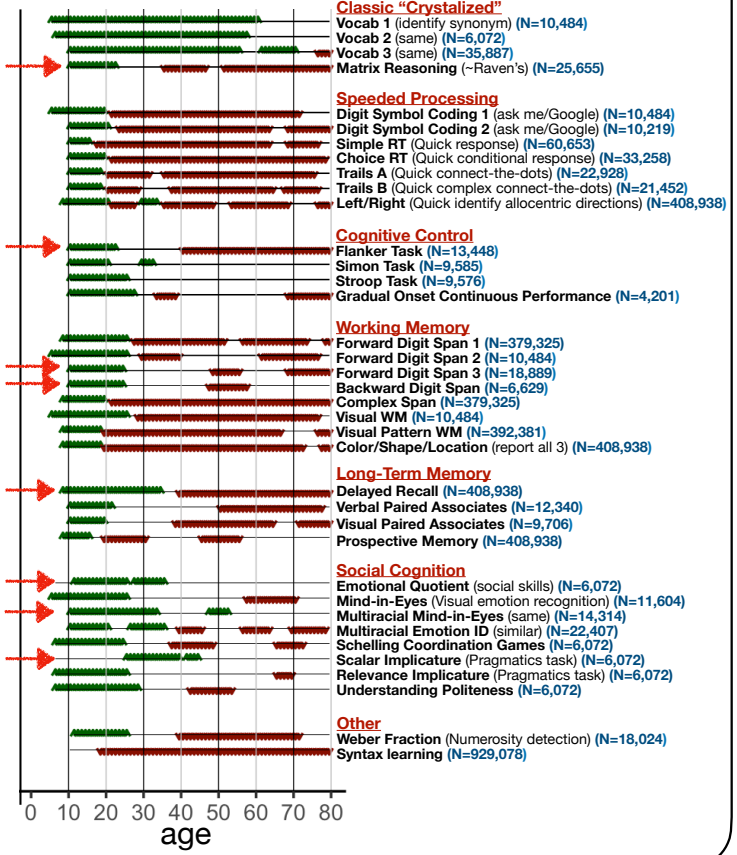
1. Salthouse, T. A. (2004). What and when of cognitive aging. Current directions in psychological science, 13(4), 140-144. **2. Doppelt, J. E., & Wallace, W. L. (1955).** Standardization of the Wechsler adult intelligence scale for older persons. The Journal of Abnormal and Social Psychology, 51(2), 312. **3. Hartshorne, J. K., & Germine, L. T. (2015).** When does cognitive functioning peak? The asynchronous rise and fall of different cognitive abilities across the life span. Psychological science, 26(4), 433-443. **4. Germine, L. T., Duchaine, B., & Nakayama, K. (2011).** Where cognitive development and aging meet: Face learning ability peaks after age 30. Cognition, 118(2), 201-210. **5. Erb, C. D., Germine, L., & Hartshorne, J. K. (2023).** Cognitive control across the lifespan: Congruency effects reveal divergent developmental trajectories. Journal of Experimental Psychology: General. **6. Hampshire, A., Highfield, R. R., Parkin, B. L., & Owen, A. M. (2012).** Fractionating human intelligence. Neuron, 76(6), 1225-1237. **7. Logie, R. H., & Maylor, E. A. (2009).** An Internet study of prospective memory across adulthood. Psychology and aging, 24(3), 767. **8. Johnson, W., Logie, R. H., & Brockmole, J. R. (2010).** Working memory tasks differ in factor structure across age cohorts: Implications for dedifferentiation. Intelligence, 38(5), 513-528. **9. The Many Brains Project.** TestMyBrain Cognitive Tests. URL: www.manybrains.net. **10. Hartshorne, Vidal, & Pinker (under revision)**. The search for *s*.

Step 1: Calculate ages of significant change

method



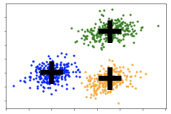
results



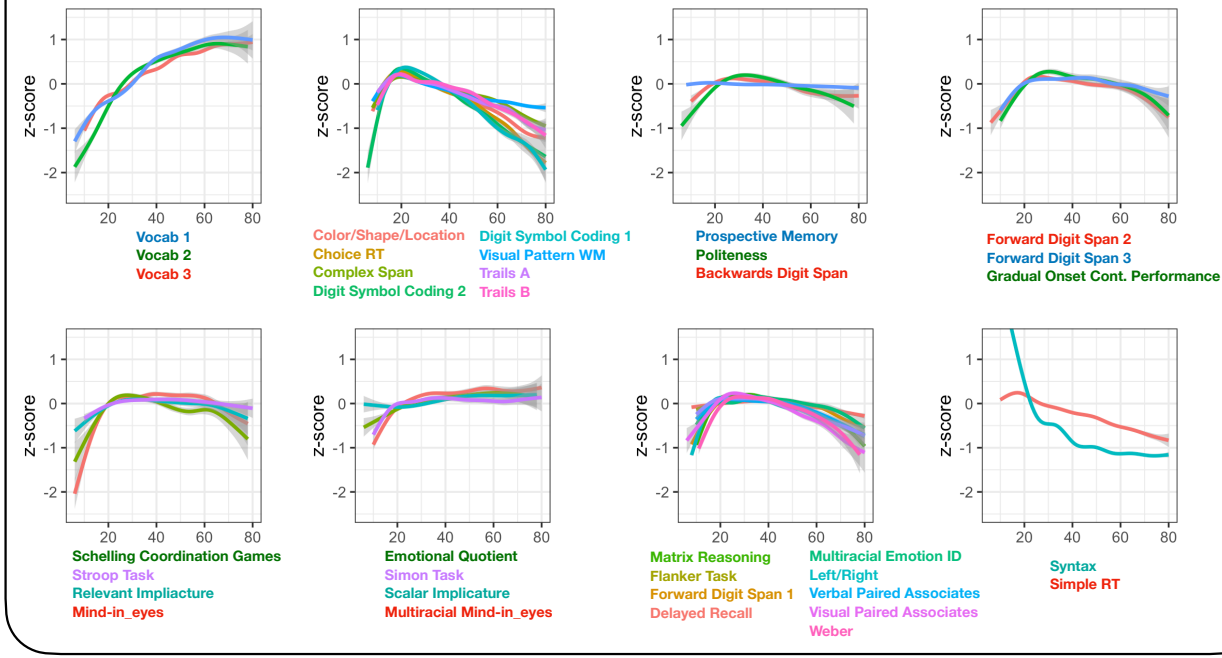
Step 1: Identifying patterns with clustering

method (modified k-means algorithm)

- Cluster "change charts" from Step 1 to identify k "mean" change charts
- Enforce smoothness constraint (infrequent changes of direction)



Example of k-means clustering in 2-D space, where k=3



Summary & Discussion

- No "young adult controls" — dev continues after 18 for some abilities
- Fluid/Crystalized dichotomy is overly coarse-grained
- **Q**: Can results be explained by classic two-factor model (speed & experience), or are more factors required?
- **Note**: Standard factor analysis models are not appropriate for lifespan data (they assume no ceiling or floor effects, no compensation)