Synthesizing evidence about developmental patterns in human visual acuity as measured by Teller Acuity Cards

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Motivation

Replication is a cornerstone of scientific rigor and a prerequisite for cumulative science. Direct replication is common in some subfields and topics, but less so in others. This project synthesized evidence from published research across a four decade period that employed a widely used measure of grating visual acuity (VA), Teller (Teller, McDonald, Preston, Sebris, & Dobson, 1986) Acuity Cards (TAC). We sought to capture findings about the development of VA in early childhood, harmonize them into an aggregated dataset, and share the dataset openly. The ultimate goal was to characterize how grating visual acuity develops.

Methods

To achive this, we did the following:

1. Searched Google Scholar for the terms "teller acuity cards", "visual acuity cards", or "teller cards" and found n=751 papers.
2. Determined which papers had full-text or PDFs available (n=433).
3. Evaluated each paper to determine which had extractable data or had summaries of data presented elsewhere (n=27).
4. Harmonized the data into a soon-to-be-shared Google sheet.
5. Created visualizations and summaries of the data.

Figure 1: QR Code for Project Site: https://gilmore-lab.github.io/visual-acuity

Results: Sources synthesized

Category	n	Comments
Found in search	751	Terms: "teller acuity cards", "visual acuity cards", or "teller cards"
Had PDFs or full text versions.	433	Continuing to seek additional papers
No PDF/full text available	318	
Extractable data	27	Includes data summarized by others for which no full-text version was available.

Results: Typically developing children

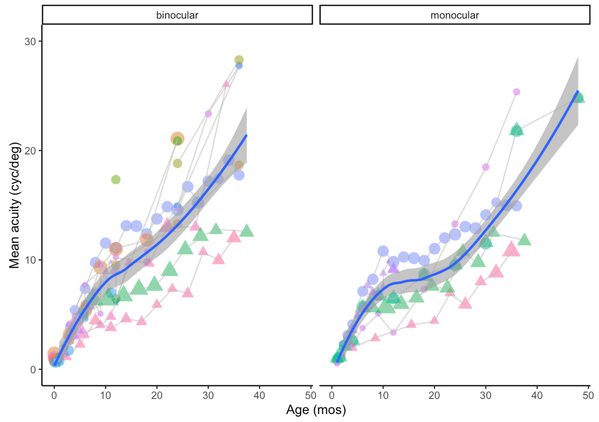

Figure 2: Mean or median visual acuity by age (mos) across n=19 papers. Binocular values (left column); monocular values (right column)

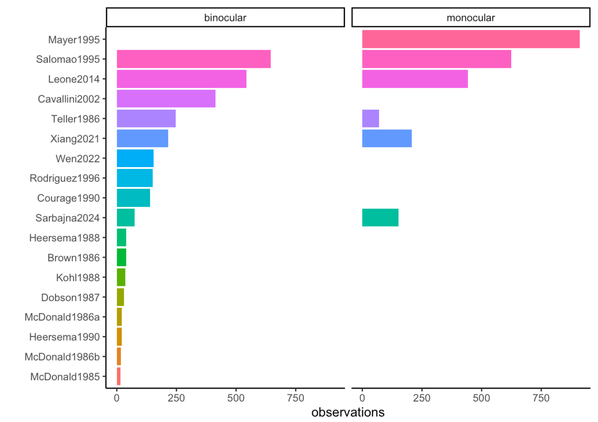

Figure 3: Number of participants by eye(s) tested for papers reporting by-condition sample sizes.

Across the n=19 papers, n=5,212 participant observations are included. The n`s per age group are in [1, 84] with a median of n=20.

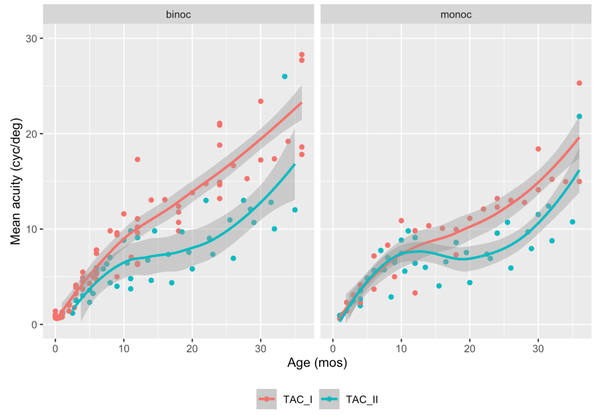

Figure 4: Best fitting (loess) functions to group acuity data by card type for children 3 and younger.

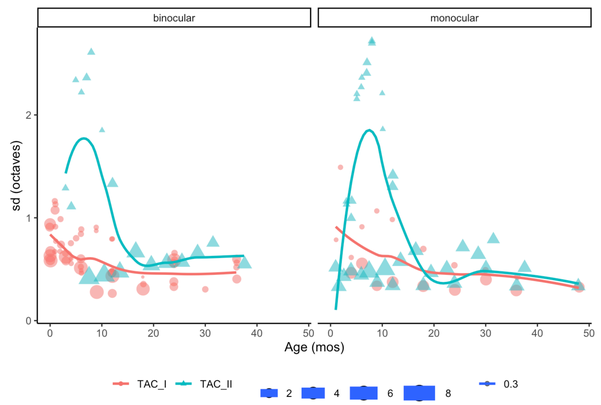

Figure 5: Standard deviation (in octaves) of group acuity estimates by mean (median) group acuity, eye(s) tested and card type.

Results: Atypically developing children

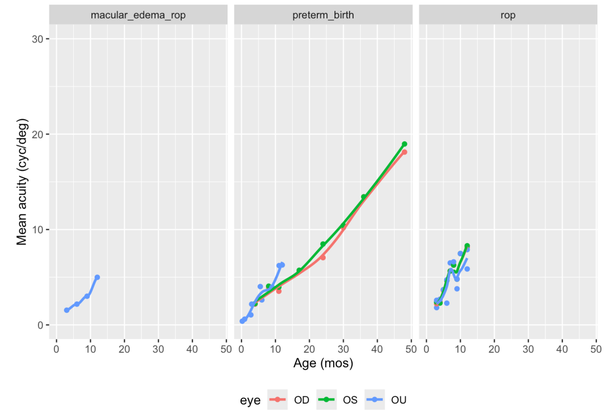

Figure 6: Atypical children caption.

Conclusions

- Synthesizing evidence about core facets of human visual development is important and illuminating.
- Variation in mean acuity thresholds at different ages and by card type pose challenges for norm or standard-setting.
- Idiosyncratic practices for reporting data in published papers make evidence synthesis challenging, even when researchers use a common method.
- Future work will involve: 1. Acquiring papers that did not have full text versions available and incorporating their findings, and 2. Contacting individual researchers to seek unpublished datasets.
- Vision scientists should adopt open data sharing practices more widely and should curate shared data in ways that make synthesis and aggregation easier.

Bibliography

Teller, D. Y., McDonald, M. A., Preston, K., Sebris, S. L., & Dobson, V. (1986). Assessment of visual acuity in infants and children: the acuity card procedure. *Developmental Medicine and Child Neurology*, *28*(6), 779–789. https://doi.org/10.1111/j.1469-8749.1986.tb03932.x