Language Production in Blind Infants

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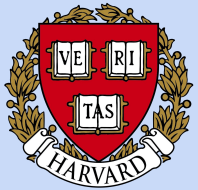


Early language development in blind infants

Blind adults' language is largely indistinguishable from sighted adults

Language acquisition - window into experience with referent-reference disconnect

Little is known on the process of language acquisition in blind infants

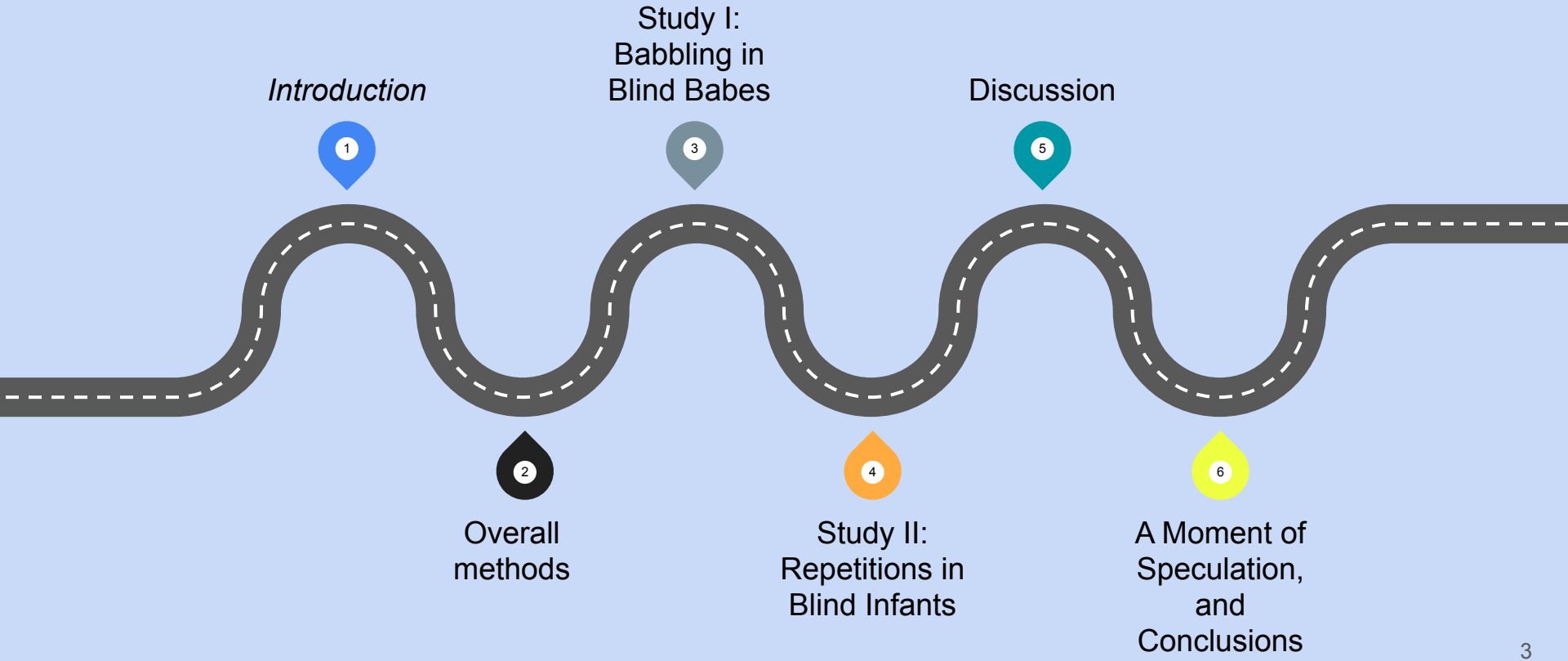
Blind infants ~7 mo delayed in vocabulary acquisition

Acquire vocabulary comparable to sighted infants in:

- Part of speech composition
- Tangibility and sensory mode (aside from very visual words)

Landau & Gleitman, 1985; Brooks & Meltzoff, 2008; Clerkin et al, 2007; Iverson & Goldin-Meadow, 2005; Greenaway & Dale, 2017; Campbell et al, 2024; Roder et al, 2012

Roadmap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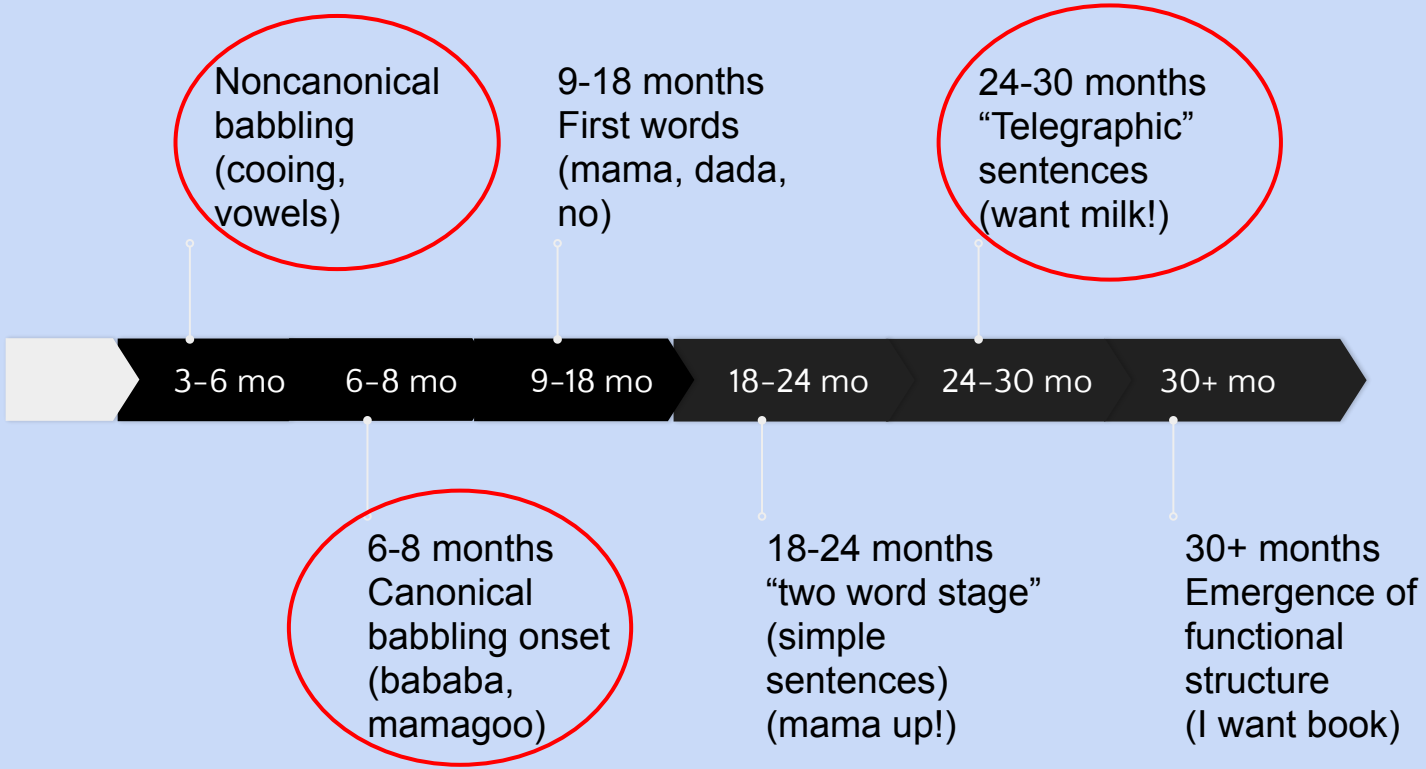
Timeline of early language production



Etiology and incidence of blindness

To ask this question we need a very specific type of population:

- Only light perception
- No cognitive disabilities

Teeny-tiny subset of a teeny-tiny population!

In the US 3% children have any kind of visual impairment (CDC)

Worldwide, blindness prevalence in youth under 20 is 0.17% (Yekta et al, 2022)

Method

Daylong audio recordings with LENA

- 15 two-minute random samples
- 5 two-minute high-talk-density samples
- Study 1: 40 min per kid (manually transcribed)

  = 800 annotated minutes (20 kids)
- Study 2: 130 min per kid (manually transcribed)

  = 1300 min (10 kids)

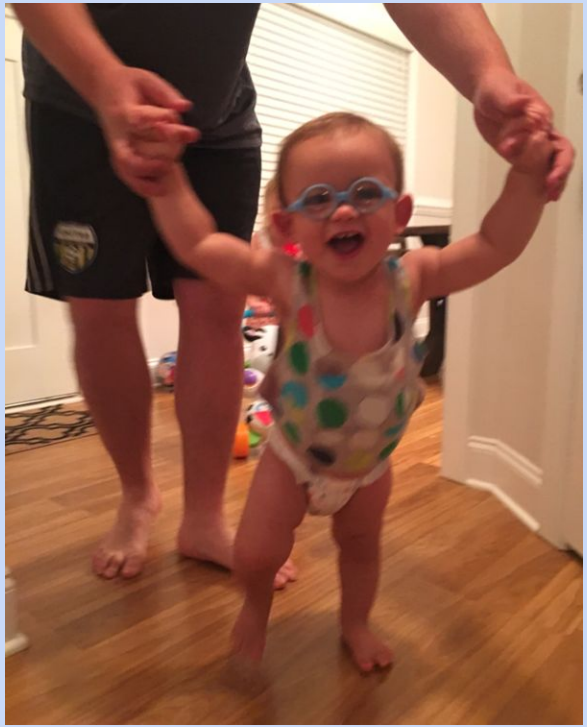


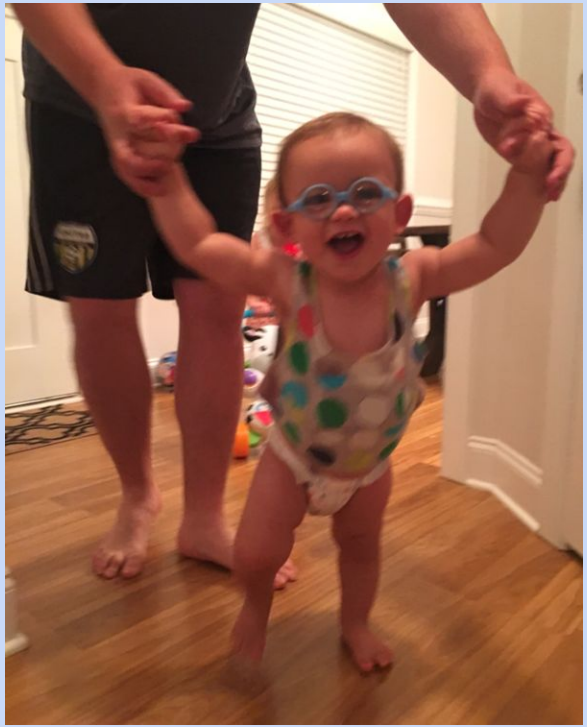
image courtesy of parent

15 blind participants (16 recordings):

- English monolingual (>75% English input)
- No more than minimal light perception
- No hearing or cognitive/developmental diagnoses
- 6.4 – 30.3 mo. old; Mean = 15.7 mo.
- 8 male, 8 female
- 0-2 older siblings
- Mid-to-high SES, majority of moms completed some post-secondary ed.

16 sighted participants (16 recordings), matched on:

- Age (within one month)
- Gender
- Maternal Education ±1
- # of older siblings ±1



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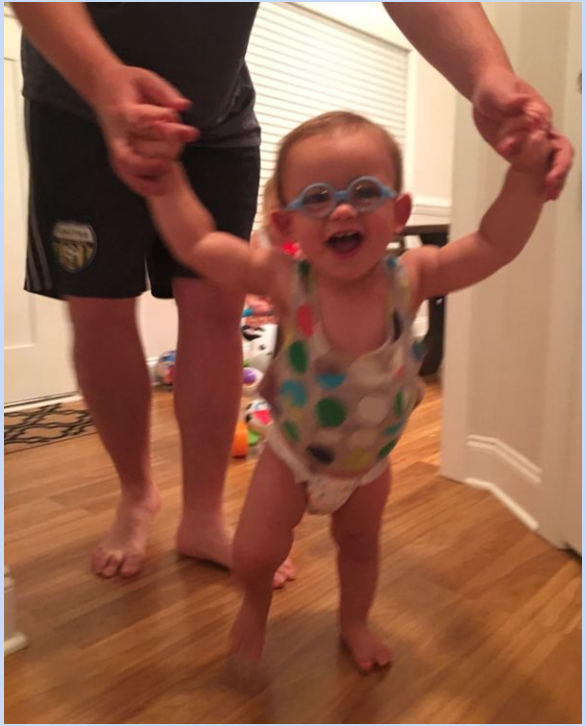
Corpus split on producing/not producing multi-word utterances

Study I: Babbling in Blind Babies

- 10 blind, 10 sighted infants
- Age 6.4-15 months

Study II: Repetitions

- 5 blind, 5 sighted infants
- Age: 15-30.3 months



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Questions to keep in mind

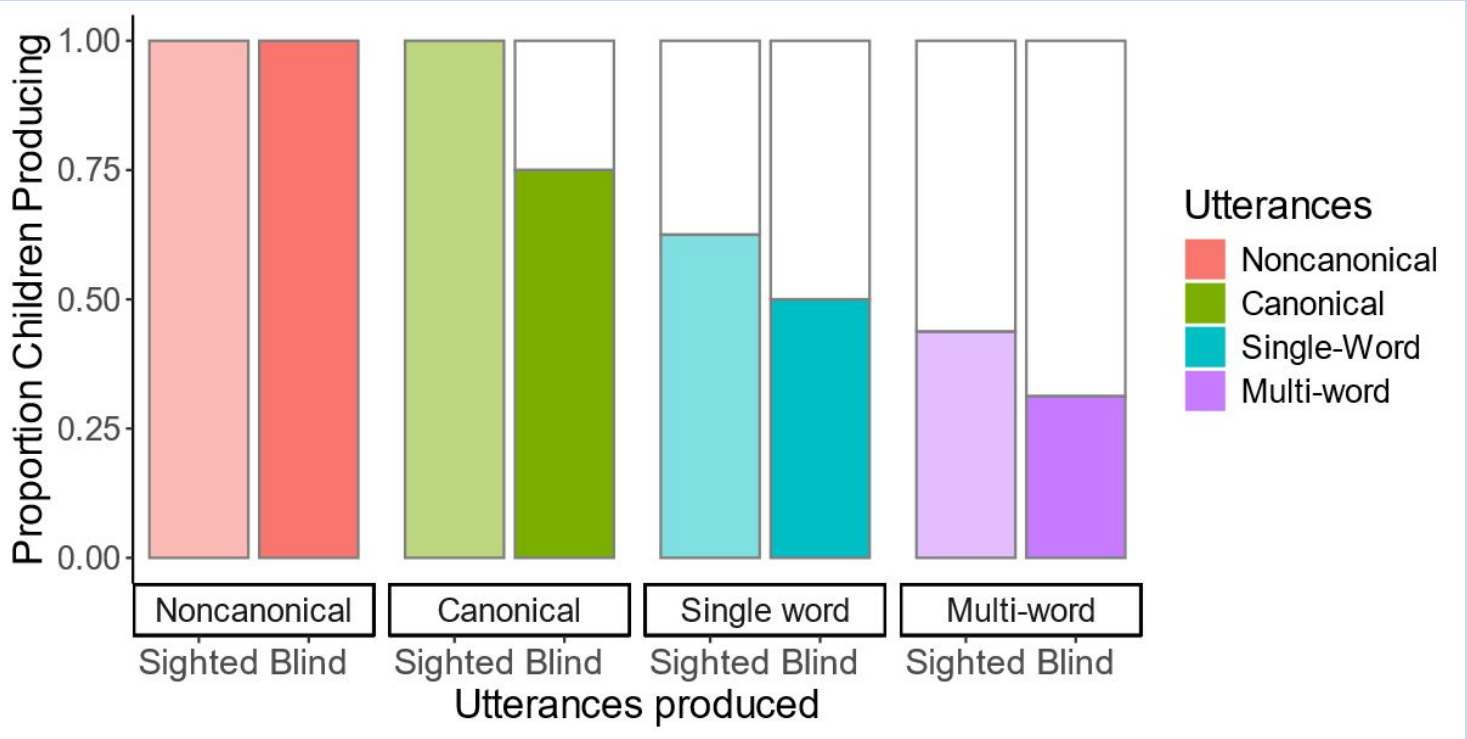
- **Do young blind and sighted children produce the same amounts of various types of vocalizations?**
- **Do blind and sighted infants babble the same way, in terms of trajectory, canonical proportion, and speech sounds?**
- **Do blind and sighted toddlers repeat their input in the same ways in terms of repetition types and functions?**

Let’s answer question 1!

Production

Do young blind and sighted children produce the same amounts of various types of vocalizations?

Do our matched samples vary across vocalization-types?

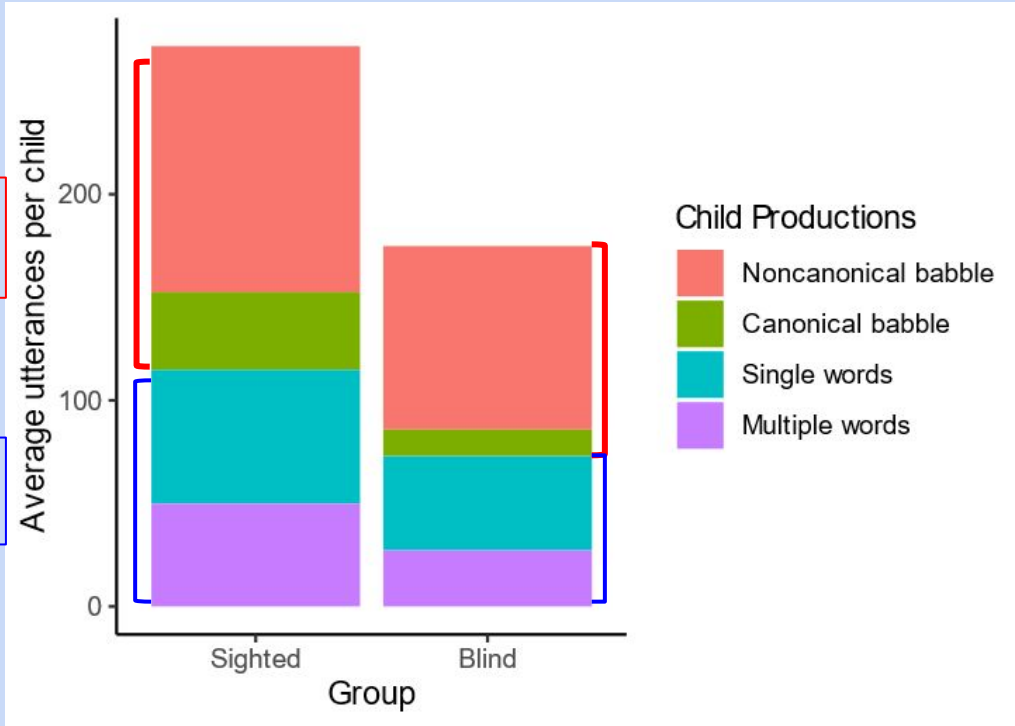


Yes, blind infants produce fewer canonical babbles, words, and multi-word utterances.

Do blind kids produce the same amount of vocalizations?

Study I

Study II



No! Blind infants produce fewer raw numbers of vocalizations across the board.

Questions to keep in mind

- **Do young blind and sighted children produce the same amounts of various types of vocalizations?**

  No, blind infants produce fewer vocalizations across the board

- **Do blind and sighted infants babble the same way, in terms of trajectory, canonical proportion, and speech sounds?**

- **Do blind and sighted toddlers repeat their input in the same ways in terms of repetition types and functions?**

Study I: Babbling in blind infants

Previous studies on babbling

Babbling progression correlates with first word production and language development.

Non-canonical babbling

- vowel sounds
- cooing
- gurgles

Canonical babbling

- CV syllables
- some multisyllable babble strings

Differences in babbled production based on language

Cychosz et al, 2021; Laing & Bergelson, 2020; Molemans et al, 2012; McGillion et al, 2017; Mills, 1984

How can we measure babbling progression?

More canonical babbling = more mature

Transition from nonrhythmic patterns to rhythmic consonant-vowel sequences

Different consonants appear in different stages

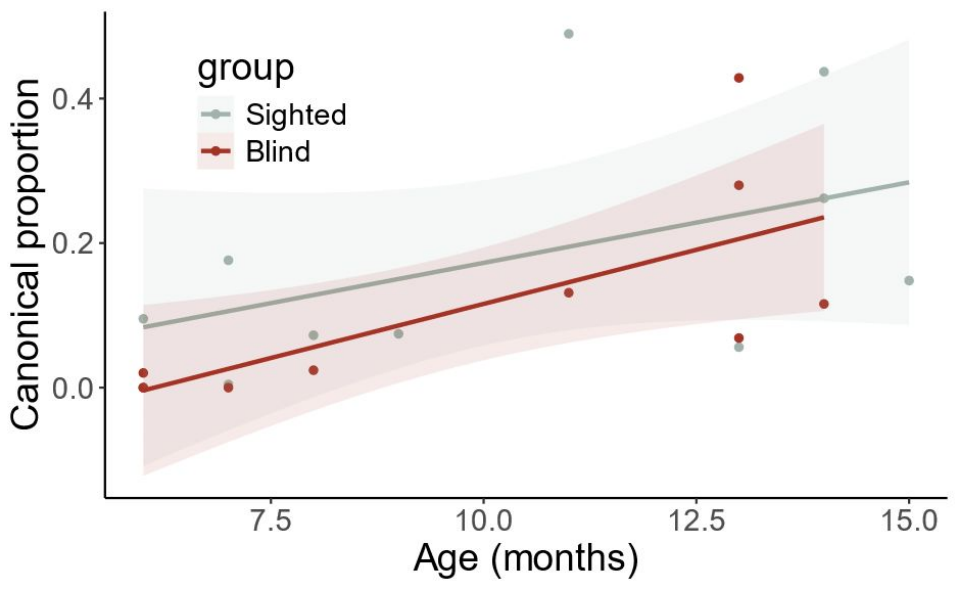
$$CP = \frac{\text{(number of canonical utterances)}}{\text{(total number of utterances)}}$$

Canonical Proportion

Progression

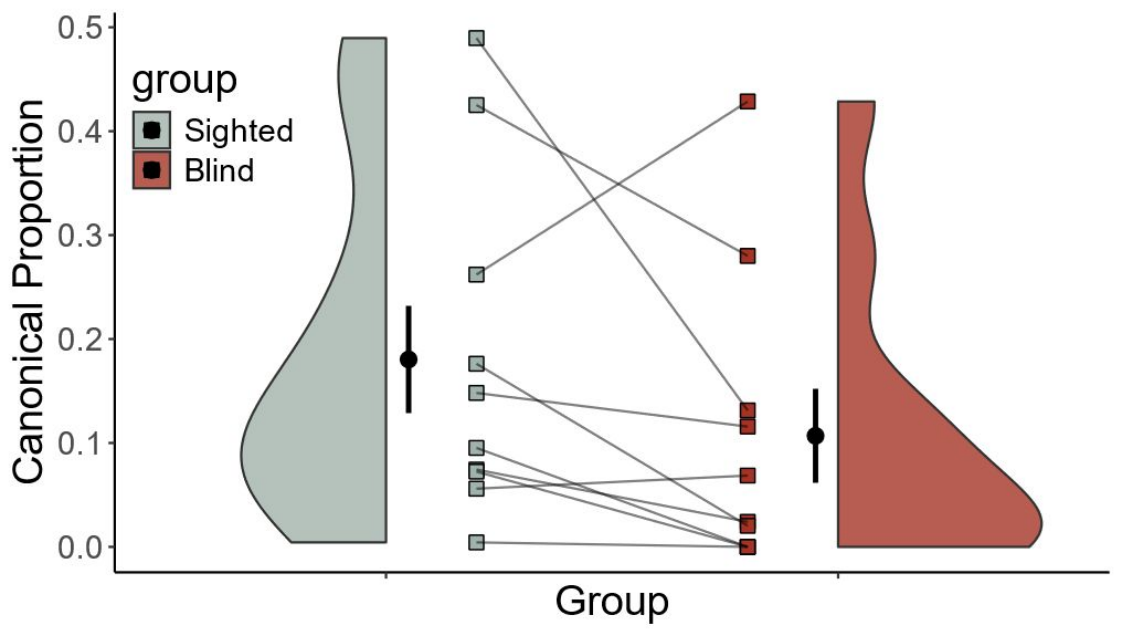
Do blind infants babble the same way, in terms of trajectory, proportion, and phonological makeup?

Is there a difference in babbling trajectory?



No! Blind = Sighted in terms of babbling onset, canonical proportion, and trajectory

Is there a difference in proportion of babbling?



No! Analysis shows no difference between the groups on babbling proportion metrics.

Phonology

Do blind infants babble the same way, in terms of trajectory, proportion, and phonological makeup?

Phonetic production

Babbling is affected by:

- Auditory input (listening to the sounds)
- Visual input (looking at faces)

Infants shift to *look at mouths* when they start to babble

Blind infants are prone to pathologies of sound production.

What does phonetic production look like without visual input?

- Fewer visible consonants involving the mouth (e.g. [b], [m], [f])
- Fewer rounded vowels (e.g. [o], [u])

Brouwer et al, 2015; Imafuku et al, 2019; Laing & Bergelson, 2020; Mills, 1984; Murakami et al, 2019; Tenenbaum et al, 2015; Lewkowitz & Hansen-Tift, 2012

Method - phonetic coding

ARPAbet - coding IPA using ASCII

Infant production: messy and tricky to transcribe

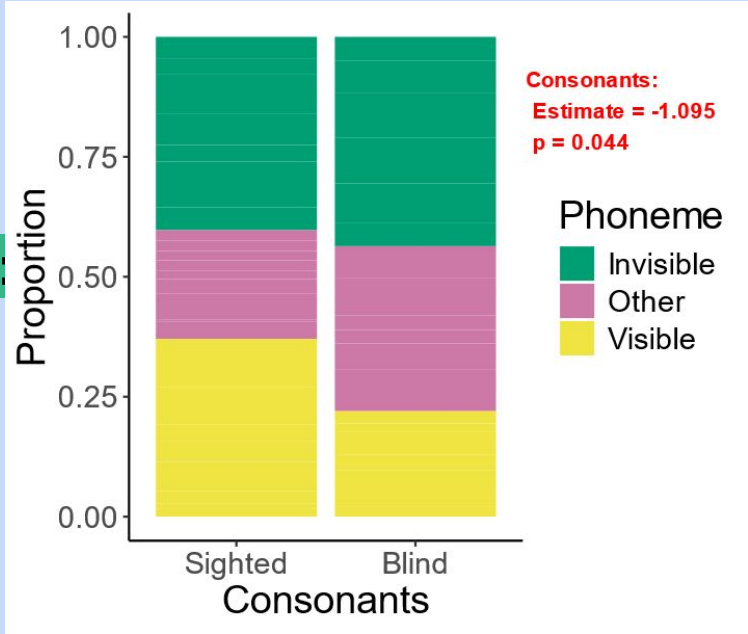
- Vowels - collapsed to 5 (a, e, i, o, u) with attention to roundness
- Consonants - distinctions of voicing ignored

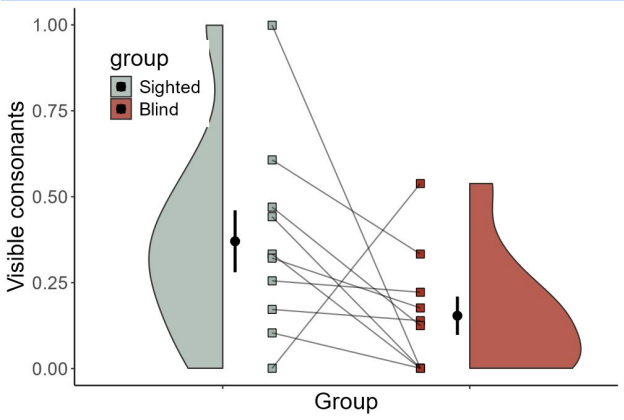
Categories of analysis:

- **Visible consonants:** any consonant apparent on the lips (**b/p, f/v, m**)
- **Invisible consonants:** any consonant produced deeper (**k/g, t/d, n**)
- **Other consonants**: later-produced consonants and glides (**l, r, y, s/z…**)
- **Rounded vowels**: visible rounding of the lips (**o, u**)
- **Unrounded vowels:** no visible rounding of the lips (**a, e, i**)

Is there a difference in consonant production?

Invisible consonants:
k, g, t, d, n
Other consonants:
l, r, y, s, z…
Visible consonants:
b, p, f, v, m



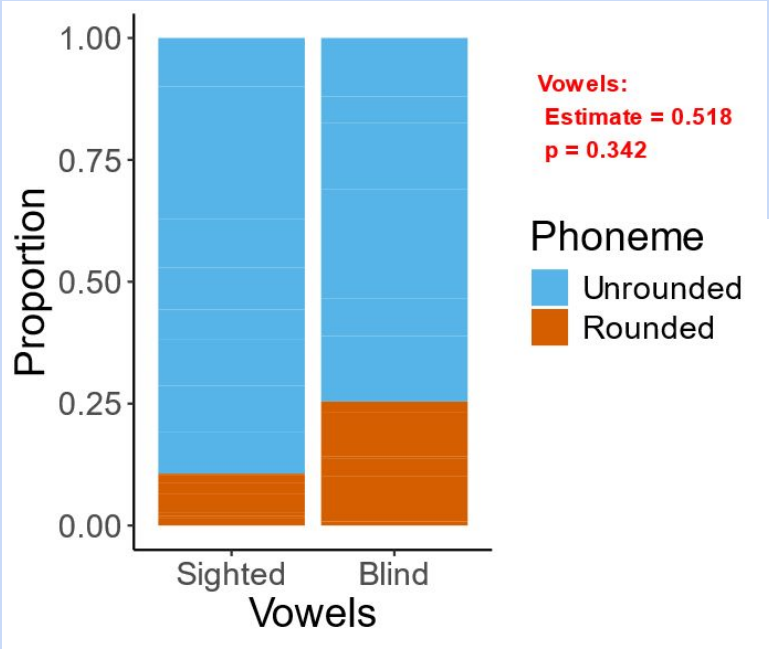


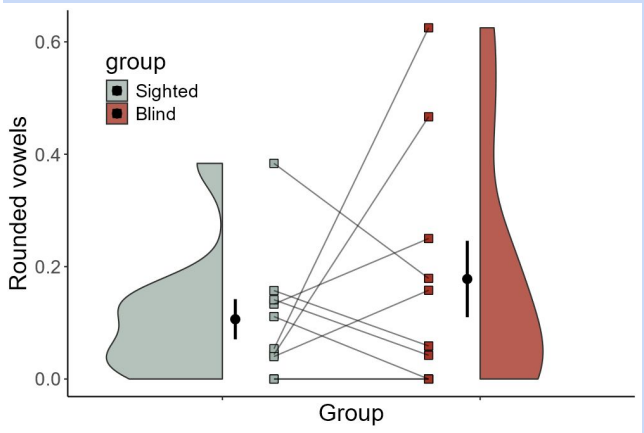
Yes! Sighted babies have a preference for visible consonants, blind babies don't.

Is there a difference in vowel production?

Unrounded vowels: a, e, i

Rounded vowels: o, u





Maybe a small one
(perhaps acoustic distinctiveness?)

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- **Do blind and sighted infants babble the same way, in terms of trajectory, canonical proportion, and speech sounds?**

  Blind infants have similar trajectories and canonical proportions, but a different sound makeup.

- **Do blind and sighted toddlers repeat their input in the same ways in terms of repetition types and functions?**

Study II: Repetitions and Echolalia

Previous studies on repetitions

All babies repeat as part of language-learning:

- Practice - helps practice words
- Learning reinforcement

Echolalia - pathological repetition without comprehension of whole phrases, stereotypical behavior

Blind infants show tendency for echolalia and high rates of ASD symptoms
How can we best characterize blind kids' repetitions?

Fay, 1973; Corrigan, 1980; Molinaro et al, 2020; Pérez-Pereira, 1994; Bloom et al, 1974; Brown et al, 1997' Fusaroli et al, 2023

Characterizing repetitions

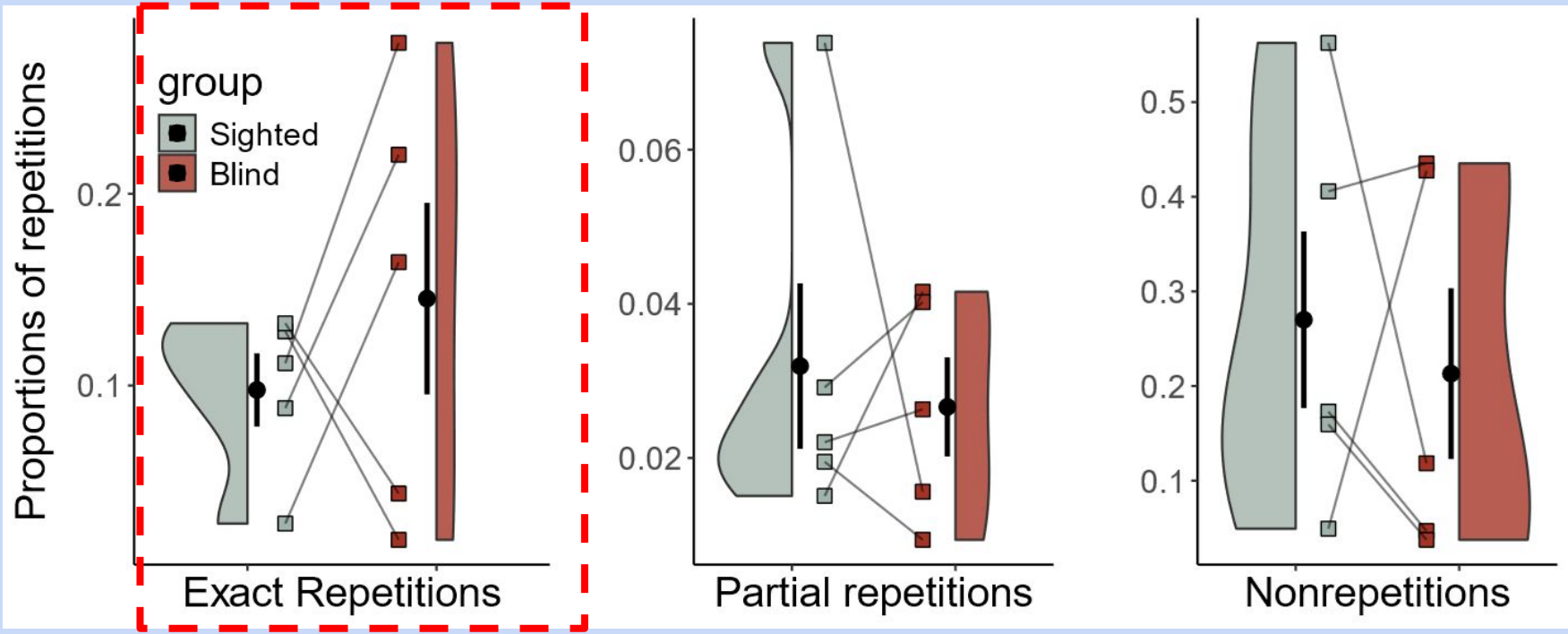
Quantity What is the proportion of repetitions blind infants produce?

Function What is their pragmatic function?

Quantity

Do blind and sighted toddlers repeat their input in the same ways in terms of repetition types and functions?

Do blind infants produce more repetitions?



Yes! Blind kids produce more repetitions than Sighted

Function

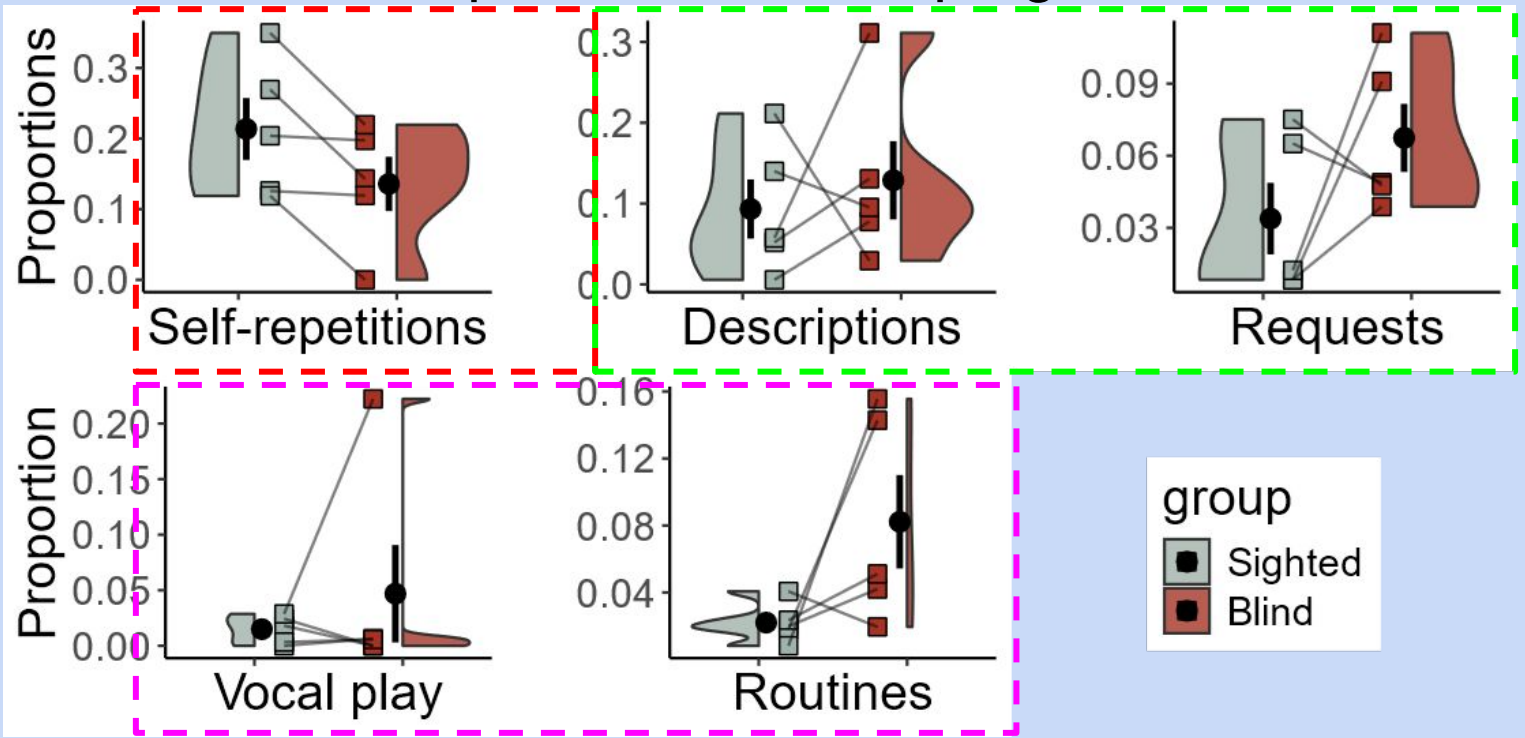
Do blind and sighted toddlers repeat their input in the same ways in terms of repetition types and functions?

Characterizing repetition functions

More common in echolalia

Descriptions	Description of object or situation
Requests	Asking or expressing a desire
Vocal play	Unrelated or out-of-context, made for fun
Routines	“Thank you,” or “please”, canned phrases
Self-repetitions	Repeating one’s own previous utterance

Do blind infants' repetitions differ in pragmatic functions?



Blind infants produce *fewer* self-repetitions, somewhat more of the other kinds.

Questions to keep in mind

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  No, blind infants produce fewer vocalizations across the board

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- **Do blind and sighted toddlers repeat their input in the same ways in terms of repetition types and functions?**

  Not entirely! Blind infants repeat more, and their repetition profile is different.

Two stories of acquisition

Bottleneck and delay

- Fewer vocalizations
- More repetitions
- Earlier-appearing speech sounds

All compatible with earlier stages of development

Difference and compensation

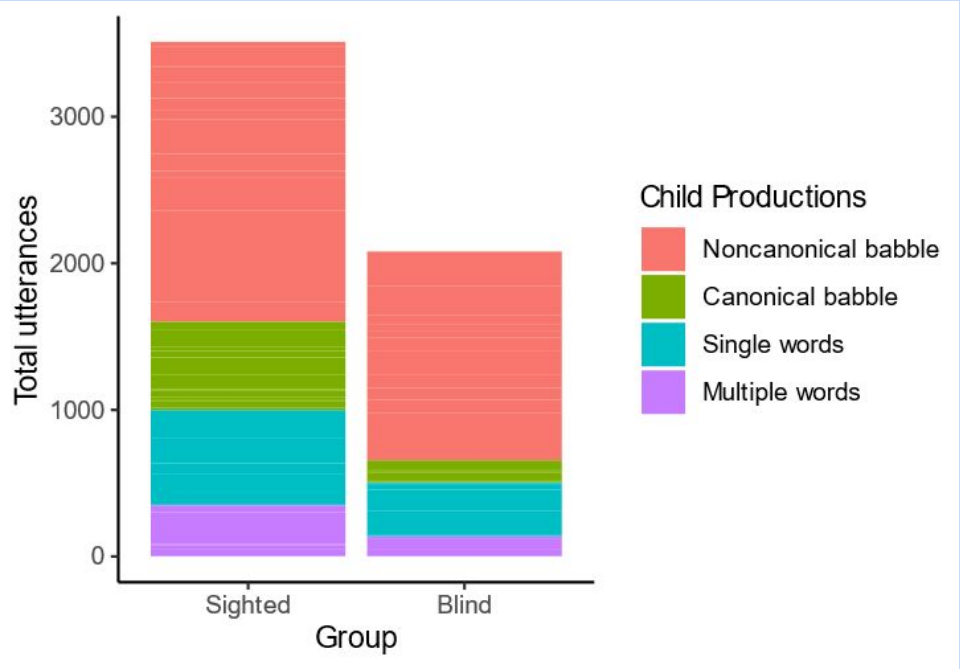
- Similar proportions of babbling
- Repetitions with high vocabulary
- Different speech sounds

Potential indicators of differential strategies

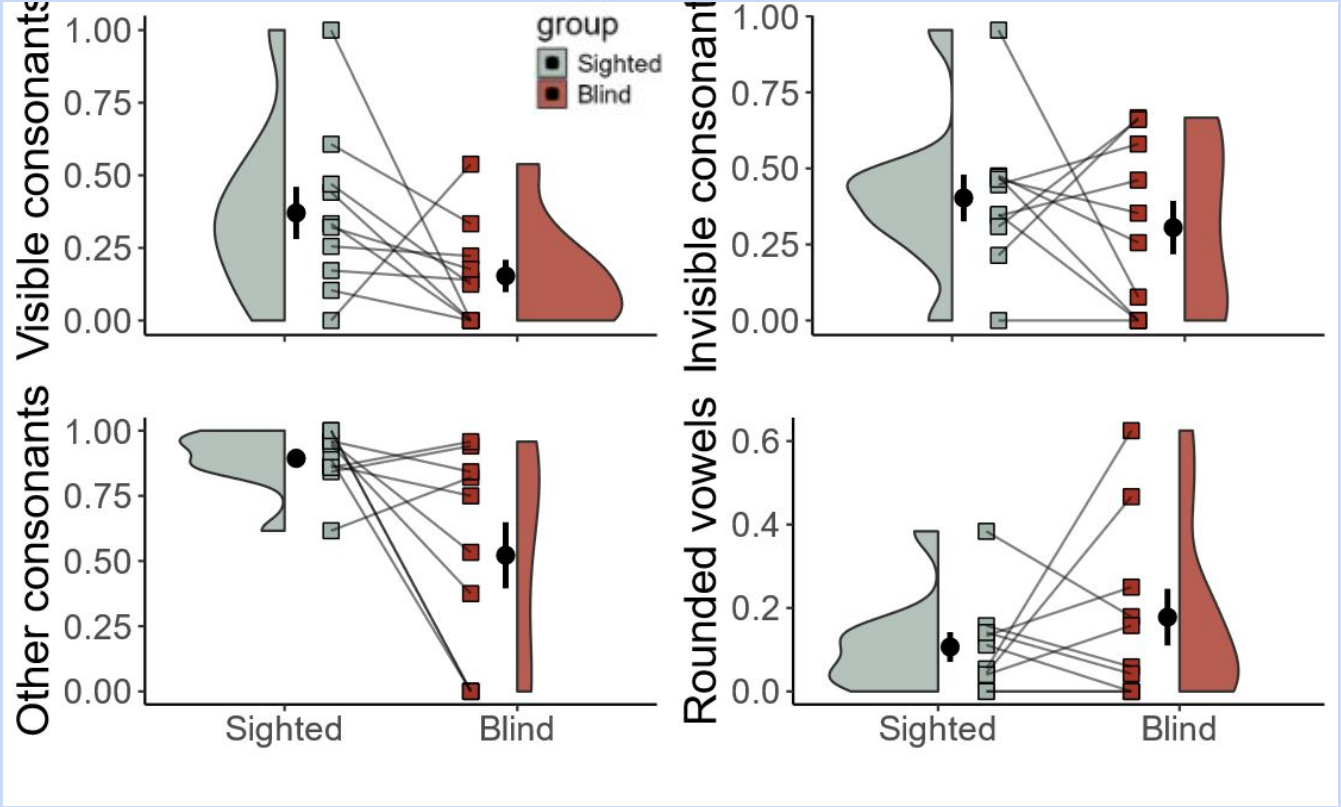
Thank you!

- Sophie Schoenbohm
- Iliad Nazari
- NSF CAREER (EB)
- Hodgson Fund (GL)
- ICIS Founding Generation Grant (IN)
- participating families!

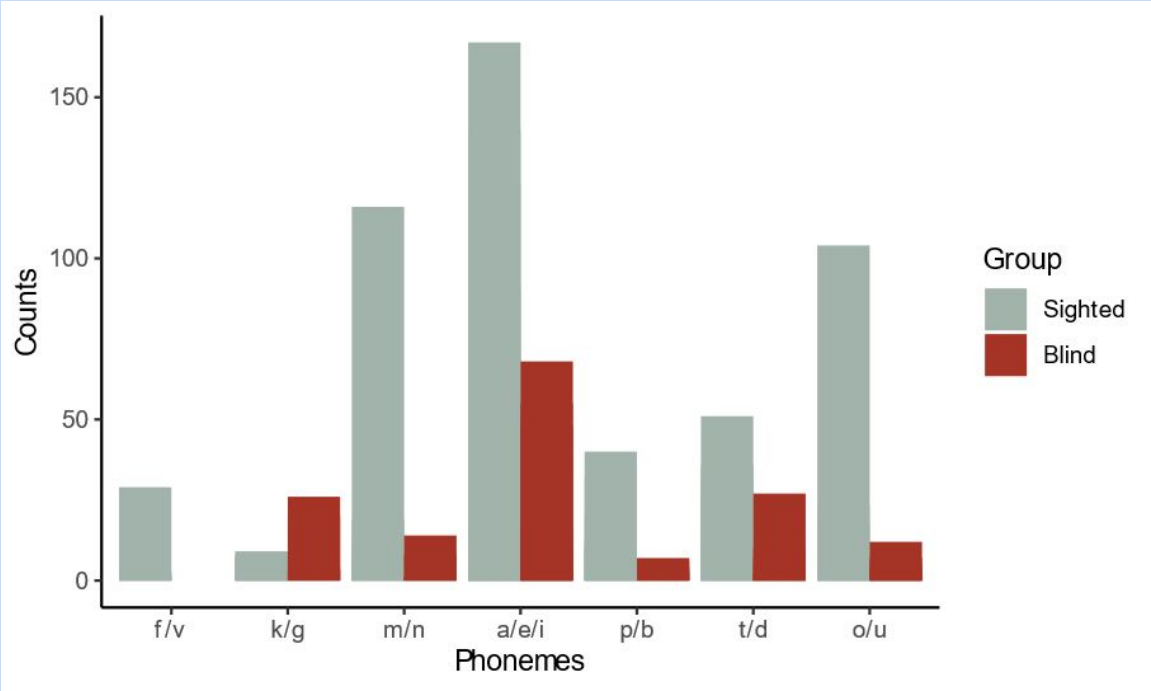
Raw utterance count



Individual pairs and phonetic proportions



What about raw phoneme counts?



Blind infants produce less sounds in general, but they still produce more k/g, and almost as many t/d sounds.