What did you say? Infants' early productions match caregiver input

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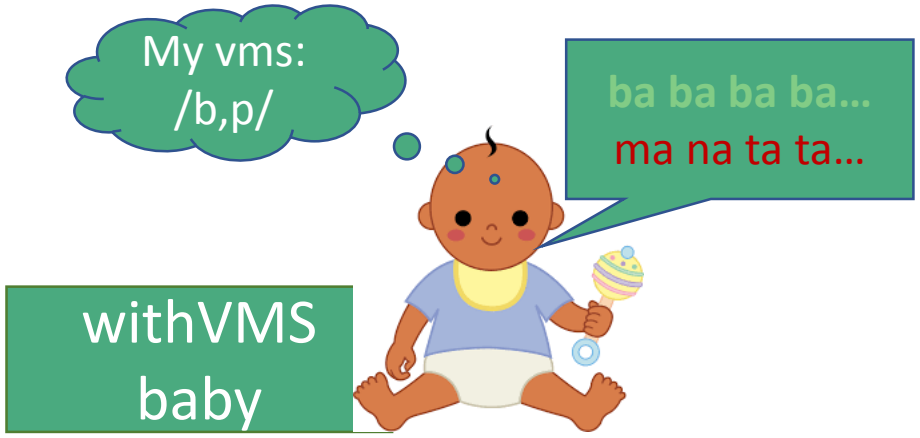
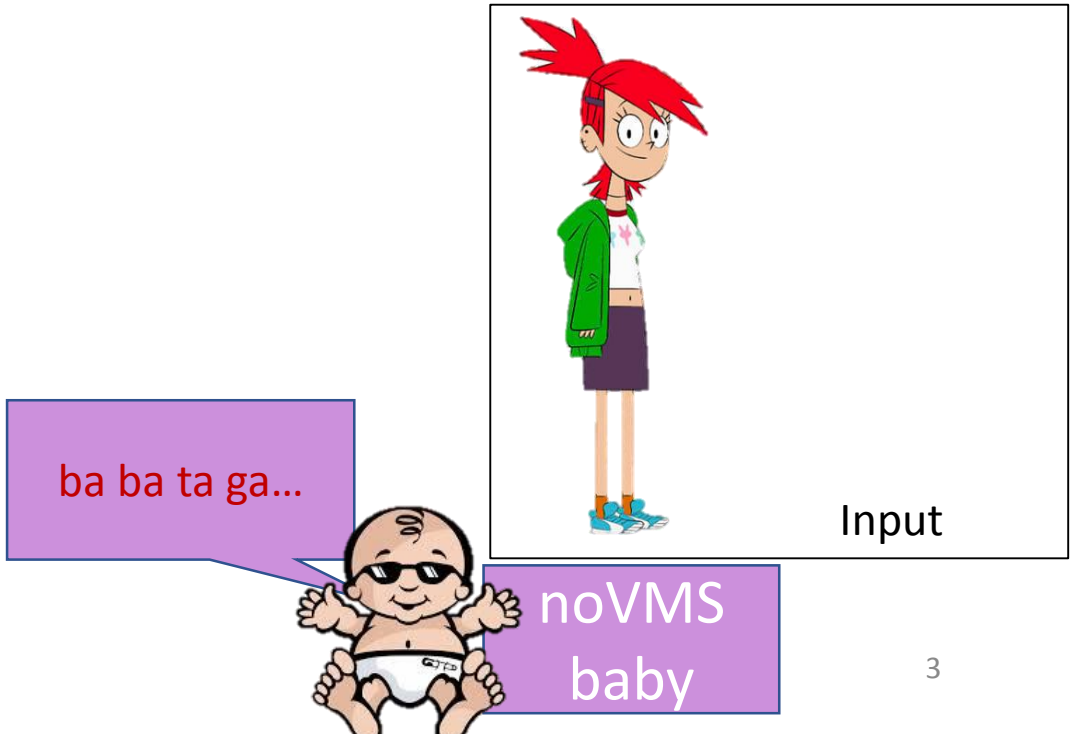
Background

- Contingent parent feedback → more speech-like babble (Goldstein & Schwade, 2008)
  - Didn't find phoneme matching above chance, but used a quite coarse metric
- Infants are more sensitive to word onsets than offsets (e.g. Swingley, 2005)
- Articulatory filter: Infant 'tuned in' to own production (Vihman, 1993)
- Vocal Motor Schemes (VMS; McCune & Vihman, 2001):
  "well-practiced and longitudinally stable vocal productions"
  - VMS influences speech perception:
  - Infants with 1 VMS listen longer to wordlists with that consonant that wordlists without it (Majorano et al, 2014)

Terminology

- for a given baby, do they have stable consonants?
  - Yes: withVMS baby
  - No: noVMS baby





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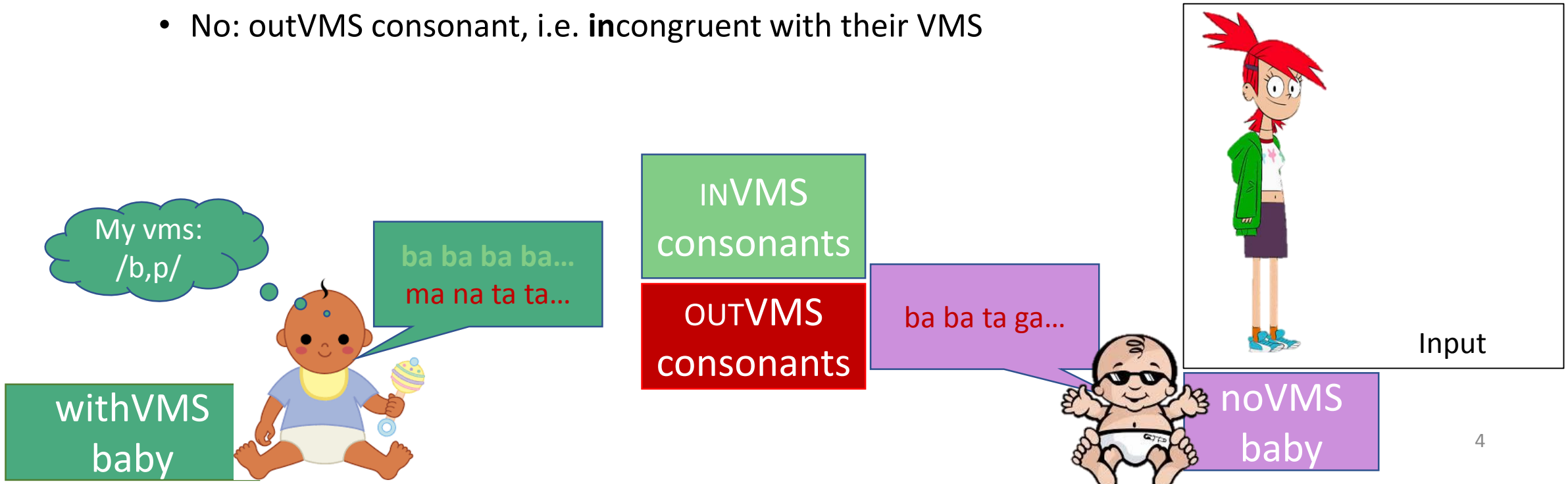
    - No: outVMS consonant, i.e. **in**congruent with their VMS



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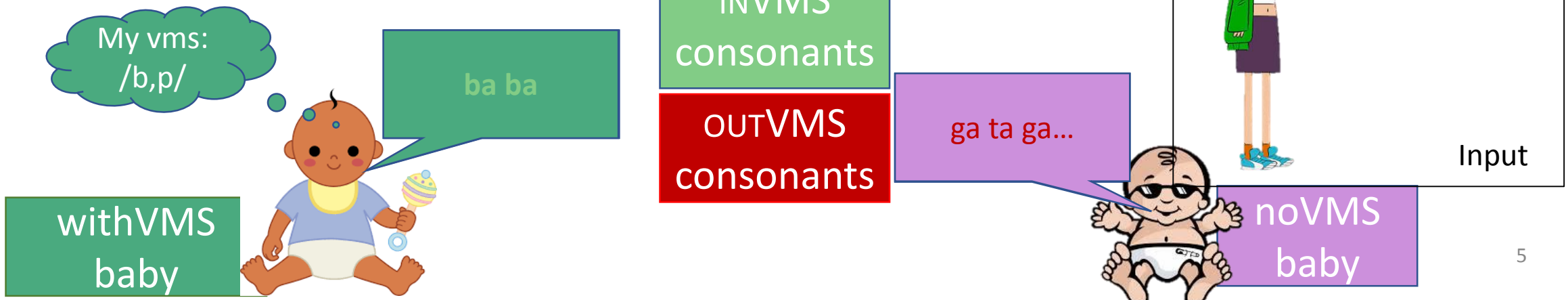
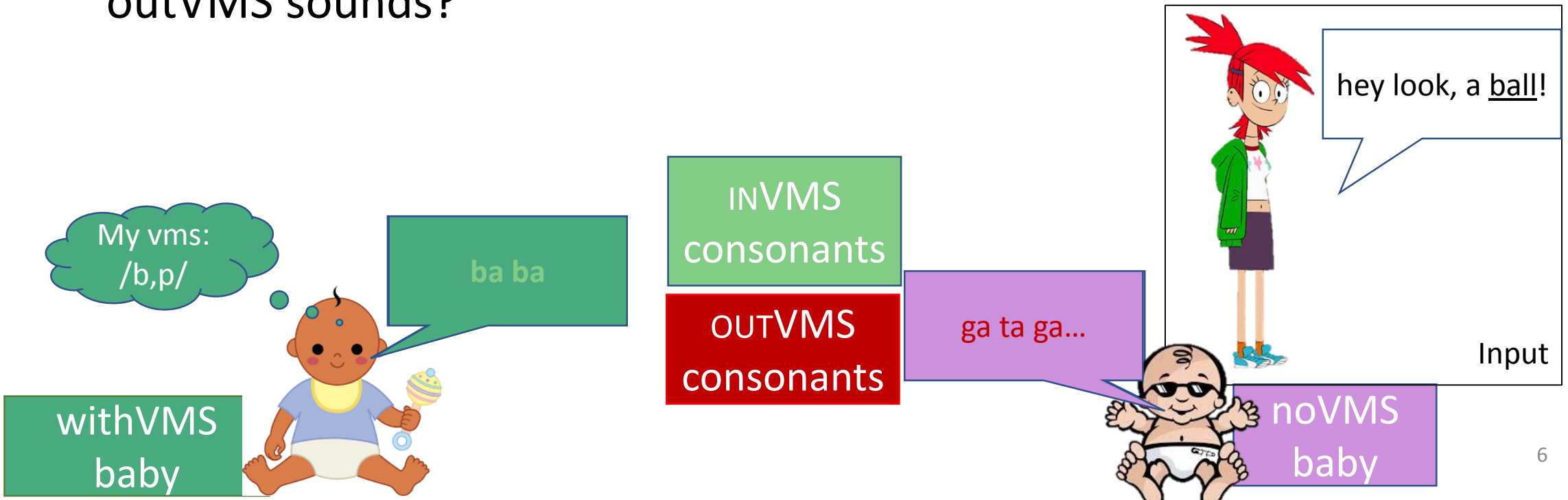
    - Yes: inVMS consonant, i.e. congruent with their VMS
    - No: outVMS consonant, i.e. **in**congruent with their VMS
  - Does it match something they just <u>heard from a caregiver</u>?
    - Yes: input-congruent
    - No: input-**<u>in</u>congruent**



Research Questions

1. Do infants with stable vocal motor schema (withVMS) produce more **VMS-congruent** consonants or **VMS-incongruent** consonants?
2. Do infants with stable vocal motor schema (withVMS) produce more consonants that are **congruent with their input** than noVMS infants?
3. Are **input-congruent consonant productions** more often inVMS vs. outVMS sounds?



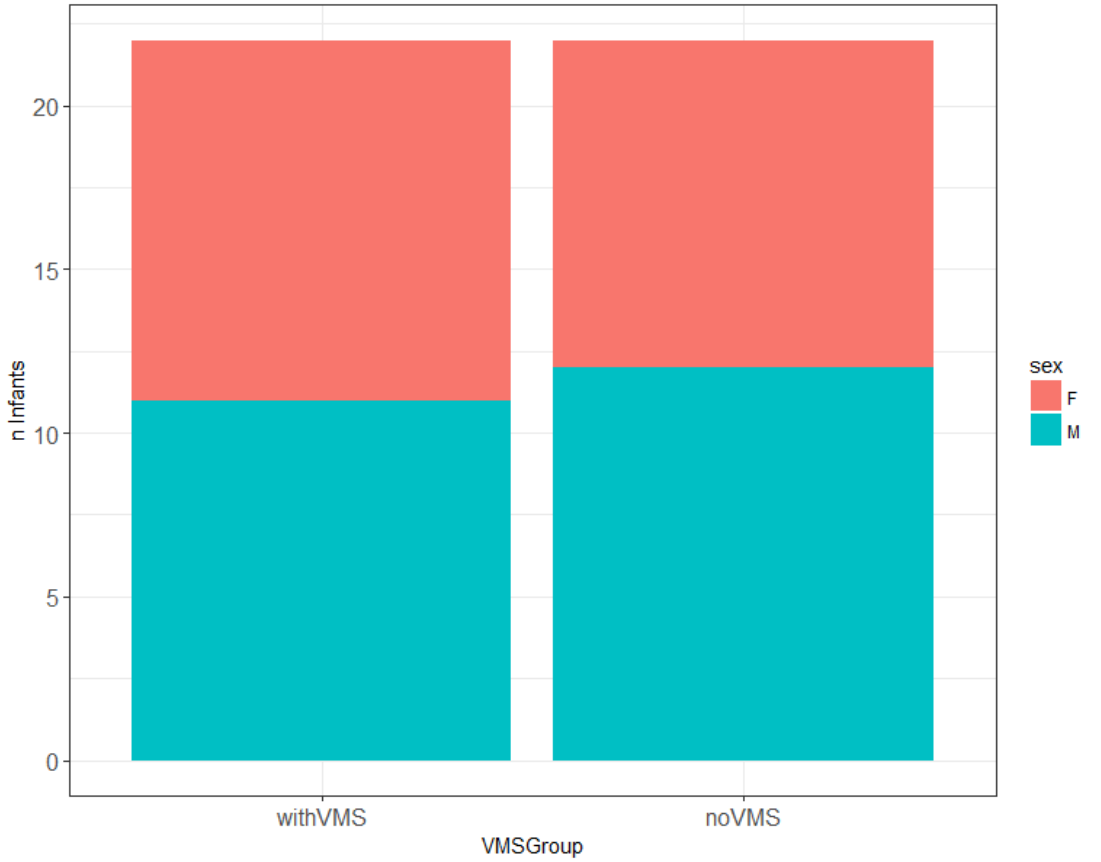
The SEEDLingS Corpus

- 44 infants recorded at home, monthly, from age 6-17 months
- Largely homogenous sample
- Hour-long video and day-long audio recordings
- Lots of other data not discussed here (e.g. CDIs, in-lab word comp., etc.)

- **Present study: Audio & Video recordings, age 10/11 months**
  - **Determine VMS from top 30 minutes of daylong audio**
  - **Annotate all child consonant productions from hourlong video**
  - **Annotate caregiver prompts from 15s preceding each child consonant production in video**

Step 1: determining each infant's VMS

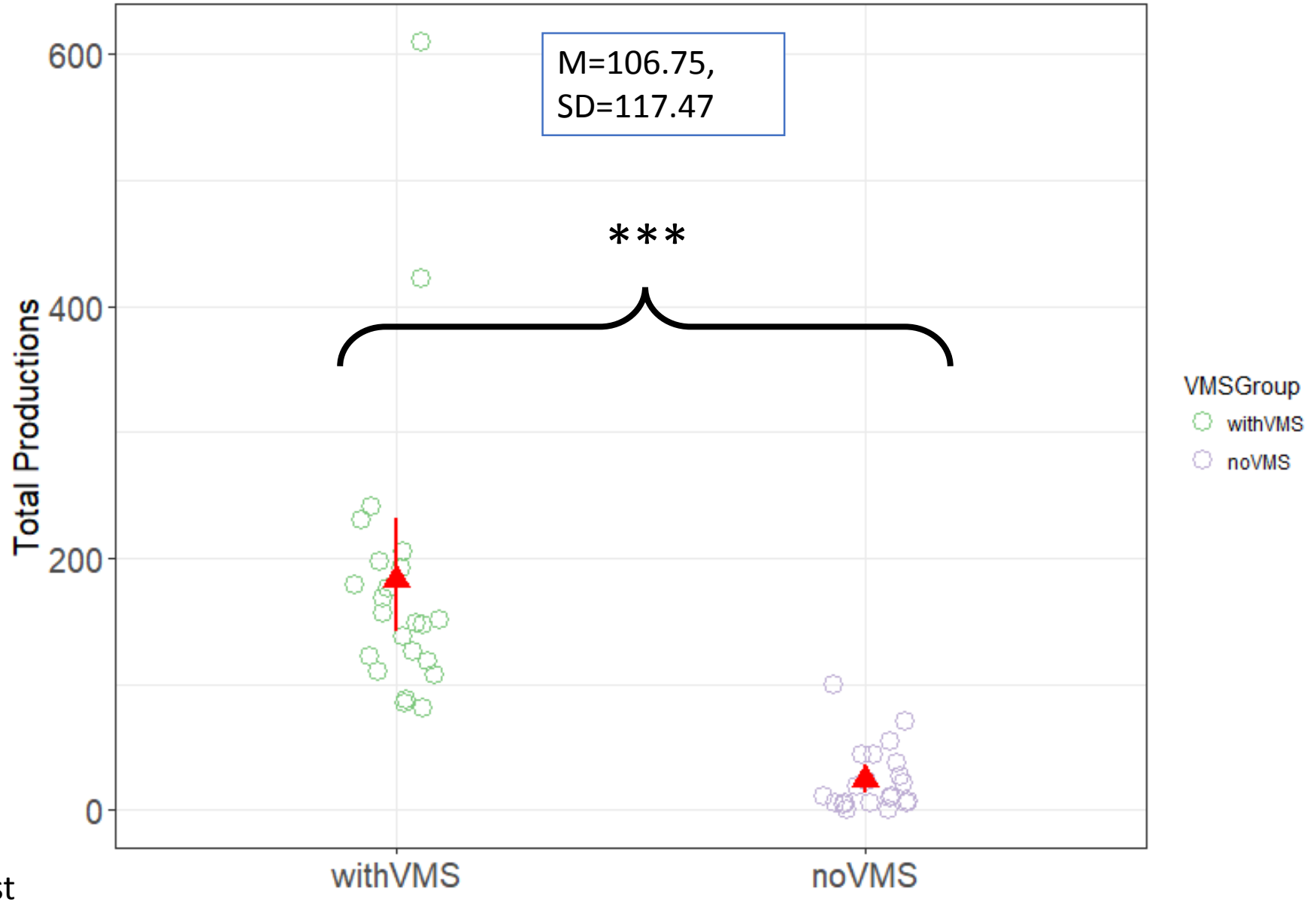
- Audio data from LENA recordings
- 30 minutes of highest-talk-volume infant productions (Child Vocalization Counts)
  - 2/3 of top 30 minutes were baby alone!
- Every consonant production (CP) counted for each infant
- VMS = ≥50 of any single Consonant Production during 30-min segment
  - Ignoring voicing distinction (p=b)
- Note: differs from VMS as defined in McCune & Vihman, 2001



22 infants = withVMS

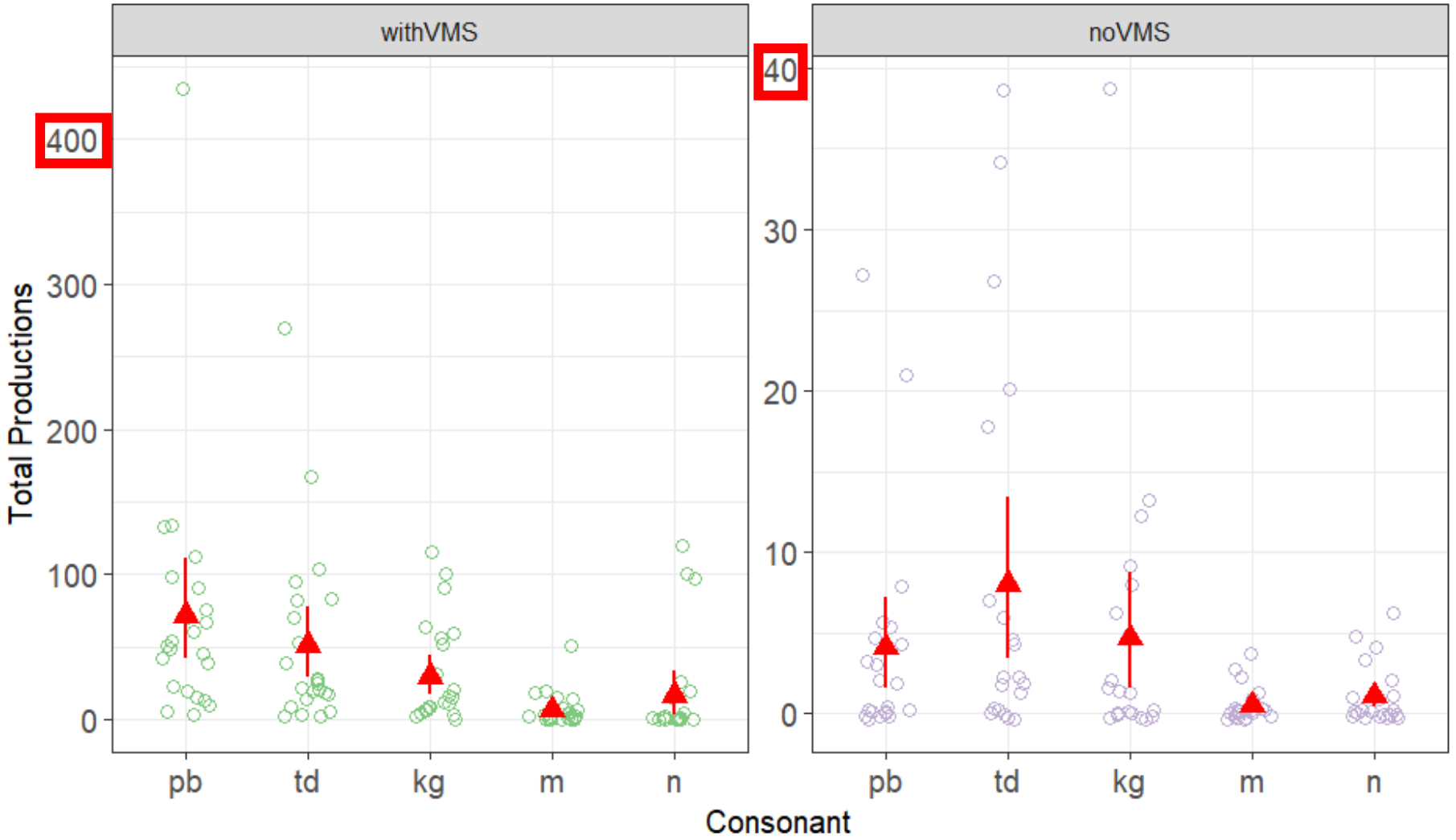
22 infants = noVMS

Consonant Production: withVMS babies produce more **tokens**



Wilcoxon Rank Sum Test

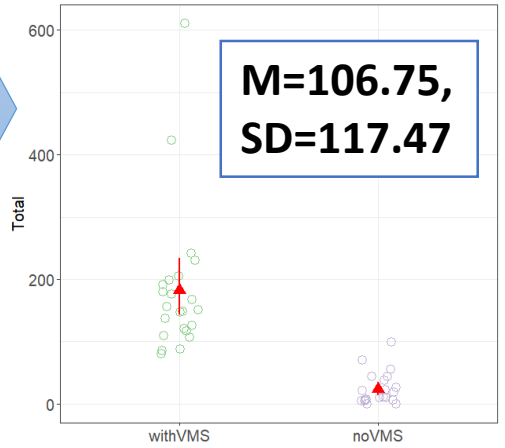
Consonant Production: same general trend across consonant categories, across groups

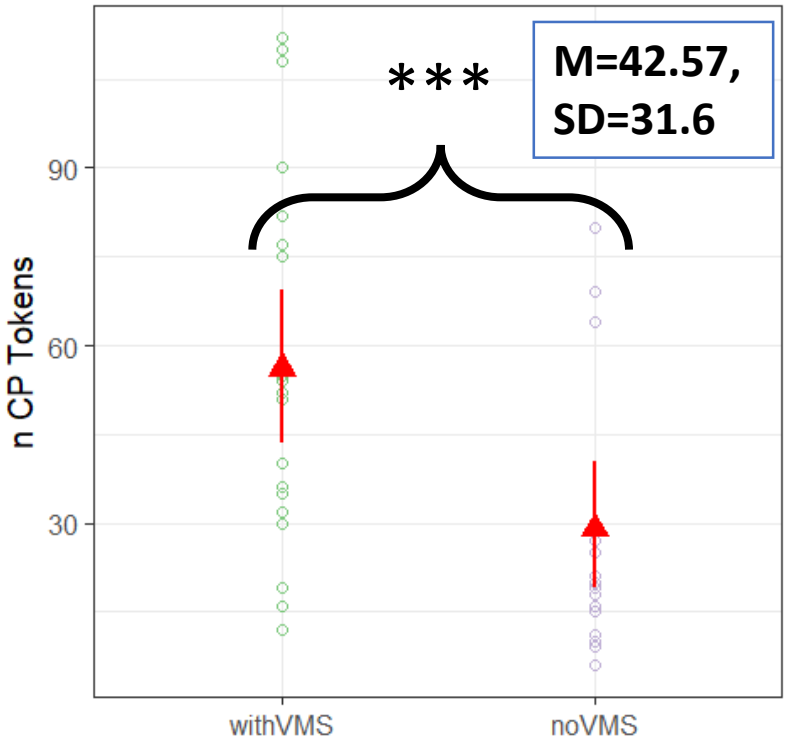


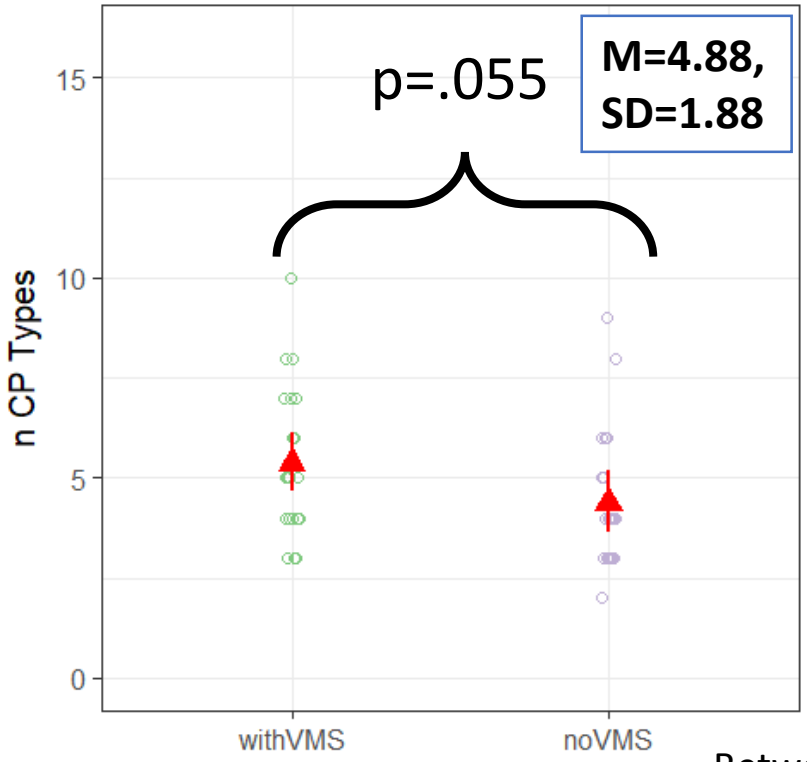
Consonant type: F(4,210)=6.22, p<.001

Sanity Check: VMS group effect holds in videos

30 minute sample







Between-subjects ANOVAs

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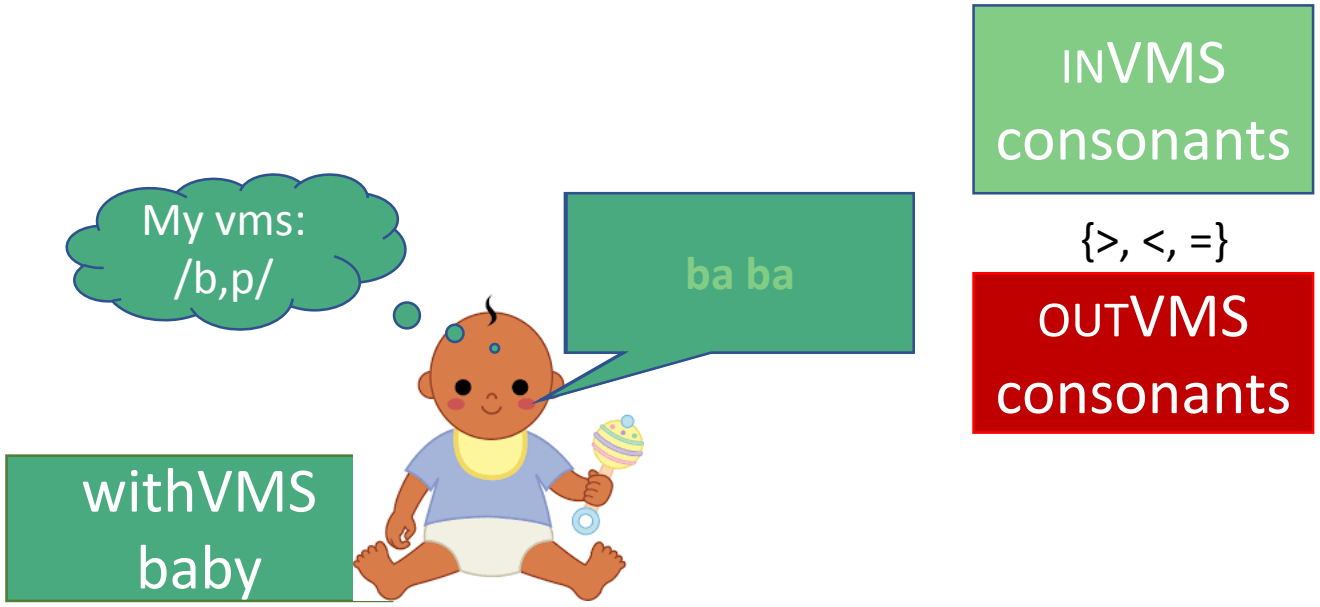


Analysis: VMS Match

% VMS match

(vs. scrambled infant data 41%= chance)

Do the Consonant Productions match VMS?

Infant	VMSGroup	VMS	Consonant Prod.	Caregiver input
1	noVMS		**g**	ball
1	noVMS		**b**	puppy
2	withVMS	b	**d**	ball
2	withVMS	b	**b**	doggie
3	withVMS	d	**d**	ball
3	withVMS	d	**b**	doggie

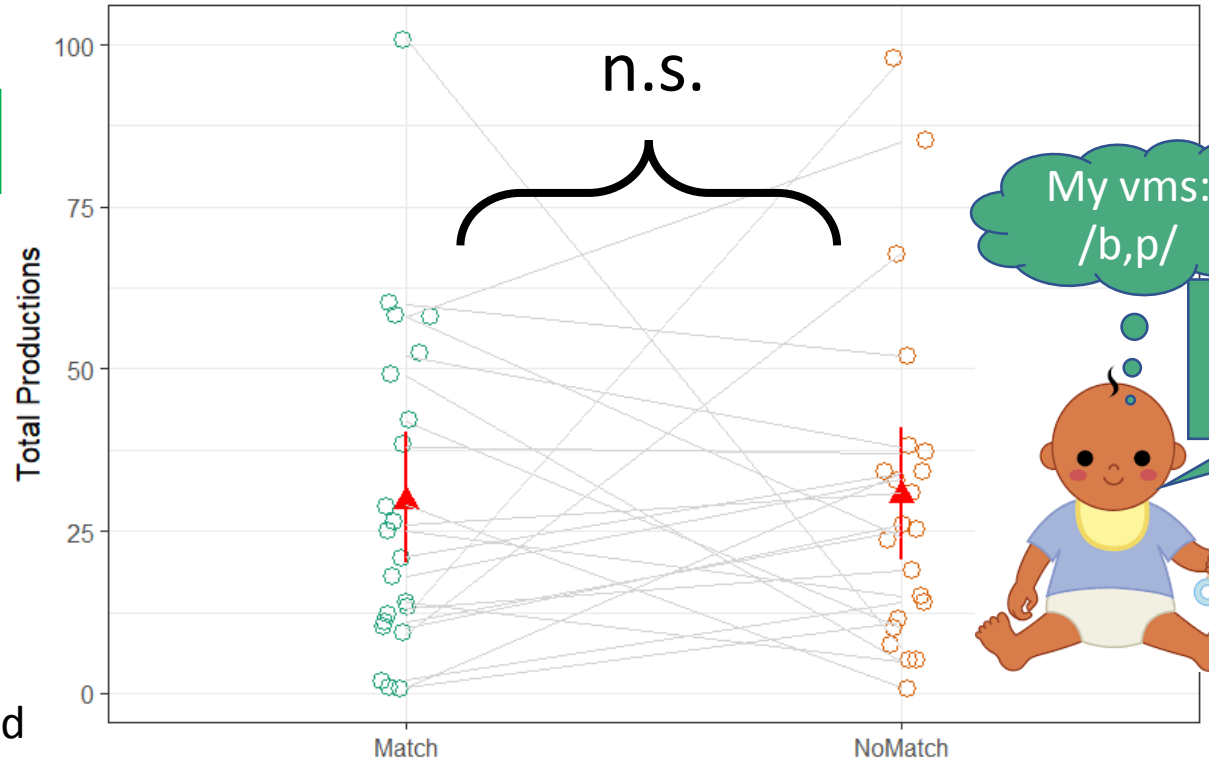
↑ audio ↑ annotation

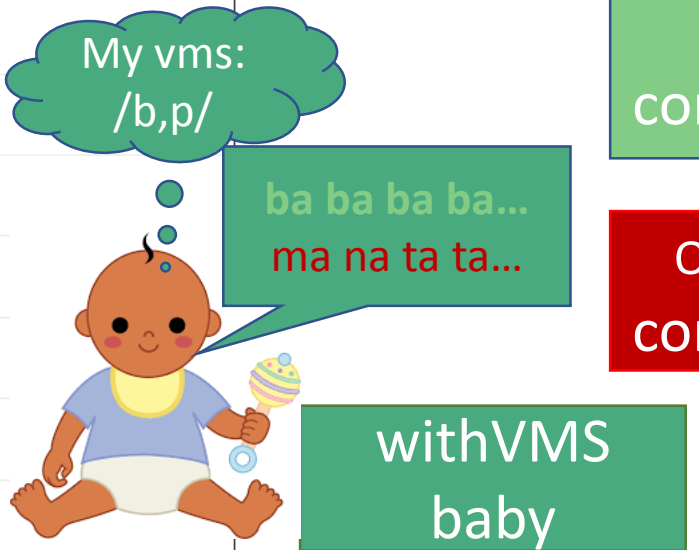
↑ video ↑ annotation

Results: withVMS infants just as likely to produce inVMS consonants as outVMS consonants in videos

- 47% of withVMS infants' CPs matched their VMS consonants (SD=.3)
- This did not differ from chance (41%; p=.24)

withVMS infants only





INVMS consonants

=

OUTVMS consonants

withVMS baby

Wilcoxon test, outliers included

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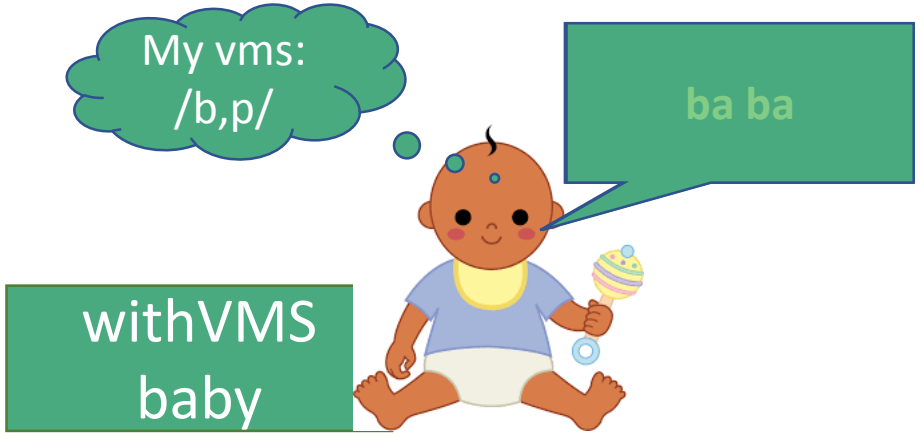
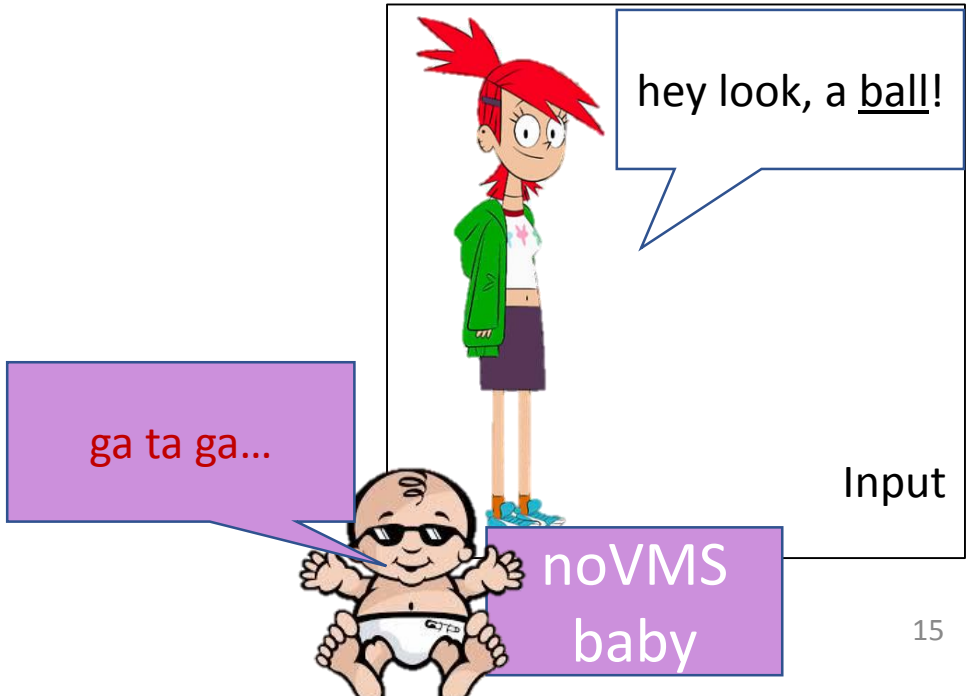




Video Example of Child Productions & Caregiver Input Matching

Analysis

% input match (vs. scrambled Caregiver data: 13%)

Do the CPs match Caregiver prompt?

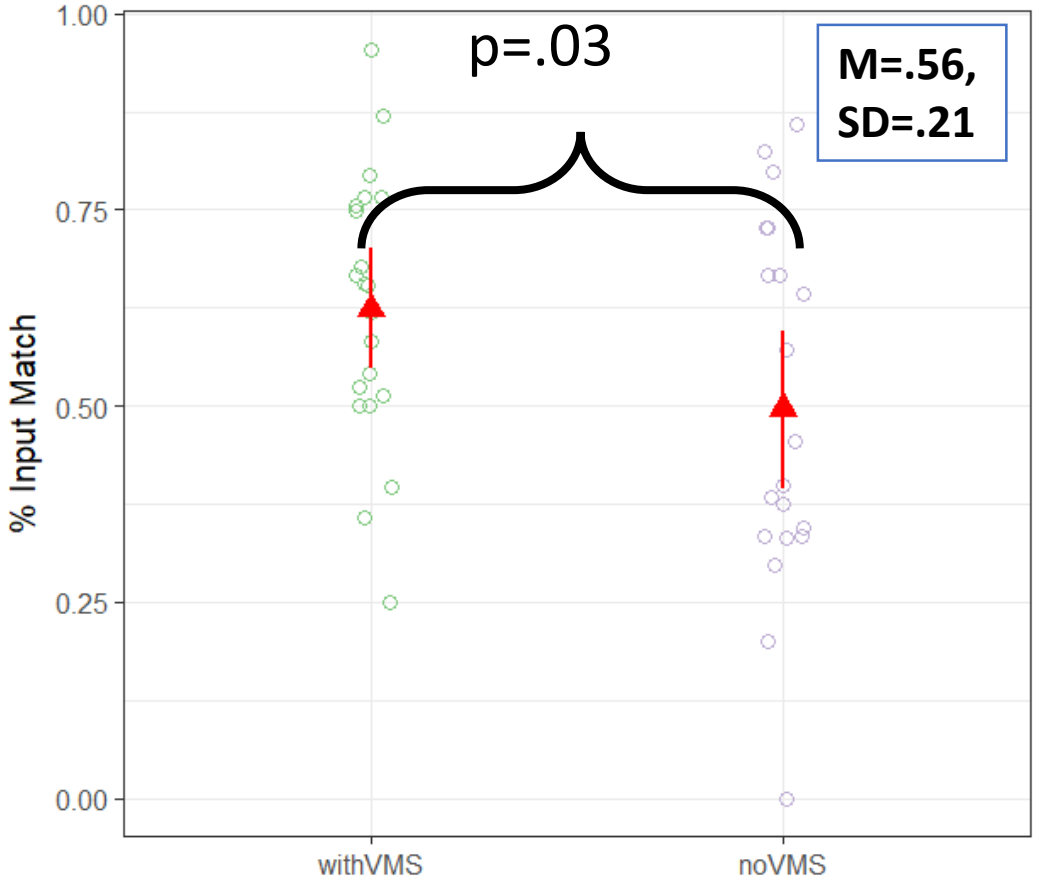
Infant	VMSGroup	VMS	Consonant Prod.	Caregiver input
1	noVMS		g	**doggie**
1	noVMS		b	**doggie**
2	withVMS	b	d	**puppy**
2	withVMS	b	b	**doggie**
3	withVMS	d	d	**ball**
3	withVMS	d	b	**ball**

↑ audio ↑ annotation

↑ video annotation ↑

Results: Infants Match Caregiver Input

- Both withVMS and noVMS infants **match caregiver input** above chance, i.e. scrambled caregiver data (.56 vs. 13: both p>.001, by Wilcoxon Test)
- withVMS infants matched caregiver input significantly more than noVMS infants:



Between-subjects ANOVA

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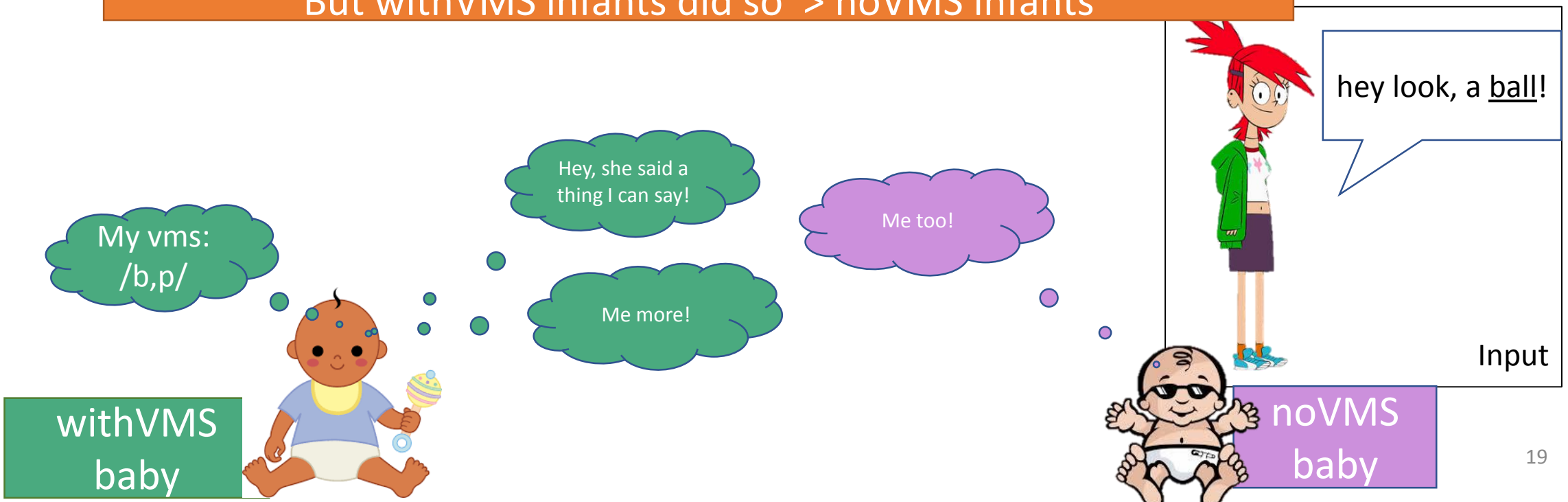
All infants produced input-congruent consonants above chance;
But withVMS infants did so > noVMS infants



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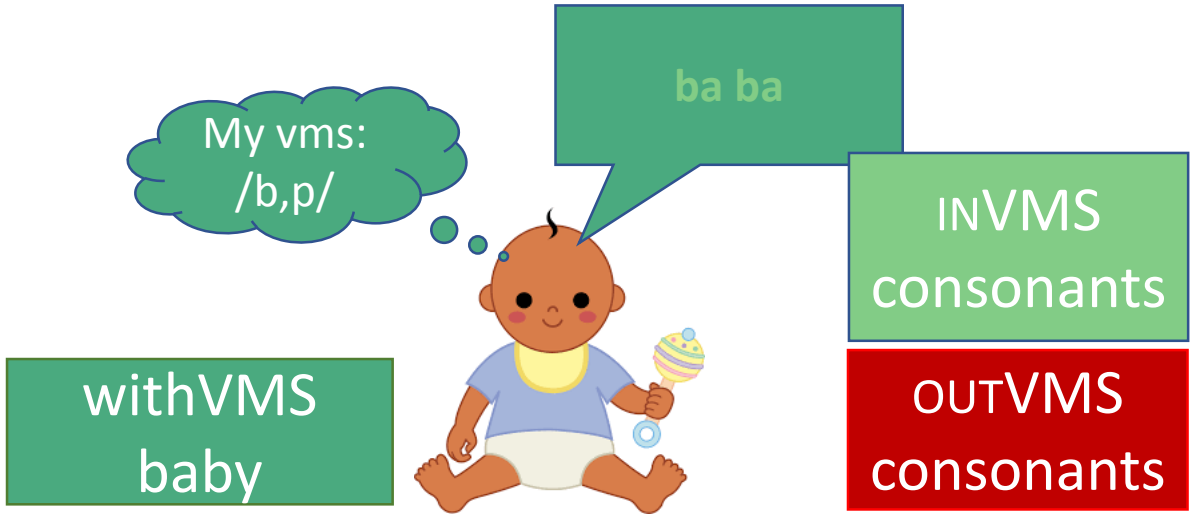
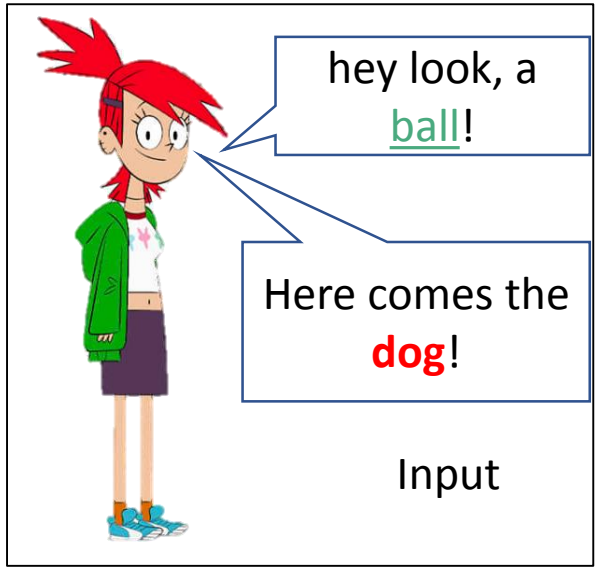
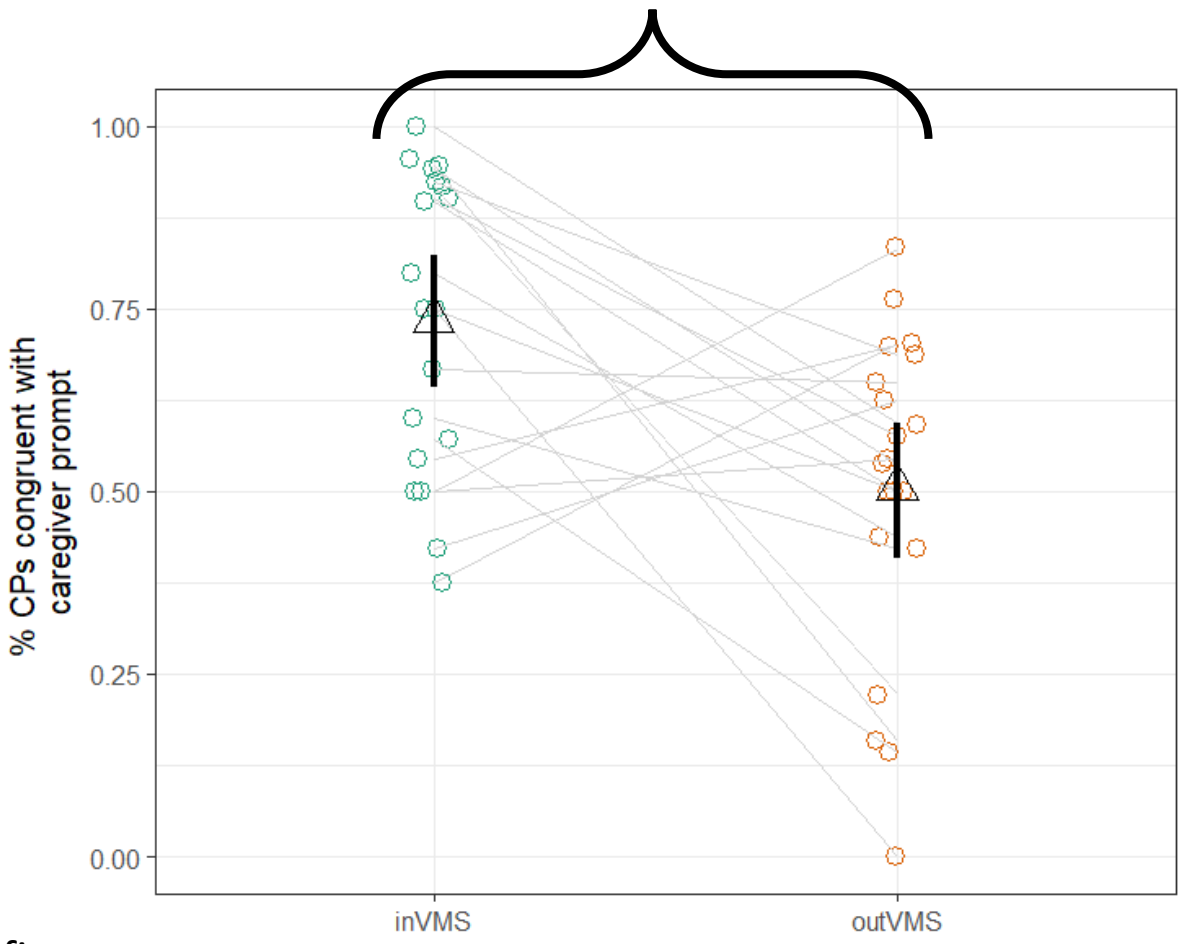




Results: withVMS infants match Caregiver Input **more** when the input is in their VMS inventory

withVMS infants only

table: ta
da
gecko: ga
ka
ball: ba
ma
shoe: ba
truck: ta
Obama: ba
boy: pa



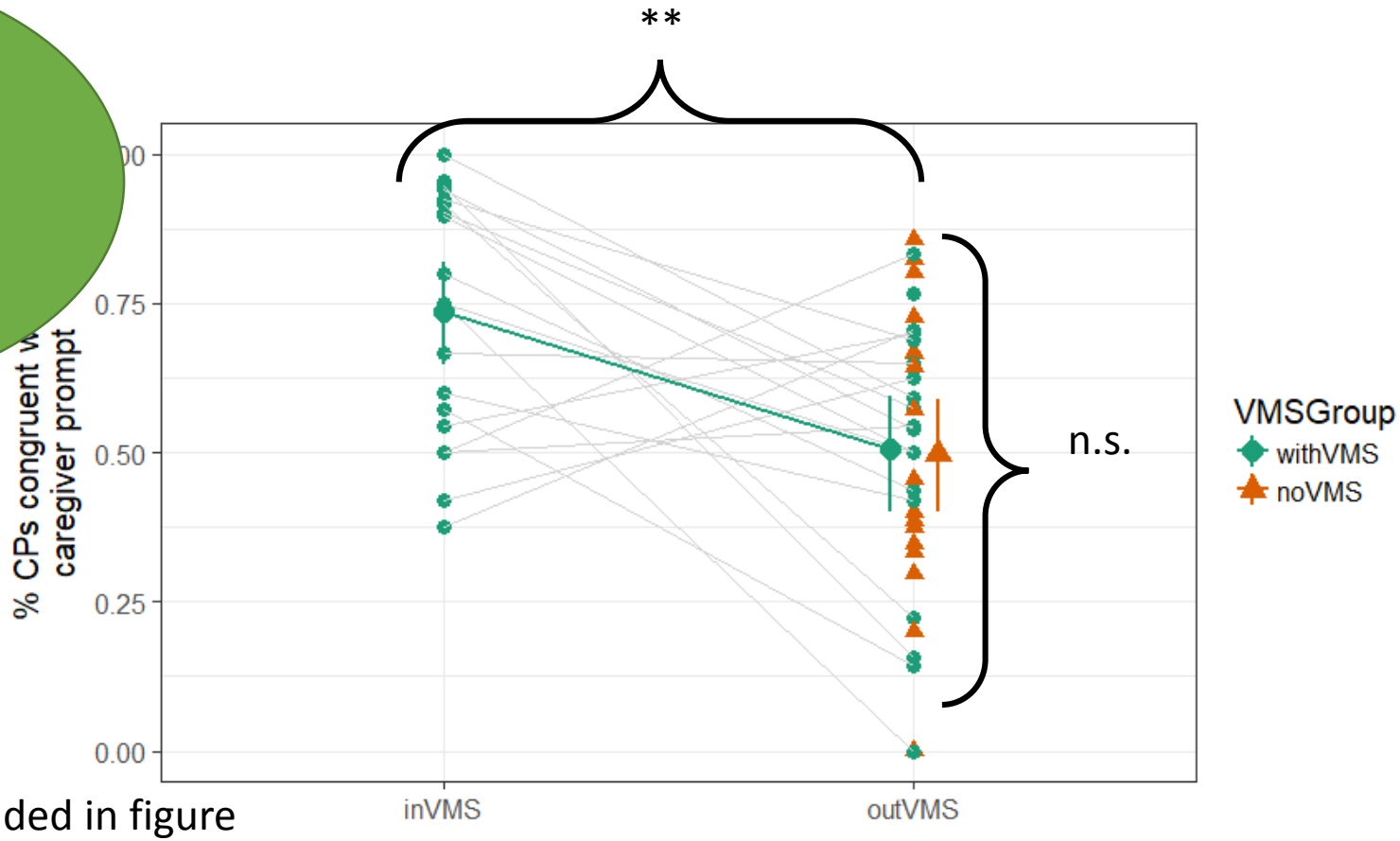
Wilcoxon test, outlier included in figure

Results: Caregiver Input

- Comparing outVMS responses to those of infants with noVMS

withVMS infants differ from noVMS infants only when input is congruent with their VMS

All CPs are outVMS for infants who have no VMS to begin with



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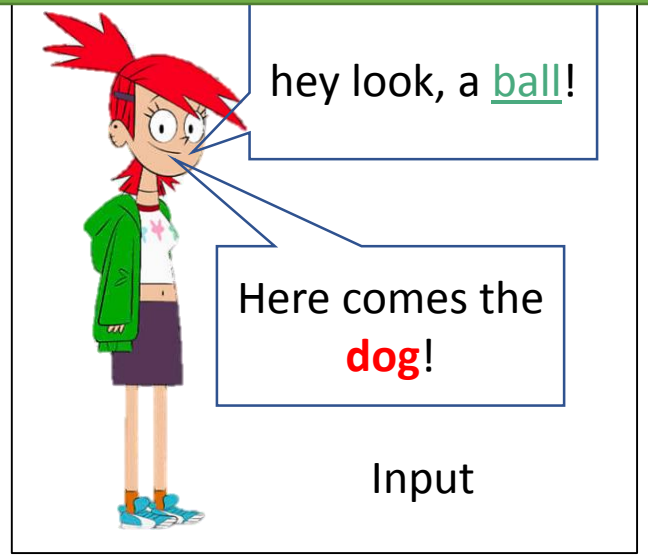
3. Are **input-congruent consonants** more likely to be inVMS than outVMS sounds? Yes! Infants produced more input-congruent CP if input was inVMS

INVMS consonants

OUTVMS consonants



Discussion

- Support for articulatory filter hypothesis
- Previous research used HPP to test **perception** of VMS; we show that this also mediates **production,** from as young as 0;10
- Perception ⟷ Production
- Goldstein & Schwade (2008): Analysis too general?
- Focusing on what infants can already produce presents new evidence for role of input on shaping infants' phonological development

Next steps

- Analysis of infants' attention to objects in environment
- Grouping one vs. multiple VMS infants
- Transition from babble → words
- Do multiple VMS infants produce more object-contingent CPs?

Conclusions

- withVMS infants produce more consonants than noVMS infants
- But, withVMS infants' productions weren't dominated by VMS consonants
- All infants' consonant production was influenced by their input…
  - But having an established VMS consonant shaped infants' production, guided by input that was congruent with their VMS
- Babbling infants 'reply' to their input, especially if it uses their best consonants

- SEEDLingS & Blab Staff: Koorathota, Tor, Schneider, Amatuni, Dailey, Garrison & small army of RAs!
- NIH Early Independence Award
- Digging Into Data NEH Award
- Our 44 SEEDLingS and their families!

Thank you!

The Bergelson Lab (BLAB) is always looking for awesome students, postdocs and staff, ask me for more information!

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Thank you!