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

My vms: /b,p/

ba ba ba ba...
ma na ta ta...

ba ba ta ga...

withVMS baby

noVMS baby
**Terminology**

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- for a given consonant production (CP) by an infant:
  - is it in that child’s VMS inventory?
    - Yes: inVMS consonant, i.e. congruent with their VMS
    - No: outVMS consonant, i.e. incongruent with their VMS
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    • Yes: inVMS consonant, i.e. congruent with their VMS
    • No: outVMS consonant, i.e. incongruent with their VMS
  • Does it match something they just heard from a caregiver?
    • Yes: input-congruent
    • No: input-incongruent
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: with VMS 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

** M=106.75, SD=117.47

Between-subjects ANOVAs

M=42.57, SD=31.6

p=.055  M=4.88, SD=1.88
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Analysis: VMS Match

% VMS match (vs. scrambled infant data 41%= chance)

Do the Consonant Productions match VMS?

<table>
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<tr>
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<th>Caregiver input</th>
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<tr>
<td>1</td>
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<td></td>
<td>g</td>
<td>ball</td>
</tr>
<tr>
<td>1</td>
<td>noVMS</td>
<td></td>
<td>b</td>
<td>puppy</td>
</tr>
<tr>
<td>2</td>
<td>withVMS</td>
<td>b</td>
<td>d</td>
<td>ball</td>
</tr>
<tr>
<td>2</td>
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<td>b</td>
<td>b</td>
<td>doggie</td>
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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)

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?

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↑ 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

\[ p=.03 \]

\[ M=.56, \]  
\[ SD=.21 \]
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2. Do infants with stable vocal motor schema (withVMS) produce more consonants that are **congruent with their input** than noVMS infants? 
   All infants produced input-congruent consonants above chance; 
   But withVMS infants did so > noVMS infants

Hey, she said a thing I can say! 
Me too! 
Me more! 

 hey look, a ball!

withVMS baby

Input
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3. Are **input-congruent consonants** more likely to be inVMS than outVMS sounds?

   ![Diagram showing examples of input-congruent consonants](image)
Results: withVMS infants match Caregiver Input more when the input is in their VMS inventory

Wilcoxon test, outlier included in figure
Results: Caregiver Input

• Comparing outVMS responses to those of infants with noVMS

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

Wilcoxon test, outliers included in figure.
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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
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 $\leftrightarrow$ 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 $\rightarrow$ 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!
References


Thank you!