Intra-word Variability in the Production of Real Words and Non-words

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Intra-word Variability

[fɛʃ]  [fɪtʃ]  [fɪθ]
Frequently described as a feature of typical phonological development, yet we don’t know very much about rates or patterns of variability in typical development.

Also cited as a hallmark of certain types of speech disorder (e.g., Childhood Apraxia of Speech, Inconsistent Phonological Disorder).

Variability may provide information about the nature of phonological representations.

A measure of phonological knowledge that doesn’t include accuracy.
In Typical Development

- Contextual factors
- “Fuzzy” or “holistic” underlying phonological representations
- Neuromotor immaturity
Can it tell us anything about the source of variability in typical development?

- **Motor immaturity**
  - similar variability in real and non-words
  - variability related to general articulation ability/accuracy

- **Phonological**
  - non-words more variable
  - children with more detailed phonological representations may have the biggest difference between real and non-words
  - real-word variability may be more closely related to vocabulary size than non-word variability
Variability vs. Inconsistency
Is there a difference?

Holm, Crosbie, & Dodd (2007) definitions:

- “normal variability” is attributable to factors that occur in typical speech development and use
- “atypical inconsistency” is the use of many different forms with multiple error types in repeated productions
Variability or Inconsistency?

Example 1
[drakm kina]  
[fokum tima]  
[bwokjum kina]  

“atypical inconsistency” example from Holm, et al., 2007

Example 2
[bækju θinə]  
[fækju klɪŋgu]  
[dækjən klɪŋə]  

variability by typically developing 3;3 boy from current study
Many different measures have been used, leading to difficulty comparing results:

- Proportion of words produced variably (e.g., 10 of 25 words produced variably = 40%)
- Inconsistency Assessment (Dodd, 1995)
- Amount of variability in the production of an individual word (e.g., 2 different phonetic forms in 5 productions of a single word = 40%)
- Proportion of whole-word variation (Ingram, 2002)

Variability relative to accuracy:

- Variability profiles: Consistent correct, consistent incorrect, variable with hits, variable no hits (Holm et al., 2007; McLeod & Hewett, 2008)
What we know about variability in typical development

1- to 2-year-olds are highly variable in their production of individual words **AND there is NOT a linear decline in variability during this period** (Sosa & Stoel-Gammon, 2006)

2-year-olds are highly variable in their production of words (72% of words produced variably) (Sosa, 2008)

2- to 3-year-olds are highly variable in their production of words **AND there is NOT a linear decline in variability during this period** (54% of words produced variably) (McLeod & Hewett, 2008)

5-year-olds are highly variable in their production of multi-syllabic words (Mason, Bernhardt, & Masterson, 2011)

5- to 10-year-olds continue to display some intra-word variability (10% of words produced variably) (de Castro & Wertzner, 2011)
Lexical and phonological factors influence variability (Sosa & Stoel-Gammon, 2012)

- Low frequency words are more variable than high frequency words
- Words from sparse phonological neighborhoods are more variable than words from dense phonological neighborhoods
- Words with later developing consonants and syllable shapes are more variable than words with earlier developing phonological characteristics
Variability is predicted by vocabulary size: children with larger expressive vocabularies exhibit less variability (Sosa & Stoel-Gammon, 2012; Sosa, 2011)
**What we know about variability in typical development (con’t)**

**HOWEVER…..**

“Inconsistent production cannot be considered a typical feature of speech development.”

(Holm et al., 2007; p. 467)

- Large normative study (409 children from 3;0-6;11) of British-English speaking children
  - Inconsistency Assessment – 25 one to four syllable words repeated 3 times each
  - Youngest children (3;0-3;11) produced 13% of the words variably – most were “variable with hits”
The Current Study

Questions

- When does intra-word variability in typically developing children go away?
- What type of variability do typically developing children display?
- How does real word variability compare to non-word variability? And what might that tell us about sources of variability?
METHODS

Participants: 34 children between 2;6 and 4;2

Standard scores within normal limits on:

- Expressive Vocabulary Test (EVT)
- Peabody Picture Vocabulary Test (PPVT)
- Goldman-Fristoe Test of Articulation (GFTA)
METHODS

Modified Inconsistency Assessment

3 productions of 25 different words elicited by picture and object naming

Target words include:

- 12 one syllable words (e.g., *boat*)
- 4 two syllable words (e.g., *zebra*)
- 6 three syllable words (e.g., *kangaroo*)
- 3 four syllable words (e.g., *helicopter*)

Subset of the children (N=13) also participated in a non-word repetition task

- 12 non-words matched to 12 of the real words on word length, syllable structure, and age-of-acquisition of the consonants
- Each non-word was elicited 3 times
METHODS

TRANSCRIPTION
- Consensus broad transcription
- Inter-transcriber reliability for 16 children (47% of participants) was .85 for consonants and .83 for all phonemes

CODING
- Words were coded as variable if the broad transcriptions differed in any way
- Coded as: Consistent correct, consistent incorrect, variable with hits, variable no hits
- Type of variability: word, syllable, segment
HELICOPTER – consistent correct
JUMP – consistent incorrect
HELIICOPTER — Variable no hits; Word level variability
Kangaroo — variable no hits; segmental variability
TEETH — variable with hits; syllabic variability
The Current Study

RESULTS

Mean Proportion of Words Produced Variably

- Overall: 0.95
- 4 syll: 0.68
- 3 syll: 0.5
- 2 syll: 0.5
- 1 syll: 0.38

All Children (N=34)

Range = .23 - .92
SD = .17

Average variability is 56% if only consonant differences are included
The Current Study

RESULTS

Variability by Age-group:
Mean proportion of words produced variably

Age Group

2;6-2;11
3;0-3;5
3;6-4;2

Range = .6-.92
SD = .09

Range = .44-.88
SD = .15

Range = .32-.88
SD = .19
The Current Study

RESULTS

All Children

- 45% Variable No Hits
- 23% Variable With Hits
- 20% Consistent Correct
- 12% Consistent Incorrect
Type of Variability: All Children

Results:

- **44%** for Segment
- **15%** for Syllable
- **41%** for Word

Examples: Boy – 3;4

- **Word:** 
  - [dæməθɔr] 
  - [θɔrθɔ] 
  - [ʔanθɔr]

- **Syllable:**
  - [bækəθınə] 
  - [fækjʊklɪŋʊ] 
  - [dækjʊnkɪŋə]

- **Segment:**
  - [tif] 
  - [tid] 
  - [tif]
68% of words produced variably
- Comparable to previous studies (McLeod & Hewett, 2008; Sosa, 2008)
- But much higher than Holm et al. (2007)
- Similar to variability rates described in older children with CAS (Marquardt et al., 2004)

Word length affects variability
- 4 syllable words are highly variable (95%)
- 1 syllable words are relatively stable (38%)
- No difference between 2 and 3 syllable words (both 50%)

Variability decreases between 2;6 and 4;2, but is still prominent in the oldest group in the study (57% for kids between 3;6 and 4;2)

Most variable productions are “variable no hits”
- Comparable to McLeod & Hewett (2008), but different from Holm et al. (2007)

The prosodic word is largely preserved; most variability involves differences at the syllabic and segmental levels (i.e., elision, epenthesis, and substitution)
12 real words from the Inconsistency Assessment and 12 non-words matched for word length, syllable structure, and age-of-acquisition of consonants; each produced 3 times. (N=13)
Variability in Real Words vs. Non-Words

Real Words
- Variable No Hits: 20%
- Variable With Hits: 17%
- Consistent Correct: 10%
- Consistent Incorrect: 53%

Non-Words
- Variable No Hits: 18%
- Variable With Hits: 27%
- Consistent Correct: 4%
- Consistent Incorrect: 51%
Variability in Real Words vs. Non-Words

Real Words
- Word: 50%
- Syllable: 38%
- Segment: 12%

Non-Words
- Word: 50%
- Syllable: 35%
- Segment: 15%
Overall rates of variability are similar in real words and matched non-words (70% vs. 78%)
- 7 children more variable on non-words (mean difference = .18)
- 4 children had equal variability in each condition
- 2 children more variable on real words (mean difference = .13)

Most variable productions are “variable no hits” for both real and non-words

Type of variability is similar in both real and non-words (primarily segmental and syllabic)

1 syllable real words are more stable than 1 syllable non-words (36% vs. 67%)
Discussion:

Variability vs. Inconsistency

Why are the results so different from Holm et al. (2007)?

- In Holm et al. (2007), original transcriptions were done on-line during testing; point-to-point transcription reliability from audio recordings was reported to be extremely high (99%)
- Consensus transcription from video recordings was used in the current study

Results suggest that “typical variability” cannot be differentiated from “atypical inconsistency” simply by the presence of a high proportion of “variable no hits” responses in this age group; more detailed analysis of variability is needed

- Increasing variability with increasing word length is a feature of the speech of typically developing 2- to 4-year-olds
Discussion:

Sources of variability

Motor immaturity
- May play a bigger role in longer words than in shorter words

Phonological representations
- In young children, variability in short words may reflect the nature of phonological representations more than variability in long words
Conclusions and Future Directions

- Discrepancy between results of different studies needs to be resolved in order to accurately describe “typical variability” so that we can identify “atypical variability”
- Variability in speech disorder vs. variability in typical development
- Relationship between variability and other measures of phonological knowledge in typical development
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References


