Individual differences in speed of lexical processing and its relationship with language development

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Introduction

Children differ considerably in their early speech production and in the rate at which their language develops.

A number of studies using the Looking-While-Listening (LWL) paradigm have shown that the **speed** at which a child can process spoken speech is related to their concurrent and future vocabulary size[1,2,3]. In other words, children who are fast language processors early on, tend to have bigger vocabularies later on.

However, an unanswered question is:

What is processing speed measuring, and why is it so closely tied to vocabulary?

Two hypotheses…

We think there are two possibilities:

1. FACILITATION HYPOTHESIS:

Faster processing of familiar words facilitates new word learning (perhaps because faster processing frees up processing power for the encoding of new words).

2. LEXICAL RETRIEVAL SPEED HYPOTHESIS:

Faster processing simply reflects how quickly children access and retrieve information from the lexicon – there is no facilitative effect on learning.

- Both predict that children with faster processing in infancy will have larger vocabularies at concurrent time points. But,
- FACILITATION predicts fast processors will have faster rates of vocabulary growth over time but,
- LEXICAL RETRIEVAL predicts fast processors will not have faster rates of growth over time.

Aims

1. REPLICATE EXISTING FINDINGS

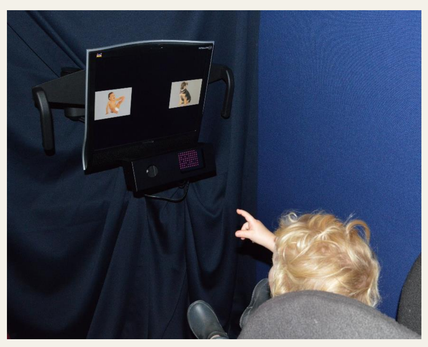
2. EXTEND FINDINGS:

- Test whether SoP is measuring: FACILITATION (faster rates of vocabulary growth at later time points) or LEXICAL RETRIEVAL SPEED (no difference between vocabulary growth at later time points).
- Test whether there is also a relationship between SoP and syntax.

Method

Online measure – speed of processing (SoP)

80, 73, and 74 children in the longitudinal Language 0-5 Project were tested at 19M, 25M, and 31M respectively, on a LWL task (adapted for use with an EyeLink eye-tracker).



DV

1. ***Reaction time (RT)***: mean time in msecs to shift from the distracter (the unnamed image) to the target (named image).
2. ***Accuracy***: mean proportion of looking time in msecs to the target image once named.

Offline measure - vocabulary

- UK-CDI Words and Gestures – 16 and 18 months
- Lincoln CDI Words and Sentences - 19, 21, 24, 25, 27, and 30 months

Offline measure - receptive syntax

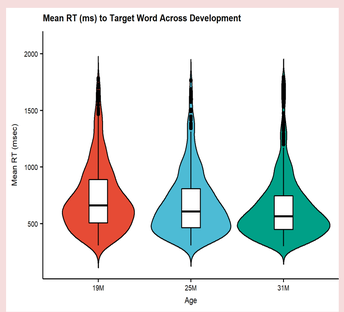
- CELF Preschool-2 sentence structure – 31 and 37 months

Offline measure - productive syntax

- Mean of Three Longest Utterances (M3L) – 19, 21, 24, 25, 27, and 30 months

Results - REPLICATION

a. SoP should decrease across development



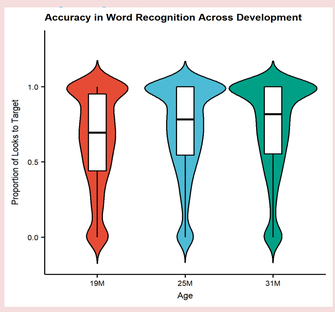
RT at both 25M (β = -54.21, *SE* = 14.10, p < .001) and 31M (β = -90.81, *SE* = 14.03, p < .001) differs significantly from RT at 19M.

Post hoc tests (Tukey) reveal:

- lower RTs at 25M than at 19M (β = -59.79, *SE* = 14.20, p < .001)
- lower RTs at 31M than at 19M (β = -99.39, *SE* = 14.06, p < .001)
- lower RTs at 25M than at 31M (β = -39.61, *SE* = 14.71, p < .01)

We found: SoP decreased across development

b. Accuracy should increase across



Accuracy at 25M (β = 0.071, *SE* = 0.009, p < .001) and 31M (β = 0.081, *SE* = 0.008, p < .001) differs significantly from accuracy at 19M.

Post hoc tests (Tukey) reveal:

- greater accuracy at 25M than at 19M (β = 0.07, *SE* = 0.009, p < .001)
- greater accuracy at 31M than at 19M (β = 0.08, *SE* = 0.008, p < .001)
- but NOT better at 25M than at 31M (β = 0.01, *SE* = 0.009, p = .46)

We found: Accuracy increased across development

c. Children who are fast processors early on should be fast processors later on

	Speed of Processing			
	25M		31M	
Speed of processing	r	p	r	p
19M	0.23	0.03	0.28	0.009
25M			-0.05	0.66

We found: SoP was stable between 19M and 25M, and between 19M and 31M, but not between 25M and 31M

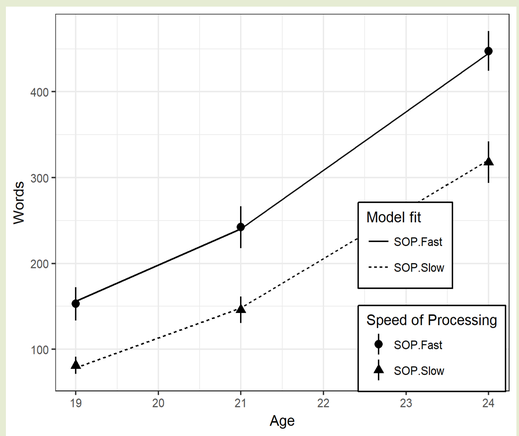
d. SoP should correlate with concurrent vocabulary size

	Speed of Processing					
	19M		25M		31M	
	r	p	r	p	r	p
Concurrent vocabulary	-0.40	0.00	-0.03	1.00	0.00	1.00

We found: SoP correlated with prior, concurrent, and later vocabulary size – but only SoP at 19M

Results - EXTENSION

e. Is SoP (19M) measuring FACILITATION or LEXICAL RETRIEVAL SPEED?

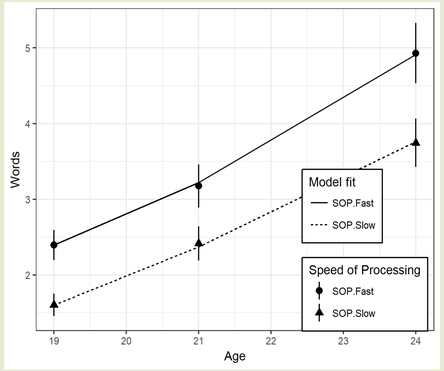


- Faster processors at 19M had bigger vocabularies than slow processors; Effect of SoP on intercept: Estimate = -0.40, χ^2 = 18.06, df = 1, p < .001
- Faster processors at 19M had faster vocab growth than slow processors; Effect of 19M SoP on linear term: Estimate = -0.12, χ^2 = 4.74, df = 1, p = .03

We found: Fast processors had larger vocabularies and learned words more quickly than slow processors => SUPPORTS FACILITATION HYPOTHESIS

f. Is there a relationship between SoP (19M) and syntax?

Productive syntax - M3L



- Faster processors at 19M produced longer sentences than slow processors; Effect of 19M SoP on intercept: Estimate = -0.03, χ^2 = 13.72, df = 1, p < .001
- No difference in the rate at which M3L grew for fast and slow processors; No effect of 19M SoP on linear term: Estimate = -0.004, χ^2 = 0.47, df = 1, p = .49

We found: Fast processors produces longer sentences than slow processors, but did not differ in rate of growth

Receptive syntax – CELF

Once controlling for concurrent vocabulary (hierarchical regression), 19M SoP did not predict performance on the CELF at either:
31M (F(66,65) = 3.10 , p = .08) or 37M (F(62,61) = 0.73 , p = .40)

We found: SoP did not predict receptive syntax once controlling for concurrent vocabulary

Conclusion

In general, we replicated the existing findings:

a. SoP decreased across development.
b. Accuracy increased across development.
c. Children who were fast processors early were fast processors later on.
d. SoP correlated with concurrent vocabulary size – but only SoP at 19M.

We also extended the findings to show:

e. Processing speed **facilitates** the learning of new words.
f. But, it does not predict:
   - productive syntactic growth nor,
   - receptive syntax

Outstanding questions…

Why do we ONLY find relationships between vocabulary and SoP at 19M?

- Perhaps because there is **more variability early on** in how well the children know the target words in our LWL task.
- But, this **variability gets smaller with age**: By the time these children reach 25M/31M, these target words are fairly well-known.
- Maybe variance in processing speed at 25M/31M to a greater extent reflects general processing speed rather than how well the children know the words.

Implications

- Faster processors might not actually process words overall faster – they may just have stronger representations of (more of) the familiar words in the tests.
- Therefore, SoP might predict vocabulary only when the items in the SoP test discriminate between early (strongly represented) and late (weakly represented) words.

Next step: Test this idea directly!

Acknowledgements

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