Influence of home language input and lexical processing on vocabulary size in 3-year-olds

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BACKGROUND

- Children learn language from their environment, and early language input from caregivers predicts later language development (e.g., Hart & Risley, 1995; Hoff, 2003; Huttenlocher et al., 1991).
- Lexical processing predicts later language development. For instance, accuracy and speed of processing at age 2 predicted language and working memory scores at age 8 (Marchman & Fernald, 2008).
- Weisleder and Fernald (2013) examined these two predictors of language growth together in 19 month-olds. Not only did both variables predict vocabulary at 24 months, lexical processing *mediated* the effect of caregiver input on vocabulary growth.
- A mediation model is a causal theory; a mediating variable represents the mechanism that generates the effect of one variable on another (Kline, 2010).
- Vocabulary development, the mediation model suggests, is not simply a matter of gaining exposure to language. Children have to process this input efficiently to capitalize on learning opportunities in their environment, and greater language input supports the development of these crucial processing skills.
- Our study applies this mediational model to older children, using a different language processing task and a direct measure of expressive vocabulary.

METHODS

Participants
- 108 preschoolers (49 boys, 59 girls), 28–39 months in age

Language Input Measure
- Language input data was collected using a digital recorder worn by the children over 12+ hours on a typical day
- LENA software (Ford, Baer, Xu, Yapanel, & Gray, 2009) analyzed each recording to generate:
  - Hourly word-counts of adult language in the child's environment,
  - Hourly number of child-adult and adult-child conversational turns, and
  - Proportion of meaningful speech (not noise, TV, distant speech or silence)

Lexical Processing Measure
- Measured overall accuracy (proportion of looking to target word) in a looking-while-listening eye-tracking task (Fernald et al., 2008).

Vocabulary Measure
- Children also received an expressive vocabulary test (EVT-2, Williams, 2007).
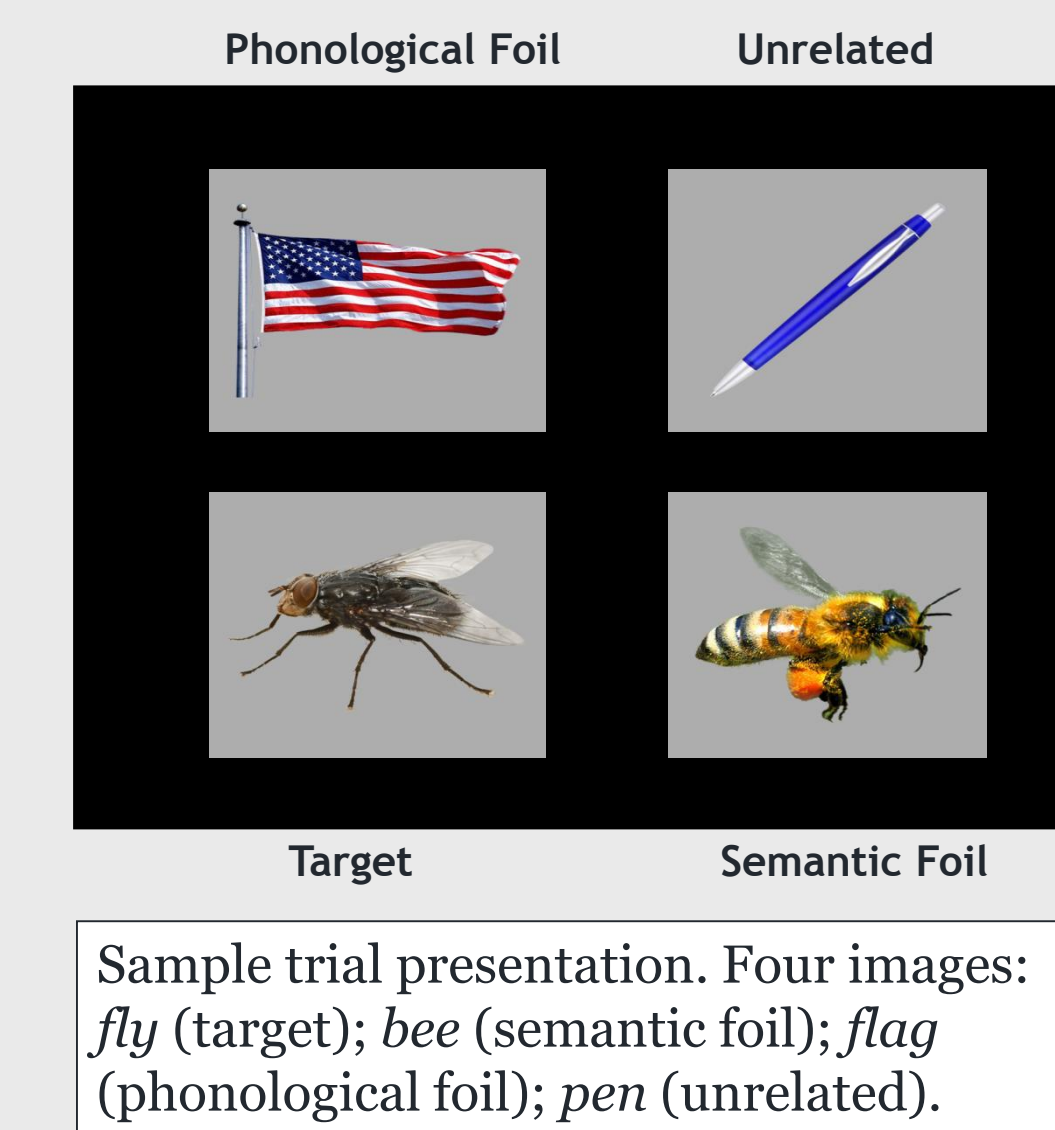- Growth scale values used for analyses.

Maternal Education
- To examine whether the relationships varied with maternal education level, participants were stratified based on maternal education.

	Below College	College	Above College	All
N	18	50	40	108
Age (months)	32.89 (3.71)	32.69 (3.5)	32.4 (3.53)	32.61 (3.52)
EVT (Growth Scale)	111.28 (14.99)	118 (11.32)	121.5 (8.58)	118.17 (11.55)
EVT (Standard)	109.94 (19.12)	117.37 (14.61)	122.58 (9.44)	118.06 (14.4)
Hourly Conv. Turns	34.72 (19.89)	46.24 (18.85)	49.88 (22.35)	45.67 (20.83)
Hourly Adult Words	850.72 (399.29)	1020.47 (402.94)	1262.55 (391.99)	1081.28 (422.53)
Prop. Meaningful Speech	0.17 (0.06)	0.2 (0.05)	0.22 (0.05)	0.2 (0.05)

Eye-tracking Procedure and Analysis

- Children heard a familiar word in a carrier phrase (e.g., *find the fly*) and saw a 2x2 array of photographs, including a semantic, phonological, and unrelated foil.
- Tobii T60XL Eye Tracking System measured children's patterns of looking to objects over the course of a trial.
- Analyzed proportion of looking to target word between 250ms and 1750ms.
- Weighted empirical-logit growth curve analysis (Mirman, 2014) modeled proportion of looking to target word between 250ms and 1750ms.
- Subject-level random effects on intercept, linear and quadratic time terms were estimated, and these values quantified individual differences in lexical processing efficiency.
- **Accuracy**: random intercept from model (proportion looking-to-target at 1000ms)

Phonological Foil | Unrelated
Target | Semantic Foil

Sample trial presentation. Four images: *fly* (target); *bee* (semantic foil); *flag* (phonological foil); *pen* (unrelated).
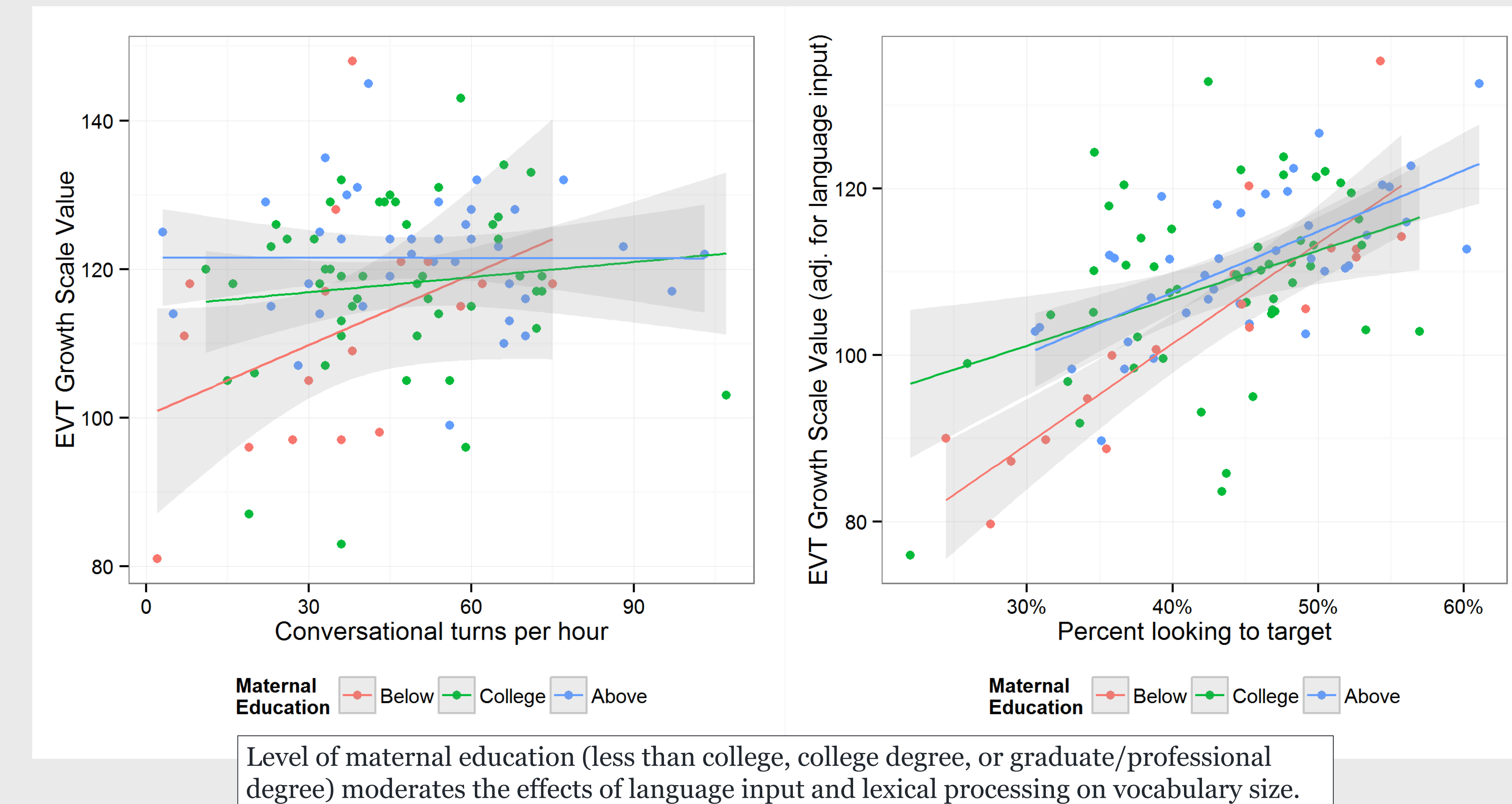
Research Questions

- Do home language variables predict vocabulary size and lexical processing? Does lexical processing in turn predict vocabulary size?
- Does maternal education moderate the effects of home language and lexical processing on vocabulary?

RESULTS

- Proportion of meaningful speech was the strongest home-language predictor of vocabulary size, $R^2 = 0.13$.
- Maternal education significantly moderated the effect of conversational turns on vocabulary size, overall model $R^2 = 0.14$. Effect of conversational turns on vocabulary was greater for children from families with lower maternal education.
- Neither home language input nor maternal education predicted lexical processing. Conversational turns, adult word count, proportion meaningful speech and maternal education together accounted for 5% of the variance in accuracy.
- Lexical processing robustly predicted vocabulary size. This relationship was moderated by maternal education; the linear relationship between accuracy and vocabulary size was greater for children from families with lower maternal education.
- Therefore, the best-fitting model of the data allowed for the effect of accuracy to vary by maternal education level while controlling for home language input:

Parameter Estimate	Outcome: EVT Growth Scale Value
Intercept (Below College)	53.050*** (9.124)
Group: College	30.920*** (11.580)
Group: Above College	25.120** (12.160)
Meaningful (%)	0.471*** (0.162)
Accuracy (%)	1.208*** (0.210)
College x Accuracy	-0.637** (0.268)
Above-College x Accuracy	-0.474* (0.274)
$\mathbf{R^2}$	0.479

Maternal Education — Below, College, Above

Level of maternal education (less than college, college degree, or graduate/professional degree) moderates the effects of language input and lexical processing on vocabulary size.

DISCUSSION

- This study failed to replicate the mediational effect found by Weisleder and Fernald (2013). For this sample of children, none of the home language measures predicted performance on the lexical processing task.
  - Weisleder and Fernald's study examined only children from families with low maternal education, for whom language input appears to be more important.
  - That study also examined younger children and used a parent-report measure of expressive vocabulary.
- In this study, both home language environment and lexical processing predicted vocabulary size; however, these effects were moderated by maternal education.
- For children from families with lower maternal education, input and accuracy were more strongly related to vocabulary size.
  - Language input matters more in families with lower maternal education.
  - These findings support the importance of intervention programs such as *Thirty Million Words* and *Providence Talks* to increase language input to children from families with low maternal education.
- Why did maternal education moderate the relationship between lexical processing and vocabulary size?
  - May be related to non-linguistic factors such as what "attention to task" means in children from families with different maternal education levels..
- These results illustrate the importance of recruiting from diverse and representative populations, as opposed to mid-SES "convenience samples".

ACKNOWLEDGEMENTS