Predictors of Word Combinations by Toddlers who Participated in Parent-Coached Language Interventions: Modeling Count Outcomes

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Purpose

Use an extant dataset (Romski et al., 2010; Romski in prep) to address two purposes.

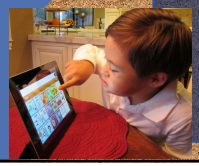
1. explore potential predictors of the total number of vocabulary combinations at the end of a parent-coached language intervention.
2. To raise awareness of potential methodological issues behind collecting frequency data (count data outcomes) and to compare popular models that address these issues.

Word Combinations of Typically Developing Children

- TD children begin to combine words around 2 years of age.
- Vocabulary is important!
  - Begin to combine with an expressive vocabulary of 50 words
  - Conceptual development plays a role in early grammar (Brown, 1973)
  - Familiarity with verbs helps young children produce abstract grammatical structures (Tomasello, 2000)

Children with Intellectual Disabilities Who Use AAC

- Youth with ID use symbol vocabularies to build complex structures to communicate (Wilkinson, Romski & Sevcik, 1994)
- Many studies have successfully used trial-based (Binger & Light, 2007; Nigam et al., 2006) and partner training interventions (Binger et al., 2008;2010) to teach vocabulary combinations.
- We know little about what contributes to the emerging combinations of children who participate in language interventions when they are being not formally taught.



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Research Questions

- RQ1: Do toddler characteristics (baseline language measures, access to an AAC device) and Language outcomes (MLU, target vocabulary size, TTR), predict emerging number of vocabulary combinations when controlling for age?
- RQ2: Does target vocabulary size mediate the relationship between toddler characteristics (baseline language measures, access to an AAC device) and total number of target vocabulary combinations?

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Participants

- Extant data were used from 113 parent-toddler dyads who participated in two parent-coached language intervention studies (Romski et al., 2010; Romski, in prep).
- Toddlers ranged in age between 24-38 months.
- Toddlers had an expressive vocabulary of less than 10 words and scored less than 12 months on the expressive language scale of the Mullen.

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Language Intervention

- All parent-child dyads participated in 24 30-minute parent=child language interventions over 12 weeks.
- All children were assigned an individualized set of vocabulary words they did not know.
- All parents were encouraged to elicit the vocabulary words using different strategies (e.g., modeling, expansion, sabotage).
- Children either did or did not have a speech-generating device (SGD) throughout the intervention.

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Measures and Variables

Baseline Receptive and Expressive Language Scales:

Mullen Scales of Early Learning, Vineland Adaptive Behavior Scales (VABS), The MacArthur-Bates Communicative Development Inventory (MCDI), and Sequenced Inventory of Communication Development (SICD).

Language Outcomes (final intervention session):

- Mean Length of Utterance (MLU)
- Type Token Ration (TTR)
- Target vocabulary size (e.g., ball, myturn, read, turnpage)

Use of AAC:

- SGD was a light-weight low-tech device using Picture Communication Symbols (PCS; Mayer-Johnson, 1981).
- Children who had access to a speech-generating device (SGD) vs. those who did not.

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Measures and Variables

Word Combinations:

- Combination included more than one target vocabulary word
- Included both spoken and aided symbol vocabulary words

Table 1
Examples of combination types made by toddlers at session 24

Agent -action	Action -object	Entity-locative	Possessor -possession	Entity – attributive
bear ride	read book	bear out	my cracker	blue bear
go cow	drink juice	train in	your cracker	drink full
go train	stop train			5 cookie
				good apple

Note: Examples are categorized according to Brown's (1973) definition of early grammatical categories (semantic relations)

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Measurement Issues with Count Data

- Measuring linguistic behaviors (frequency data) in children with language and ID may result in counts-with a preponderance of zeros and over-dispersion.
- This creates complex issues when trying to analyze the data.

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Types of Count Data Distributions

May want to consider modeling using count models rather than regular OLS regression. Why?

- Poisson regression: conditional mean is modeled as a function of the covariates. Assumes that the unconditional mean and unconditional variances are equal.
- Negative binomial: Same mean structure as Poisson. Makes a provision for overdispersion in the data (variance is greater than the mean).
- Zero inflated Poisson (zip): uses a logit model to model probability of a constant (Structural) zero and count data is modeled by the Poisson regression.
- Zero inflated negative binomial (zinb): Model the probability of structural zero. Models count data and overdispersion in the distribution of the NB component.

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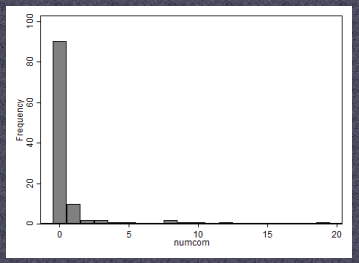
Outcome : Number of Vocabulary Combinations

Let's take a look at descriptives for the outcome of the present study:

- Only 22 out of 113 combined target vocabulary words.



- The unconditional Mean=.85 and the Variance=7.3

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Data Analysis Plan

- Model fit was compared across four count-data models (e.g. poisson, negative binomial, zero inflated negative binomial, zero-inflate poisson) by comparing Loglikelihood Ratios for nested models and comparing BIC values and Vuong tests (1989) for non-nested models.
- For RQ1 and RQ2, We utilized expressive and receptive language factor scores in our analyses as independent variables. Factor scores were calculated in Mplus (Muthén & Muthén, 1998–2012) by fitting a two-factor model, (p = .017, CFI = .976, RMSEA = .084). Factors were correlated at .541, p<.001
- For RQ1, we conducted a multiple regression analysis. For RQ2 we conducted a mediation model. Analyses were conducted using STATA (RQ1; Statacorp, 2013) and Mplus (Muthén & Muthén, 1998–2012)

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Research Question 1:

Do toddler characteristics (access to AAC [yes or no], baseline language skills) and language outcomes (MLU, TTR, Functional vocabulary size) predict total number of vocabulary combinations at session 24 over and above age?

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Research Question 1: count data coefficients

Table 2. Comparison of count data models.

Parameter	Poisson	Negative Binomial	Zero-inflated Poisson	Poisson Logit	Zero-inflated NB	Negative binomial Logit
Intercept	1.54**	-0.24	-1.70	2.19**	0.80	0.70
Age	0.04	-.002	0.01		-0.01	
Expressive Language (baseline)	0.05*	0.09	-0.01		0.06	
Receptive Language (baseline)	0.03	0.03	0.04		0.05	
AAC use	1.29	1.02	1.13		1.01	
MLU (session 24)	-0.68	-3.14	0.14		-2.82	
TTR (session 24)	1.02	-1.83	-1.97		-1.87	
Total Vocabulary Size (session 24)	0.12***	0.14**	0.08***	-0.08*	0.11*	-0.06
Dispersion		3.81***			1.82***	
Parameter	8	9	10		11	

Note: Values are unstandardized coefficient estimates for Poisson, Negative Binomial, Zero-inflated Poisson and Zero-inflated binomial. MLU=Mean length of utterance. TTR=type-token ratio. Dispersion=dispersion parameter, α. *Statistically significant (p<.05), **statistically significant (p<.01) ***statistically significant (p<.000)

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Research Question 1: tests of model fit

Table 3. Comparison of count data model fit indices

	Fit Statistics	Negative Binomial (NB)	Zero-inflated Poisson (ZIP)	Zero-inflated Negative Binomial (ZINB)
Poisson	LR	91.67***		
	BIC		65.62	78.03
	Vuong		2.26*	
NB	LR			
	BIC		-21.34	-8.95
	Vuong			.29
ZIP	LR			17.13***
	BIC			
	Vuon			

Note: LR=Likelihood ratio test (nested models). BIC=Difference in BIC values (non-nested models). Vuong=significance test between non-nested models *Statistically significant (p<.05), **statistically significant (p<.01) ***statistically significant (p<.000)

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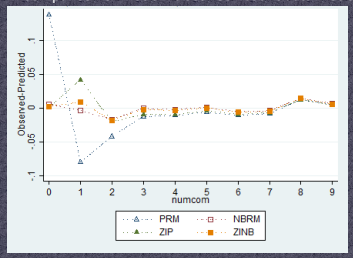
Research Question 1: visualizing model fit

Figure 2. Comparison of model fit between count data models



Note: LR=Likelihood ratio test (nested models). BIC=Difference in BIC values (non-nested models). Vuong=significance test between non-nested models *Statistically significant (p<.05), **statistically significant (p<.01) ***statistically significant (p<.000)

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Research Question 1: NB results

- The negative binomial model provided the best model fit.
- Functional vocabulary words was a significant predictor the number of vocabulary combinations produced at session 24, p<.01
- For every one word increase in functional vocabulary, the number of total vocabulary combinations increased by 14.6% (1−exp (0.1363) = 0.146),
- Pseudo R2=.13

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Research Question 2

Does target vocabulary size mediate the relationship between toddler characteristics (baseline language measures, access to AAC) and outcome of target vocabulary combinations?

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Research Question 2: Analyses

- Tested mediation using MPLUS.
- Applied the same steps to compare model fit as in RQ1.
- As in RQ 1, Negative binomial regression was the best fit to the data.

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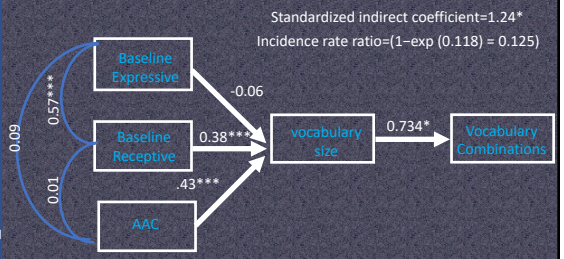
Research Question 2: Results



Note: Values are standardized coefficient estimates. *** significance at p<.000 * significance at p<.05

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Discussion and Implications

- Vocabulary combinations can emerge in toddlers without teaching targeted vocabulary combinations.
- Receptive language skills and use of a SGD do not directly explain emerging vocabulary combinations. However SGDs and receptive language skills promote acquisition of target vocabulary (Romski et al, 2010; Barker et al., in prep).
- Teaching parents to use language eliciting techniques (with a focus on targeting vocabulary growth) in a natural communication context is helpful to eliciting emerging vocabulary combinations.

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Discussion and Implications

- Using count data models gives us a unique opportunity to understand more about factors that contribute to emerging grammar in children with ID and language delays.
  - We can look at skewed distributions
  - Testing for model fit is important!

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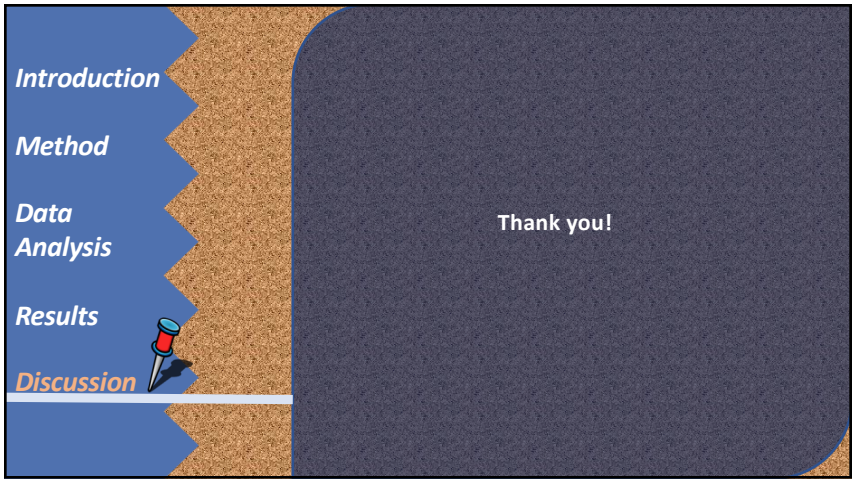
Discussion and Implications

Limitations

- Vocabulary repertoires are idiosyncratic!
- Other toddler characteristics?
- Comparison group?

Future Directions

- Combine intervention and follow-up data to look at individual growth curve patterns (has been done with count data!).
- Qualitative look at grammatical structures over time (follow up data).



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