Developmental Changes in the Early Childhood Executive Function and Language Relationship: A Preliminary Analysis

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ABSTRACT

Recent studies demonstrate strong, concurrent relationships between. language and executive functions (EF), particularly during early childhood. Whereas some studies cite a bidirectional relationship, others suggest that EF is predictive of language gains, while others suggest that it is language which affects EF through conversational practice. Further controversy remains in the literature regarding which components of EF are engaged in the processes. The bidirectionality of current research in this area suggests that perhaps EF and language are best fitted by a curvilinear relationship. This is compounded by the fact that a large number of these studies have employed linear statistical analyses to examine the relationship of the two constructs. Thus, in order to further specify the relationship between EF and language development, we examined toddler performance on a variety of language measures to determine the utility of a curvilinear model to assess the EF and language relationship and to assess which aspect of language inhibitory control most correlates to EF. Results indicate that the EF and language early childhood relationship is best fitted by a curvilinear model.

INTRODUCTION

- EF and language develop rapidly during early childhood in a dynamic, iterative process (Farkas & Beron, 2004; Vygotsky & Kozulin, 2012).
- Recent behavioral studies cite strong, concurrent relationships between language and EF, particularly during early childhood (Gooch et al., 2016).
- The specific direction of this relationship remains unclear.
- Multiple studies cite a bidirectional relationship between the two constructs (Slot & Suchodoletz, 2018).
- Other studies suggest that EF is predictive of language gains (Fuhs et al., 2014).
- Other research suggest that it is language which affects EF through conversational practice (Gooch et al., 2016).
- In addition, controversy remains in the literature regarding which components of EF are engaged in language processes.

RESEARCH

1. Is the relationship between EF and language during early childhood best fitted by a curvilinear model?
2. What aspect of language most correlates to inhibitory control?

METHODS

Parent Survey

- Parents completed a brief demographic questionnaire regarding their household and their child

Snack Delay Task

- Child waits to reach for an M&M placed under a transparent cup until the examiner rang the bell that she lifted mid-way through the delay but did not ring until the end. The task consisted of four trials with delays of 10 seconds, 20 seconds, 30 seconds, and 15 seconds.

Preschool Language Scales, Fifth Edition (PLS-5)

- Participants completed the Auditory Comprehension tests of the PLS-5. The PLS-5 is an interactive assessment of receptive communication in children ages birth-7:11.

Early Communication Indicator (ECI)

- The ECI is a brief, repeatable, play-based observational measure of a child's communication performance during a 6-minute play period with a familiar adult, standardized around the Fisher-Price House or Farm. The ECI assesses gestures, vocalizations, single words, and multiple words.

MacArthur-Bates Communicative Development Inventories (MB-CDIs)

- The MB-CDIs are parent report instruments examining 8-30 month old's developing abilities in early language, including vocabulary comprehension, production, gestures, and grammar

RESULTS

Curvilinear regressions were conducted to assess the relationship between Snack Delay scores and each of the language measures. After evaluating a linear model, each additional step involved entering the next highest power of the predictor (Snack Delay score). This continued until the addition of the next highest power increased the fit of the model to the data by an insignificant or otherwise amount.

Preschool Language Scale (PLS-5)

Adding a quadratic component produced a significant increase in fit, as did adding a cubic component. Accordingly, the cubic model was adopted, $F(3, 147) = 3.422$, $p = .019$, $R^2 = .065$.

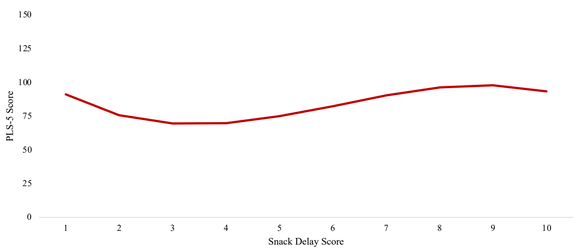

Table 1: Predicting PLS-5 Performance from Snack Delay Scores

Step	ΔR	F for ΔR^2	df	p
1: Linear	0	0.066	1, 147	.797
2: Quadratic	.01	0.776	2, 147	.225
3: Cubic	.06	3.422	3, 147	.004

RESULTS, cont.

Early Communication Indicator(ECI)

Adding a quadratic component produced a significant increase in fit, but adding a cubic component did not. Accordingly, the quadratic model was adopted, $F(2, 76) = 5.89$, $p = .004$, $R^2 = .314$.

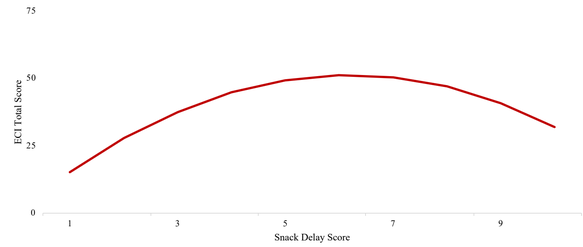

Table 2: Predicting ECI Performance from Snack Delay Scores

Step	ΔR	F for ΔR^2	df	p
1: Linear	.076	6.362	1, 76	.014
2: Quadratic	.0058	5.89	2, 76	.004
3: Cubic	0	3.883	3, 76	.012

MB-CDI Toddler

Adding a quadratic component to the model produced a significant increase in fit, as did adding a cubic component. Accordingly, the cubic model was adopted: $F(3, 101) = 3.518$, $p = .018$, $R^2 = .095$.

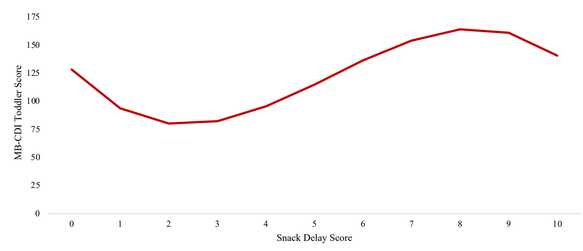

Table 3: Predicting MB-CDI Toddler Performance from Snack Delay Scores

Step	ΔR	F for ΔR^2	df	p
1: Linear	.028	2.969	1, 101	.088
2: Quadratic	.023	2.759	2, 101	.068
3: Cubic	.043	3.518	3, 101	.018

DISCUSSION

- Relationship between inhibitory control and language may be best fitted by a curvilinear model, and perhaps the curvilinear relationship reflects the lack of consensus in studies employing linear models.
- Results demonstrate a cubic relationship between Snack Delay scores and receptive language, as measured by the PLS-5. This is in line with existing studies pointing to a relationship between receptive language skills and nonverbal inhibitory control via linear regression models (Kaushanskaya et al., 2017)
- Results demonstrate a quadratic relationship between Snack Delay scores and communicative performance (ECI). This reflects existing research demonstrating that EF searches the mental lexicon to achieve correct word choice for a given communicative context and task, while inhibiting production of the inappropriate word (Ye & Zhou, 2009).
- Results indicate a cubic relationship between Snack Delay scores and expressive language (MB-CDI). The results align well with studies demonstrating significant relations between inhibitory control, word production, and internal state vocabulary during this age group (Bohlmann et al., 2015).

IMPLICATIONS

- Understanding the relationship between EF and language throughout development will provide insight into the potential importance of developing language curriculums which strengthen domain-general skills, like EF, within a process-specific framework in order to enhance domain-specific skills, like language.
- Early childhood education curriculum may need to be critical of task demands and consider that results may differ when minimizing executive and attentional demands of language tasks.
- Language intervention strategies that focus on building EF skills within linguistic tasks may be of particular importance to special populations and the remediation strategies that are used to serve these populations.

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