MEASURING THE RELATIONSHIP BETWEEN CHILDREN'S COMMUNICATIVE ABILITIES AND EXECUTIVE FUNCTIONS

by

Lauren Clough

A Thesis Submitted to the Faculty of the

DEPARTMENT OF EDUCATIONAL PSYCHOLOGY

In Partial Fulfillment of the Requirements

For the Degree of

MASTER OF ARTS

In the Graduate College

THE UNIVERSITY OF ARIZONA

2018

STATEMENT BY AUTHOR

The thesis titled "Measuring the Relationship Between Children's Communicative Abilities and Executive Functions" prepared by ***Lauren Clough*** has been submitted in partial fulfillment of requirements for a master's degree at the University of Arizona and is deposited in the University Library to be made available to borrowers under rules of the Library.

Brief quotations from this thesis are allowable without special permission, provided that an accurate acknowledgement of the source is made. Requests for permission for extended quotation from or reproduction of this manuscript in whole or in part may be granted by the head of the major department or the Dean of the Graduate College when in his or her judgment the proposed use of the material is in the interests of scholarship. In all other instances, however, permission must be obtained from the author.

SIGNATURE: Lauren Clough

APPROVAL BY THESIS DIRECTOR

This thesis has been approved on the date shown below:

Adriana Cimetta

Adriana Cimetta
Assistant Research Professor, Educational Psychology

4-30-18
Date

Acknowledgments

I would like to thank everyone who has supported me through this journey. In particular, I want to give special thanks to my parents and brothers for always believing in me. Meghan, I would not be here without your constant love and encouragement. I am also incredibly grateful to my academic mentors within the Educational Psychology department, including Dr. McCaslin, Dr. Cimetta, Dr. Erbacher, Dr. Marx, Dr. Tullis, Dr. Smith, Dr. Burross, and Dr. Good. Many thanks to the friends that have become family – you've been with me through the good days, bad days, and everything in between.

Lastly, I would like to dedicate this accomplishment to my grandma, who passed away the first semester of my graduate program. I would not be the woman I am today without your unconditional love and guidance. Thank you for being my army.

TABLE OF CONTENTS

LIST OF TABLES

Abstract

The present study builds upon previous research to explore the relationship between children's performance on a measure of executive function and scores of verbal ability and communication. In addition, the study examined if executive function is predictive of protective factors and behavioral concerns. Data used for this analysis were drawn from a sample of 1,350 three- to four-year-olds who had not yet entered kindergarten. Linear regression analysis suggested a relationship between child executive functions and receptive communication skills. This finding opens the door for future research to explore if the development of these two skill sets co-occurs or if one precedes the other.

Keywords: executive function, communicative abilities, protective factors, early childhood

Background

There are three core executive functions (EF) that are frequently discussed in the current literature: *inhibition, working memory,* and *cognitive flexibility* (Diamond, 2013; Lehto et al., 2003; Miyake et al., 2000). Inhibition refers to the ability to halt or suppress an action or thought (Diamond, 2013). Inhibition is the mechanism that allows children to stay on task in a classroom setting, making it a crucial component of school readiness. Working memory involves holding recently acquired information in the mind. In the classroom, children utilize working memory to recall the instructions of the task at hand. Cognitive flexibility is the ability to alter mental demands and expectations based on differing circumstances. Cognitive flexibility is a necessary component of switching between tasks in the classroom.

The purpose of this study is to examine the link between indicators of EF and receptive language abilities in young children. In addition, this study will assess whether child EF is predictive of another component of school readiness variables, socio-emotional development.

School readiness. What does it mean for a child to be ready for school? To address this question, the difference between readiness to learn and readiness for school should be discussed. Readiness to learn is a malleable characteristic and applies to people of all ages, while school readiness refers to an expected level of ability that prekindergarten and kindergarten aged children must possess to be successful in the classroom (Kagan, 1990). Kagan discusses varying schools of thought on the mechanisms underpinning readiness to learn. While the definition of readiness to learn is widely agreed upon, there is less consensus as to the mechanisms behind readiness. Robert Gagne (1970), an educational psychologist, has argued that learning requires three characteristics: attentional set, motivation, and developmental status. The Piagetian (1970) school of thought suggests that readiness revolves around the assimilation and accommodation of

new stimuli with existing mental schema. Jerome Bruner (1960) places a large emphasis on the impact of environmental influences. For the purposes of this study, school readiness will be used as an umbrella term for any variables that aid children in classroom success.

In addition, there is often a distinction between two major components of school readiness: academic preparedness and social and emotional development (Raver & Zigler, 1997; Raver, 2003). Policy makers often focus on academic preparedness as the main element of school readiness, at the detriment of children's socio-emotional development. However, there is a need to address the potential role that socio-emotional skills can play in the classroom setting.

Difficulties with attention, following directions, working well with peers, and controlling negative emotions and disruptive behaviors are often associated with lower academic success (Arnold et al., 1999; McClelland et al., 2000). While it is challenging to determine the directionality of the relationship between socio-emotional development and academic preparedness (Arnold et al., 1999), there is substantial longitudinal research supporting the importance of children's emotional adjustment on success in the classroom (Raver, 2003).

Research by Ladd et al. (1999) has suggested that peers and teachers are crucial in children's academic success because they act as a "source of provisions" in the learning environment (p. 1375). When discussing the role of peers and mentors in the classroom, a mention of Vygotsky and the zone of proximal development (ZPD) is crucial (Vygotsky, 1978). According to Vygotsky, the ZPD is the space in which children can acquire new knowledge and skills with the aid of a more experienced mentor. With this theory in mind, social relationships within the classroom can be a key component to children's academic success.

Executive function and language. Hughes (1998) assessed the verbal ability, executive function, and theory of mind of 50 preschoolers. Theory of mind (ToM) is the understanding that

people have thoughts and beliefs that can drive their actions (Wellman, 1992). Using a battery of assessments, Hughes (1998) found a significant relationship between performances on EF and ToM related tasks. In addition, the results suggested that age-related improvements in deception were correlated with improved inhibitory control. On the other hand, higher inhibitory control was not associated with scores on false-belief predictions, thereby suggesting that different dimensions of ToM might develop according to the presence of different EF-related skills. According to Grice (1975), typical human communication makes two assumptions: (1) speakers offer beneficial information, and (2) that beneficial information is believed by the speaker to be accurate. Based on these two assumptions, Hughes (1998) suggests, "the ability to inhibit default responses may be a core feature of children's effective engagement in deception" (p. 249).

A study by Guajardo et al. (2017) examined the relationship between EF, ToM, and reading expressiveness in adults. In the experiment, participants were asked to read passages aloud during a measure of reading expressiveness. In addition, EF and ToM tests were administered to the participants. The researchers found a significant correlation between all three measures, suggesting that these skills are interrelated. Language expressiveness requires the major components of EF: cognitive flexibility, inhibition, and working memory. Expressive language requires the speaker to adjust their speech characteristics to fit with the context or conversation at hand. In particular, reading expressiveness requires that people be able to switch between character perspectives and imagine themselves in each character's shoes. Participants must consider: How might this person sound? What is their personality like? How is their personality reflected in their voice and speech patterns? In addition, the reader must be able to hold the characteristics of the character in mind, recalling these attributes when switching between different characters.

Autism Spectrum Disorder (ASD) and receptive language skills. While the present study does not measure ASD, it would be remiss to discuss the relationship between communicative skills and executive function without addressing the important role each can play in this developmental disorder. ASD represents a unique opportunity to explore the relationship between receptive language and EF skills.

Autism spectrum disorder (ASD) is a developmental disability that can cause differences in communication, behaviors, and learning that vary from typically developing children (Johnson, 2004). ASD symptoms typically present by the age of three and will continue throughout the lifespan. It's important to note that while ASD can be diagnosed as early as two years of age, diagnosis does not typically occur until after four years of age (Center for Disease Control and Prevention, 2018). Perhaps the two most widely known characteristics of ASD are differing social skills and communicative abilities. While the manifestation of social and communicative behaviors can vary greatly between people diagnosed with ASD, people with ASD typically show signs of increased social isolation and delayed speech and language skills.

Children with ASD commonly struggle with their communication abilities. Receptive language, while only one component of communication, is essential in a classroom setting. Arguably, receptive language is a key component of school readiness. In order for children to be successful in the classroom, they need to be able to follow verbal directions by their teachers. In a study by Hudry et al. (2010), researchers used a clinician assessment to compare the receptive and expressive language abilities of children with ASD against typical age norms. As expected, children with ASD scored lower overall in language ability than the age-matched comparison norms. However, participants tended to show a higher level of impairment in receptive ability than in expressive ability. These results suggest that receptive language skills are more difficult

to acquire than expressive language, particularly for children with ASD. The present study, while not directly examining children with ASD, examines the relationship between receptive language and other variables related to school readiness, many of which children with ASD exhibit struggles with.

Adaptive behaviors and socio-emotional development. For the purposes of the present study, adaptive behaviors, also referred to as protective factors, are defined as behaviors relating to initiative, self-control, and attachment (LeBuffe & Naglieri, 1999). Initiative in children involves exhibiting independent thoughts and action to fulfill a child's needs or goals. Self-control involves a child's ability to perceive multiple feelings and use the appropriate words and actions to express themselves. Lastly, attachment refers to the strength of relationship between the child and adults in the child's life, including parents and teachers.

Parent-reported adaptive behaviors, particularly those revolving around social skills, have been linked to child executive function (Janusz, Ahluvalia, and Gioia, 2002). Adaptive behaviors have also been linked to executive function skills of children with ASD. Gilotty et al. (2002) conducted a study utilizing parent reports of everyday behaviors of their children, all of whom had been diagnosed with ASD. The researchers found a relationship between initiative and working memory domains with adaptive behaviors. In addition, they found the communication and socialization domains of their measure to be negatively correlated with executive skills, "suggesting that impairments in executive abilities are strongly associated with the deficits in communication, play and social relationships found in children with autism" (p. 241). The results of the studies above suggest that there is a complex relationship between communicative abilities, adaptive behaviors, and executive function that should be further explored.

Research Questions

Research Question 1: Are scores on a measure of child EF predictive of receptive language skills?

Research Question 2: Is child EF predictive of protective factors of socio-emotional development?

Research Question 3: Is child EF predictive of behavioral concerns of socio-emotional development?

This study is intended to contribute to the existing literature on the relationship between young children's receptive communication skills and EF and socio-emotional development and EF. For the purposes of this study, we will be examining child EF through a measure of cognitive flexibility.

Method

Participants

Our sample included 1,350 three- to four-year olds (33 months to 53 months old) who took part in the Longitudinal Child Study of Arizona (LCSA)(Marx et al., 2011). The LCSA was a convenience and purposive sample of 7,396 children from the ages of two-months to approximately six-years old (who had not yet entered kindergarten), drawn from various regions of Arizona and from various community and childcare settings. A battery of instruments was used to assess children's gross and fine motor development, height and weight, socio-emotional development, language and literacy, executive function, and math concepts (see Marx et al., 2011, for a complete description of implementation and procedures).

Demographic variables. Demographic variables were controlled for in each linear regression model. Demographic variables included: parental education, child's gender, parental marital status, child's ethnicity, test language, and poverty (see Table 1 for coding).

Table 1

Description of Variables used in Linear Regression

Demographic Variables	
Gender	1 = Male; 0 = Female
Ethnicity	1 = Hispanic; 0 = Non-Hispanic
Parental Education	1 = No High School Diploma/GED; 2 = High School Diploma/GED; 3 = Some college/vocational training/AA; 4 = BA or above
Poverty Level	Household income is 100% below federal poverty level (1 = Yes; 0 = No)
Parental Marital Status	Single (1 = Yes; 0 = No)
Test Language	Language that the DCCS was administered in (1 = Spanish; 0 = English)
School Readiness Variables	
DCCS Post-Switch Separated	Child correctly answered 5 or more test trials (1 = Yes/Pass; 0 = No/Fail)
Batelle Receptive Language	Basal = score of 2 on three consecutive questions; Ceiling = score of 0 on three consecutive questions
DECA	
Protective Factors	<41 = "Concern"; 41-59 = "Typical"; >59 = "Strength"
Behavioral Concerns	<61 = "Concern"; 41-59 = "Typical"

Poverty variable. Original data collection took place between the years 2010 and 2011. Federal poverty guidelines from 2010 and 2011 were used to create a poverty threshold by averaging across the two years. Next, number of people in each participant's household was added up and that number was used to identify the income level at which each family was

considered 100% below the poverty threshold (Table 2). Participants were coded as either: 100% below the poverty threshold, or above the poverty threshold.

Table 2
Poverty Guidelines (2010 & 2011 midpoint)

Number of Persons in Family	*Poverty Threshold (in USD)*
1	10,860
2	14,640
3	18,420
4	22,200
5	25,980
6	29,760
7	33,540
8	37,320

Note: For each additional person, the poverty threshold is increased by $3,780.

Household income was collected via income brackets, not as a continuous variable. Because these brackets did not represent a continuous variable, multiple poverty guidelines sometimes fell within brackets. For example, if there were four people in the household, the poverty threshold was $22,200. If a participant had four people in the household and a reported income bracket of $20,000 to $24,999, that participant was coded as not being in poverty. Because the population of interest is at-risk children, the goal was to avoid overestimating the number of participants in poverty, thus reducing the possibility of a Type I error.

In order to assess potential differences related to age, the sample was dichotomized at the midpoint for age in months, which created one group of younger children (33 months to 41 months) and one group of older children (42 months to 53 months). Table 3 reports the demographic characteristics and school readiness measures for each age group examined in this study.

Table 3
Descriptive Statistics

	Total Sample	33-41 months	42-53 months
	% (n)	% (n)	% (n)
Demographic Variables			
Gender			
Male	48.2 (859)	50.3 (300)	47.1 (559)
Female	51.8 (925)	49.7 (296)	52.9 (629)
Ethnicity			
Hispanic	49.3 (865)	45.5 (265)	51.1 (600)
Non-Hispanic	50.7 (891)	54.5 (317)	48.9 (574)
Parental Education			
No HS diploma/GED	17.6 (308)	17.4 (101)	17.7 (207)
HS diploma/GED	15.6 (274)	13.6 (79)	16.6 (195)
Some college/Vocational training/AA	33.2 (583)	34.0 (198)	32.8 (385)
BA or higher	33.6 (589)	35.1 (204)	32.8 (385)
Poverty			
100% below FPL	30.4 (493)	30.0 (162)	30.6 (331)
Above FPL	69.6 (1129)	70.0 (378)	69.4 (751)
Parental Marital Status			
Single/Separated	39.2 (700)	39.6 (236)	39.1 (464)
Married	60.8 (1084)	60.4 (360)	60.9 (724)
Test Language			
Spanish	17.9 (314)	15.8 (93)	19.0 (221)
English	82.1 (1436)	84.2 (495)	81.0 (941)
School Readiness Variables			
DCCS Separated			
Pass	45.4 (778)	25.4 (146)	55.5 (632)
Fail	54.6 (936)	74.6 (429)	44.5 (507)
DECA Protective Factors	M = 50.03 (SD = 10.35)	M = 48.85 (SD = 10.28)	M = 50.62 (SD = 10.33)
Range: 28-72			
DECA Behavioral Concerns	M = 58.65 (SD = 9.17)	M = 59.03 (SD = 9.16)	M = 58.45 (SD = 9.18)
Range: 41-72			
BDI Receptive Language	M = 10.88 (SD = 5.04)	M = 11.12 (SD = 5.61)	M = 10.76 (SD = 4.74)
Range: 1-19			

Measures

DCCS Separated. To assess the cognitive flexibility of participants, dichotomous scores of pass/fail on the Dimensional Card Sort Task *Separated* (DCCS)(Diamond, Carlson, & Beck, 2005) were used. Children were instructed by trained data collectors to sort 14 cards (3 x 5) into two boxes based on either shape or color. In the *Separated* condition, the card contains either a solid black truck or star on a blue or red background. Before the test phase, children are familiarized with the task by sorting 7 cards on either color or shape. At test, the children must switch tasks and begin sorting the other 7 cards according to the other dimension (e.g. from color to shape or vice versa). Data collectors gave children reminders of sorting criterion after each test trial but did not provide any feedback on task performance. Children passed the DCCS Separated by correctly sorting at least five of the six total post-switch test trials. Because passing was denoted at a specific cut point (5 correct test trials), scores were dichotomized as pass/fail. Data collectors conducted the testing in either English or Spanish, depending on the language indicated by the child's caregiver.

Batelle Developmental Inventory (BDI). The BDI (Newborg, 2005) was used as the measure of receptive language skills. Children begin at the established starting point for their chronological age. To establish the basal level, a child must score a 2 on three consecutive items. If the child does not score 2 on the first item, the items are administered in reverse order until a score of 2 is reached for three consecutive items. The ceiling level is reached when a children scores 0 on three consecutive items.

Devereux Early Childhood Assessment (DECA). The DECA (LeBluffe & Naglieri (1999) was used as a measure of children's protective factors and behavioral concerns. The Protective Factors scale was broken down into three components: initiative, self-control, and

attachment. Both the Protective Factors Scale and Behavioral Concerns Scale are self-report measures completed by the teacher or guardian of the child. This person, referred to as the rater, is instructed to base their responses on direct observations of behaviors and report only behaviors which have been directly witnessed within the past four weeks. For children aged two to five years (within our sample age range), the same form is used for teacher and parent raters.

Raw scores are added up for the Behavioral Concerns and each of the subscales on the Protective Factors Scale (e.g. initiative, self-control, and attachment). The total raw score for protective factors is obtained by adding up the values in the three subdomains. The standardization sample included 2,000 children between the ages of two and five years. Using these scores, three categories were created for each score: "concern", "typical", and "strength". Only "concern" and "typical" were used as ratings for the Behavioral Concerns Scale.

Analyses

Descriptive analyses for the demographic characteristics and school readiness measures were performed (see Table 3). In addition, correlation tables were created for each of the three groups (total sample, younger children, older children) with all demographic and school readiness variables of interest.

I ran multiple linear regression models evaluating the existence of a relationship between DCCS scores and socio-emotional development and DCCS scores and communicative abilities. Three linear regression models were run for each research question. The first regression model examined the relationship between DCCS and each school readiness variable of interest (i.e. DECA Protective Factors, DECA Behavioral Concerns, or BDI Receptive Language). The second and third models tested the effects by age.

Results

Many of the variables in the correlation matrices were statistically significantly related (Tables 4-6). Most of the correlations were not practically significant, with low correlation values. For the total sample, there were a few variables with slightly higher correlation values. In particular, parental education level was related to ethnicity (r = -.48) and poverty level (r = -.52). For the school readiness variables, there were slightly higher correlations between the DCCS *Separated* and BDI Receptive Language (r = .30) and DCCS *Separated* and DECA Protective Factors (r = .26).

Table 4
Correlations (Total Sample)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Demographic Variables									
Male (1)	1.00	-.05*	.02	-.01	-.02	-.09**	-.08**	.09**	-.12**
	(1784)	(1756)	(1754)	(1622)	(1784)	(1714)	(1472)	(1590)	(1523)
Hispanic (2)	-	1.00	-.48**	.32**	.20**	-.13**	-.18**	.09**	-.31**
		(1756)	(1750)	(1618)	(1756)	(1686)	(1449)	(1567)	(1501)
Parental Education Level (3)	-	-	1.00	-.52**	-.30**	.18**	.22**	-.15**	.39**
			(1754)	(1618)	(1754)	(1684)	(1449)	(1564)	(1499)
In Poverty (4)	-	-	-	1.00	.31**	-.14**	-.12**	.11**	-.24**
				(1622)	(1622)	(1561)	(1353)	(1463)	(1387)
Single Parent (5)	-	-	-	-	1.00	-.09**	-.10**	.09**	-.21**
					(1784)	(1714)	(1472)	(1590)	(1523)
School Readiness Variables									
DCCS *Separated* Pass (6)	-	-	-	-	-	1.00	.11**	-.07*	.30**
						(1472)	(1418)	(1531)	(1467)
DECA Protective Factors (7)	-	-	-	-	-	-	1.00	-.29*	.26**
							(1714)	(1415)	(1268)
DECA Behavioral Concerns (8)	-	-	-	-	-	-	-	1.00	-.17**
								(1590)	(1367)
BDI Receptive Language (9)	-	-	-	-	-	-	-	-	1.00
									(1523)

* p>.05; ** p>.01

Table 5

Correlations (33 – 41 months)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Demographic Variables									
Male (1)	1.00	-.10	.05	.01	-.05	-.10*	-.08	.09*	-.12**
	(596)	(582)	(582)	(540)	(596)	(575)	(497)	(539)	(493)
Hispanic (2)	-	1.00	-.50**	.30**	.20**	-.08	-.21**	.13**	-.31**
		(582)	(580)	(539)	(582)	(561)	(486)	(528)	(483)
Parental Education Level (3)	-	-	1.00	-.55**	-.31**	.12**	.23**	-.17**	.40**
			(582)	(538)	(582)	(561)	(486)	(527)	(483)
In Poverty (4)	-	-	-	1.00	.38**	-.10*	-.12*	.11*	-.27**
				(540)	(540)	(524)	(456)	(494)	(449)
Single Parent (5)	-	-	-	-	1.00	-.01**	-.10*	.09*	-.23**
					(596)	(575)	(497)	(539)	(493)
School Readiness Variables									
DCCS *Separated* Pass (6)	-	-	-	-	-	1.00	.10*	-.11*	.30**
						(575)	(481)	(521)	(475)
DECA Protective Factors (7)	-	-	-	-	-		1.00	-.26**	.26**
							(497)	(485)	(413)
DECA Behavioral Concerns (8)	-	-	-	-	-			1.00	-.18**
								(539)	(448)
BDI Receptive Language (9)									1.00
									(493)

* p>.05; ** p>.01

Table 6
Correlation (42 – 53 months)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Demographic Variables									
Male (1)	1.00	-.02	.01	-.02	-.01	-.09**	-.08**	.08**	-.13**
	(1188)	(1174)	(1172)	(1082)	(1188)	(1139)	(975)	(1051)	(1030)
Hispanic (2)	-	1.00	-.47**	.33**	.20**	-.18**	-.17**	.07*	-.31**
		(1174)	(1170)	(1079)	(1174)	(1125)	(963)	(1039)	(1018)
Parental Education Level (3)	-	-	1.00	-.51**	-.30**	.24**	.22**	-.14**	.39**
			(1172)	(1080)	(1172)	(1123)	(963)	(1037)	(1016)
In Poverty (4)	-	-	-	1.00	.28**	-.17**	-.13**	.10**	-.23**
				(1082)	(1082)	(1037)	(897)	(969)	(938)
Single Parent (5)	-	-	-	-	1.00	-.09**	-.10**	.10**	-.19**
					(1188)	(1139)	(975)	(1051)	(1030)
School Readiness Variables									
DCCS *Separated* Pass (6)	-	-	-	-	-	1.00	.09**	-.04	.34**
						(1139)	(937)	(1010)	(992)
DECA Protective Factors (7)	-	-	-	-	-		1.00	-.31**	.27** (855)
							(975)	(930)	
DECA Behavioral Concerns (8)	-	-	-	-	-			1.00	-.17**
								(1051)	(919)
BDI Receptive Language (9)									1.00
									(1030)

* p>.05; ** p>.01

RQ1. Passing the DCCS (β = .22, p < .01) also predicted higher receptive language scores, $F(6, 1326) = 70.81$, $p < .001$, $R^2 = .243$ (see Table 7). The addition of the DCCS into the original model added a small amount of variance, $R^2 = .046$. For the younger group (33 to 41 months) passing the DCCS (β = .24, p < .01) also predicted higher receptive language scores, $F(6, 426) = 25.95$, $p < .001$, $R^2 = .268$. The addition of the DCCS into the original model added a small amount of variance, $R^2 = .055$. For the older group (42 to 53 months), passing the DCCS (β = .25, p < .01) was also predictive of higher receptive language scores, $F(6, 893) = 49.37$, $p <$

.001, R^2 = .249. The addition of the DCCS into the original model added a small amount of variance, R^2 = .058.

Table 7

Regression Model for BDI Receptive Language and DCCS *Separated*

	B	β	t	p	95% CI
Total Sample (*N* = 1333)					
Demographic Variables					
Male	-1.23	-.12	-5.08	.00**	(-1.71, -.76)
Hispanic	-1.51	-.15	-5.53	.00**	(-2.05, -.97)
Parental Education Level	1.19	.25	8.14	.00**	(.90, 1.47)
In Poverty	-.16	-.01	-.50	.62	(-.78, .46)
Single Parent	-.79	-.08	-2.95	.00**	(-1.32, -.27)
School Readiness					
DCCS *Separated*-Pass	2.24	.22	9.02	.00**	(1.75, 2.72)
33-41 months (*N* = 433)					
Demographic Variables					
Male	-1.65	-.15	-3.49	.00**	(-2.57, -.72)
Hispanic	-1.65	-.15	-3.09	.00**	(-2.70, -.60)
Parental Education Level	1.37	.26	4.75	.00**	(.80, 1,93)
In Poverty	-.34	-.03	-.54	.59	(-1.56, .88)
Single Parent	-1.14	-.10	2.19	.03*	(-2.17, -.12)
School Readiness					
DCCS *Separated*-Pass	3.11	.24	5.68	.00**	(2.04, 4.19)
42-53 months (*N* = 900)					
Demographic Variables					
Male	-1.05	-.11	-3.78	.00**	(-1.59, -.50)
Hispanic	-1.39	-.15	-4.44	.00**	(-2.00, -.78)
Parental Education Level	1.06	.23	6.42	.00**	(.74, 1.38)
In Poverty	-.05	-.01	-.14	.89	(-.75, .65)
Single Parent	-.64	-.06	-2.07	.04*	(-1.24, -.03)
School Readiness					
DCCS *Separated*-Pass	2.39	.25	8.33	.00**	(1.83, 2.96)

* p>.05; ** p>.01

RQ2. For the total sample, passing the DCCS *Separated* (β = .06, p = .04) predicted a higher score on the DECA Protective Factors scale, $F(6, 1295) = 14.11$, $p < .001$, $R^2 = .061$ (see Table 8). The DCCS added a small amount of variance to the original model, $R^2 = .003$. For the younger age group, passing the DCCS *Separated* (β = .05, p = .32) was not predictive of a higher protective factors score, $F(6, 436) = 4.58$, $p < .001$, $R^2 = .059$. The DCCS did not add much variance to the model, $R^2 = .002$. In the older participant group, passing the DCCS *Separated* (β = .03, p = .47) was also not predictive of a higher protective factors score, $F(6, 852) = 9.86$, $p < .001$, $R^2 = .065$. Once again, the DCCS did not add much variance to the original model, $R^2 = .001$.

Table 8

Regression Model for DECA Protective Factors and DCCS *Separated*

	B	β	t	p	95% CI
Total Sample (*N* = 1302)					
Demographic Variables					
Male	-2.11	-.10	-3.78	.00**	(-3.21, -1.02)
Hispanic	-1.82	-.09	-2.92	.00**	(-3.04, -.60)
Parental Education Level	1.40	.14	4.12	.00**	(.73, 2.06)
In Poverty	-.44	-.02	-.60	.55	(-1.88, 1.00)
Single Parent	-.41	-.02	-.66	.51	(-1.63, .81)
School Readiness					
DCCS *Separated*-Pass	1.16	.06	2.03	.04*	(.04, 2.28)
33-41 months (*N* = 443)					
Demographic Variables					
Male	-2.32	-.12	-2.44	.02*	(-4.20, -.45)
Hispanic	-1.96	-.10	-1.81	.07	(-4.09, .17)
Parental Education Level	1.25	.12	2.06	.04*	(.06, 2.44)
In Poverty	.22	.01	.17	.87	(-2.33, 2.77)
Single Parent	-1.52	-.07	-1.40	.16	(-3.65, .61)
School Readiness					
DCCS *Separated*-Pass	1.07	.05	.99	.32	(-1.06, 3.19)
42-53 months (*N* = 859)					
Demographic Variables					
Male	-2.08	-.10	-3.01	.00**	(-3.44, -.73)
Hispanic	-1.97	-.10	-2.57	.01**	(-3.47, -.47)
Parental Education Level	1.57	.16	3.80	.00**	(.76, 2.37)
In Poverty	-.69	-.03	-.77	.44	(-2.44, 1.07)
Single Parent	.11	.01	.15	.89	(-1.39, 1.61)
School Readiness					
DCCS *Separated*-Pass	.52	.03	.73	.47	(-.89, 1.93)

* p>.05; ** p>.01

RQ3. A pass score on the DCCS *Separated* (β = -.03, p = .34) was not predictive of DECA Behavioral Concerns, $F(6, 1398) = 8.10$, $p < .001$, $R^2 = .034$ for the total sample (see

Table 9). Passing the DCCS *Separated* did not predict scores on the DECA Behavioral Concerns, for the younger group of participants (33 to 41 months) (β = -.07, p = .12), $F(6, 471) = 4.22$, $p <$ .001, R^2 = .051, nor for the older group (42 to 53 months) (β = .03, p = .47), $F(6, 920) = 4.66$, $p <$ .001, R^2 = .029. For both groups of participants, the addition of the DCCS scores to the original model did not add any additional variance: younger group, R^2 = .005; older group, R^2 = .000.

As with the DECA Protective Factors, Behavioral Concerns were also related to gender. This relationship held across the total sample (β = 1.72, $p < .01$), the younger age group (β = 1.83, p = .03), and the older group (β = -2.08, $p < .01$).

Table 9

Regression Model for DECA Behavioral Concerns and DCCS *Separated*

	B	β	t	p	95% CI
Total Sample (*N* = 1405)					
Demographic Variables					
Male	1.72	.09	3.53	.00**	(.76, 2.68)
Hispanic	.30	.02	.55	.58	(-.77, 1.37)
Parental Education Level	-1.01	-.11	-3.43	.00**	(-1.58, -.43)
In Poverty	.45	.02	.70	.49	(-.81, 1.70)
Single Parent	.77	.04	1.42	.16	(-.29, 1.84)
School Readiness					
DCCS *Separated*-Pass	-.48	-.03	-.95	.34	(-1.45, .51)
33-41 months (*N* = 478)					
Demographic Variables					
Male	1.83	.10	2.19	.03*	(.19, 3.47)
Hispanic	1.19	.06	1.25	.21	(-.67, 3.04)
Parental Education Level	-1.22	-.14	-2.36	.02*	(-2.23, -.20)
In Poverty	.14	.01	.13	.90	(-2.07, 2.36)
Single Parent	.22	.01	.23	.82	(-1.64, 2.08)
School Readiness					
DCCS *Separated*-Pass	-1.50	-.07	-1.58	.12	(-3.36, .37)
42-53 months (*N* = 927)					
Demographic Variables					
Male	1.68	.09	2.78	.01**	(.49, 2.87)
Hispanic	-.04	-.00	-.07	.95	(-1.37, 1.28)
Parental Education Level	-.94	-.11	-2.62	.01**	(-1.64, -.24)
In Poverty	.63	.03	.81	.42	(-90, 2.17)
Single Parent	1.03	.05	1.55	.12	(-.28, 2.34)
School Readiness					
DCCS *Separated*-Pass	.19	.01	.30	.77	(-1.05, 1.42)

* p>.05; ** p>.01

Discussion

There was a statistically significant effect of passing the DCCS *Separated* on two dependent measures: DECA Protective Factors and Batelle Receptive Language. However, only

scores on the BDI held practical significance. Passing the DCCS *Separated* only accounted for 0.03% of the variance in DECA scores. These results suggest that this particular measure of cognitive flexibility might not be predictive of children's protective factors and behavioral concerns.

In the current literature, there is a demonstrated link between poverty and EF skills (Blair et al., 2011; Hackman et al., 2015; Nelson et al., 2015). Surprisingly, poverty was not statistically significantly related to higher protective factors for any of the age groups, including total sample. This could be due to our poverty variable not being a sensitive enough measure of poverty. As mentioned in the methods, poverty was coded according to reported income bracket. Because of this, it's impossible to know if participants' family incomes fell toward the higher or lower end of the income bracket, potentially leading to an underrepresentation of families in poverty.

When broken down into the two age groups, passing the DCCS Separated no longer predicted protective factors. However, there appeared to be a relationship between gender and the school readiness variables. In a previous logistic regression analysis conducted with the data set from the present study, there was a significant relationship found between gender and executive function (Clough et al., under review). The present study further supported these findings, suggesting that males might develop school readiness-related skills later than their female peers. The implications of this should be explored in potential interventions aimed at assessing and increasing the school readiness of male children.

Rates of ASD diagnoses are higher in males than females. In the present study, gender had a significant effect on the dependent variable for each linear regression model. Males were more likely to exhibit lower scores on the DECA Protective Factors and higher scores on the

DECA Behavioral Concerns. Males also had statistically significantly lower scores on the BDI Receptive Language. These results held across age groups. ASD is more commonly diagnosed in males than females by a 4.3:1 ratio (Center for Disease Control and Prevention, 2018; Fombonne, 2003). Because of this, the majority of research on ASD and its symptomatology focuses on males. Research over the past couple decades has suggested that ASD may present different symptoms in males than females (Holtmann et al., 2007; McLennan et al., 1993; Tsai & Beisler, 1983), potentially creating an underrepresentation of ASD in females (Rivet & Matson, 2011). Future research could explore the relationship interaction between gender, communicative strategies, and ASD sympatology. A measure of child EF skills allows for more thorough examiniation of the potential variables at play by exploring the relationship between language and cognitive flexibility.

Previous research has suggested that typical characteristics of ASD may be related to differences in executive function skills (Ozonoff, 1997; Pennington & Ozonoff, 1996). According to Rumsey (1985), the ability to successfully interact with other people requires the "integration and weighing of multiple contextual variables, selective attention, and inductive logic" (p. 34). However, more research is needed to decipher the difference between social communication skills and executive function. Gilotty (2002) argued that the reliability of laboratory studies examining executive function in both typically developing children and children diagnosed with ASD is questionable. Because of the very structured lab setting, it is challenging to make generalizations as to how children might utilize executive function skills in real-life situations. However, the present study offers some insight into the individual characteristics that may lead to differences in acquiring EF skills. In addition, the present study sample's participants are roughly three years old, just under the age at which ASD diagnoses are

typically made (Center for Disease Control and Prevention, 2018). It offers a unique opportunity to examine ASD-related characteristics such as communicative abilities and EF during a critical period in cognitive development.

School readiness is essential to learning, but are we preparing students for school or preparing schools for students? As we move forward with research on how to create the greatest opportunities for learning for our students, we need to develop a consensus on the implications of learning preparedness versus school readiness. We also need to work on a more coherent definition of school readiness if we want to accurately measure the phenomenon. However, educational researchers are in general agreement that there are components of school readiness that can have long-lasting impacts on student achievement.

Duncan et al. (2007) examined the link between school readiness and later reading and math achievement. The researchers characterized school readiness as containing three main components: school-entry academic, attention, and socio-emotional skills. Using six longitudinal, publically available data sets, the researchers found that "the regression results indicate that school-entry reading and math skills are almost always statistically significant predictions of later reading and math achievement" (Duncan, 2007, p. 1437). On the other hand, socio-emotional skills were not predictive of later academic achievement. While socio-emotional skills are often associated with engagement in the classroom (Ladd, Birch, & Buhs, 1999; Pianta & Stuhlman, 2004), some researchers have argued that certain socio-emotional behaviors are more influential than others. In particular, the literature suggests that behaviors like attention may be more beneficial to academic achievement because they deal with behaviors that are "directly relevant for learning," unlike behaviors such as social skills and problem behavior (Alexander et al., 1993; Cooper & Farran, 1991; McClelland et al., 2000; McWayne, Fantuzzo,

& McDermott, 2004). Further research should explore the nuances between different types of socio-emotional skills and behaviors. Parsing out socio-emotional behaviors, rather than using a larger measure intended to capture all aspects of socio-emotional development, may offer deeper insight into the unique roles that specific behaviors and skills can play in school readiness.

There were some potential limitations to this study. While this study was originally intended to be longitudinal, the project was halted prior to additional data collection. Therefore, data is only available at one point in time. Because of this, we cannot make any causal inferences about the connection between executive function and these school readiness related measures. If possible, further research may be conducted with a small subsample of the participants to examine long-term effects of communicative skills and EF.

Because the DECA Protective Factors and Behavioral Concerns dealt with a wide-range of socio-emotional skills and behaviors, it's possible that we were not testing for behaviors specifically relevant to learning. The Protective Factors scale measured multiple components, including initiative, self-control, and attachment. The results of the present study further strengthen the argument that there may be a distinct difference between types of socio-emotional development that may aid learning in a classroom setting. Further research should explore the differences between types of socio-emotional development. Likewise, further research needs to continue on determining the level of difference between the three main components of EF: working memory, inhibition, and cognitive flexibility. In particular, future studies should examine the appropriateness of using measures that rely on one of the three components of EF, rather than using a measure that is directly marketed at testing all three. There is a possibility that all three components are required during all EF tasks, but the challenge lies in parsing out the strength of influence that each specific skill has over EF development as a whole.

References

Alexander, K. L., Entwisle, D. R., & Dauber, S. L. (1993). First grade classroom behavior: Its short- and long-term consequences for school performance. *Child Development, 64*, 501-514.

Arnold, D. H., Ortiz, C., Curry, J. C., Stowe, R. W., Goldstein, N. E., Fisher, P. H., Zeljo, A., & Yershova, K. (1999). Promoting academic success and preventing disruptive behavior disorders through community partnership. *Journal of Community Psychology, 27*(5), 589-598.

Blair, C., Raver, C. C., & Berry, D. J. (2014). Two approaches to estimating the effect of parenting on the development of executive function in early childhood. *Developmental Psychology, 50*(2), 554-565.

Bruner, J. (1960). The process of education. New York, NY: Random House.

Center for Disease Control and Prevention (2018, February 12). *Autism Spectrum Disorder: Data and Statistics.* Retrieved from https://www.cdc.gov/ncbddd/autism/data.html.

Clough, L. T., Cimetta, A. D., Yaden, Jr., D. B., Cutshaw, C. A., & Marx, R W. (under review). Influences of home environment variables on the executive function of young children.

Cooper, D. & Farrand, D. (1991). *The Cooper-Farran Behavior Rating Scale.* Brandon, VT: Clinical Psychology.

Diamond, A. (2013). Executive functions. *Annual Review of Psychology, 64*, 135-168.

Diamond, A., Carlson, S. M., & Beck, D. M. (2005). Preschool children's performance in task switching on the dimensional change card sort task: Separating the dimensions aids the ability to switch. *Developmental Neuropsychology, 28*(2), 689-729.

Duncan, G. J., Dowsett, C. J., Claessens, A., Magnuson, K., Huston, A. C., ……. (2007). School readiness and later achievement. *Developmental Psychology, 43*(6), 1428- 1446.

Elam, S. M. (1990). The 22nd annual Gallup Poll of the public's attitudes toward the public schools. *Phi Delta Kappan,* p. 42.

Fombonne, E. (2003). Epidemiological surveys of autism and other pervasive developmental disorders: An update. *Journal of Autism and Developmental Disorders, 33*(4), 365-382.

Gagne, R. M. (1970). The conditions of learning. New York, NY: Holt, Rinehart & Winston).

Gilotty, L., Kenworthy, L., Sirian, L., Black, D. O., & Wagner, A. E. (2002). Adaptive skills and executive function in autism spectrum disorders. *Child Neuropsychology, 8*(4), 241-248.

Guajardo, Cartwright, Horst, Dewey, & Welsh. (October, 2017). Executive function and theory of mind as predictors of reading expressiveness. Poster presented at the Cognitive Development Society Conference.

Hackman, D. A., Gallop, R., Evans, G. W., & Farah, M. J. (2015). Socioeconomic status and executive function: Developmental trajectories and mediation. *Developmental Science, 18*(5), 686-702.

Holtmann, M., Bolte, S., & Poustka, F. (2007). Autism spectrum disorders: Sex differences in autistic behavior domains and coexisting psychopathology. *Developmental Medicine and Child Neurology, 49*(5), 361-366.

Hudry, K., Leadbitter, K., Temple, K., Slonims, V., McConachie, H., Aldred, C., Howlin, P., Charman, T., & Pact Consortium. (2010). Preschoolers with autism show greater impairment in receptive compared with expressive language abilities. *International Journal of Language and Communication Disorders, 45*(6), 681-690.

Hughes, C. (1998). Executive function in preschoolers: Links with theory of mind and verbal ability. *British Journal of Developmental Psychology, 16,* 233-253.

Janusz, J., Ahluvia, T., & Gioia, G. (2002). *The relationship between executive function and adaptive behavior.* Poster presented at the annual meetings of the International Neuropsychological Society, Toronto, Canada.

Johnson, C. P. (2004). Early clinical characteristics of children with autism. In Gupta, VB: Autistic Spectrum Disorders in Children. New York, NY: Marcel Dekker.

Ladd, G. W., Birch, S. H., & Buhs, E. S. (1999). Children's social and scholastic lives in kindergarten: Related spheres of influence? *Child Development, 70*(6), 1373-1400.

LeBuffe, P. A. & Naglieri, J. A. (1999). Devereaux Early Childhood Assessment. Lewisville, NC: Kaplan Early Learning Company.

Lehto, J. E., Juujarvi, P., Kooistra, L., & Pulkkinen, L. (2003). Dimensions of executive functioning: Evidence from children. *British Journal of Developmental Psychology,* 21, 59-80.

McClelland, M. M., Morrison, F. J., & Holmes, D. L. (2000). Children at risk for early academic problems: The role of learning-related social skills. *Early Childhood Research Quarterly, 15*(3), 307-329.

McLennan, J. D., Lord, C., & Schopler, E. (1993). Sex differences in higher functioning people with autism. *Journal of Autism and Developmental Disorders, 23*(2), 217- 227.

McWayne, C., Fantuzzo, J., & McDermott, P. A. (2004). Preschool competency in context: An investigation of the unique contribution of child competencies to early academic success. *Developmental Psychology, 40*, 633-645.

Miyake, A., Friedman, N. P., Emerson, M. J., Witski, A. H., Howerter, A., & Wager, T. D. (2000). The unity and diversity of executive functions and their contributions to complex "frontal lobe" tasks: A latent variable analysis. *Cognitive Psychologist, 41*, 49-100.

Nelson, J. M., Choi, H. J., Clark, C. A., James, T. D., Fang, H., Wiebe, S. A., & Espy, K. A. (2015). Sociodemographic risk and early environmental factors that contribute to resilience in executive control: A factor mixture model of 3-year-olds. *Child Neuropsychology*, *21*(3), 354-378.

Newborg, J. (2005). Battelle developmental inventory (2nd ed.). Rolling Meadows, IL: Riverside. Retrieved from http:// dx.doi.org/10.1177/0734282907300382

Ozonoff, S. (1997). Components of executive function in autism and other disorders. In J. Russell (Ed.), *Autism as an executive disorder* (pp. 179-211). New York, NY: Oxford University Press.

Pennington, B. F.. & Ozonoff, S. (1996). Executive functions and developmental psychopathology. *Journal of Child Psychology and Psychiatry and Allied Disciplines, 37*, 51-87.

Piaget, J. (1970). *Science of education and the psychology of the child.* New York, NY: Orion Press.

Pianta, R. C. & Stuhlman, M. W. (2004). Teacher-child relationships and children's success in the first years of school. *School Psychology Review, 33*, 444-458.

Raver, C. C. (2002). Emotions matter: Making the case for the role of young children's emotional development for early school readiness. *Social Policy Report, 16*(3), 3-19.

Raver, C. C. & Zigler, E. F. (1997). Social competence: An untapped dimension in evaluating Head Start's Success. *Early Childhood Research Quarterly, 12*(4), 363-385.

Rivet, T. T. & Matson, J. L. (2011). Review of gender differences in core symptomatology in autism spectrum disorders. *Research in Autism Spectrum Disorders, 5*(3), 957-976.

Rumsey, J. M. (1985). Conceptual problem-solving in highly verbal, non-retarded autistic men. *Journal of Autism and Developmental Disorders, 15*, 23-36.

Tsai, L. Y. & Beisler, J. M. (1983). The development of sex differences in infantile autism. *British Journal of Psychiatry, 142*, 373-378.

Wellman, H. M. (1992). *The MIT Press series in learning, development, and conceptual change. The child's theory of mind.* Cambridge, MA, US: The MIT Press.

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*, Cambridge, MA: Harvard University Press.