THE RELATIONS AMONG EXECUTIVE DYSFUNCTION, DELAY AVERSION AND PHONEMIC AWARENESS IN PRESCHOOLERS

by

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The Dual Pathways theory of AD/HD explains that there may be two independent neurologically based pathways in which AD/HD may develop: executive dysfunction (EDF) and delay aversion (DAv). A separate line of research has linked AD/HD to early reading problems. The purpose of this study was to further explore the two pathways of AD/HD in relation to the development of early literacy skills. More specifically, the relationship between EDF and DAv in preschoolers and phonemic awareness ability was examined. Using a hierarchical regression, it was indicated that there was a statistically significant relationship between EDF scores and levels of inattention as rated by teachers. Teacher-rated hyperactivity/impulsivity was also significantly correlated with our early literacy outcome measure, indicating a possible connection between these two variables. No significant relationships emerged between EDF or DAv and the early literacy measure. Future research should explore the role of teacher-reported inattention as a potential mediator of EDF and preliteracy development. Lastly, a third pathway has recently been proposed; the pathways model should be explored further using multiple measures for each to determine potential relationships with common functional impairments such as literacy development.

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CHAPTER I: INTRODUCTION & LITERATURE REVIEW

Throughout the last thirty years, researchers have had many breakthroughs in the study of Attention-Deficit/Hyperactivity Disorder (AD/HD) that help us understand the disorder and how it may arise. The Dual Pathways theory of AD/HD explains that there may be two independent neurologically based pathways in which AD/HD may develop. Prior research indicates that these two pathways, executive dysfunction (EDF) and delay aversion (DAv), manifest in different ways and may have diverse effects on child outcomes (Nigg, 2006). A separate line of research has linked AD/HD to early reading problems (Spira, Bracken, & Fischel, 2005; Morgan, Farkas, Tufis, & Sperling, 2008). However, researchers have yet to explore how these different pathways might predict reading outcomes. The purpose of this study was to further explore the two pathways of AD/HD in relation to the development of early literacy skills. More specifically, the relationship between EDF and DAv in preschoolers and phonemic awareness ability was examined. There is limited research on this topic, and it is possible that one pathway more strongly links to deficits in phonemic awareness. Understanding how AD/HD arises and the potential effects on developing phonemic awareness skills may help to inform intervention development.

Dual Pathways Model of AD/HD

According to the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition* (DSM-IV-TR, 2000), AD/HD is categorized by three different types: inattentive, hyperactive, or combined type. Studies have found AD/HD to be a possible indicator for a spectrum of problematic behaviors that may develop later in life, such as conduct disorder, dysfunctional emotional regulation, and reading disorder (Nash & Barkley, 2003; Wahlstedt, Thorell, & Bohlin, 2008). It is important to avoid over-diagnosing individuals with AD/HD, although we

must not underestimate signs of AD/HD, for they might be precursors for severe problems later (Sonuga-Barke & Halperin, 2010).

According to some researchers, the typical age of onset for AD/HD can vary from the first to the seventh year of an individual's life (Brandau & Pretis, 2004). Brandau and Pretis reviewed research on AD/HD-like behaviors in two- to five-year-old children. Conclusions from this research were that identifying children with AD/HD, or preclinical levels of AD/HD, and providing them early intervention may prevent later academic problems or problems of conduct disorder, drug use, or other social issues (Brandau & Pretis, 2004). The current research examined preschoolers with subclinical levels of AD/HD because, according to Brandau and Pretis, negative impacts of inattention on reading development are apparent, even for children with subclinical levels of attention problems. In addition, early assessment and identification is important for preventing early literacy deficits and the other comorbid problems that were previously mentioned.

Although the DSM-IV-TR categories are the typical view of AD/HD, recent research has switched its perceptions of AD/HD from how the disorder presents itself to how it arises. Attention-Deficit/Hyperactivity Disorder may come about from two different manifestations. This theory is known as the Dual Pathways model of AD/HD because it explains how AD/HD may be due to a deficit in executive functioning or an aversion to delay (Sonuga-Barke, 2001). Since there are such variances in AD/HD symptoms in children, adolescents, and adults, some researchers believe this is evidence for the neuropsychological differences suggested by the dual pathways model (Nigg, 2006; Sonuga-Barke et al., 2010). Recently, a third pathway has been suggested, known as temporal processing, but less research has examined this area (Sonuga-

Barke, Bitsakou, Thompson, 2010). Therefore, this area was not included in this study. Each pathway in the dual-pathways model presents with various symptoms and deficits in different, yet sometimes overlapping, areas. To further explain these areas and understand their effects on children, each pathway must be clearly defined.

Executive dysfunction. Executive Dysfunction (EDF) is a neuropsychological deficit that includes difficulties in areas such as behavioral inhibition or working memory (Sonuga-Barke, 2010). In 1997, Russell Barkley described a unifying theory of AD/HD, which explained it as a problem with executive execution as characterized by deficits in working memory, self-regulation of affect-motivation-arousal, internalization of speech, and reconstitution (Barkley, 1997). This deficit has roots in the dorsal fronto-striatal portion of the brain, and its extent is mediated by inhibitory-based EDF (Sonuga-Barke et al., 2010). Swanson and colleagues (1998) believe that EDF results in more severe and pervasive symptoms of AD/HD than the second pathway, although other research has not supported this claim (Sonuga-Barke, 2002). EDF is also thought to present itself as a dysregulation of thought, action, or higher order control due to a lessening of the ability to control one's behavioral inhibitions (Barkley, 1997; Sonuga-Barke, 2002). Children with EDF lack flexibility in attention and the ability to strategize effectively. Individuals with EDF may not have successful planning skills, have difficulty self-monitoring, and/or may show deficits in working memory (Sonuga-Barke, 2002; Kofler, Rapport, Bolden, Sarver, & Raiker, 2010). Although it may be categorized with a large variety of symptoms, inhibitory deficits seem to be the most commonly recognized sign of EDF (Pennington & Ozonoff, 1996).

Studies conducted to examine AD/HD via executive dysfunction have found that children with EDF have a harder time with tasks of planning, inhibiting behavior, and working memory (Welsh, Pennington, & Grossier, 1991). These researchers studied one hundred children ages three to twelve years old and found that other difficulties stemmed from speeded responding, set maintenance and planning (Welsh et al., 1991). Floyd and Kirby (2001) examined EDF by using tasks similar to "Simon Says" where children have to inhibit their behavior when one puppet speaks, but respond when the other puppet speaks. This is an example of a go/no-go task, which is often used to measure one's ability to perform a particular behavior when a certain cue is given, and to inhibit their response when another cue is given (Floyd & Kirby 2001). Individuals with AD/HD who have high levels of EDF may respond regardless of which cue is presented to them, indicating their lack of ability to inhibit behavior (Barkley, 1997).

Delay aversion. In 1983, Douglas and Parry posited a factor in AD/HD that had to do with an individual's response to delayed outcomes (Bitsakou, Psychogiuo, Thompson, & Sonuga-Barke, 2009). Sonuga-Barke (2001) has since named this as a second pathway, known as delay aversion (DAv). Delay aversion is linked to the ventral fronto-striatal circuits in the brain causing signals within the brain to be altered in regard to delayed rewards and delay aversion (Marco, Miranda, Schlotz et al., 2009; Songua-Barke et al., 2010). Delay aversion is defined by a preference to seek an immediate reward over a more desirable reward later, presumably due to an unsuccessful regulatory system (Sonuga-Barke, Taylor, Sembi, & Smith, 1992). These individuals make a conscious choice to escape or avoid delay by engaging in immediate behaviors. In the absence of a choice presented to them, individuals with DAv will use their environment to decrease the perception of time by creating or focusing on a non-time related

aspect of the environment (Anthrop, Roeyers, Van Oost, & Buysse, 2000). Delay Aversion often produces less task-engagement, allowing for these individuals to be seen as inattentive and/or hyperactive (Sonuga-Barke, Williams, Hall, & Saxton, 1996). Other characteristics of DAv that are nonexecutive dysfunctions include: deficits in perception, timing, memory and motivational processes (Sonuga-Barke et al., 2010). As previously mentioned, Sonuga-Barke and colleagues (2010) have recently proposed that temporal processing may be a separate pathway instead of a characteristic of delay aversion, although information regarding this claim is limited.

Many experiments have been done to test for DAv. In these studies, researchers have found that children with AD/HD have a preference for rewards that are smaller sooner instead of larger later, even when the rewards do not equal each other over time (Antrop, Stock, Verte, Wiersema, Baeyens, & Roeyers, 2006; Luman, Oosterlaan, & Sergeant, 2005). When researchers varied the ease of the tasks, making the later task easier, the individuals with DAv still chose the immediate task and reward (Neef, Marckel, Ferreri, Bicard, Endo, Aman, et al., 2005). Bitsakou and colleagues (2009) state that, when individuals with AD/HD are made to wait, they experience frustration and emotional arousal. These individuals will then attempt to change the experience so that the delay does not seem aversive. Research suggests that there is a not a connection between DAv and EDF, providing evidence that these are independent pathways (Solanto et al., 2001; Sonuga-Barke, 2001).

Subclinical Levels of AD/HD Symptoms in Children

Early executive dysfunction and delay aversion should be explored as a possible indication for later development of AD/HD. AD/HD is typically diagnosed in early-to-middle childhood; however, elevated symptoms have been noted in preschool populations (Hughes,

White, Sharpen, & Dunn, 2000). These subclinical levels may still have negative impacts on a child's functioning. It is essential to recognize symptoms in attempt to provide early intervention. Some researchers have noted that even subclinical levels of AD/HD symptoms may have a negative impact on a child (Merrell & Tymms, 2001; Rodriguez et al., 2007). By using AD/HD indicators to screen for those who may develop correlating problems, such as deficits in preliteracy skills, practitioners can better target interventions.

Phonemic Awareness and Preliteracy Skills

The development of preliteracy skills has important implications for a child's future success in reading (Lonigan, 2006). Lonigan has identified oral language, phonological processing skills and print knowledge as strong predictors of learning to read and write. Early literacy is developed by a set of preliteracy skills including but not exclusive to phonemic awareness. In the absence of core literacy skills, one is at a higher risk of developing a reading disability (Lonigan, 2006; Snider, 1997). To obtain phonemic awareness, one must understand phonemes, specific sounds when letters are combined, and how they join together to form words (Snider, 1997). Mastering phonemic awareness is necessary to fully understand the alphabetic principle, and it is related to being able to sound out unfamiliar words and spell new ones (Moats, 2007). It is also essential toward developing early literacy and reading skills (Stanovich, Cunningham, & Feeman, 1984). Phonemic awareness skills precede the development of phonics because phonemic awareness does not require knowledge of letter-sound correspondence, as phonics does (Moats, 2007). A study conducted by Snider (1997) presented results showing a powerful and predictive relationship between phonemic awareness and future reading abilities. Findings suggested that focusing interventions and teaching strategies to incorporate mandatory

learning of phonemic awareness is essential to later literacy development. Phonemic awareness can be measured using a variety of methods such as Curriculum-based Measurements (CBM), subtests from standardized achievement tests, or specific purpose reading tests, such as the *Test of Early Reading Ability—Third Edition* (TERA-3; Reid, Hresko, & Hammill, 2012). Tasks could include rhyming, sound blending, phonemic segmentation, or phonemic manipulation.

Inattention and Phonemic Awareness

Attention plays a critical role in the development of preliteracy skills (Lonigan, Bloomfield, Anthony, Bacon, Phillips, & Samwel, 1999). Links between AD/HD and reading problems have been found, with inattention acting as a moderator (Carroll et al., 2005). Not only are children with AD/HD at-risk for reading problems but so are children with subclinical levels of inattention (Rodriguez et al., 2007). Examining the different pathways of AD/HD and how each may link to development of phonemic awareness may provide insight into which specific subgroups of children with AD/HD are most at risk for reading difficulties. Dalen, Sonuga-Barke Hall and Remington (2004) noted that a distinction between EDF and DAv can be seen early in a child's development. Although few have examined the degree of association between these two variables, there is thought to be a link between significant inattention and preliteracy deficits (Walcott, Scheemaker, & Bielski, 2010). According to Catts and Kamhi (1999), learning to read requires more attention and motivation than learning to talk, therefore the first year or two of school is a critical time to recognize attention and motivation problems in children. The research of Agapitou and Andreou (2008) found that preschoolers with signs of AD/HD or previously diagnosed AD/HD had lower scores then comparison peers on grapheme discrimination, phoneme discrimination and phoneme synthesis, which together comprise

phonemic awareness. Willcutt, Olson, Pennington, Boada, Ogline, Tunick et al. (2001) found that reading disorders were significantly related to deficits in phonemic awareness and verbal working memory, whereas AD/HD was associated with deficits in inhibition and not reading areas. Research should be done to reveal if an association between DAv and early reading problems exists and if so, determine the strength of association between the two. The consideration of AD/HD pathways could enhance prevention efforts to aid in identifying and providing to support to children prior to attention difficulties influencing reading abilities.

Present Study

The purpose of this research was to examine the relationship between the dual pathways of AD/HD and phonemic awareness skills in preschool children. This population can be targeted for prevention and intervention to mitigate later problems in academic skills. Each pathway presents with deficits in different areas. Examining the pathways and how each links to literacy may provide insight into which specific subgroups are most at risk for reading problems. This study utilized a correlational design to explore relationships among key variables proposed as AD/HD pathways (EDF or DAv) and early literacy performance. The following research question was examined: Which pathway of AD/HD is most strongly associated with phonemic awareness ability in a community sample of preschoolers? No specific hypotheses were forwarded due to the exploratory nature of the research.

CHAPTER II: METHOD

Participants

Using *G-Power*, a power analysis program, a target sample size was determined a priori. Alpha was set at 0.05, power was set at 0.85, and 0.85 was used for anticipated effect size. This resulted in a sample size requirement of approximately 50 participants. Participants were currently in preschool or pre-kindergarten and were recruited from two private local preschools in a midsized town within a southeastern state. The sample comprised of 50% males (n = 22) and 50% females (n = 22). Ages ranged from 5 to 6 years old. The sample included 64% African American/Black (n = 28), 27% White/Caucasian (n = 12), 4.5% Asian (n = 2), and 4.5% Indian (n = 2). The study excluded participants who have a severe developmental disability so as to eliminate other likely causes of early literacy delays.

Measures

EDF tasks. Two measures of EDF were used, which were labeled *Tower* and *Lion and Wolf*. The *Tower* task is a go/no-go task that calls for children to stack blocks. The examiner first modeled how six blocks can be stacked into a tower. Following the demonstration, children were given a chance to stack the blocks into a tower by themselves, receiving verbal praise for demonstrating tower-building behavior. Then the examiner instructed the participant to build a tower with 11 blocks, while taking turns with the examiner. The participant placed the first block and then the examiner waited for 10 seconds to see if the child placed a second block or prompted the examiner to place a block. Participant behaviors that were out of turn were ignored during each trial of the tower building. The number of blocks placed correctly across three trials was the outcome measure. According to prior research, test-retest reliability was .85 for the

Tower task (Floyd & Kirby, 2001). No other psychometric data could be found, however, Tower is commonly used in research exploring executive functioning.

Lion and Wolf is another go/no-go task that resembles "Simon Says." It is a modified version of Dog and Dragon (Floyd & Kirby, 2001). Participants watched two recorded videos from a computer. Participants were either asked to obey commands of the lion and not the wolf or the wolf and not the lion. Participants were randomly assigned to watch either the lion or the wolf prior to the task. The orange lion and the brown wolf made verbal commands on 3-second intervals. There were 6 trials of each type of command; those of the lion and those of the wolf. The correct responses to the command were scored on a scale of 0 to 3: 3 for full completion of the command and 0 for no response. Any responses for the incorrect puppet's commands were scored on a reverse point scale: 0 points for no response and 3 for acting out the command completely. Scores for both the lion and wolf trials were summed to produce a total score. Although there is limited evidence for validity for the Lion and Wolf task, it is a commonly used measure of EDF and has test-retest reliability of .52 (Floyd & Kirby, 2001; Reed, Pien & Rothbart, 1984).

DAv task. The *Flower-Delay* task is a computer-based task that has the participant choose between a smaller-sooner (SS) reward or a larger-later (LL) reward. The Flower-Delay task is similar to the choice delay task created by Sonuga-Barke and colleagues (1992) and the Delay of Gratification task created by Mischel (1974). The smaller, immediate reward was one flower after three seconds and the larger reward was two flowers after thirty seconds. Participants were told they were going to play a game on the computer where they could earn flowers and the goal was to see how many flowers they could receive. Participants were

informed that they would get candy at the end if they tried hard. Five practice trials were done prior to beginning the task, where the experimenter and participant went through the different options of the game, ensuring the participant understood the difference in time and amount of flowers received. The participants were told prior to beginning that they would have 20 trials to earn flowers. There was a clear cup next to the computer with twenty beads sitting next to it. After each trial, a bead was placed in the cup. When all the beads were in the cup, the game was over. The overall score was the number of times the smaller, sooner reward was taken. The larger the total score, the more delay averse the child behaved. Test-retest reliability for this task was .85 using 26 participants roughly two weeks apart (Thorell, 2007; Sonuga-Barke, Taylor, Sembi & Smith, 1992; Solanto, Abikoff, Sonuga-Barke, Schacher, Logan, Wigal, et al. 2001).

Phonemic awareness tasks. The *Comprehensive Test of Phonological Processing* (CTOPP) is a test designed to explore phonological awareness, rapid naming and phonological memory (Wagner, Torgesen, & Rashotte, 1999). The phonological awareness composite score was used from the CTOPP as the overall measure. The three subtests that load onto phonological awareness were Elision, Blending Words, and Sound Matching. In Elision, the experimenter produced a word and asked the participant to repeat it back to him or her. The experimenter asked the participant to say the word again but this time taking out a certain sound (i.e. "say powder," "now say powder without saying /d/"). The participants were given three practice items. After three consecutive incorrect answers, the subtest was discontinued. In Blending Words, a CD was used and the participant was told they would hear a word one part at a time and they would have to put all the parts together to make a whole word. The participant was given five practice items. After three consecutive incorrect answers, the subtest was

discontinued. In Sound Matching, a book with pictures was used. There were two parts to this subtest. Part one consisted of the student being told one word and then three more that all matched pictures in the book. The participants were asked to tell which one of the three matched the first sound of the first word and they were given three practice turns and the subtest was discontinued after four incorrect answers. If they had not missed four answers after all ten questions they moved on to part two. Part two was identical to part one with the exception of the goal was to match the final sound of the words. Four consecutive incorrect answers ended the subtest. Internal consistency reliability was .80 or greater when tested by researchers (Davis, 2003). Validity was .82 for phonological awareness measures (Davis, 2003).Wagner, Torgesen and Rashotte (1999), authors of the CTOPP, report internal consistency reliability estimates of the Phonological Awareness composite score of .96 for age 5-6 years. The authors also report an overall median content sampling reliability estimate of .90, interscorer reliability ranged from .97 to .99 for all years.

Participants also completed the *Dynamic Indicators of Early Literacy Skills—6th Edition* (DIBELS) Initial Sound Fluency (ISF) task (Dynamic Measurement Group, 2008). ISF is a task that measures one's ability to recognize and produce the initial sound of a word that is orally presented by the examiner. During the task, the examiner presented four pictures to the participant and named each picture. The participant was asked to either orally identify or point to the picture that begins with the sound that was given by the examiner. An example would be the experimenter saying "horn, tulip, robot, cap; which picture beings with /h/?" The participant would then point to the picture of the horn. The child was also asked to produce the initial sound of a word that matches one of the pictures. ISF was scored by adding the amount of time taken

for the child to identify and produce the correct sound. The total was then converted into the number of initial sounds correct in a minute. ISF took approximately 3 minutes to administer and there were 20 alternate forms used. ISF is a revision of Onset Recognition Fluency (OnRF). Alternate-form reliability for this measure is .72 in January of kindergarten (Good, Kaminski, Shinn, Bratten, Shinn Laimon, et al., 2004). Concurrent criterion-related validity with the Woodcock-Johnson Psycho-Educational Battery Readiness Cluster score for the spring of kindergarten is .36 (Good et al., 2004). A study conducted by Hintze, Ryan and Stoner (2003) produced intercorrelations between ISF and CTOPP measures: Elision= .52, Blending Words=.51, and Sound Matching =.51.

Behavior rating scales. The *Connors' ADHD/DSM-IV Scales-Parent Form* (CADS-P) is a scale that is consistent with questions asked on the Conners Rating Scale-Revised (CRS-R) (Conners Rating Scale-Revised, 2012). It was used in this study to differentiate children with Attention Deficit/Hyperactivity Disorder from nonclinical children. Participants' parents were given the rating form (26 items) and gave them the option to complete both or only one of the subcomponents. The items included both an AD/HD Index and a DSM-IV Symptom Subscale. Similarly, the *Connors' ADHD/DSM-IV Scales-Teacher Form* (CADS-T) is a scale that is consistent with questions asked on the CRS-R. It is used to differentiate children with Attention Deficit/Hyperactivity Disorder from nonclinical children. Participants' teachers were given the rating form for teachers and it contained 27 items. Teachers had the option of completing 12 items, 18 items, or all 27. However, all teachers filled out all of the items. The scale corresponded with the DSM-IV criteria for AD/HD.

Procedure

Institutional Review Board-approved consent letters were developed and sent home to the children's parents. After receiving consent from the school and from the participant's parents, students were assessed during regular class time. They were each given the delay aversion measure, the two EDF measures, ISF, and CTOPP Sound Awareness measures. Full testing took 30 to 45 minutes for each participant. There were four examiners used for the assessments. Each examiner was a graduate student in a psychology program, with the exception of one fourth-year undergraduate psychology student. Each examiner was trained to administer each task by the primary researcher until 100% inter-scorer agreement was acquired for each task. During training, one examiner role-played while two or more scored the tasks. Tasks were assigned a number and entered into a random number generator for each child. The child was administered tasks in the order produced by the generator. Data collection was completed twice per week for 8 weeks. Each task took a maximum of 10 minutes to complete. Procedural integrity measures were taken during the first two trials of each task for each examiner.

Data Analytic Plan

Descriptive statistics for all of the variables were assessed. We conducted a hierarchical regression to determine the strength of association between the two main variables of interest (DAv & EDF) and the outcome variable (phonemic awareness ability). A hierarchical multiple regression was chosen so that the researcher could determine the order the variables were entered into the regression equation (i.e. teacher-rated AD/HD symptoms being entered first as established predictors of literacy outcomes). Once variance was accounted for by teacher-rated AD/HD symptoms, EDF and DAv variables were added into the model.

CHAPTER III: RESULTS

Descriptive Statistics

Descriptive statistics for all variables in the study are presented in Table 1. The *Tower* task was used as a measure of EDF, and the raw scores were converted into Z scores to standardize the data (*M=0, SD=1*). The *Lion and Wolf* task was also used as a measure of EDF and scores were converted into Z scores. These two scores were then combined to create an overall EDF score. These scores were combined because they were theoretically linked to the same construct. The *Flower* task was used as a measure of DAv and the raw scores were converted into Z scores (*M=0, SD=1*). Higher scores indicated more delay aversion. Initial Sound Fluency (ISF) and CTOPP Sound Awareness were used as measures of phonemic awareness. ISF was dropped from later analysis due to lack of variability in scores, with most children scoring 13.24 to 37.94 (91%). The CTOPP Sound Awareness composite score was derived from combining scores on the Blending Words, Elision, and Sound Matching subtests to obtain an overall Sound Awareness score reported as a *T*-score (*M* = 50, *SD* = 10), with higher scores indicating better sound awareness skills. Raw scores for the CADS-T and CADS-P were converted into *T*-scores (*M* = 50, *SD* = 10) with higher scores representing higher levels of inattention and hyperactivity/impulsivity. The mean for CADS-T inattention *T*-score was 50.05 (*SD* = 10.86) and the mean for Teacher hyperactivity/impulsivity *T*-score was 53.93 (*SD* = 12.53), which approximates the normal distribution. Teacher scores falling in the clinically significant range were given for the following: AD/HD scale (9 participants), DSM-IV Inattention scale (4 participants), DSM-IV Hyperactive/Impulsive scale (7 participants) and DSM-IV Total (6 participants). Parent CADS are reported for descriptive purposes, but are not included in analysis due to a poor return rate (approximately 56%). Of the Parent CADS

returned, scores falling in the clinically significant range were given for the following: AD/HD scale (4 participants), DSM-IV Inattention scale (5 participants), DSM-IV Hyperactive/Impulsive scale (5 participants) and DSM-IV Total (6 participants). Six of the participants who obtained scores in the clinically significant range for one or more areas on the teacher ratings did not have a parent who returned a rating scale. All parametric assumptions were met (e.g., multicollinearity was absent due to the combining of variables to make an overall EDF variable).

Table 1

Descriptive Statistics for Delay Aversion, Executive Dysfunction, Inattention, Hyperactivity/Impulsivity, and Phonemic Awareness

Variables	Minimum	Maximum	Mean	Standard Deviation	At-Risk Range
Tower Task	.00	13.00	3.39	3.54	n/a
Initial Sound Fluency (ISF)	.95	55.49	18.08	14.22	18%
Lion and Wolf	-14.00	36.00	30.09	10.85	n/a
CTOPP Sound Awareness	79.00	121.00	96.61	10.08	n/a
Flower	.00	20.00	14.30	6.67	n/a
Teacher Inattention T-Score	40.00	87.00	50.05	10.90	9%
Teacher Hyp/Imp T-Score	42.00	90.00	53.93	12.53	16%
Parent Inattention T-Score	41.00	80.00	51.80	10.92	25%
Parent Hyp/Imp T-Score	39.00	83.00	55.00	12.37	25%

Note: (n = 44) except for parents, n = 25

Correlations among all the variables are presented in Table 2. As mentioned previously, the *Flower-Delay* task and EDF measures were converted into Z-scores for standardization (*M= 0, SD=1*). Sound Awareness, Teacher Inattention, and Teacher Hyperactivity/Impulsivity were converted into *T*-scores. As consistent with previous researchers (Lonigan et al., 1999), teacher ratings of inattention significantly correlated with sound awareness abilities. Teacher rated Hyperactivity/Impulsivity was correlated with literacy scores (p=.01). There was not a significant correlation between the literacy variable and EDF or DAv measures suggesting neither construct is significantly associated with literacy outcomes. There was a significant negative correlation between the EDF and DAv measures.

Table 2

Correlations (n = 44)

	1.	2.	3.	4.	5.
1.Sound Awareness	1.00				
2.Flower Z-score	.08	1.00			
3. EDF Total	-.11	-.30*	1.00		
4.Teacher Inattention T-score	-.44**	-.14	.27*	1.00	
5.Teacher Hyp/Imp T-score	-.33*	.18	.12	.63**	1.00

* $p < .05$, ** $p < .01$.

Test of Research Question

The research question was: Which pathway of AD/HD is most strongly associated with phonemic awareness deficits? A hierarchical regression was conducted with Sound Awareness as the outcome variable. The CADS-T Inattention, and CADS-T Hyperactive/Impulsive scores were entered on Step 1 as predictor variables, given the known association between these variables (inattention in particular) and literacy outcomes. EDF Total and DAv Flower were then entered on Step 2 to measure whether these pathway constructs added any unique explanatory power above and beyond the AD/HD ratings. The regression results showed that the overall model was significant ($F_{[4, 43]} = 2.84$, $p = .04$), explaining 23% (adjusted $R^2 = 15\%$) of the variance in phonological awareness skills. However, the *F* change from step 1 to step 2 was not statistically significant, suggesting that the addition of EDF and DAv variables did not account for a significant portion of additional variance above and beyond what was explained by teacher AD/HD ratings (R^2 Change = .029; $p = .49$). In examining the specific predictors, only teacher-

rated inattention accounted for a statistically significant portion of the variance in the outcome variable. Participants with lower levels of teacher-reported inattention were more likely to have higher levels of phonological awareness skills (B= -.39, Std. Error= .18; *Beta*= -.42, *t*=-2.19, *p* = .03). No significant relationship between Phonological Awareness scores and either DAv or EDF measures was noted.

Table 3

Hierarchical Regression (n = 44)

Criterion Variables	B	*Beta*	*t*
Flower Task	1.86	.18	1.20
EDF Total	3.06	.08	.48
Teacher Inattention T-score	-.39	-.42	-2.19*
Teacher Hyp/Imp T-score	-.09	-.11	-.58

* $p < .05$.

CHAPTER IV: DISCUSSION

Summary of Results

The following research question was examined: Which pathway of AD/HD is most strongly associated with phonemic awareness ability in a community sample of preschoolers? Results indicated that there was a statistically significant relationship between EDF scores and levels of inattention as rated by teachers. Higher teacher-reported levels of inattention were statistically significant in predicting lower preliteracy skills in the children in the sample. This finding has been supported in prior research (Lonigan et al., 1999; Walcott et al., 2010). However, no significant relationships between either EDF or DAv and phonemic awareness skills were found. When entered into the model, teacher-reported inattention explained approximately 15-23% of the variance, however, all other factors added little to this explanation of variance. The lack of significant relationship between EDF and literacy outcomes raises questions as to why EDF and inattention ratings would be correlated as well as inattention and phonemic awareness but not EDF and phonemic awareness. This may be due to inattention variance being explained by sound awareness which may be different from the inattention variance explained by executive dysfunction. Another possible explanation is that there may be some third variable that is unaccounted for in the study that links these constructs. Future research should explore if teacher-reported inattention and/or AD/HD acts as a mediator between EDF and preliteracy skills.

There was no support for a link between DAv and levels of inattention as reported by the teacher, nor for DAv and preliteracy skills. Delay Aversion and Executive Dysfunction shared little variance in the model and were negatively correlated with each other. Future research should explore the DAv pathway to examine why its characteristics, at least as it was measured

here, were not related to teacher ratings of AD/HD symptoms. It is possible that the third pathway, temporal processing, which was not measured in this study, would have some significance in the connection of AD/HD and preliteracy skills. Future research should explore this possibility as well.

Dalen, Sonuga-Barke, Hall and Remington (2004) noted that a distinction between executive dysfunction and delay aversion can be seen early in a child's development. After testing all variables, it was unclear these two pathways can be seen in a non-clinical sample of preschoolers, prior to any official diagnoses. Our measures of these pathway constructs may not have been sufficiently sensitive enough to detect subclinical levels of differentiation. Likewise, a recent meta-analysis suggests that the most valid assessment of delay aversion might occur at a younger age (age 3) than was used for this study (Pauli-Pott & Becker, 2011). Future researchers should explore additional measures of delay aversion (such as delay of gratification tasks) and different timings of assessment within the preschool timeframe.

According to the symptom criteria given by the Conners' ratings, 9% of the students met the criteria for teacher-rated Inattention, 16% for teacher-rated Hyperactivity/Impulsivity, 25 % for parent-rated Inattention, and 25 % for parent-rated Hyperactivity/Impulsivity. Eighteen percent of students scored in the "At-Risk" range for Initial Sound Fluency. Although results show signs of issues, it is unclear as to the whether the theorized AD/HD pathways are distinctly visible within a community (non-diagnosed) sample. As previously mentioned, a significant relationship between EDF and teacher-reported inattention was found. Some researchers believe that EDF results in more severe and pervasive symptoms of AD/HD than DAv (Swanson et al.,

1998). This may explain the significance between EDF and teacher reported inattention and not between DAv and inattention ratings within this community sample.

A significant relationship between teacher-rated inattention and hyperactivity/impulsivity indicated that the rank ordering of students was consistent across variables. Teacher-rated hyperactivity/impulsivity was also significantly correlated with our literacy outcome measure, indicating a possible connection between these two variables. However, this finding is inconsistent with previous research, which suggests that the relationship between AD/HD and literacy problems is mediated primarily by inattention and not hyperactivity (Spira & Fischel, 2005; Willcutt & Pennington, 2000). Hyperactive behaviors are described as fidgeting, being restless, or constantly on the go, whereas inattentive behaviors have to do with distraction and not attending to classroom or teacher instruction. An individual can be hyperactive, but still be paying attention and learning in class, therefore supporting the previous findings (DSM-IV, 2000).

Significance of Study

Results of the study guide future research in this area and open the door to further understanding of the role of the Dual Pathways of AD/HD model on early childhood literacy development. First, this study showed the relationship between EDF and teacher-reported inattention. This is important to the field due to the other findings indicating a connection between teacher-reported inattention and preliteracy development (Lonigan et al., 1999). Results point researchers in the direction of considering teacher-reported inattention as a moderator for EDF and preliteracy skills. Although EDF was not a significant predictor of preliteracy skills in this study, it may be mediated by the presence or absence of inattentive behaviors. This idea

would be better supported if findings showed a relationship between EDF and preliteracy skills as well as between EDF and inattention and inattention and preliteracy skills. This should be explored further in future research.

Another important finding was the significant negative correlation between EDF and DAv scores. The correlation between these two variables was small and suggests measurement of different constructs. This provides further support for the distinctness of the two constructs posited by the Dual Pathways model of AD/HD, suggesting that the two pathways may exist and researchers may be able to tap into each separate from the other. Early identification of teacher-reported inattention problems may aid in targeting those who are at risk for literacy development difficulties. Preventive measures should be taken to help these children remain at grade-level such as parent education and training and systemic family work (Brandau & Pretis, 2004).

Limitations of Study

As previously mentioned, the third pathway, temporal processing should be assessed to examine its possible significance in preliteracy development. Participants' general cognitive or language abilities were not controlled, and these are known correlates of reading ability. A larger sample may elucidate the relationships among these variables better, particularly by providing additional variation in the constructs of interest. The participant sample came from two types of preschool classrooms. The first was one paid for by the state for individuals who were identified as having some developmental risks such as low socioeconomic status or a parent in jail. The other classrooms consisted of children whose parents paid for their daycare out of pocket. There were two classrooms of the first type and four of the second. Socioeconomic status was not measured but may contribute to the understanding of these relationships.

An additional limitation of the current study was the lack of normal distribution in the ISF findings, leading to it being dropped from analyses. The majority of children scored well on this task. Therefore, results on this measure did not provide adequate variation to examine low to high ability levels. Better, more sensitive, measures of phonemic awareness for this age group should be used in future studies.

Future Research

Future research should explore the role of teacher-reported inattention as a potential mediator of EDF and preliteracy development. Replication of this study with a larger, more diverse sample is imperative for generalization. Looking more specifically at factors such as age, ethnicity, and socioeconomic status should be done to increase internal validity. Lastly, using temporal processing as a third pathway, the pathways model should be explored using multiple measures for each to determine how taking out the time component affects a child's preliteracy development.

Summary and Conclusions

The results of the current thesis study further support the finding that teacher-reported inattention is significantly correlated with preschool preliteracy skills (Lonigan et al., 1999; Walcott et al., 2010). However, a strong and predictive relationship between either of the variables of interest (EDF & DAv) and phonemic awareness was not identified. Therefore, the relationship between these pathways and early literacy skills may need to be further explored as we search for mechanisms explaining why a significant proportion of children with AD/HD have reading problems. Results showed a potential relationship between EDF and teacher-reported

inattention. Understanding how these pathways relate to early phonemic awareness and preliteracy development is important in guiding intervention to help elevate possible problems.

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APPENDIX A: INFORMED CONSENT

East Carolina University

Informed Consent to Participate in Research

Information to consider before taking part in research that has no more than minimal risk.

Title of Research Study: **Relations among executive dysfunction, delay aversion, and phonemic awareness in preschoolers.**
Principal Investigator: Christy Walcott, Ph.D.
Institution/Department or Division: East Carolina University, Psychology Department
Address: Mail Stop 565, Dept of Psychology, ECU, Greenville, NC 27858
Telephone #: 252-328-1378

Researchers at East Carolina University (ECU) study problems in society, health problems, environmental problems, behavior problems and the human condition. Our goal is to try to find ways to improve the lives of you and others. To do this, we need the help of volunteers who are willing to take part in research.

Why is this research being done?
The purpose of this research is to study of the relations between different levels of attention and impulsivity and phonemic awareness in a community sample of preschoolers. The decision to take part in this research is yours to make. By doing this research, we hope to learn what features associated with common behavior problems predict early reading problems. To do this, we need to study children with and without behavior concerns.

Why am I being invited to take part in this research?
You are being invited to take part in this research because your child is of preschool age and does not have significant developmental disabilities. If you volunteer to take part in this research, your child will be one of about 50 people to do so.

Are there reasons I should not take part in this research?
You should not volunteer your child for this study if he or she has known significant developmental disabilities or if English is a second language for your child.

What other choices do I have if I do not take part in this research?
You can choose not to participate.

Where is the research going to take place and how long will it last?
The research procedures will be conducted at your child's daycare/preschool center within one to two days. The total amount of time your child will be asked to volunteer for this study is 25-30 minutes during one day.

What will I be asked to do?
Your child will be asked to do the following game-like tasks with a trained school psychology graduate student:

- Two short tasks from the *Comprehensive Test of Phonological Processing (CTOPP)* – This is a test designed for young children to measure their awareness of sounds in our language; this is an important early reading skill. Children will be asked to break words into syllables and sounds and to combine words from sounds. They will also be asked to quickly name objects, colors, digits, or letters from memory. (about 5 minutes)

- Initial Sound Fluency – This is a short test that measures one's ability to recognize and produce the initial sound of a word that is orally presented by the examiner. During the task, the examiner presents four pictures to the child and names each pictures. Then the child is asked to either orally identify or point to the picture that begins with the sound that is given by the examiner. An example would be the experimenter saying "horn, tulip, robot, cap. Which picture beings with /h/?". (about 3 minutes)
- Lion and Wolf is a go/no-go task that resembles "Simon says." Children will watch a recorded version of the game. Children will be asked to obey commands (e.g., touch your toes) of the lion, but not of the wolf (or vice-versa). (about 5 minutes)
- Tower is a go/no-go task that involves the child taking turns with the graduate student placing blocks on top of each other to make a tower. (about 5 minutes)
- The Maudsley's Index of Childhood DAv (MIDA) - MIDA is a computer-based task that was created to test delay aversion for preschoolers. Children will make a choice between a smaller reward sooner or a larger reward later. It is a space game where the participants have to destroy the enemy spaceships by shooting from their own spaceship. (about 5 minutes)

You and your child's teacher each will be asked to complete a short, one-page behavior rating scale (Conner's Rating) that asks questions about how often common problem behaviors occur (often, sometimes, never). Your child's ratings are then scored compared to other children his or her age to get an overall behavior score.

What possible harms or discomforts might I experience if I take part in the research?
It has been determined that the risks associated with this research are no more than what your child would experience in everyday life. It is possible that children might get frustrated if they do not like the tasks. We are minimizing this, however, by making the tasks very quick (less than 5 minutes each) and simple. Also, preschool students will be told they can stop participating at any time and return to their classroom.

What are the possible benefits I may experience from taking part in this research?
We do not know if your child will get any benefits by taking part in this study. This research might help us learn more about early intervention targets for children with early reading problems. There may be no personal benefit from your child's participation but the information gained by doing this research may help others in the future.

Will I be paid for taking part in this research?
We will not pay you for the time you volunteer while being in this study.

What will it cost me to take part in this research?
It will not cost you any money to be part of the research.

Who will know that I took part in this research and learn personal information about my child?
To do this research, ECU and the people and organizations listed below may know that you took part in this research and may see information about you that is normally kept private. With your permission, these people may use your private information to do this research:

- Any agency of the federal, state, or local government that regulates human research. This includes the Department of Health and Human Services (DHHS), the North Carolina Department of Health, and the Office for Human Research Protections.
- The University & Medical Center Institutional Review Board (UMCIRB) and its staff, who have responsibility for overseeing your welfare during this research, and other ECU staff who oversee this research.

How will you keep the information you collect about me secure? How long will you keep it?
Dr. Walcott (who is full time faculty or staff) will set up a file on her password-protected computer in the department of psychology where all research data will be kept. This data file will identify your child using a code (e.g., Child 1A) instead of using his or her name. After parents and teachers complete the behavior ratings, the child's name will be removed/blocked-out and replaced with a code as well. Dr. Walcott and the graduate student working on the project will know which code relates to which child. Those coded forms will be stored in a file cabinet in a locked office on ECU's campus for a minimum of 5 years, after which it will be shredded.

What if I decide I do not want to continue in this research?
If you decide you no longer want to be in this research after it has already started, you may stop at any time. You will not be penalized or criticized for stopping. You will not lose any benefits that you should normally receive.

Who should I contact if I have questions?
The people conducting this study will be available to answer any questions concerning this research, now or in the future. You may contact the Principal Investigator at 252-328-1378 (days, between 9am and 5pm).

If you have questions about your rights as someone taking part in research, you may call the Office for Human Research Integrity (OHRI) at phone number 252-744-2914 (days, 8:00 am-5:00 pm). If you would like to report a complaint or concern about this research study, you may call the Director of the OHRI, at 252-744-1971.

I have decided I want to take part in this research. What should I do now?
The person obtaining informed consent will ask you to read the following and if you agree, you should sign this form:

- I have read (or had read to me) all of the above information.
- I have had an opportunity to ask questions about things in this research I did not understand and have received satisfactory answers.
- I know that I can stop taking part in this study at any time.
- By signing this informed consent form, I am not giving up any of my rights.
- I have been given a copy of this consent document, and it is mine to keep.

Participant's Name (PRINT)	**Signature**	**Date**

APPENDIX B: UMCIRB APPROVAL

EAST CAROLINA UNIVERSITY
University & Medical Center Institutional Review Board Office
1L-09 Brody Medical Sciences Building· Mail Stop 682
600 Moye Boulevard · Greenville, NC 27834
Office **252-744-2914** · Fax **252-744-2284** · **www.ecu.edu/irb**

Notification of Initial Approval: Expedited

From: Social/Behavioral IRB
To: Christy Walcott
Date: 2/6/2012
UMCIRB 11-001351
Re: Relations among executive dysfunction, delay aversion, and phonemic awareness in preschoolers

I am pleased to inform you that your Expedited Application was approved. Approval of the study and any consent form(s) is for the period of 2/3/2012 to 2/2/2013. The research study is eligible for review under expedited category #7. The Chairperson (or designee) deemed this study no more than minimal risk.

Changes to this approved research may not be initiated without UMCIRB review except when necessary to eliminate an apparent immediate hazard to the participant. All unanticipated problems involving risks to participants and others must be promptly reported to the UMCIRB. The investigator must submit a continuing review/closure application to the UMCIRB prior to the date of study expiration. The Investigator must adhere to all reporting requirements for this study.

The approval includes the following items:

Name	Description
Consent Form for Parent Consent | History	Consent Forms
cover sheet/flyer for parent consent | History	Consent Forms
cover/flyer | History	Recruitment Documents/Scripts
Script to introduce tasks to child | History	Consent Forms

The Chairperson (or designee) does not have a potential for conflict of interest on this study.
