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Executive Function, Parent Involvement, and Children with Hearing Impairment

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EXECUTIVE FUNCTION, PARENT INVOLVEMENT, AND CHILDREN WITH HEARING IMPAIRMENT

BY

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ABSTRACT

This research explores the relationship between parent involvement and executive function (EF) development in children with hearing impairment. The study sample includes 205 children who were identified as having hearing impairment in the Early Childhood Longitudinal Study – Kindergarten Cohort (ECLS-K) data set. It uses reports from teachers on three different outcomes to measure EF – including approaches to learning, self-control, and externalizing problem behaviors – as well as a questionnaire filled out by parents on their level of involvement with their children based on nine specific activities. Findings reveal that parent involvement is not significantly correlated with the development of EF skills, although it is marginally significant in the outcome of externalizing problem behaviors. Results suggest that future research on this population and EF development should include more specific measures and variables related to hearing impairment.

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INTRODUCTION

Current research highlights the importance of cultivating executive functioning in early childhood in order to develop skills we rely on as adults, such as the ability to multitask, delay gratification, wait one's turn, and exercise self-control (Cuevas, et al., 2014; Cameron, et. al, 2012; Center on the Developing Child, 2011). Researchers at the Center on the Developing Child at Harvard University contend that "executive function skills are crucial building blocks for the early development of both cognitive and social capacities" (Center on the Developing Child, 2011, pg. 3). While there has been some debate in the literature on what behaviors or cognitive processes constitute executive function (EF), working memory, inhibitory control, and cognitive or mental flexibility are three domains of EF that have been identified in recent research. These processes are thought to be vital to healthy brain and socio-emotional development in early childhood, as well as foundational for other skills that promote positive development (Center on the Developing Child, 2011).

The term "working memory" signifies our capacity to hold information in our minds so that we can later recall it without prompting, including following directions or remembering rules; "inhibitory control" refers to our ability to control impulses, think before we act, filter distractions, and maintain focus on a specific task; and "cognitive or mental flexibility" is our capacity to juggle multiple demands at once, exercise self-control, make deliberate choices, switch gears if necessary, and to understand how our behavior might need to change depending on our environment (Mayfield, Fuccillo, & Greenfield, 2013; Center on the Developing Child, 2011).

Many studies indicate that the presence of strong EF skills in these three domains in preschool students tends to increase their readiness for and ability to perform well in kindergarten classrooms and is strongly correlated to later academic performance and adaptive functioning (Fitzpatrick, McKinnon, Blair, & Willoughby, 2013; Cameron et al, 2012; Vuontela et al., 2012). Some researchers argue that executive functioning gives the process of learning meaning as it enables children to learn how to conduct purposeful, goal-directed behavior (Center for the Developing Child, 2011; Anderson, 2002). For example, our ability to successfully perform math problems is dependent on our ability to tackle increasingly difficult steps. Learning this process enables us to figure out how to apply higher-order thinking skills such as reasoning, comparison, and reflection; thus, it becomes an important ability that we can use for more than just completing math problems (Mayfield, Fuccillo, & Greenfield, 2013).

The development of EF does not occur as a result of maturation alone; rather, these skills should be trained and cultivated beginning in early childhood as different components develop at different times (Cuevas, et al., 2014; Center for the Developing Child, 2011). Early experiences in childhood, including both parenting and schooling, are influential in determining the outcomes of this trajectory (Fitzpatrick, et al., 2014). For example, research indicates that adults can encourage children to exercise various EF skills by establishing routines and boundaries (Cuevas, et al., 2014). When children are asked to remember and follow routines, to behave in certain ways in certain settings (i.e., "use your indoor voice in the library"), and to take turns, they can learn different behaviors identified as falling within one of the three domains of EF. Further, as adults engage in scaffolding by doing things such as verbally narrating a problem solving

activity, they are contributing to the shaping of the child's ability to do so on his or her own (Bernier, et al., 2012). To that end, home and school environments that are orderly and healthy can naturally encourage EF development in children without specific, targeted interventions aimed at doing so (Center for the Developing Child, 2011).

Studies have shown that exposure to stressful early environments is associated with deficits in EF development (Cuevas, et al., 2014; Fitzpatrick, et al., 2014). Sometimes the deficits can be the result of physically adverse situations, such as exposure to alcohol before birth that results in weakened development of the prefrontal cortex—part of the brain that has been linked to EF—and sometimes the deficits are the result of unstable environments that result in emotionally adverse situations, compromising children's opportunities to learn and exercise EF skills (Anderson, 2012; Center on the Developing Child, 2011, pg. 7). For example, children in at-risk populations such as in low socioeconomic homes tend to struggle with EF skills (Calderon, 2000). Ultimately, because the development of executive functioning is dependent on healthy physical and socio-emotional environments in early childhood, it is recognized that early surroundings—including at home and school—play a formative role in preparing children to have the capacity to learn EF skills and to then be able to cultivate specific behaviors by mimicking adult's scaffolding (Center on the Developing Child, 2011).

Lev Vygotsky's sociocultural theory provides a theoretical framework that supports the notion of scaffolding as crucial to EF growth. Ultimately, Vygotsky's work centered on the idea that higher mental processes emerge from the child's interactions with more experienced peers, including parents and teachers. He contended that scaffolding was crucially important to the development of behaviors, skills, and cognitive

processes researchers now generally characterize as executive functioning. More importantly, Vygotsky thought the child's development and ability to grow toward new levels of functioning and understanding was dependent on meaningful interactions with others on an interpersonal level. However, it is important to note that the effectiveness of the interaction or scaffolding between the teacher and student or parent and child is dependent on the adult's ability to provide support without being too challenging or too boring (Hauser, Lukomski, & Hillman 2008). Further, many studies point to the added stress a family faces when a child is diagnosed with a disability or condition such as hearing loss, ultimately influencing how the culture of the family and even surrounding community function and interact with the child (Hintermaier, 2006). Thus, it is important to consider how the action and importance of scaffolding may be influenced by factors such as hearing impairment.

This research study will examine the relationship between parent involvement and EF development in children with hearing impairment. It is expected that high levels of parent involvement at kindergarten will increase scores on measures of EF skills taken in fifth grade among children with hearing impairment. For the purpose of this study, hearing impairment is defined as difficulty hearing and understanding speech in normal conversation to the extent that it is noticeable to others (i.e., to parents and teachers). The term "hearing impairment" indicates a large spectrum with many different variables that impact the severity and need for intervention, including: what type of hearing loss it is (i.e., if there is something stopping sound from getting from the outer to inner ear, or if there is a problem with the way the inner ear and/or hearing nerve function), the extent of hearing loss (i.e., some sense of sound or no sense of sound), whether or not the hearing

loss occurred in a pre-lingual or post-lingual stage of life, and whether the hearing loss is progressive, sudden, fluctuating, or stable (CDC, 2015). The definition of this term is intentionally broad in this study for the purpose of including children who have some level of hearing loss but may not yet have an official diagnosis from a professional as it is quite likely that any degree of hearing loss will disrupt the development of executive functioning (Figueras, Edwards, and Langdon, 2008).

REVIEW OF LITERATURE

Hearing Impairment

Current research in this area varies in terms of how hearing impairment is defined. Some studies look solely at children who have profound hearing loss—whether acquired or congenital—who have undergone cochlear implantation (Kronenberger, Pisoni, Henning, & Colson, 2013; Burkholder & Pisoni, 2003; Surowiecki, et al., 2002), some studies look solely at children who have hearing loss but do not have cochlear implants or other types of hearing aids (Sipal & Bayhan, 2011), and some studies include children who use cochlear implants as well as those who do not use any type of hearing device (Figueras, Edwards, & Langdon, 2008). Many studies acquire their samples through schools, some of which are specifically for deaf children and some of which are not (Sipal & Bayhan, 2011; Figueras, Edwards, & Langdon, 2008).

Executive Function and Hearing Impairment

Current research that focuses on EF development in children with hearing impairment is notably sparse. As previously mentioned, there has been some debate in the literature about what behaviors or cognitive processes constitute EF. Thus, it can be difficult to differentiate between what would be a normal trajectory versus a challenged trajectory. However, although it is not a large literature base and there remains some debate about the term EF, most of the research on this topic agrees that children with hearing impairment will face added challenges with behaviors and skills widely identified as being EF development (Kronenberger, et al., 2013; Figueras, Edwards, & Langdon, 2008; Horn, et al., 2004; Burkholder & Pisoni, 2003; Surowiecki, et al., 2002). More research has focused on the impact of learning spoken language and consequent EF

development in children with cochlear implants (CIs) than on hearing impaired children without them, although neither population has been studied comprehensively (Corina & Singleton, 2009; Figueras, Edwards, & Langdon, 2008). CIs are electronic medical devices that are surgically placed under the skin of the ear. They provide a sense of sound by directly stimulating the auditory nerve in the brain, bypassing damaged portions of the ear. After surgical implantation, people who receive them require "significant therapy to learn or relearn the sense of hearing" (National Institute on Deafness and Other Communication Disorders, 2014, pg. 1). Individuals must have severe hearing loss to be eligible for a CI. It is also important to note that one significant barrier to receiving a CI is the cost, as one must pay for the device, the surgery, and subsequent therapy, and insurance does not always cover the full cost of the process (NIDCD, 2014). Because of these two reasons, not all children diagnosed with hearing impairment receive a CI.

Even after cochlear implantation, children with hearing impairment might not "catch up" to their hearing peers in terms of auditory-verbal skills and subsequent EF growth. That is, even with a CI children will still face challenges with EF development. Many studies have found that hearing impaired children with and without CIs face difficulties with EF skills such as planning, problem solving, verbal memory tasks, reading skills, conceptual thinking, and classroom performance (Figueras, Edwards, & Langdon, 2008; Horn, et al., 2004; Surowiecki, et al., 2002). Research also indicates that children with hearing impairment "score below age norms on measures of auditory-verbal short-term and working memory capacity" even after cochlear implantation (Kronenberger, et al., 2013, pg. 903). Language ability has been linked to the development and growth of some EF skills; therefore, the lack or delay of spoken

language ability in children with hearing impairment has been correlated with problems like impulsivity and lack of initiative (Horn, et al., 2004, & Kronenberger et al., 2013) argue that even if children undergo cochlear implantation at a young age, the period of deafness during critical times of brain development renders auditory-verbal experiences and skills irreversibly compromised, further reinforcing the argument that physical development of the brain is intricately entwined with a child's capacity to learn and exercise the behaviors and skills associated with EF.

However, despite claims that children might never be able to "catch up" to their hearing peers even if they undergo cochlear implantation, it is important to note that a significant volume of research contends that EF deficits in this population are usually reflective of *delayed* rather than *disordered* functioning (Sipal, & Bayhan, 2011). This distinction is important. While hearing impairment often falls into the category of "disability," some current research indicates that the delay in EF growth in this population should not signify a deficit as much as an impediment. For example, Sipal and Bayhan (2011) contend that language development and EF growth might be interdependent and that "executive functions themselves may be dissociable" (pg. 741). They have conducted studies to examine if emphasizing visual cues through sign language and placing minimal demands on verbal language might assist children with hearing impairment in developing stronger EF skills (specifically the skills that would require spoken language ability) whether or not they have a CI. The results of their studies, although based on small and non-generalizable samples, are promising. A study conducted by Surowiecki (2002) et al. suggests that adults can emphasize visual memory skills in children with hearing impairment (i.e., recognition memory, delayed recall, and

associative learning memory abilities) in place of verbal language to cultivate certain EF skills typically identified as problem areas. While this body of literature is small, it suggests that more research should focus on non-verbal language and how it might impact brain development and subsequent EF development and performance in order to determine if different trajectories can reach the same end goal.

Parent Involvement

The term parent involvement can be operationalized in a myriad of ways as it is generally recognized to be a multidimensional construct (Bernier, Carlson, & Whipple, 2010). The simplest definition—and the one that is used in this study—is the amount of time parents spend with their children on a daily basis as well as the kinds of activities pursued (i.e., participating in interactive activities with the child, such as reading books or playing games, rather than solely activities that are conducted for the survival and care of the child, such as providing the child with meals and/or giving him or her a bath). Research indicates that parent involvement can have a positive impact on child development, school readiness, and academic achievement (Xu et al., 2010).

While limited studies to date have looked specifically at parent involvement and the development of EF skills in children with hearing impairment, the results are promising. For example, Moeller (2000) looked at early intervention and language development in children with hearing loss. She measured parent involvement with a global rating from at least two independent raters who participated in intervention services (looking specifically at familial adjustment, session participation, advocacy efforts, etc.). She concluded that "the most successful children…were those with high levels of [parent] involvement who were enrolled in early intervention services" (1), and

that parent involvement explained the most significant amount of variance found in language scores that were obtained when the children were five years old. Ultimately, her study found a significant positive correlation between high levels of parent involvement and desired language outcomes.

Calderon (2000) looked at parent involvement in deaf children's school-based education programs as a significant predictor for language development, early reading skills, and social-emotional development (outcomes that are closely tied to EF). She measured parent involvement with questionnaires given to parents and teachers respectively (looking specifically at parental participation in IEP meetings, requesting and accessing additional services for the child, etc.), as well as from two independent coders who participated in intervention meetings with the family. She determined that there is a significant positive correlation between parental involvement in school and the outcomes, although she found that other indicators of involvement such as maternal communication skill were also significant predictors—even more so than involvement at school. Further, socioeconomic status was a marginally significant predictor of maternal communication. Calderon contends that mothers from a higher socioeconomic status may have more access to resources and tools that enhance communication with the child, including "private or public sign language classes, books, videotapes, auditory-verbal training for the child, or the most advanced listening devices" (151). Thus, Calderon's study not only suggests that parent involvement—especially in the form of maternal communication—supports positive development for children with hearing impairment, but suggest that demographic variables such as socioeconomic status may play a key role in the type of involvement parents are able to give.

Parent involvement has also been positively linked to EF growth in early childhood among typically developing children. Although these studies are not focused on children who have hearing loss, the results signify the importance of parent involvement to positive development and success in school. For example, Bernier et al. found through a longitudinal study that positive maternal caregiving behaviors, such as maternal sensitivity and autonomy support through which mothers provided young children with physically, emotionally, and mentally nurturing and stimulating environments, were associated with better EF performance in early childhood (Bernier, et al., 2012; Bernier, Carlson, & Whipple, 2010). Their study focused on how parental interactive behavior, including things like scaffolding externally guided problem-solving activities while also fostering affective bonds, can support EF growth. The results of their studies ultimately reinforce the idea that orderly, healthy environments in the home—arguably the environments that have the most profound impact on young children—can have a positive impact on EF development by allowing children to observe and mimic various abilities associated with EF (Bernier, et al., 2012; Bernier, Carlson, & Whipple, 2010).

Further, other studies have used the Early Child Longitudinal Study – Kindergarten Cohort (ECLS-K) data to investigate how parent involvement might impact outcomes such as academic achievement and well-being in typically developing children. For example, Xu et al. (2010) sought to examine the relationship between parent involvement, self-regulated learning, and reading achievement of fifth graders. They measured parent involvement similarly to this study's definition, as well as looked at involvement at school (i.e., attending Parent Nights and Open Houses). They included the

measures of parent involvement used in this study as well as other variables from the ECLS-K data. The results of their study suggest that parent involvement does have a significant beneficial effect on reading achievement. Artis (2007) looked at maternal cohabitation and child well-being in kindergarten children. She included measures of academic performance in her analysis of well-being and determined that cohabitation is positively linked to child well-being. She argues that this important link is largely due to parental practices and involvement that result from the supportive kin network of having more than one adult or parent in the home.

Ultimately, these studies are reflective of a more broadly scoped literature base that examines the many ways parent involvement can contribute to child development, academic achievement, and subsequent EF growth in typically developing children and in children with hearing impairment. It is important to note that parent involvement has been found to be significantly related to positive child development, but it has not been thoroughly examined in this population specifically. This retrospective research study involves secondary data analysis and seeks to explore whether there is a positive correlation between parent involvement at kindergarten and scores on measures of EF skills in children with hearing impairment.

METHODOLOGY

Procedures

This study utilized data from the Early Childhood Longitudinal Study – Kindergarten Cohort (ECLS-K). The ECLS-K study began by looking at 21,260 public and private schooled kindergarteners in full-day and half-day programs from 1,280 schools throughout the United States in 1998. It was the first longitudinal study that followed a nationally representative sample focused specifically on children's early schooling experiences. It used a multistage stratified sampling design and data were collected through multiple sources, including: parent interviews, student records, direct assessments of children, and questionnaires given to teachers and school administrators. Two objectives of the original study were to assess how children developed at the start of formal schooling and throughout their first few years in elementary school, and to assess how family, community, and early educational experiences shaped children's development, progression, and success through the early school years.

The U.S. Department of Education, National Center for Education Statistics (NCES) sponsored the ECLS-K study. Base-year data were collected in the fall and spring of the 1998-99 school year when the children were in kindergarten. Data were collected again twice when they were in first grade, once in third grade, once in fifth grade, and once in eighth grade. Data were collected via telephone and in-person computer assisted interviewing (CAI) from the parents and via self-administered questionnaires from teachers. Approximately 20,628 parents or guardians and 3,102 teachers were interviewed. Interviews were conducted primarily in English, although accommodations were made for parents or guardians who needed interpreters or other

assistance. Approximately 91% of parent respondents at the fifth grade data collection period were the same respondent as the base year kindergarten collection. Field supervisors and interviewers—the groups of people responsible for collecting the parent and teacher data—went through in-person training sessions that lasted up to five days after completing at least eight hours of home training on the study design and field procedures (NCES, 2005). The NCES protects confidentiality of individually identifiable information through adherence to four separate laws—the Privacy Act of 1974, the Education Sciences Reform Act of 2002, the USA Patriot Act of 2001, and the E-Government Act of 2002 (NCES). Parental consent was dependent on the policies of the individual schools that participated in the study. About half of the schools used explicit consent (i.e., the parent or guardian's signature was required for the child to participate) and the other half used implicit consent (i.e., parental consent was implied if the school did not receive paperwork indicating the refusal of consent) (NCES), 2005).

Sample

This study combined the data from the kindergarten collection in 1998-99 and the fifth grade collection in 2004. The sample for this study was identified through a variable created from the parent interview in which parents were asked if children have difficulty hearing and understanding speech in normal conversations. The sample includes only those who answered yes to that question (n=523) as it is a group that is most consistent with the study's definition of hearing impairment. Finally, the sample was further pared down to include only children who had data from the first and second time point of the study (n=205). Participants in this group reported as 58% White, 12% Black or African-American, 19% Hispanic, and 12% Other. There were 121 males (59%) and 84 females

(41%). In terms of poverty status, 32% reported as being below poverty level and 68% reported as being at or above poverty level.

Measures

The independent variable used for this analysis was the parental report of involvement with the child at home at the first time point in kindergarten. Parent involvement was measured at kindergarten using a 9-item scale with four possible answers. Parents were asked to report how often they did specific activities (reading books, telling stories to the child, singing songs, doing arts and crafts, involving the child in household chores, playing games or doing puzzles, talking about nature or doing science projects, building something together, playing a sport or exercising together) by responding using a scale of 1=not at all, 2=once or twice, 3=3 to 6 times, and 4=every day in a typical seven-day week. For the analysis, the nine items from the parent involvement scale were summed to create an overall scale with a range from 9 to 36. Higher scores indicate greater involvement. The list of activities in the original study is consistent with this study's definition of parent involvement. Because there was no reliability indicated in the ECLS-K study for the parent involvement scale, it was tested as part of this study and was found to be reliable with a Cronbach's alpha of .71.

As this study seeks to understand how EF skills in a certain population might be influenced by early parental involvement, the dependent variables used for this analysis were the children's scores on three different scales ascertained in kindergarten and fifth grade. The scales consist of the teacher's reports on a Social Rating Scale (SRS) that measure different aspects of EF development. Teachers rated the 4-6 items on each scale from 1 (never) to 4 (very often) to indicate the frequency with which a child displayed

certain behaviors or social skills. The SRS was given to teachers at all time-points of the study, although this study will only examine the data from first time point in kindergarten (T1) and the fifth grade collection (T2). The SRS consists of five scales focused on five different areas, three capturing positive aspects of child development and two indicating problem behaviors, including: Approaches to Learning, Self-Control, Interpersonal Skills, Externalizing Problem Behaviors, and Internalizing Problem Behaviors.

The original scales were not specifically designed to measure executive functioning as it did not become a well-recognized term or concept in child development literature until several years after the scales were developed. Of these five scales, the Approaches to Learning, Self-Control, and Externalizing Problem Behaviors scales were the only ones utilized in this study because the specific questions within these three scales are the most consistent with behaviors identified as EF. For example, the six-item Approaches to Learning scale includes behaviors that specifically represent inhibitory control (attentiveness and task persistence), cognitive flexibility (flexibility and eagerness to learn), and working memory (learning independence and organization). The four-item Self-Control scale includes behaviors that represent cognitive flexibility (the child's ability to accept peer ideas for group activities and respond appropriately to pressure from others) and inhibitory control (how well the child can control his or her behavior by respecting others' property as well as control his or her temper). Lastly, the five-item Externalizing Problem Behaviors scales measures inhibitory control (how often the child disturbs ongoing activities and acts impulsively) and cognitive flexibility (how often the child gets angry, fights, and argues with classmates or teachers). All items of each measure are noted in the appendixes. Thus, this study took a validated measure and

focused on only three of the five scales that strongly reflect behaviors defined as executive functioning.

The SRS given to teachers was adapted with permission from the Social Skills Rating Scale (SSRS) developed by Gresham and Elliot in 1990. Its original psychometric data was based on 4,170 K-12 students with test-retest correlation over four weeks at .85 (Gresham & Elliot, 1990). Later studies aimed at discerning the scale's psychometric properties through correlational and factor analyses supported the measures' construct validity, indicating strong reliability in the teacher's portion of the questionnaire and moderate reliability in the parent questionnaire (Furlong & Karno, 1995). Split-half reliabilities for the five scales for first grade, third grade, and fifth grade ranged from .76 (for Internalizing Problem Behavior) to .91 (for Approaches to Learning) (NCES, 2005). The reliability of the scales was tested in the ECLS-K study with split half reliabilities ranging from .79 (for Self-Control) to .89 (for Approaches to Learning).

Covariates were examined to determine confounding variables that could present alternative explanations for the children's EF scores. They were drawn from the parent interviews at the first time point in the study (at kindergarten) when respondents gave demographic information and information related to the child's hearing loss, as well as drawn from scores on the dependent variables at the first time point. Gender was grouped into two categories (1=male, 2=female). In the original ECLS-K study, race was organized into nine categories but was recoded into four smaller categories for this study—White, Black or African-American, Hispanic, and Other—due to small sizes in some categories (i.e., less than 11 people). Poverty status was defined by putting people in one of two groups: at or above the poverty threshold or below the poverty threshold. In

the original study, the poverty variable was created from an imputed income variable comparing income to preliminary Census poverty thresholds for 1998. The thresholds varied by size (ranging from $10,973 for a family of 2 and $33,073 for a family of 9+).

Data Analyses

Preliminary frequencies and descriptive statistics were run to determine if there was missing data on any variable and if any data needed to be recoded. Normality of the data were checked and descriptive statistics were used to find the means, distributions, and potential outliers. Tests of normality revealed the data were normally distributed and there were no potential outliers. The reliability of the parent involvement and EF measures were tested prior to hypothesis testing. Cross tabs and an independent samples t-test were conducted to compare the groups that had data and did not have data at the second time point to determine if there were significant demographic differences between the two groups. Bivariate Pearson Correlations were conducted to check for multicollinearity in the three outcome variables. Finally, the research question was tested by conducting correlations to determine how strongly parent involvement and the EF scales are related to each other. Multiple regression analyses were then run to explore whether parent involvement significantly explained EF after controlling for confounding variables. Three regressions were run for the three different scales that measure EF outcomes.

FINDINGS

The first analyses sought to examine if those who stayed in the study till the second time point were different from those who left the study to determine if the final sample could be representative of the larger group. Cross tab analyses revealed that the group who had data at both Time 1 (T1) and Time 2 (T2)—the group used in the final analyses of this study—were demographically similar to those who did not have data at T2 but were in the study at T1. Gender and poverty level were not significantly different, although race was significant with a Pearson Chi-Square of .015. The greatest significant difference was between "White" (58% as compared to 48% respectively) and "Black or African-American" (12% as compared to 23% respectively). That is, there were more people in the "White" category and fewer people in the "Black or African-American" category in the study sample than those among those who only had data at T1. Although there was a higher percentage of boys than girls and more people who were in the "at or above poverty threshold" range than those in "below poverty level" at T2 as compared to T1, the differences were not statistically significant. Descriptive statistics are displayed in Table 1.

Table 1
Descriptive Statistics of the Sample

	Study Sample N = 205		T1 Only N = 318		Test statistic χ^2, *t*
	% (N)	Mean (SD)	% (N)	Mean (SD)	
Gender					0.504
Male	59 (121)		62 (197)		
Female	41 (84)		38 (121)		
Race					.015*

White	58 (118)		48 (152)		
Black or African-American	12 (24)		23 (72)		
Hispanic	19 (38)		19 (60)		
Other	12 (25)		10 (33)		
Poverty Level					0.45
Below poverty threshold	32 (65)		35 (111)		
At or above threshold	38 (140)		61 (207)		
Parent Involvement	205	24.46 (4.50)	316	24.89 (4.66)	-1.025
T1 Approaches to Learning	201	2.67 (.668)	307	2.66 (.689)	0.177
T1 Self-Control	191	2.90 (.617)	300	2.87 (.685)	0.519
T1 Externalizing Problem Behaviors	197	1.76 (.694)	304	1.89 (.743)	-2.046*

* $p <$ .05, ** $p <$ .01, *** $p <$ .001

The independent and dependent variables were also examined with these analyses. It is important to note that the independent samples t-tests revealed that the mean is significantly higher on the T1 Externalizing Problem Behaviors scores for participants who did not stay in the study till the second time point (p=.041). In other words, children with fewer problems in the area of Externalizing Problem Behaviors were more likely to stay in the study. The groups did not vary on the T1 Approaches to Learning, Self-Control, and parent involvement scores.

Independent samples t-tests were conducted to determine if there were any confounding variables related to parent involvement at T1 or to the other T1 measures to identify any significant demographic differences that would need to be adjusted for in the final analyses. As shown in Table 2, girls have significantly higher mean scores on T1 Approaches to Learning (M=2.8, SD=0.67 as compared to M=2.6, SD=0.65, p=.010). People in the "at or above poverty level" range also have significantly better scores on T1 Approaches to Learning scale (p=0.006). On T1 Self-Control, girls have significantly

higher mean scores (M=3.0, SD=0.5 as compared to M=2.8, SD=0.7, p = .04). Race and poverty level were not significant for this outcome. On T1 Externalizing Problem Behaviors, boys have a significantly higher mean score (M=1.9, SD=.79 as compared to M=1.6, SD=0.50, p = .003). There were no significant differences by race or poverty level for this outcome. For the parent involvement variable, gender and poverty level were not significant but race was significantly related (p = 0.001). Finally, because there were more than two categories of race, an ANOVA was conducted to determine how parent involvement varied by race on T1 scores and the final results revealed that only parent involvement, not the outcomes or individual categories of race, was significant (p =.001).

Table 2
Demographic Information for Time 1 Variables

Variable	T1 Approaches to Learning		T1 Self Control		T1 Externalizing Problem Behaviors		T1 Parent Involvement	
	Mean (SD)	t score	Mean (SD)	t score	Mean (SD)	t score	Mean (SD)	t score
Gender		-2.61*		-1.94		2.83*		0.061
Boys	2.6 (0.6)		2.8 (0.7)		1.9 (0.8)		24.5 (4.0)	
Girls	2.8 (0.7)		3.0 (0.5)		1.6 (0.5)		24.4 (4.0)	
Race	2.74	0.1	0.971	0.14	.490	.84	79.09	.02*
White	2.74 (.65)		2.95 (.60)		1.77 (.68)		24.90 (3.95)	
Black or African-American	2.52 (.70)		2.88 (.71)		1.74 (.76)		25.79 (4.33)	
Hispanic	2.73 (.73)		2.91 (.62)		1.67 (.69)		22.66 (4.86)	
Other	2.42 (.60)		2.61 (.56)		1.84 (.75)		23.88 (5.76)	
Poverty level		-2.78*		-1.05		1.39		-0.37
Below threshold	2.5 (0.7)		2.8 (0.7)		1.86 (0.8)		25.0 (5.2)	
At or above threshold	2.8 (0.7)		2.9 (0.6)		1.71 (0.7)		24.5 (4.2)	

* $p < .05$, ** $p < .01$, *** $p < .001$

Gender, race, and poverty were controlled for in the final analyses. All three variables were treated as confounding variables and included in each regression equation for all three outcomes in the final analyses. This was done because each variable was found to be significant to at least one outcome variable as well as to provide consistency in the interpretation of the results.

Correlations were run to explore the relationship between parent involvement and T1 dependent variables and between the T1 dependent variables. Results are shown in Table 3. The level of multicollinearity between the three T1 dependent variables was not reached although it was high enough to warrant concern because they were moderately correlated (-.467) to highly correlated (.763). Parent involvement was not significantly correlated with any of the T1 dependent variables.

Table 3
Bivariate Correlations Among T1 Independent and Dependent Variables

	Approaches to Learning T1	Self-Control T1	Externalizing Problem Behaviors T1
Approaches to Learning T1			
Self-Control T1	.597**		
Externalizing Problem Behaviors T1	-.467**	-.763**	
Parent Involvement	-0.007	-0.01	0.014

* $p < .05$, ** $p < .01$, *** $p < .001$

Next, correlations were run to explore the relationship between parent involvement and T2 outcome variables for a preliminary hypothesis test. Results are shown in Table 4. In terms of correlation with parent involvement, T2 Externalizing Problem Behaviors is the only dependent variable that is marginally significant (p = .056). The results indicate that high levels of parent involvement led to lower scores on

T2 Approaches to Learning and T2 Self-Control but increased the scores on T2 Externalizing Problem Behaviors.

Table 4
Hypothesis Testing

	Approaches to Learning T2	Self-Control T2	Externalizing Problem Behaviors T2
Approaches to Learning T2			
Self-Control T2	.679**		
Externalizing Problem Behaviors T2	-546**	-.720**	
Parent Involvement	-0.022	-0.072	0.133

* $p < .05$, ** $p < .01$, *** $p < .001$

Finally, multiple linear regression tests were conducted to explore the relationship between parent involvement and EF after controlling for the confounding variables of gender, race, poverty level, and the T1 EF scales. These were the final tests of the hypothesis. Three regressions were run for the three different scales that measure EF outcomes. The first regression model was conducted to predict T2 Approaches to Learning scores at T2. As seen in Table 5, this model was significant, $R^2 = .22$, $F(7, 193) = 7.538$, p. = .00; however, only gender and T1 scores were significant predictors (p = .00). Gender and T1 scores were positively related to T2 scores, indicating that being female and having higher scores at T1 explained higher scores at T2 for Approaches to Learning.

The second regression model was conducted for the T2 Self-Control outcome and was found to be significant, $R^2 = .25$, $F(7,183) = 8.890$, p =.00. As seen in Table 6, the significant predictors in this model include T1 scores (p = .00), poverty level (p = .015), the racial category black (p = .014), and gender (p = .001). T1 scores, poverty level, and gender were all positively related to T2 scores, indicating that higher scores on the T1

scales, being at or above poverty level, and being female all explained higher scores on the T2 Self-Control scale. The racial category black was negatively related, indicating that being in this demographic group led to lower scores at T2.

As seen in Table 7, the final regression model was conducted for T2 Externalizing Problem Behaviors and was significant, R^2 =.25, F(7, 189) = 9.126, p =.00; however, only T1 scores (p = .00) and parent involvement (p = .044) were significant predictors in this model. They were both positively related to T2 scores, indicating that higher scores at T1 on this scale and higher levels of parent involvement explained higher scores on the T2 Externalizing Problem Behaviors scale (indicating more problems in this area). This finding is consistent with the bivariate analysis, which determined that parent involvement and scores on this particular outcome are marginally significantly correlated.

Table 5
Regression for T2 Approaches to Learning

	b coefficient	(S.E.)	Beta	t score
T1 Approaches to Learning Score	0.268***	0.07***	0.26***	3.9***
Race (white omitted)				
Black or African-American	-0.009	0.14	-0.00	-0.1
Hispanic	-0.103	0.12	-0.06	-0.9
Other	0.046	0.14	0.02	0.3
At or above poverty level (vs. below)	0.165	0.10	0.11	1.7
Female (vs. male)	0.411***	0.09***	030***	4.7***
Parent Involvement	-0.008	0.1	-0.05	-0.8

* $p <$ .05, ** $p <$ .01, *** $p <$ .001

Note. R^2 = .22, F(7, 193) = 7.538, p. = .00.

Table 6
Regression for T2 Self-Control

	b coefficient	(S.E.)	Beta	t score
T1 Self-Control Score	.323***	.07***	.33***	5.0***
Race (white omitted)				

Black or African-American	-.320***	.13***	-.17***	-2.5***
Hispanic	.047	.11	.03	.44
Other	.177	.13	.09	1.4
At or above poverty level (vs. below)	.210***	.90***	.16***	2.5***
Female (vs. male)	.261***	.08***	.21***	3.4***
Parent Involvement	-.009	.10	-.70	-1.0

* $p < .05$, ** $p < .01$, *** $p < .001$

Note. $R^2 = .25$, $F(7,183) = 8.890$, $p = .00$

Table 7

Regression for T2 Externalizing Problem Behaviors

	b coefficient	(S.E.)	Beta	t score
T1 Externalizing Problem Behaviors Score	.376***	.06***	.42***	6.4***
Race (white omitted)				
Black or African-American	.109	.13	.05	.81
Hispanic	-.050	.11	-.03	-.46
Other	-.052	.12	-.03	-.42
At or above poverty level (vs. below)	-.126	.09	-.09	-1.5
Female (vs. male)	-.156	.08	-.12	-1.9
Parent Involvement	.018***	.10***	.13***	2.0***

* $p < .05$, ** $p < .01$, *** $p < .001$

Note. $R^2 = .25$, $F(7, 189) = 9.126$, $p = .00$

DISCUSSION

This research study explored the relationship between parent involvement and EF development in children with hearing impairment. It was expected that there would be a significant positive correlation between T1 parent involvement and scores on measures of EF in children with hearing impairment at T2. However, the results of this study suggest that early parent involvement is not significantly related to the development of EF skills in this population except for marginally in the realm of externalizing problem behaviors. In fact, the findings were the reverse of what was hypothesized. As parent involvement increased, the scores on Approaches to Learning and Self-Control decreased (indicating that more parent involvement led to less desirable outcomes on these measures) and the scores on Externalizing Problem Behaviors increased (meaning that as parent involvement increased, the children had more difficulty with issues such as acting impulsively).

It is important to consider why the reverse of what was hypothesized was found. Notably, the only marginally significant correlation was to an increase in externalizing problem behaviors. That is, as parent involvement increased so did the child's likelihood of disturbing ongoing activities, acting impulsively, and arguing with classmates or teachers. One possible reason for this connection might be because the behaviors characterized as parent involvement in this study are not the most important types of activities for parents to do with children in this population in order to foster EF growth. For example, the scale included things like involving the child in household chores, teaching the child about nature, building things together, and engaging in sports together. These types of activities might only be meaningful to a child who can understand what

the parent is doing and thus be able learn from the interaction as the parent engages in scaffolding, etc.—as is vitally important to EF growth.

Further, the lack or delay of spoken language ability in this population has been correlated with problems such as impulsivity and acting out (Kronenberger et al., 2013; Horn, et al., 2004). Perhaps the parents in this study were highly involved in the activities that the scale measured but less so in activities that are more important to the nuances of a hearing impaired child's needs and desires, leading to children who were frustrated and acted out as a result. It is also important to consider that the children might have been acting out with externalizing problem behaviors for some other reason that could not be determined with the set of variables used in this study, leading to parents who were more involved because of those behaviors—that is, perhaps the scores were not a *result* of high levels of parent involvement but reflective of other problems that were *prompting* high levels of parent involvement.

Consistent with the limited research base on this topic, this study's results suggest that demographic factors such as gender, poverty level, and race are related to EF outcomes in this population in various ways (Anderson, 2012; Center on the Developing Child, 2011; Calderon, 2000). At least one of these demographic factors was found to be significant in all of the analyses. For example, girls and children in the "at or above poverty level" range had higher scores on Approaches to Learning. Being "at or above poverty level" and being female explained higher scores on the T2 Self-Control scale, while being in the "black or African-American" demographic group explained lower scores. Further, race was significantly related to parent involvement in general, suggesting that there is an important relationship between the parent's race and his or her

involvement. Ultimately, the results suggest that demographic characteristics are important considerations when looking at this topic—consistent with other studies' findings about how these factors can significantly influence what types of environments children grow up in as well as what kinds of resources parents have access to order to cultivate environments that teach and stimulate EF growth (Anderson, 2012; Calderon, 2000; Center on the Developing Child, 2011, pg. 7). Future research should explore this connection more in depth.

It is also important to consider how parent involvement might not be as important to this population as other factors such as parent communication. For example, Calderon (2000) looked at parent involvement in deaf children's education programs. She found that although parent involvement at school was positively correlated with language, socio-emotional development, and reading skills, it was not as significant as maternal communication skills. She found that better maternal communication with the child led to fewer problems with externalizing problem behaviors specifically. Her results are interesting in light of other studies that have found that parents who are deaf themselves and/or learn sign language in an effort to communicate with their deaf children lead to positive outcomes—largely because as parents and deaf children are better able to communicate with each other from a young age, their interactions with each other increase in quality and the child's communication skills are enhanced, leading to stronger EF growth in general (Cuevas, et al., 2014; Fitzpatrick, et al., 2014; Anderson, 2012; Center on the Developing Child, 2011, pg. 7; Calderon, 2000).

Limitations

Several significant limitations to this study may have influenced results. First, the study lost many children by T2 and analyses indicate that results are only generalizable to those who stayed in the group till that time point. The significant difference between those in the study sample and those who only had data at T1 was in the category of race—that is, there were more children in the "white" category and fewer in the "black or African-American" category in the study sample. There were also more boys than girls and children who were in the "at or above poverty level" range. Although those results are not significant, they suggest that people in the high-risk group were more likely to drop out by T2. As previously discussed, current research suggests that children who are exposed to highly stressful environments from a young age—including being in a family with low socioeconomic status—may struggle with EF development (Cuevas, et al., 2014; Fitzpatrick, et al., 2014; Anderson, 2012; Center on the Developing Child, 2011, pg. 7; Calderon, 2000). Considering previous research findings, the results of this study are unexpected considering most children in the high-risk population were not included in the group used in the final analyses. Thus, the results suggest that more attention should be paid to how demographic factors such as socioeconomic status—whether low or high—impacts EF development in this population.

It is important to reiterate that the finding of increased parent involvement leading to the children's increased externalizing problem behaviors was only marginally significant ($p = .056$). Thus, there are limitations to this finding in terms of making implications. While the finding suggests there is likely a link between parental involvement and this particular outcome measure, the fact that the relationship is only marginally significant warrants caution when determining implications based on the data.

Future research should examine this connection more in depth as the results of this study suggest there may be a link but they cannot be conclusive.

It is also important to consider how effectively this study was able to measure hearing impairment. Several variables that would have been useful and important to explore—including specifics related to the child's condition, such as: the age the child was diagnosed at, the extent of the child's hearing loss, and whether or not the child used a CI—had limited or extensive missing data and were thus rendered unusable in the analyses. Previous studies indicate these factors significantly impact the development of EF in this population (Kronenberger, Pisoni, Henning, & Colson, 2013; Sipal & Bayhan, 2011; Burkholder & Pisoni, 2003; Surowiecki, et al., 2002). Some researchers argue that assessment of children with hearing impairment is "fraught with challenges due to the heterogeneous nature of this population," furthering the argument that specifics related to the particular condition must be considered when looking at something like EF growth, rather than lumping children together under the broad umbrella term of hearing impairment (Oberg and Lukomski, 2011, pg. 1). Thus, it is crucially important that any measures used (including the parent involvement scare and measures of EF) be designed with the nuances of hearing impairment in mind rather than using a "one size fits all" approach.

Other measurement issues may have impacted the results as well. For example, the particular activities constituting parent involvement in the original ECLS-K study included things like reading books and singing songs together. While the scale's activities were reflective of the typical definition of parent involvement that has been used in other studies looking at this concept, those studies were not specifically looking at children

with hearing impairment (Xu et al., 2010; Artis, 2007). The scale's consistency with that definition may not allow for an appropriate measure for this population. For example, reading books and singing songs with a child who has hearing loss may not be as important to his or her development as engaging in sign language or other interactions that utilize nonverbal communication, as other studies have found that shared communication is vital to EF growth (Calderon, 2000). It is unfortunate that the parent involvement scale used in this study did not include any measure of sign language usage, and the variable in the dataset indicating whether or not the child had learned sign language had too much missing data to be usable in the analyses. Future research should include sign language interaction as a measure of involvement in this population to see if it impacts the correlation between parent involvement and EF skills.

Further, as mentioned previously, the SRS scales that were used to measure EF skills in this study were not designed for the purpose of examining, identifying, or measuring executive functioning in child development. While the scales have proven validity and reflect behaviors identified in literature as falling within one of the domains of EF, as previously discussed, they ultimately are not scales meant to measure EF. Future research should include measures that were specifically designed to examine EF development and growth.

Some indication of the parent's involvement at school (rather than just at home) could have been useful in this research, as both Calderon's and Moeller's study connected it to positive outcomes and other studies have found it has a positive impact on school readiness, reading skills, and academic achievement in children who do not have hearing loss (Xu et al., 2010; Artis, 2007). Ultimately, the results of these previous

studies point to the need to assess parent communication when attempting to understand EF development in this population. While thoroughly investigating this link is outside the bounds of the current study, it warrants some consideration as to how it might apply to the direction future studies might take in order to investigate this area. It would important for future studies to use more reliable measures of both parent involvement and parent communication that had been developed and validated for this population in particular.

Finally, another significant limitation was the lack of parent involvement data at T2; that is, the parents were only asked questions about their involvement at T1. While the focus of the study was to see if early parent involvement predicted later outcomes, it would have been interesting and useful to explore how involvement changed over time and to thus assess its relationship to scores at T2. Further, the nature of reporting from parents on the parent involvement could be seen as problematic. Social desirability could play in a role in prompting parents to inflate scores to reflect better on their participation in the child's development. Lastly, the data set is more than thirteen years old and it is possible that more recent data may reflect different results reflective of more current trends.

Conclusion

As the data set used for this study was not specifically designed for the purpose of examining the population of children with hearing impairment or EF development specifically, it would be useful if future research could focus solely on this area. Although this research study suggests there may be a link between parent involvement and EF development in this population, particularly in the realm of externalizing problem behaviors, it is not in-depth or specific enough to offer solid, actionable suggestions for

how parents can impact positive EF growth in children with hearing impairment. It is important to note that one consistent thread has been woven across all research on the topic of EF development in children in this population despite differing methodology, samples, and goals: children with hearing impairment will face unique challenges with delayed or disordered EF functioning. Future research should develop data focused solely on EF development in this population, taking into consideration the unique spectrum and nuances of hearing impairment, particularly looking at how parents and other caregivers can support positive development through shared communication styles despite other challenges such as socioeconomic status.

APPENDICES

Parent Involvement Scale

Parents were asked to report how often they did nine specific activities by responding using a scale of 1=not at all, 2=once or twice, 3=3 to 6 times, and 4=every day in a typical seven-day week.

This scale is composed of the following items:

1. Reading books with the child.
2. Telling stories to the child.
3. Singing songs with the child.
4. Doing arts and crafts with the child.
5. Involving the child in household chores.
6. Playing games or doing puzzles with the child.
7. Talking about nature or doing science projects together.
8. Building something together.
9. Playing a sport or exercising together.

Teacher Social Rating Scales

Approaches to Learning: The teacher indicated how frequently the child exhibited the following behaviors or characteristics. The response scale included four points ranging from "1 = never" to "4 = very often," and there was also a "-7 = no opportunity to observe" option.

This scale is composed of the following items:

1. Keeps belongings organized.
2. Shows eagerness to learn new things.
3. Works independently.
4. Easily adapts to changes in routine.
5. Persists in completing tasks.
6. Pays attention well.

In fifth grade, the following item was added to the SRS and added to the Approaches to Learning subscale:

7. Following classroom rules

Self-Control: The teacher indicated how frequently the child exhibited the following behaviors or characteristics. The response scale included four points ranging from "1 = never" to "4 = very often," and there was also a "-7 = no opportunity to observe" option.

This scale is composed of the following items:

1. Controls behavior by respecting the property rights of others.
2. Controls temper.
3. Accepts peer ideas for group activities.
4. Responds appropriately to pressure from peers.

Externalizing Problem Behaviors: The teacher indicated how frequently the child exhibited the following behaviors or characteristics. The response scale included four points ranging from "1 = never" to "4 = very often," and there was also a "-7 = no opportunity to observe" option.

This scale is composed of the following items:

1. Child argues with others.
2. Child fights with others.
3. Child gets angry.
4. Child acts impulsively.
5. Child disturbs ongoing activities.

To increase the variance on this scale, an item was added in third and fifth grade asking about the frequency with which a child talks during quiet study time.

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