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Academic Impacts of Intergenerational Trauma: Assessing the Relationship Between Ace Scores of Parents and the Language and Literacy Development of Their Elementary-Aged Children

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ACADEMIC IMPACTS OF INTERGENERATIONAL TRAUMA: ASSESSING THE RELATIONSHIP BETWEEN ACE SCORES OF PARENTS AND THE LANGUAGE AND LITERACY DEVELOPMENT OF THEIR ELEMENTARY-AGED CHILDREN

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ABSTRACT

This paper contributes to the current literature by investigating factors that may contribute to language and literacy difficulty among children, to support the future development of effective intervention techniques. The data analyzed in this paper was collected from children and families participating in Reach Every Reader, a research study currently being conducted to improve literacy outcomes in the U.S. by developing a computer-adaptive screening assessment tool to identify children at risk for language and literacy difficulties early in their educational development. Children enrolled in kindergarten through third grade completed tasks that target language and literacy skills, and their parent(s) completed the Adverse Childhood Experiences (ACE) questionnaire. Prior research indicates that a greater number of ACEs corresponds with a heightened risk of poor academic outcomes (Burke et al., 2011), and that this risk may continue intergenerationally (Jensen, S.K. et al., 2021). When examining relationships between parent ACE scores and the language and literacy task performance of their children, a statistically significant, albeit small, correlation was noted between ACE scores and the CELF-5 Recalling Sentences task when not accounting for other variables. Area Deprivation Index (ADI) percentiles were also examined based on participants' home and school locations to determine the impact of social determinants and were found to have a statistically significant impact on literacy task performance. Current and future research on the relationship between intergenerational trauma and academic performance could be beneficial in determining a child's need for psychotherapy and educational services.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ABBREVIATIONS

ACE.....Adverse Childhood Experiences

AAPI ..... Adult-Adolescent Parenting Inventory

ADI .....Area Deprivation Index

BASC-3.....The Behavior Assessment System for Children, 3rd edition

BCE.....Benevolent Childhood Experiences

CELF-5.....Clinical Evaluation of Language Fundamentals, 5th edition

CZI .....Chan Zuckerberg Initiative

EVT-3 ..... Expressive Vocabulary Test, 3rd edition

GPA.....Grade Point Average

KTEA-3.....Kaufman Test of Educational Achievement, 3rd edition

PTSD..... Post-Traumatic Stress Disorder

RER.....Reach Every Reader

SES..... Socio-Economic Status

WPPSI-IV .....Wechsler Preschool & Primary Scale of Intelligence, 4th edition

CHAPTER 1: LITERATURE REVIEW

Individuals who experience traumatic events during childhood are at increased risk for poor health (Wolfe et al., 2019), behavioral (Briggs et al., 2021), and academic (Burke et al., 2011) outcomes throughout their lifespan. Without effective intervention, the negative impacts of trauma experienced by parents can affect their children's development even after the traumatic events have ended (F. Lê-Scherban et al., 2018; Wolfe et al., 2019). This is referred to as intergenerational trauma. Trauma during childhood can develop into intergenerational trauma when adults who had adverse childhood experiences develop maladaptive parenting behaviors, such as a lack of involvement with their children (Petscher et al., 2022) and/or harshness in parenting (Jensen et al., 2021), and undergo disadvantageous epigenetic changes, referring to the modification in gene expression based on environmental influences during childhood (Howie et al., 2019). These behaviors and epigenetic changes can influence children's experiences and development (Howie et al., 2019; Jensen et al., 2021). Encouraging awareness among parents of their own childhood trauma, providing information regarding how this trauma could have a negative impact on their own children, and supporting the management of maladaptive behaviors through psychotherapy may be beneficial in initiating the healing process to breaking the cycle of trauma within the family (Isobel et al., 2019).

A commonly used method for measuring childhood trauma is the administration of the Adverse Childhood Experiences (ACE) questionnaire (Briggs et al., 2021). This questionnaire is a brief measure designed to quantify the amount of exposure an individual has had to three types of negative experiences during childhood: abuse, neglect, and household dysfunction (Dong et al., 2004). The abuse questions within the ACE score focus on emotional, physical, or sexual abuse (Dong et al., 2004). Neglect encompasses emotional neglect and/or not providing for the physical needs of a child including food, shelter, and education (Dong et al., 2004). Household dysfunction includes experiences such as having divorced parents, being a witness of domestic abuse, and having an incarcerated parent (Dong et al., 2004).

Prior research has linked higher ACE scores to increased levels of disruptive behavior and decreased overall health and academic outcomes in the same individual (Wolfe et al., 2019; Briggs et al., 2021; Burke et al., 2011). However, limited research has investigated the nature of specific academic difficulties that may occur among children whose parents experienced varying levels of ACEs. Investigating the relations between parental ACE scores and child performance on language and literacy tasks that are critical to academic development may assist educators in providing a rationale for concurrent referrals to psychotherapy and speech-language pathology (SLP) services for children. Further, identifying specific areas of deficit(s) may contribute to improving assessment and goal-writing processes for school Individualized Education Plan (IEP) teams to enhance interprofessional collaboration between the two disciplines of psychotherapy and SLP. Addressing the psychological component of academic difficulties is imperative to maximize outcomes.

Importantly, evidence indicates that adverse childhood experiences do not inherently lead to intergenerational trauma and negative outcomes for parents and their children (Crandall et al., 2019). On the contrary, benevolent childhood experiences (BCEs) can positively influence individual and family responses to trauma (Crandall et al., 2019) in addition to external financial and communal factors. Some of the experiences listed and benefits associated with BCEs are congruent with Vygotsky's Sociocultural Theory of Cognitive Development, which proclaims that cognitive development occurs in children through a process that includes adults providing and teaching psychological tools to a child (Tzuriel, 2021). Furthermore, Bronfenbrenner's Ecological Systems Theory proclaims that relationships with adults are impactful in addition to other components in the child's environment (Noursi et al., 2021). There are five levels of impact, with the most influential being the individual's microsystem, which includes their family, neighbors, and school (Noursi et al., 2021). Area Deprivation Index (ADI) percentiles are utilized in the analysis of this paper to account for the impact of the child's surrounding environment on their performance. Research on ADI percentiles present associations between poor social determinants and chronic health conditions, particularly for residents of the top 15% of disadvantaged neighborhoods (Kind, A. et al., 2014). This may indicate a potentially negative compounding effect between high ADI and ACE scores in relation to health outcomes.

Given the potential for variation in how ACEs may impact different individuals, the purpose of the present paper is to investigate the associations between the self-reported ACE scores of parents and the language and literacy skills of their elementary-aged children. To do this, parental ACE scores, collected using a survey format during

the 2019-2022 years, will be examined in relation to children's academic performance as measured by language and literacy screening measures developed as part of a larger research study. Area Deprivation Index (ADI) scores will also be accounted for to take into consideration the larger systems of the environment they are a part of. The following literature review includes a discussion of intergenerational trauma, neuroplasticity, and relationships between individual ACEs with corresponding evidence regarding potential associations between ACEs and academic achievement.

1.1 Intergenerational Trauma & Neuroplasticity

Genetics, individual experiences, and nutrition each play an important role in brain development (Evans, G.W., 2006). Importantly, each of these areas can also be impacted by ACEs (Shields et al., 2019; Oshri et al., 2019). As previously noted, trauma in the environment can influence the expression of genes, resulting in intergenerational changes in genetics (Howie et al., 2019). This field of study, referred to as epigenetics, has yielded information indicating that these changes in genetics can have multi-generational impacts on how individuals respond to stress and/or traumatic events (Howie et al., 2019). The prevalence of post-traumatic stress disorder (PTSD) is one example of individualized responses to trauma; although over half of the population will experience at least one traumatic experience throughout their life, less than 10% of individuals meet criteria for a PTSD diagnosis (Howie et al., 2019). This can be understood by considering that PTSD results from both genetic and environmental factors, and a parent who experienced chronic stress throughout childhood may have modifications in gene expression which can be passed down and increase the likelihood of the child developing a psychological disorder (Howie et al., 2019).

The intergenerational implications of chronic stress can be profound for multiple reasons. While neuroplasticity may allow for rapid acquisition of knowledge and habits at a young age, it can also result in decreased functional connectivity and atrophy of neurological structures when exposed to highly stressful situations (Shields et al., 2019; Oshri et al., 2019). Children who endure adverse experiences are more likely to exhibit chronic stress (F. Lê-Scherban et al., 2018) which can result in the shrinking of the hippocampus and decrease of gray matter volume in the prefrontal cortex (Kim et al., 2015). These neurological changes can later present as parents who experience difficulties with problem-solving, attending appointments, and advocating for their own children (Wolfe et al., 2019). Consequently, these epigenetic changes and behaviors exhibited by the parents because of chronic stress from their own childhood could increase the likelihood of their child presenting with similar behaviors and chronic stress (F. Lê-Scherban et al., 2018).

Research shows that adverse childhood experiences can also lead to a reduction in overall cognitive-linguistic functioning in the areas of attention, emotional regulation, memory, language comprehension, and executive functioning within the individual who experienced them (Shields et al., 2019; Oshri et al., 2019; Burke et al., 2011; Petruccelli et al., 2019). Brain scans from research participants exposed to a stimulated stressful event have revealed lower levels of functional connectivity between the hippocampus and the superior temporal gyrus among stressed participants compared to control participants (Shields et al., 2019). The hippocampus and superior temporal gyrus are brain regions associated with memory and language comprehension, respectively. There is also a negative correlation between ACE scores and gray matter volume of the right amygdala,

which is a crucial structure for emotional regulation and memory formation (Oshri et al., 2019). These neurological studies are consistent with educational and behavioral concerns identified in other studies examining ACE scores (Burke et al., 2011; Petruccelli et al., 2019).

Tasks that present only auditory input may be differentially impacted by ACEs compared to tasks that include visual input. Stress leads to atrophy of the inferior colliculi in rats, which relay auditory information from the ear to the brain, but not the superior colliculi, which transmit visual information from the eye to the brain (Dagnino-Subiabre et al., 2005). This is consistent with research showing stronger connectivity between primitive neuronal structures (McDonald, 1998). The amygdala develops stronger functional connectivity with sensory systems that are earlier developing, such as the auditory system, compared to those that develop later, such as the visual system (McDonald, 1998). The research on neurological connectivity suggests that auditory stimuli may be more difficult to process in children of parents who experienced chronic stress than visual stimuli.

Taken together, these neural responses to stress and adverse experiences suggest that receptive language tasks may be more severely impacted by chronic stress that result from ACEs than expressive language tasks. Receptive language tasks rely on memory, language comprehension, and auditory processing; all of which may be difficult for children who experience chronic stress.

1.2 Individual ACEs

The three categories of ACEs, abuse, neglect, and household dysfunction, include 10 specific adverse experiences. Evidence regarding the impact of adverse experiences on

academic performance are similar within each category and suggest that overall ACEs correspond with increased rates of mental health disorders, difficulty connecting with peers, attentional deficits, behavioral concerns, and below-average overall academic performance in the individual who experienced them (Daignault & Hébert, 2009; Borrego et al., 2008; Vassoler et al., 2014; Levendosky et al., 2003; Wells et al., 1997). Although each individual ACE has been shown to be associated with elevated risk for behavioral and cognitive dysfunction, it is difficult to determine the direct impacts of each ACE independently because approximately 60% of individuals who have experienced at least one ACE have experienced more than one (Giano et al., 2020). It is even more difficult to determine and interpret the impact of these ACEs intergenerationally in relation to academics due to a paucity of research and myriad of external variables that cannot all be accounted for. Despite this, research depicting correlations between adverse experiences and poor academic performance intergenerationally can allow us to make an educated hypothesis on the relationship between these variables.

Research is limited to the direct implications of individual ACEs on academic performance, but multiple statistically significant correlations that are present in current research can provide some insight on this matter. For example, physical abuse is a risk factor for mental health problems and drug abuse even after controlling for demographic factors and childhood sexual abuse (Thompson et al., 2004) which both increase an individual's risk for poor academic performance (Vassoler et al., 2014; Lin et al., 2017). Increased frequency of physical abuse and extended drug use within the home environment correspond with greater risk for academic difficulty among children (Vassoler et al., 2014). Children of parents with mental illness are at an increased risk of

having mental illness themselves (Naughton et al., 2018). Taken together, physical abuse and drug use within the home increases the risk of a child developing mental illness and academic difficulties (Thompson et al., 2004; Vassoler et al., 2014; Lin et al., 2017), which puts their future children at increased risk for the same outcomes (Naughton et al., 2018).

Research also suggests that additional ACEs furthers the risk for poor academic performance (Kendall-Tackett & Eckenrode, 1996). In addition to abuse, neglect is also shown to be associated with poor academic performance (Kendall-Tackett & Eckenrode, 1996). One study yielded evidence of lower English and Math grades among children who experienced neglect as compared to children who did not experience maltreatment. Children who experience both abuse and neglect exhibited even lower grades in the same areas (Kendall-Tackett & Eckenrode, 1996). One example of neglect is malnourishment. A common nutritional deficit amongst malnourished youth is iron, and iron deficits have been linked to increased fatigue and decreased concentration abilities (Joe et al., 2009). Poverty is the root cause of malnutrition, and many malnourished girls become malnourished women which greatly increases their likelihood of having a malnourished fetus (Delisle, H.F., 2008).

Research is abundant on ACEs but is limited in relation to intergenerational impacts on academic performance, specifically within the domains of language and literacy. Despite this, research showing similar behavioral (Naughton et al., 2018) and health (Delisle, H.F., 2008) concerns across generations because of individual ACEs further promotes the hypothesis that a correlation may present between ACE scores and language and literacy skills intergenerationally.

1.3 Purpose & Research Questions

The overall purpose of this thesis project is to improve the intra-collaborative efforts between psychotherapists and speech-language pathologists by building evidence to increase awareness of the potential intergenerational impacts of adverse childhood experiences on language and literacy development. I aim to characterize the nature of language and literacy difficulties observed among children whose parents report childhood trauma. In this thesis, I will address the following research questions:

1. What are the associations between parent ACE scores and child language and literacy scores?
2. What associations are present between parent ACE scores and child language and literacy scores when accounting for social determinants in the children's school areas?

1.4 Hypotheses

Based on findings addressed in the literature review it is presumed that the higher a parent's ACE score is, the lower their child's performance will be on tasks that require auditory comprehension, memory, and attention. Due to anticipated deficits with auditory comprehension for children of parents with high ACE scores, the strongest correlations between parent ACEs and child assessment performance will likely be observed for the CELF-5 sentence repetition task, followed by the KTEA nonsense word decoding and letter word recognition tasks, and finally expressive vocabulary measured by the EVT-3 or WPPSI-IV depending on the participant's age.

If accounting for social determinants in the children's school areas, then the statistical significance between ACE scores and standardized assessment subtests will be

lessened, but the ranking of significance between standardized assessment subtests and ACEs will remain the same. It is likely that high ACE scores and low ADI scores will have a compounding negative impact on outcomes due to both variables having similar associated health implications in the current literature.

CHAPTER 2: METHODS

Data for this thesis paper has been collected from the Reach Every Reader (RER) Project. The data collected includes children from four different states in grades KG-3rd from 2019-2023. The Reach Every Reader Project is working to ensure every child is provided with the resources they need to acquire language and literacy skills to read for both learning and pleasure. There are five areas of focus within the project to achieve this goal. This paper will be collecting data from the K-3 Screener & Assessment area of focus, where an assessment is being created to provide a more accurate understanding of the child's language and pre/reading skills. To do this, the Reach Every Reader Project is studying the impact of factors including teacher perceptions of child behavior, parent beliefs, demographics, and trauma to better predict the likelihood of the child being a proficient reader based on their scores of this virtual screener. This screener is also in development to be administered as an interactive game for children to allow for increased access and eliminate human error in administration.

2.1 Participants

Participants included 475 children and their parents as part of the sample collected by the Reach Every Reader Project. The demographic information for participants was gathered from optional school and parent reporting, resulting in some data not accounting for all children. The ethnicities of study participants include white (n=350), multi-Racial (n=64), Black or African American (n=24), Asian (n=18), American Indian/Alaska

Native (n=2), Native Hawaiian or Other Pacific Islander (n=1), and other (n=11). Participants in this sample all reside in the United States in Florida, Georgia, South Carolina, Massachusetts, and Oregon.

Of 129 families who reported on financial status, 21.7% (n=28) are in poverty. Parents who reported education level included 96.4% (n=898) graduating high school or obtaining a GED and 68.9% (n=642) obtaining a college degree. Mothers in this study reported higher rates of college degree attainment (n=358) than fathers (n=284). Of the children represented in this sample, 55 are English language learners and 101 come from families with a history of learning difficulty.

2.2 Procedure

Children in the RER Project are asked to participate in five testing sessions throughout the school year, each year that they were part of the project, which could be up to four years. These assessments were completed by children on an iPad through an app created by RER project. One of the five testing sessions included a series of subtests from standardized assessments to compare with performance on the RER tasks, which will be analyzed for this paper. Parents were asked to complete a packet that includes the following: BASC-3 Parent Rating Scales, ACES Questionnaire, and the AAPI. From this packet, the ACES questionnaire will be analyzed for this paper. Teachers were asked to complete a survey regarding the behaviors of children in their class. This survey will not be analyzed for this paper.

Part of the parent packet included providing the home zip-code which was used to determine Area Deprivation Index (ADI) scores. ADI scores are based on U.S. Census Blocks, and there are one-to-seven of these for each zip-code in the regions participants

of this research study reside. For household zip-codes that encompass more than one Census Block, the average was taken.

The way in which data was collected for the project varied to ensure participant safety during COVID-19 and to maximize participation while also accommodating the IRB. Virtual, hybrid and in-person models were utilized for administering standardized assessment subtests. In the virtual model, the assessment administrator and child are tested from different locations while the child is not at school. In a hybrid model, the assessment administrator and child are testing from different locations while the child is at school. To limit the potential spread of germs, another research assistant from the project went into the schools to set up testing stations for the children and cleaned the station between each participant. In the in-person model, the assessment administrator and child test together in the school. Participants were recruited using both opt-in and opt-out forms, depending on the state and IRB restrictions. Parents and teachers received an incentive for completing a survey that was delivered to them in the mail at the end of each school year.

2.3 Exclusionary Criteria

The Reach Every Reader Project requires parental consent and student verbal assent to participate in assessment tasks. Children are allowed to discontinue the assessment at any time. For the child to be included in the analysis, they had to complete at least one assessment subtest in its entirety. Additionally, parents had to report yes/no for at least one question within the ACE questionnaire. If there is no score for any assessment subtests and/or ACE questions, the child was not able to be analyzed for the purposes of this paper.

2.4 Measures

In one school year, each student participating in the Reach Every Reader Project is expected to participate in five testing sessions. The student participants complete four batteries of assessment created by the CZI team: two in the fall and two in early spring. Then one battery of standardized tasks at the end of the school year. The standardized testing session is composed of the following standardized tasks which are used in the data analysis for this paper:

CELF-5: The recalling sentences subtest of the CELF-5 was administered to all participants of the Reach Every Reader Project and evaluates the ability to remember spoken sentences of increasing complexity in meaning and structure. Such skills are required for following directions and academic instructions, writing to dictation, copying, and note-taking, as well as learning vocabulary and related words, grammar, and subject content. The recalling sentences subtest has an internal consistency reliability coefficient of .94 and an average internal consistency reliability of .96 among clinical groups (language disorder, learning disability, and autism spectrum disorder).

WPPSI-IV: The picture naming subtest from the WPPSI-IV was administered to participants of the Reach Every Reader Project that were in kindergarten and 1st grade. The WPPSI-IV picture naming task is designed to assess children's ability to concentrate on picture detail by asking them to name pictorial stimuli. Test-retest reliability ranges from.75 to .87 and interrater reliability ranges from .96 to .99.

EVT-3: The EVT-3 was administered to participants of the Reach Every Reader Project that were in 2nd and 3rd grade. The EVT-3 assesses expressive vocabulary and word retrieval skills based on words in Standard American English. A robust expressive

vocabulary and good word retrieval skills can be helpful in all aspects of communication and writing, from communicating feelings to writing a book report. For the EVT-3, alternate form reliability is .89 and test-retest reliability is .90 for all ages.

KTEA-3: Letter and Word Recognition and Nonsense Word Decoding subtests from the KTEA-3 were administered to all participants of the Reach Every Reader Project and assesses the ability to identify letters and read grade-appropriate words. Letter and word recognition skills are strong indicators of future success in learning to read. In the Nonsense Word Decoding subtest of the KTEA-3, children are directed to pronounce pseudowords (i.e., made-up words). This task yields information regarding individuals' phonetic decoding, or ability to break down text to sound out and spell words. Strong phonetic decoding skills help beginner readers to recognize unknown words. Internal consistency reliability coefficients range from 0.77 to 0.85, and test-retest reliability is above .90 across age groups.

Area Deprivation Index (ADI): The Area Deprivation Index (ADI) percentile is collected from participants' reported home zip codes and school addresses from those who attend brick and mortar school for Reach Every Reader Project participant. ADI percentiles are compiled of 17 measures of social determinants which include education, employment, housing-quality, and poverty measures; these percentiles are provided for each U.S. Census Block (King AJH & Buckingham W., 2018) and demonstrate statistically significant associations with chronic health outcomes (Kind, A. et al., 2014).

ACEs Questionnaire: The ACEs questionnaire was provided to all legal guardians of student participants of the Reach Every Reader Project and quantifies aversive experiences during the first 18 years of life. The ACEs questionnaire consists of

10 questions, and each experience amounts to a score of one, for a total ACE score between 0 and 10. These experiences cover those of abuse, neglect, and household dysfunction. Associations present between increasing ACE scores and decreasing overall health and academic outcomes within the same individual (Briggs et al., 2021; Burke et al., 2011)

2.5 Participant Backgrounds

Scoring in the Reach Every Reader Project does not take dialectal variations into account explicitly, meaning that any deviation from the target sentence within the Recalling Sentences subtest of the CELF-5 is scored as incorrect. This may result in an underestimation of ability among children who speak dialects other than Generalized American English, such as Southern English or African American English

Individuals who are part of certain marginalized groups, such as individuals who are an ethnic minority, experience poverty, and/or are part of the LGBTQ+ community, are more likely to experience ACEs (Merrick et al., 2019). Individuals who are a part of a marginalized community are also at an increased risk of experiencing additional issues outside of the home that could result in decreased performance on academic tasks such as emotional abuse, isolation, and lack of resources that can have a compounding impact on their neurological development (Merrick et al., 2019).

2.6 Analytic Approach

To address the initial research question, both a correlational matrix and linear mixed model were used. A correlational matrix was used to look at the relationships between percentage of ACEs experienced by parents and their children's performance on various language and literacy subtests. Two linear mixed models were used to examine

associations between ACE Scores of parents and children's performance on various language and literacy subtests, one of which includes an interaction term to address variability associated with participant grade level and nesting within schools.

To address the second research question, four linear mixed models were employed, incorporating ADI home and ADI school values, to determine whether they contribute any additional predictive significance. The ADI values in the analysis are in addition to the variables accounted for in the linear mixed model addressing question one. All analyses were conducted using the lme4 package (Bates et al., 2015) within R Version 3.6.3 (R Core Team, 2020)

CHAPTER 3: RESULTS

Table 3.1 provides a correlational analysis that encompassed all study participants, and thus excludes scores for picture naming subtests as they varied between grade levels. Tables 3.2 and 3.3 are divided by grade level based on the picture naming subtest administered. As shown in Table 3.1, each percentage increase of ACEs is correlated with a .11 decrease in the CELF-5 Recalling Sentences subtest score (r = -.11, 95% CI [-.19, -.01]).

Table 3.1 Full K-G3 Sample: Means, standard deviations, and correlations with confidence intervals

Variable	*M*	*SD*	1	2	3	4	5	6	7
1. Grade	1.35	1.08							
2. Total ACE Score	1.74	2.25	.00 [-.09, .09]						
3. ACE Percentage	0.18	0.23	.00 [-.09, .09]	.97** [.96, .97]					

4. CELF-5 RS	11.30	2.99	-.06 [-.15, .03]	-.11* [-.20, -.02]	-.10* [-.19, -.01]				
5. KTEA-3 LWR	105.41	17.40	.03 [-.06, .12]	-.08 [-.17, .01]	-.07 [-.16, .02]	.49** [.42, .56]			
6. KTEA-3 NWD	102.82	17.84	.16** [.07, .24]	-.07 [-.16, .02]	-.07 [-.16, .02]	.44** [.36, .51]	.77** [.73, .81]		
7. ADI Home	46.42	21.53	.02 [-.09, .13]	.16** [.05, .26]	.13* [.02, .23]	.01 [-.10, .12]	-.13* [-.24, -.02]	-.15** [-.25, -.04]	
8. ADI School	40.83	18.67	.42** [.23, .57]	.09 [-.12, .28]	.08 [-.12, .28]	-.13 [-.32, .08]	-.09 [-.29, .12]	-.08 [-.28, .12]	.59** [.37, .74]

Note. M and *SD* are used to represent mean and standard deviation, respectively. Values in square brackets indicate the 95% confidence interval for each correlation. The confidence interval is a plausible range of population correlations that could have caused the sample correlation (Cumming, 2014). * indicates $p < .05$. ** indicates $p < .01$.

Table 3.2 Students in K-G1: Means, standard deviations, and correlations with confidence intervals.

Variable	*M*	*SD*	1	2	3	4	5	6
1. Grade	0.48	0.50						
2. Total	1.71	2.30	-.05					

ACE Score			[-.17, .07]					
3. ACE Percentage	0.18	0.24	-.04 [-.16, .08]	.97** [.96, .98]				
4. CELF-5 RS	11.40	2.94	-.11 [-.23, .01]	-.16* [-.28, -.04]	-.15* [-.26, -.02]			
5. KTEA-3 LWR	104.57	16.54	-.08 [-.20, .04]	-.09 [-.21, .04]	-.07 [-.20, .05]	.46** [.35, .55]		
6. KTEA-3 NWD	101.09	16.81	.29** [.18, .40]	-.04 [-.16, .08]	-.03 [-.15, .09]	.36** [.25, .46]	.73** [.67, .78]	
7. WPPSI-4 PN	12.10	2.92	-.07 [-.19, .06]	-.08 [-.20, .04]	-.09 [-.21, .04]	.47** [.37, .56]	.22** [.10, .34]	.15* [.03, .27]

Note. *M* and *SD* are used to represent mean and standard deviation, respectively. Values in square brackets indicate the 95% confidence interval for each correlation. The confidence interval is a plausible range of population correlations that could have caused the sample correlation (Cumming, 2014). * indicates $p < .05$. ** indicates $p < .01$.

Table 3.3 Students in G2-G3: Means, standard deviations, and correlations with confidence intervals

Variable	*M*	*SD*	1	2	3	4	5	6
1. Grade	2.40	0.49						

2. Total ACE Score	1.77	2.18	.03 [-.10, .17]					
3. ACE Percentage	0.18	0.23	.02 [-.12, .15]	.96** [.95, .97]				
4. CELF-5 RS	11.19	3.05	-.01 [-.14, .13]	-.06 [-.19, .08]	-.05 [-.18, .09]			
5. KTEA-3 LWR	106.41	18.36	.03 [-.10, .16]	-.08 [-.21, .05]	-.07 [-.20, .07]	.54** [.44, .63]		
6. KTEA-3 NWD	104.90	18.84	-.03 [-.17, .10]	-.12 [-.25, .01]	-.12 [-.25, .02]	.53** [.43, .62]	.81** [.76, .85]	
7. EVT-3	104.39	9.29	-.13 [-.26, .00]	-.01 [-.14, .13]	-.01 [-.15, .12]	.64** [.55, .71]	.48** [.37, .58]	.51** [.41, .61]

Note. *M* and *SD* are used to represent mean and standard deviation, respectively. Values in square brackets indicate the 95% confidence interval for each correlation. The confidence interval is a plausible range of population correlations that could have caused the sample correlation (Cumming, 2014). * indicates $p < .05$. ** indicates $p < .01$.

C*ELF-5 Recalling Sentences*

In the dataset provided, a total of 469 student participants completed the CELF-5 Recalling Sentences subtest in addition to their parent(s) completing at least one question from the ACE questionnaire. As previously noted, there was a small negative correlation between CELF-5 Recalling Sentences scores of children and ACE scores of parents (-0.10, 95% CI [-0.19, -0.01]), but further investigation revealed that the association no longer met criteria for statistical significance after accounting for child grade and nesting of participants within schools (-1.14, 95% CI [-2.29, 0.02], p=0.053). Furthermore, there are no statistically significant associations presented between ACE scores and CELF-5 Recalling Sentences scores when accounting for ADI scores.

Table 3.4 Percent ACEs predicting CELF-5 Recalling Sentences Scores.

	Model 1			**Model 2**		
Predictors	*Estimates*	*CI*	*p*	*Estimates*	*CI*	*p*
(Intercept)	11.24	10.41 – 12.08	**<0.001**	11.33	10.46 – 12.20	**<0.001**
ACE Percentage	-1.14	-2.29 – 0.02	0.053	-1.59	-3.40 – 0.21	0.084
Grade	-0.26	-0.52 – 0.01	0.055	-0.32	-0.65 – 0.00	0.054
ACE Percentage × Grade				0.34	-0.70 – 1.39	0.522
Random Effects						
σ^2	8.51			8.52		
τ_{00}	0.91 $_{School}$			0.88 $_{School}$		
ICC	0.10			0.09		
N	13 $_{School}$			13 $_{School}$		
Observations	469			469		
Marginal R^2 / Conditional R^2	0.015 / 0.110			0.016 / 0.109		

KTEA Letter-Word Recognition

Of the provided dataset, 473 student-family pairs had complete data for the KTEA Letter Word Recognition subtest and ACE scores. There was no evidence of an association between KTEA Letter-Word Recognition scores and ACE scores, grade level, or ADI school scores. However, for each percentage increase in ADI home value, children tend to perform 0.10 standard score points lower on KTEA Letter-Word Recognition (-0.10, 95% CI [-0.19, -0.01], p = .025). Despite a sufficient sample size, this association does not inherently indicate practical significance due to limitations in determining accuracy of ADI home scores and a weak correlation.

Table 3.5 Percent ACEs predicting KTEA-3 Letter-Word Recognition Scores.

	Model 3: ADI School			**Model 5: ADI Home**		
Predictors	*Estimates*	*CI*	*p*	*Estimates*	*CI*	*p*
(Intercept)	104.38	93.76 – 115.00	**<0.001**	107.03	98.82 – 115.24	**<0.001**
ACE Percentage	-0.32	-2.64 – 2.01	0.788	-1.26	-2.80 – 0.29	0.111
Grade	0.04	-4.32 – 4.40	0.985	-1.11	-2.96 – 0.74	0.237
ADI School	-0.12	-0.34 – 0.10	0.290			
ADI Home				-0.10	-0.19 – -0.01	**0.025**
Random Effects						
σ^2	164.51			282.22		
τ_{00}	30.94 $_{School}$			46.28 $_{School}$		
ICC	0.16			0.14		
N	10 $_{School}$			7 $_{School}$		
Observations	93			319		
Marginal R^2 / Conditional R^2	0.025/0.180			0.028/0.165		

Table 3.6 Percent ACEs predicting KTEA-3 Nonsense Word Decoding Scores.

	Model 1			**Model 2**		
Predictors	*Estimates*	*CI*	*p*	*Estimates*	*CI*	*p*
(Intercept)	96.33	91.63 – 101.04	**<0.001**	95.65	90.68 – 100.63	**<0.001**
ACE Percentage	-5.13	-11.93 – 1.66	0.138	-1.75	-12.21 – 8.70	0.742
Grade	1.96	0.40 – 3.51	**0.014**	2.43	0.51 – 4.35	**0.013**
ACE Percentage × Grade				-2.60	-8.72 – 3.52	0.404
Random Effects						
σ^2	300.73			300.84		
τ_{00}	26.21 $_{School}$			26.95 $_{School}$		
ICC	0.08			0.08		
N	13 $_{School}$			13 $_{School}$		
Observations	474			474		
Marginal R^2 / Conditional R^2	0.018 / 0.096			0.019 / 0.099		

KTEA Nonsense Word Decoding

There are 474 students from the dataset provided that have an ACE score reported from their parent in addition to completing the KTEA Nonsense Word Decoding subtest. The analysis reveals a statistically significant relationship between performance on the KTEA-Nonsense Word Decoding subtest and ADI score. For each percentage increase in ADI home value, children tend to perform 0.11 standard score points lower on KTEA Nonsense-Word Decoding task (-0.11, 95% CI [-0.20, -0.02], p = .013). For each percentage increase in ADI school value, children tend to perform 0.29 standard score

points lower on KTEA Nonsense-Word Decoding task (-0.29, 95% CI [-0.54, -0.04], p = .023). Additionally, study participants in each successive grade level scored on average 1.96 points higher on the KTEA-3 Nonsense Word Decoding task (1.96, 95% CI [0.40, 3.51], p= .014).

Table 3.7 Percent ACEs predicting KTEA-3 Nonsense Word Decoding Scores when accounting for ADI scores.

	Model 3: ADI School			**Model 5: ADI Home**		
Predictors	Estimates	CI	p	Estimates	CI	p
(Intercept)	102.02	89.74 – 114.30	**<0.001**	107.42	102.35 – 112.49	**<0.001**
ACE Percentage	9.07	-2.17 – 20.31	0.113	-7.79	-15.73 – 0.14	0.054
Grade	5.83	1.28 – 10.38	**0.013**	2.23	0.48 – 3.99	**0.013**
ADI School	-0.29	-0.54 – -0.04	**0.023**			
ADI home				-0.11	-0.20 – -0.02	**0.013**
σ^2	172.79			292.14		
τ_{00}	46.86 $_{School}$			0.00 $_{School}$		
ICC	0.21					
N	10 $_{School}$			7 $_{School}$		
Observations	94			325		
Marginal R^2 / Conditional R^2	0.129 / 0.315			0.051 / NA		

WPPSI Picture Naming Task

Due to the WPPSI Picture Naming subtest only being presented to students in kindergarten and 1st grade, there are less overall family participants compared to previous subtests discussed. Of the 254 student participants, there is no statistically significant

relationship between ACE scores of parents and WPPSI Picture Naming performance of students, with and without accounting for ADI values.

Table 3.8 Percent ACEs predicting WPPSI Picture Naming Scores.

	Model 1			**Model 2**		
Predictors	*Estimates*	*CI*	*p*	*Estimates*	*CI*	*p*
(Intercept)	12.13	11.35 – 12.92	**<0.001**	12.24	11.42 – 13.05	**<0.001**
ACE Percentage	-0.98	-2.47 – 0.52	0.199	-1.49	-3.48 – 0.49	0.140
Grade	-0.44	-1.18 – 0.30	0.246	-0.65	-1.56 – 0.26	0.162
ACE Percentage x Grade				1.19	-1.82 – 4.20	0.438
Random Effects						
σ^2	8.23			8.25		
τ_{00}	0.42 $_{School}$			0.40 $_{School}$		
ICC	0.05			0.05		
N	11 $_{School}$			11 $_{School}$		
Observations	254			254		
Marginal R^2 / Conditional R^2	0.011 / 0.059			0.014 / 0.059		

EVT-3

From the provided data set, 214 student participants had sufficient data to analyze associations in relation to EVT-3 performance. This lower sample size can be attributed to the fact that this assessment was only provided to participants in the 2nd and 3rd grade. Study participants in the 3rd grade scored on average 3.27 points lower (95% CI [-5.77, -0.76], p = .011) than participants in the 2nd grade on the EVT-3 assessment. Moreover, when accounting for ADI home scores, there was an average decrease of 3.75 in 3rd grade scores when compared to 2nd grade (95% CI [-6.80, -0.69], p = .017).

Table 3.9 Percent ACEs predicting EVT-3 Scores

	Model 1			**Model 2**		
Predictors	*Estimates*	*CI*	*p*	*Estimates*	*CI*	*p*
(Intercept)	107.62	99.46 – 115.78	**<0.001**	106.26	96.74 – 115.77	**<0.001**
ACE Percentage	0.16	-5.20 – 5.52	0.952	7.56	-19.32 – 34.45	0.580
Grade	-3.27	-5.77 – -0.76	**0.011**	-2.72	-5.90 – 0.47	0.094
ACE Percentage x Grade				-3.03	-13.83 – 7.77	0.581
Random Effects						
σ^2	79.17			79.40		
τ_{00}	43.52 $_{School}$			44.52 $_{School}$		
ICC	0.35			0.36		
N	7 $_{School}$			7 $_{School}$		
Observations	214			214		
Marginal R^2 / Conditional R^2	0.020 / 0.368			0.021 / 0.373		

Table 3.10 Percent ACEs predicting EVT-3 Scores when accounting for ADI Scores

	Model 3: ADI School			**Model 5: ADI Home**		
Predictors	*Estimates*	*CI*	*p*	*Estimates*	*CI*	*p*
(Intercept)	96.37	43.00 – 149.75	**0.002**	111.21	96.53 – 125.90	**<0.001**
ACE Percentage	10.01	-12.85 – 32.88	0.352	-0.65	-7.16 – 5.86	0.843
Grade	7.75	-13.18 – 28.67	0.429	-3.75	-6.80 – -0.69	**0.017**
ADI School	-0.25	-0.68 – 0.18	0.223			
ADI home				-0.04	-0.11 – 0.03	0.230
Random Effects						
σ^2	51.25			81.31		

τ_{00}	87.24 $_{School}$	86.83 $_{School}$
ICC	0.63	0.52
N	5 $_{School}$	3 $_{School}$
Observations	16	144
Marginal R^2 / Conditional R^2	0.227 / 0.714	0.024 / 0.528

3.1 Discussion

The CELF-5 Recalling Sentences subtest demonstrated the strongest, and only statistically significant, correlation with ACE scores of parents in the correlation tables, aligning with the hypothesis that auditory tasks that lack visual elements would have the most significant inverse relationship with ACE scores. This hypothesis was supported by a study performed on rats that demonstrated a correlation between chronic stress and atrophy of the inferior colliculi, which relay auditory information from the brain, but no impact on the visual relay system (Dagnino-Subiabre et al., 2005). These findings also align with neurological research indicating that the amygdala, an area of the brain that plays a key role in emotional processing, develops stronger functional connectivity with more primitive neuronal structures, suggesting a stronger relationship between the amygdala and auditory system than to the visual system (McDonald, 1998).

Although the relationship between CELF-5 Recalling Sentences and ACE scores is significant, the correlation is small and could be explained by other variables. When accounting for ADI scores, child grade, and school-level nesting of children in a linear mixed model, the correlation between CELF-5 Recalling Sentences scores and ACEs is just outside of the range considered to be statistically significant. The variation in testing environments may explain the decrease in statistical significance, as some children tested

in areas of schools with many distractions while other students completed the assessment at home where they were not subject to the same distractions. None of the tasks administered for this study showed a statistically significant association with the percentage of ACEs when accounting for child grade and school-level nesting of children.

When determining intergenerational trauma for the purposes of this study, ACE scores were the only measures collected. This does not consider Benevolent Childhood Experiences (BCEs), demographic factors, or other traumatic experiences during childhood, such as community violence or discrimination, that could yield similar negative outcomes to the experiences indicated in the ACE questionnaire. Additional factors may be considered in future works to further determine intergenerational trauma and how it relates to language and literacy task performance.

Even though the study had a sufficient participant sample, the distribution of ACE scores was positively skewed, and the mean ACE score is 1.8. This means there was a limited representation of individuals with high ACE scores in the sample population, which may be attributable to a participant sample of parents that are not representative of the U.S. population. In 2021, 48.4% of the U.S. population attained a college degree, compared to the 68.9% of the sample population, a 20.5% difference (United States Census Bureau, 2021). Furthermore, there is a lack of minority representation in the sample population, with 14.37% more non-Hispanic white individuals represented than in the U.S. population (United States Census Bureau, 2021). These statistics demonstrate a lack of inclusion of marginalized groups in the sample population which could make the associations in this study appear less significant as marginalized groups are at an

increased risk of exposure to daily stressors that are not analyzed in this study which include microaggressions and limited resources (Merrick et al., 2019).

Within the linear mixed models, ADI scores demonstrated predictive value for literacy tasks but not for language tasks. ADI home scores added predictive value to KTEA Letter-Word Recognition and Nonsense Word Decoding performance. ADI school scores added predictive value to Nonsense Word Decoding performance. The correlation between literacy performance and ADI scores could be attributed to less educational resources and increased levels of chronic stress within populations that reside in areas with lower ADI scores. Chronic stress is more likely to present in populations living in regions with a low ADI score due to factors that comprise this score including decreased health outcomes, employment opportunities, and communal resources (Neighborhood Atlas, 2018). This chronic stress can result in decreased functional connectivity and atrophy of neuronal structures (Shields et al., 2019; Oshri et al., 2019.)

When interpreting associations with ADI scores in this study, it is important to exercise caution. A sufficient portion of the sample population had ADI home scores that were based on the averages of scores within 5-digit zip codes and, thus, may not precisely reflect the participants home address. The ADI database uses scores based on U.S. Census Blocks and can provide scores that are even more exact when provided with a specific address. Furthermore, it is important to exercise caution when interpreting ADI school values due to a limited sample size caused by a large portion of the same population for this study being composed of virtual students. A more significant correlation may be present between ADI school values and other variables than what is identified in the analysis for this paper.

Unexpectedly, statistically significant relationships presented between grade level and performance on the KTEA-3 Nonsense Word Decoding and EVT-3 tasks. Despite a relationship presenting, it is important to note that both assessment subtests results were converted to standard scores, which have a mean of 100, and the differences in scores between grade levels are less than 4 for both tasks, meaning the correlation is weak. The positive association between grade and performance on the KTEA-3 Nonsense Word Decoding task may be attributed to a skewed distribution as many children in earlier grades scored a zero on this task which can be attributed to limited or no previous instruction of orthographic mapping for children who began school during the COVID-19 pandemic. The negative association between grade and EVT-3 performance is more questionable, but the difference in scores is minimal. One possible factor is that students are informed it is voluntary and ungraded, and as school content becomes more difficult and additional testing demands are placed on the child, less effort may be provided for optional assignments.

These findings contribute to current literature by providing additional insight on how intergenerational trauma and social determinants in the environment can impact language and literacy performance in elementary-aged children. Research indicates that awareness of childhood trauma, understanding of its implications, and working with psychotherapy to support management of maladaptive behaviors can be beneficial in initiating the healing process which is needed to break the cycle of trauma within a family (Isobel et al., 2019).

3.2 Future Directions

In the future, using a larger variety of assessment for childhood experiences of parents, such as the extended ACE questionnaire or the Benevolent Childhood Experiences questionnaire, may be helpful in further determining if an association exists between parental experiences and child performance on assessment measures. The benevolent childhood experiences (BCEs) can positively influence individual and family responses to trauma (Crandall et al., 2019) in addition to external financial and communal factors. Getting a more comprehensive view of the parents' childhood can provide a more accurate understanding of the intergenerational impact.

When assessing the implications of social determinants, acquiring exact home addresses for all participants could be helpful in determining if ADI home values have an impact on language and literacy assessment performance. When using the same data points collected from participants of this study, ADI scores that are more than one standard deviation from the mean of scores could be eliminated from the analysis to exclude regions with a large range of ADI scores where the average within the zip code would not be near the representation of each U.S. Census Block within it.

Future research on this subject could be beneficial for individuals working in the education and healthcare settings, particularly for speech-language pathologists, psychotherapists, and social workers. Analyzing other academic skills and furthering the research on language and literacy deficits associated with chronic stressors can benefit these professionals in determining appropriate interventions that address the child's mental health to ensure maximum benefit from educational interventions.

3.3 Conclusion

This study looked for correlations between intergenerational trauma and academic outcomes by looking at the ACE scores of parents and the language and literacy task performance of their elementary-aged children. Statistically significant findings presented between ACE scores of parents and students' performance on a recalling sentences task, but caution should be made when generalizing this skill as a deficit for individuals experiencing intergenerational trauma due to study limitations and a decreased association outside of statistically significant limits when accounting for child grade and nesting of children within schools. Further investigation into the impact intergenerational trauma has on academic outcomes can be valuable in supporting the need for concurrent psychotherapy and educational support.

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