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Impact of Trauma on Brain Morphology & Maladaptive School Behaviors

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Critically Appraised Topic: Impact of Trauma on Brain Morphology & Maladaptive School Behaviors

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This evidence project, submitted by
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has been approved and accepted
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Key words: Childhood Trauma, Brain Changes, Behavioral Problems

Critically Appraised Topic

Abstract

Wendi Trummert, DrOT, OTR/L, the collaborating clinician for this project, works with students in a self-contained program. Wendi wanted to know how childhood trauma affects brain structure and morphology and how it is linked to behaviors seen in children affected by trauma. A synthesis of all articles looking at the brain reveals differences in both structure and function in the brains of individuals exposed to childhood trauma versus those not exposed (e.g. Daniels, Lamke, Gaebler, Walter, & Scheel, 2013; McGowan et al., 2009; Saleh et al., 2017). A synthesis of articles looking at maladaptive behaviors finds that those often seen in children affected by trauma, including aggression, emotional dysregulation, decreased executive functioning, and hyporeactivity may be linked to these brain changes and may explain why traditional behavioral approaches are often ineffective with this population (e.g. Briggs-Gowan et al., 2010; Lemmey et al., 2001; Shields & Cicchetti, 1998). It is recommended this information be disseminated to educators and others who work with children exposed to trauma to increase understanding and promote appropriate supports.

A toolkit including a presentation, pamphlet, and conversational sound bytes were created for the clinician to increase knowledge and combat bias about problem behaviors in children affected by trauma amongst educators and coworkers. Insiders' perspectives were included to generate empathy, help guide the best type of support for additional student services, and reduce occurrences of inappropriate interventions for maladaptive behaviors.

Options and resources to effectively address maladaptive behaviors should be provided to educators after they are presented with this information.

Executive Summary

This project was initiated by Wendi Trummert, DrOT, OTR/L, a school-based therapist practicing in the public school system. Her caseload includes children with emotional behavioral problems within a self-contained program. She often experiences push-back from educators and coworkers when attempting to promote this population's participation in general education. She sought to increase educators' understanding of the effects of childhood trauma, and increase empathy towards those whose behavioral problems were likely a result of childhood trauma. Given her concerns and goals, Wendi originally set out to focus on all types of trauma, and to positively change attitudes towards students in her local school district's program. The topic was narrowed by our research group to address only trauma experienced in the microsystem, and simultaneously widened to encompass behaviors seen in all children who may have experienced trauma. As a result, the research question was split into two discrete aspects: 1) What is the effect of childhood trauma on brain structure and morphology? 2) What are the behaviors seen in children affected by trauma? The result is a compilation and interpretation of research looking at physical changes in brain structures of individuals with a history of childhood trauma compared to those without, and associations found between problem behaviors in children and their exposure to trauma.

Most of the research indicates that exposure to childhood trauma is linked to both gray and white matter changes in brain structures associated with stress responses, emotional regulation, executive functioning, integration of behavioral reinforcement, and

functions related to the ability to focus and learn (e.g. Fainsilber Katz & Low, 2004; Mongillo, Briggs-Gowan, Ford, & Carter, 2009). The resting brain states of these individuals also reflected higher than average arousal levels (McGowan et al., 2009; Teicher, Anderson, & Polcari, 2012; Twardosz & Lutzker, 2010). These effects were found to be connected to specific problem behaviors including academic difficulties, attentional deficits, emotional dysregulation, heightened arousal, social avoidance, and somatic symptoms, with a high prevalence of aggression, anxiety, and depression seen among study subjects (e.g. Bell, Limberg, & Robinson, 2013; Fainsilber Katz & Low, 2004; Lemmey et al., 2001). Vissing et al. (1991) suggests that reciprocal cycle within the household due to poor parent-child interactions may compound these effects.

The implication of this information for general educators is to be aware that traditional approaches, including negative reinforcement, may not be effective for children with a history of trauma, and that due to the nature of these behaviors, this population may require different support and services to be successful (AOTA, 2015). Practitioners can utilize this research to increase understanding of neuroscience surrounding trauma in order to more effectively identify client needs and to develop better treatment plans and programs tailored to the individual. Children with a history of trauma may benefit from increased understanding and empathy from teachers, family, and peers. Once previous biases regarding behavior are ameliorated, these children may receive better support needed to develop successfully (AOTA, 2015). It is recommended that this information be disseminated to as many people who work with children as possible to produce the most effective outcome.

To achieve this, a toolkit was created for Wendi to use in her daily interactions with

school administrators, educators, and coworkers. This includes a presentation containing easily digestible research, findings, and insider's perspectives to comprehensively increase understanding and empathy. A pamphlet with more condensed information can be handed out to people if time is lacking or interest in viewing the presentation is low. Lastly, conversational sound bytes were provided for times when only brief interaction is possible. Also included in the kit are immediate and 6-months post presentation surveys, which can be used to determine the effectiveness of the knowledge translation process, and provide a resource for improving the presentation over time.

Focused Question:

Are changes in the brain due to trauma connected to behaviors seen in children affected by trauma?

Collaborating Occupational Therapy Practitioner:

Wendi Trummert, DrOT, OTR/L

Prepared By:

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Chair:

Yvonne Swinth, PhD, OTR/L, FAOTA

Course Mentor:

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Date Review Completed:

January 25, 2017

Clinical Scenario:

A school based occupational therapist is treating a child affected by trauma who displays emotional behavioral problems. The educator has indicated that the child frequently shows socially inappropriate behaviors, and according to them the traditional forms of discipline (such as negative reinforcement) have not worked. The therapist needs evidence that the displayed behaviors are a result of brain changes due to trauma to be able to educate other therapists and educational professionals about the link between neurobiological changes from trauma and subsequent maladaptive behaviors. The therapist hopes to inspire empathy for the child, and provide more effective and evidence based tools for the educator.

CAT Question #1: What is the effect of trauma on the brain?
CAT Question #2: What are the behaviors seen in children affected by trauma?

Review Process
Procedures for the selection and appraisal of articles

Inclusion/Exclusion criteria for CAT question #1
Inclusion criteria:
- The article examines a link between trauma and changes in the brain.

Exclusion criteria:
- The article was published before the year 1990.

Inclusion/exclusion criteria for CAT question #2; Behaviors seen in children affected by trauma.
Inclusion criteria:
- The article examines a link between trauma and behavioral problems.
- The population includes children ages birth to 13 (at the time of exhibited behaviors).
- The article examines children's behaviors linked to directly experienced trauma.
- The population studied experienced trauma after birth.

Exclusion criteria:
- The article was published before the year 1990.
- The article examines children's behaviors linked to indirectly experienced trauma (i.e. transgenerational effect of parental trauma).
- The article examines children's behaviors linked to specific national traumatic events (i.e. war, 9/11/2001).
- The population studied experienced natural disasters (i.e. tornadoes, hurricanes, floods).
- The population studied experienced solely in-utero trauma.
- The population studied has traumatic brain injuries.

Search Strategy

Categories	Key Search Terms
Patient/Client Population	children w/ trauma children affected by trauma children w/emotional behavioral problems childhood trauma psychological trauma
Assessment of population	history of trauma exposure to trauma brain scans/MRIs
Comparison	participants w/o exposure to trauma children w/o trauma
Outcomes	brain changes brain structural changes brain differences brain development maladaptive behaviors behaviors emotional behavioral problems behavioral issues

Databases and Sites Searched
AJOT
CINAHL (via UPS Collins Library)
ERIC (via UPS Collins Library)
Primo (via UPS Collins Library)
PsycINFO (via UPS Collins Library)

PubMed (via UPS Collins Library)
Refworks

We began by selecting three key terms identified through our initial meeting with Wendi Trummert, OTR/L: "severe behavior", "trauma", and "brain changes." We then developed a PICO question to include all three parameters. Initial inclusion criteria required that articles examine the link between at least two of the key terms, and that they were peer-reviewed. We excluded articles which only examined one of the three crucial key terms. The question itself was then split into two distinct questions. After consulting with George Tomlin, PhD, OTR/L, FAOTA, it was decided that any neuroscience articles examining trauma linked to brain changes would act as background information to set the stage for the second part, which would focus on the severe behaviors linked to either trauma or brain changes. Initial searches using various key terms were conducted in PubMed and CINAHL databases. Search terms used originated from various forms of initially identified key terms and through clarifying email communication between Wendi Trummert, OTR/L and our research group with the plan to operationalize definitions of "trauma" and "behaviors" through the researched articles. Early research efforts yielded 3,187 articles. Out of those, 3,172 were rejected for not fully meeting the inclusion criteria, specific parameter "severe behaviors", and not addressing the specific topic of interest, leaving 15 to be included in the table.

After meeting with our faculty chair Yvonne Swinth, PhD, OTR/L, FAOTA, revisions were made to contextualize the PICO question, revise the search parameters, and reorganize the CAT table. The PICO question was slightly altered to divide the investigation to answer both CAT Question 1 and 2. The inclusion criterion also expanded specifically for the "what" portion to have a limited age range in researched populations (birth – 21 years) and limited to articles published after the year 1990. Exclusion criteria were also expanded for CAT question 2 to exclude articles examining the effects of trauma that is not directly experienced by children. Search terms were also altered to drop the "severe" portion of "severe behaviors" to broaden the research to include all children with maladaptive behaviors, whether or not they would be identified for a self-contained program. Some operationalized definitions of behaviors were also identified through our faculty chair based on her research and knowledge and suggestions for additional resources on the topic through the works of Deborah Gray, MSW, MPA and Karyn Purvis, PhD. CAT table suggestions included either having a different table for each CAT question or having one table organized using symbols to delineate articles answering either aspects or both. The second round of research found 1,453 articles, of which 1,437 were excluded for not being peer reviewed, or not examining trauma directly experienced by children, leaving 16 articles to be included in the table. Ten articles from the first round of research kept for review were then ultimately excluded from the final CAT table after they were deemed irrelevant to the refined PICO question. After meeting with the library liaison, Eli Gandour-Rood, we added 6 articles. We removed 1 article from the second round of research at this point that did not meet our inclusion criteria for age range.

Our current operational definitions of trauma and maladaptive behavior are as follows:
Trauma: Events within the child's microsystem in the Bronfenbrenner's (1994) Ecological Systems Theory that directly threatens the individual's life and/or well-being and is likely to interrupt typical development during childhood (Falasca & Caulfield, 1999; CDC, 2016). For the purposes of this project, trauma includes:

- Death or illness of family member or peer
- Bodily injury
- Sexual abuse
- Physical abuse
- Emotional abuse
- Emotional and physical neglect

- Witnessing violence or threats against a caregiver
- Witnessing violence within the neighborhood or community
- Psychological impact from any of these stressors

Maladaptive behavior: Exhibited behaviors that interrupt or prevent participation in daily life across contexts and environments. For the purposes of this project, maladaptive behaviors include:

- Hyperactivity (leading to frequent and/or inappropriate outward aggression)
- Hyporeactivity (withdrawing from social interactions & having low emotional expression)
- Dissociation (leads to disengagement during daily activities) (Lanktree & Briere, 1995 & Deblinger et al., 1990 as cited in Falasca & Caulfield, 1999).
- Verbal or physical assault
- Picking fights
- Quick to anger
- Emotional dysregulation ("fear and patterns of 'angry/labile' & 'flat/blunted affect'") (Shields & Cicchetti, 1998)
- High anxiety
- Poor executive functioning
- Poor processing

Results of Search

Table 1. Search Strategy of databases.

Search Terms	Date	Database	Initial Hits	Articles Excluded	Total Selected for Review
"violent behavior" AND "brain	9/14/2016	CINAHL	39	36	3
"foster" AND "trauma" AND "behavior"	9/14/2016	PubMed	228	227	1
"abuse trauma behavior"	9/20/2016	Primo	1910	1907	3
"adverse childhood"	9/21/2016	Refworks	10	9	1
"childhood abuse"	9/21/2016	Refworks	10	9	1
"abuse trauma behavior childhood"	9/22/2016	Primo	903	902	1
"child maltreatment"	10/8/16	CINAHL	1	0	1
"child maltreatment and the developing brain"	10/8/16	Psycinfo	20	19	1
"trauma" AND "brain" AND "behav*"	10/21/2016	ERIC	62	59	3
"behaviors" AND "trauma affected" AND "children"	10/21/2016	ERIC	6	5	1
"Emotional Regulation" AND "Child*" AND "Trauma"	10/23/16	PsychINFO	278	277	1

"Lanktree Briere"	10/22/16	Primo	131	130	1
"Teicher abuse"	10/22/16	Primo	777	776	1
"maltreatment child behavior"	10/22/16	CINAHL	24	23	1
"trauma AND behavioral changes"	10/22/16	AJOT	75	73	2
"Trauma" AND "Child*Behav*" NOT "adults/adult/adulthood" NOT "intervention/treatment/therapy"	11/09/16	ERIC	39	38	1
"Trauma affected children AND anxiety"	11/09/16	PubMed	43	42	1
"child* anxiety" NOT "adult/adults/adulthood" NOT "intervention/treatment/therapy" AND "trauma exposure"	11/09/16	ERIC	4	3	1
"psychological trauma [Mesh] AND anxiety" (filter = birth-18)	11/12/16	PubMed	13	12	1
"childhood trauma behavior classroom"	11/13/16	Primo	56	55	1
"childhood abuse effects on amygdala"	1/20/17	PubMed	42	40	2
Total number of articles used in review from database searches = 29					

Table 2. Articles from citation tracking.

Article	Date	Database	Initial Hits	Articles Excluded	Total Selected for Review
N/A					
Total number of articles used in review from citation tracking = 0					

Table 3. Articles from reference tracking.

Article	Date	Articles Referenced	Articles Excluded	Total Selected for Review
Weltz, Armeli, Ford, & Tennen (2016)	10/2/2016	66	63	3
Gronski, Bogan, Kloeckner, Russell-Thomas, Taff, Walker, & Berg (2013)	10/22/16	34	32	2
Waldman-Levi, A., & Weintraub, N. (2014)	10/22/16	22	18	4

Marusak, Martin, Etkin, Thomason (2015)	10/23/16	44	43	1
Saleh, Potter, McQuoid, Boyd, Turner, MacFall, & Taylor (2017)	1/20/17	47	43	4
Total number of articles used in review from reference tracking = 14				

Total number of articles used in review from database searches = 29 (7 eliminated from earlier research & 1 eliminated for additional age inclusion criteria)
Total number of articles used in review from citation tracking = 0
Total number of articles used in review from reference tracking = 14 (3 eliminated from earlier research)
Total number of articles used in review from UPS Master's Thesis = 0
Total number of articles used in CAT = 32

Summary of Study Designs of Articles Selected for the CAT Table

Pyramid Side	**Study Design/Methodology of Selected Articles**	**Number of Articles Selected**
Experimental	0 Meta-Analyses of Experimental Trials 0 Individual Randomized Controlled Trials 2 Controlled Clinical Trials 0 Single Subject Studies	2
Outcome	1 Meta-Analyses of Related Outcome Studies 2 Individual Quasi-Experimental Studies 11.5 Case-Control Studies 0 One Group Pre-Post Studies	14.5*
Qualitative	0 Meta-Syntheses of Related Qualitative Studies 1 Small Group Qualitative Studies 0 brief vs prolonged engagement with participants 0 triangulation of data (multiple sources) 0 interpretation (peer & member-checking) 0 a posteriori (exploratory) vs a priori (confirmatory) interpretive scheme 0 Qualitative Study on a Single Person	1
Descriptive	1 Systematic Reviews of Related Descriptive Studies 5.5 Association, Correlational Studies 2 Multiple Case Studies (Series), Normative Studies 0 Individual Case Studies	8.5*
Comments: AOTA Levels I- # of articles = 2 II- # of articles =18 III- # of articles = 1 IV- # of articles = 4 V- # of articles = 0 N/A- # of articles = 7 (Qualitative & non-research) * Each CAT article was given a total value of 1.0 in this table. Articles that described two pyramid categories were given a 0.5 value per category in order to not exceed their total		32

allotted value of 1.0 for this table.	

Both PICO questions (located on page 5) are being answered in the following CAT tables. Please refer to the symbol key located on page 26 for meaning of symbols.

Table Summarizing the *QUANTITATIVE* Evidence

Author, Year	**Study Objectives**	**Study Design/ Level of Evidence**	**Participants: Sample size, Description Inclusion/ Exclusion Criteria**	**Outcome Measures**	**Summary of Results**	**Study Limitations**
Andersen, Tomada, Vincow, Valente, Polcari, & Teicher (2008) ♦	Effect of CSA on brain development during different stages of childhood development.	D2, O2, Level II, correlational case control w/ covariates	N = 43 (age 18-22) n = 26 women CSA n = 17 healthy women **E:** alcohol/substance abuse, in utero exposure to alcohol or drugs, complicated or premature birth, growth or development medical disorders, neurological disorders, pregnancy, hx of physical abuse, exposure to preceding or subsequent trauma, or corticosteroid txs.	TAQ, volumetric MRI, & 1.5 T MRS.	Exposure to CSA b/t 3-5 & 11-13 yrs assoc. w/ reduced hippocampal volume. Exposure to CSA b/t 9-10 yrs was as associated w/ reduced corpus callosum volume. Exposure to CSA at 14-16 yrs resulted in an attenuated frontal cortex.	• Small sample size for participants in the CSA group for each stage of childhood when brain structures were evaluated.
Aust, Stasch, Jentschke, Hartwig, Koelsch, Heuser, & Bajbouj (2014) ♦	Effect of ELS on hippocampus & amygdala volumes w/& w/o alex.	O3 Level II preexisting groups comparison	N = 50 healthy German natives (22-55 yrs) divided: n = 25 h-ALEX (12 females) n = 25 l-ALEX (12 females) **E:** substance abuse, neurologic disease, current or long-term psychiatric dx, & taking medications.	CTQ for ELS matched h-ALEX & l-ALEX. Toronto Alex Scale & Bermond-Vorst Alex Questionnaire. MRI of amygdala & hippocampus. ANOVA to measure main effects of ELS & alex & interaction of the two.	No sig. diff b/t groups for ELS or alex on amygdala & hippocampal volumes, but sig. interaction of both. No alex w/ELS showed bigger volume of left amygdala than w/o ELS. Alex w/more ELS showed smaller right hippocampal volume than w/ less ELS. The effects of ELS on limbic system brain structures are diff depending on emotional functioning abilities.	• Participants all had moderate levels of emotional abuse & neglect which affects statistical sig. re brain laterality. • Emotional abuse usually can't be verified w/medical records. • Bias & inaccurate reports of ELS could not be verified w/ family interviews. • Emotional fxn is better measured w/structured interviews, but no valid version available at the time.

Baker, Williams, Korgaonkar, Cohen, Heaps, & Paul (2013) ♦	Compare physical brain diffs of children exposed to trauma before vs. after age 7.	O3, D2 Level II, Case-control; preexisting group comparison	N=173 (1 mo-17 yrs) n =76 no ELS n =38 ELS before age 7 n =59 ELS after age 7 **I:** part of BRID **E:** psychiatric or medical conditions affecting cog.	T1-weighted MRI.	Children exposed to ELS after age 7 had lower brain volumes in ACC & insula than children exposed b/t 1 mo. & 7 yrs.	• Participants selected from preexisting database • Possibility of false recall or reporting by participants • No specific measure taken for type, quantity, or duration of ELS
Dannlowski, Stuhrmann, Beutelmann, Zwanzger, Lenzen, Grotegerd, … Kugel (2012) ♦	Effect of childhood maltreatment on amygdala responsivity and brain structure volumes.	D2 Level IV Correlational	N = 148 (20-57 yrs) E: hx of seizure, head trauma or unconsciousness, any lifetime psychiatric diagnoses, psychotropic use, MRI contrast, neurological abnormalities, $\geq$ 10 on BDI.	VBM measured amygdala responses to facial expressions & grey matter volumes. PSS, LTE-Q, CTQ assessed maltreatment.	For those with higher CTQ scores, threatening facial expressions elicited increased fear response in amygdala & reflected smaller OFC, insula, hippocampus, caudate, & cingulate gyrus size.	• CTQ used recall & self-report for maltreatment which may be biased or inaccurate. • Retrospective self-report measures for screening may limit validity.
De Brito, Viding, Sebastian, Kelly, Mechelli, Maris, & McCory (2013) ♦	Compare grey matter volume b/t maltreated & nonmaltreated children using brain imaging.	O3 Level II, cross sectional study, case control	N= 38 (10-14 yrs) Maltreated, n = 18 (Mean age:12.01 yrs) Nonmaltreated, n = 20 (Mean age: 12.6 yrs) E: neglect, abuse, exposure to intimate-partner violence reported by a caretaker using the CBEQ.	VBM measured grey matter volumes. CBEQ, IPVS, S-TAIC assessed maltreatment.	Maltreated children showed smaller left middle temporal gyrus & the medial OFC which have been implicated in reinforcement-based decision making, autobiographical memory, & emotional regulation.	• Cross-sectional design limits causal inferences b/t grey matter & maltreatment experience. • Study criteria relied on parent & child report instead of formal psychiatric assessment. • Prenatal exposure or teratogens may have influenced observed effects.

Marusak, Martin, Etkin, Thomason (2015) ♦	Effect of trauma exposure on automatic regulation of emotional conflict in urban, high-risk children.	E3 Level II Controlled Clinical Trial	N = 30 (9-16 yrs recruited through online ads or psychiatry clinics) 2 groups: Trauma exposed: n = 14 Control: n = 16. **E:** lower than 2nd grade reading level, hx of brain injury, primary language not English, neurologic or movement dx, MRI contra.	Intervention: Visually identify pictures while ignoring emotional words. Outcomes: Functional brain images acquired using a 3-Tesla Siemens Verio scanner. Measures incl. SCR, CDI, BIS/BAS, VAS & T-tests.	Trauma exposed had higher amygdala reactivity in response to emotional conflict & unable to improve accuracy in repeat trials to regulate emotional conflict. There is inability to regulate the dorsolateral prefrontal cortex & engage the inhibitory amygdala-pregenual cingulate connections. Conflict assoc. amygdala reactivity linked to lower reward sensitivity.	• 21 of 51 children were excluded from original recruitment due to exclusion criteria affecting sample size. • Ltd. generalizability due to non-varied sample. • Cross sectional study limits ability to examine long term effects.
McGowan, Sasaki, D'Alessio, Dymov, Labonte, Szyf, Turecki, & Meaney (2009) ♦	Compare levels of specific hippocampal glucocorticoid receptor & HPA activity in brains of suicide victims w/& w/o a hx of CT.	O3 Level II Case-control; preexisting group comparison	Suicide victims w/hx of abuse: n = 12. Suicide victims w/o hx of abuse: n = 12. Control group: no suicide, no abuse: n = 12.	Tissue samples from deceased pts' hippocampi examined in a blind analysis.	Suicide victims w/ hx of CT showed lower glucocorticoid expression & higher HPA activity than suicide victims w/o hx of abuse. No diff b/t suicide victims w/o hx of CT & control group.	• Req. an in-depth understanding of neuroscience, beyond avg. OT. • Unequal number of alcohol/drug vs. childhood abuse and lack of control group w/hx of abuse impacts results. • PMI, brain pH, & age variability at death may be confounds. • Ltd. generalizability of sample.

Saleh, Potter, McQuoid, Boyd, Turner, MacFall, & Taylor (2017) ♦	Effects of ELS & specific predictive ELS (emotional abuse, sexual abuse, or severe family conflict) on a priori brain structures of depressed vs. non-depressed subjects.	O3 Level II Cross-sectional case-control w/covariates	N = 104 (20-50yrs) n = 51 depressed n = 53 non-depressed I: DSM IV MDD dx w/onset before 35 yrs, no psychotropic meds use w/i 1 mo, & MADRS score of ≥15. Control had no hx of psychotropic use or psychiatric disorders. E: Other lifetime DSM IV Axis I or Axis II dx, hx of substance abuse, psychosis, electroconvulsive therapy w/i last 6 mos, neurological illness, MRI contrast, head injury, unstable medical conditions, or family hx of bipolar disorder.	ELSQ for ELS & eight-channel parallel imaging head coil for cranial MRI w/duplicate T1-weighted image sets for brain scans. Cortical thickness & regional volumes measured by FreeSurfer 5.1 & GLM.	Increased OFC volumes found for non-depressed w/ higher ELSQ scores. For depressed group only, predictive ELS assoc. w/ smaller left hippocampus. Prolonged exposure to sexual abuse also assoc. w/ smaller caudate volume. For both depressed & non-depressed, reports of 1 or more predictive ELS assoc. w/ smaller right caudate & left OFC volumes & reduced cortical thickness of parietal & frontal lobes & bilateral insula.	• Used recall & self-report of ELS which may be biased or inaccurate. • Cross-sectional study can't account for longitudinal effects on brain structures. • Doesn't address effects of depression tx on brain structures. • Depressed & non-depressed group differed in age. Mean age of depressed group = 35.1 and non-depressed group = 29.7. • Higher possibility of false positives due to multiple analyses comparisons. • Analyzed a priori brain structures which may not be thorough.
van Harmelen, van Tol, Dalgleish, van der Wee, Nic Veltman, Aleman, . . . Elzinga (2014) ♦	Effects of CEM on brain structures related to cognition & emotional memory.	O2, Level II, correlational case control w/ covariates	N = 194 (18-65 yrs) from larger Netherlands Study of Depression & Anxiety. n = 96 CEM n = 98 no abuse (healthy controls) **I:** Diagnosed w/ anxiety disorder, MDD, &/or CDA in < 6 mos. **E:** Taking psychotropic medications (not incl. SSRIs) or infrequently taking benzodiazepines.	MRI, NEMESIS trauma interview, LTE-Q, Neuroticism w/ the NEO Five-Factor Inventory, the BAI, the MADRS.	MRI revealed hypoactivation of the medial prefrontal cortex in the CEM group when negative, positive, & neutral words were being recognized & encoded.	• Hypoactivation of the medial prefrontal cortex couldn't be explained based on the findings of group diffs or volume of the medial prefrontal cortex.

Becker & McCloskey (2002) ♥	Effects of childhood exposure to family violence on behaviors.	O3 Level II Case-control Cohort Study	N = 287 mothers w/ children 6-12 yrs. Index group: n = 141 Comparison group: n = 146 **I:** Child lived w/mom for 1 yr prior to study. **E:** Children w/chronic illness, birth complications, developmental disabilities, &/or prematurity.	Interviews conducted b/t 1990-1991. Mothers interviewed using Child Assessment Schedule (CAS) to assess & measure ADHD and/or conduct disorder. Results compared to the results of 2nd interview conducted w/ same mothers 6 yrs later.	Child exposure to family violence impacted behaviors in girls, leading to attention and conduct issues.	• Methods for identifying the comparison group and location of ads used for recruitment not incl. • Confounding variables may have contributed to behaviors or risk factors for family violence. • Excluded child version of CAS may have made mother reports alone inaccurate.
Briggs-Gowan, Carter, Clark, Augustyn, McCarthy & Ford (2010). ♥	Assoc. b/t exposure to potentially traumatic events (PTEs) & clinical patterns of symptoms & disorders in preschool children.	D2 Level II cross-sectional correlational study	N = 213 children 24 -48 mos recruited from behavioral pediatric clinics. **I:** Legal guardian fluent in English or Spanish. **E:** Autism or global cognitive delays, or child sexual abuse.	PTE grouped into family violence & non-interpersonal events & assessed w/ Preschool Age Psychiatric Assessment (PAPA) & Child Life Events Scale.	Violence exposure sig. assoc. w/ PTSD, ADHD, SAD, depression, & conduct problems. 92 children met psychiatric disorder criteria & violence exposed (81.8%) were more likely to have a disorder compared to unexposed children (40.0%).	• Referral based sampling of children ltd ability to identify PTSD. • Parental PTSD symptoms were not assessed which could influence reports. • Due to infrequency, some PTEs were not able to be analyzed.

DePrince, Weinzierl, Combs (2009) ♥	Determine basic EF performance in trauma-exposed children.	D2 Level IV Cross-sectional three group correlational study	N = 110 children. (Mean: 10.39 yrs, SD 1.19) Familial trauma (FT): n = 44 Non-FT: n = 38 No trauma : n = 28	Working memory, processing speed, & auditory attention were assessed w/ the WISC-IV Scales. Behavioral inhibition was assessed w/GDS Blocks. Full scale IQ scores were estimated w/the Block Design & Vocabulary scales	Familial trauma assoc. w/ worse performance on EF composite from intervention tasks w/ medium effect size. Trauma exposed children had unique variance in EF performance after controlling for covariates such as socioeconomic status, anxiety symptoms, & potential traumatic brain injury.	• The study used a guardian-report to place children in trauma groups which may lead to false-negatives. • No data on severity, age of onset, recency, chronicity of exposure, & frequency of the children being tested.
Fainsilber Katz & Low (2004) ♥	Effects of marital violence on ability to adjust; examining family dynamics, parenting, & the emotional & behavioral development of the child.	D2 Level IV Correlational study	N = 130 families found through preschools, ads, & doctor offices w/children 49-71 mos (81 males) **I:** Parents were married when participating in the study.	Lab observations of family & peer interactions. Measures incl. Physical Violence subscale of CTS, Locke-Wallace Marital Satisfaction Inventory, & CBC. Parent self-reports on marital violence & satisfaction, child behavior, & income.	Family-level & co-parenting processes were linked to child outcomes. Marital violence influenced family level & co-parenting processes, resulting in parent reports of anxiety/depression, delinquency, aggression, and withdrawal behaviors in children.	• Self-reports may be biased due to sensitive material or reluctance to share. • Sample wasn't chosen based on target population which may account for the ltd reports of marital violence in the study.

Fox, Perez, Cass, Baglivio, & Epps (2015) ♥	Effectiveness of ACE assessment at predicting SVC juvenile offenders (≤18 yrs).	D2, O2, Level II, Correlation, preexisting group comparison w/covariate analysis	Case records reviewed: N = 22,575 SVC offenders: n = 10,714. O&D reference group (1 time offenders): n = 11,861. I: SVC offenders who turned 18 b/t 1/1/07-12/31/12.	Measures incl. Criminal records & PACT. ACE score (0-9) given w/1 point for each type of CT trauma. SVC defined as 3+ felony referrals, w/at least 1 violent by age 35. O&D defined as 1 referral, no recidivism.	ACE predicted 80% of SVC youths & 81% of O&Ds. Odds of becoming SVC increases 35% for each ACE item present. Strongest predictor = family member in jail, followed by physical abuse, then physical neglect, emotional abuse, household violence, & household substance abuse. Sexual abuse not a predictor.	• Cases reviewed from 2007-2012, so laws/definitions of violent crimes/felonies may have changed. • Excluded those w/ 2 referrals (only 3+ or 1). • Details may be missed in memory recall & underreporting of abuse incidence. • Exclusion of some info (i.e. family data). • Older participants at time of referral had less time b/t crime & study to become SVC. • Data only from juveniles in Florida, no specific biological/ neurological effects studied.
Jimenez, Wade, Lin, Morrow, & Reichman (2016) ♥	Assoc. b/t CT & academic/behavior problems in kindergarten.	D2, O2 Level II Longitudinal Correlation; preexisting group comparison w/covariate analysis	N= 1,007 selected from a larger study. **I:** experienced 1+ ACE item. **E:** Not involved in FFCWS study.	ACE to determine CT. Teacher observed academic & behaviors in classroom.	3 or more ACE items correlated w/difficulties in academics, attention, social, & behavioral problems in the classroom.	• Used data from a previous study performed in one large city, limiting sample generalizability. • Relied on teacher behavioral assessments, which is subjective.

Lemmey, Malecha, McFarlane, Willson, Watson, Gist, & Schultz (2001) ♥	Effects of childhood exposure to (& severity of) DV on child behaviors.	D3 Level IV descriptive survey, normative study	N = 83 women who experienced partner abuse & had a child b/t 4-18 yrs. **I:** women were 18 yr+, had at least 1 child b/t 4-18yrs, primary language English, either filed assault charges against their partner or sought protective orders.	Interviews & 2 questionnaires: Severity of Violence Against Women Scale assessed degree of violence experienced & CBC reported their children's behavioral problems.	Children b/t 4-11 yrs experienced more behavioral problems than a national norm sample, but the girls specifically experienced more behavioral problems than boys. Reported behavioral problems incl.: delinquency, sleeplessness, aggressiveness, depression, somatization, anxiety, & withdrawal.	Biased or incorrectly recalled during self-report measures. ● Ltd generalizability of sample population who had access/means to get help. ● Monetary compensation for interview may have had an impact on results.
Liu, Chu, C. M., Neo, Ang, Tan, & Chu, J. (2016) ♥	Effects of trauma on foster/orphan children; examining the prevalence of MTE & effect on psychosocial fxns.	O2 Level II preexisting group comparison w/covariate analysis	N = 721 (5-17 yrs w/mean age 10.87, SD = 3.42). 515 from 13 diff. VCHs & 206 from foster care. Data gathered from larger studies from Oct. 2011 - Dec. 2013. Participants grouped as children w/no trauma, one trauma, & MTE. **I:** Children were in out-of-home-care placements.	Singapore version of CANS measuring four domains of fxn & eight domains of diff traumas each participant exposed to during their lifetime.	63% of participants experienced at least one interpersonal trauma. Neglect & physical abuse were most common. 35% had MTE & showed higher fxnl needs measure on the CANS indicating poor familial relationship development, poor adjustment, depression, & higher delinquency. Children classified as MTE were also mostly female & sig. older.	● CANS administered by caseworkers on ltd info & may be biased to Singaporean culture limiting generalizability. ● No other measures taken so could not account for other kinds of trauma. ● Does not differentiate b/t the severity levels of the trauma. ● Does not comprehensively identify specific items measured in modified CANS subtests limiting reproducibility & reflecting poor audit trail.

Mongillo, Briggs-Gowan, Ford, & Carter (2009) ♥	Effects of traumatic life events on the behaviors of young children.	D3 Level II Descriptive Survey	N = 917 toddlers b/t 18-36 mos. randomly selected from state records. **E**: children who were adopted or had potential developmental delays, parents didn't speak English, child not in custody of biological parent, or family who didn't live in Connecticut.	Measures incl. CBC, Child Life Events Scale, Modified CBCL PTSD Scale, Infant-Toddler Social & Emotional Assessment (ITSEA), & ITSEA Trauma Related Symptoms Scale.	215 experienced a traumatic event & parents reported sig. behavior changes in 42. Exposure to traumatic events linked to greater levels of dysregulation, externalizing, internalizing, atypical, & maladaptive behavior issues, such as: poor emotional regulation, increased arousal, social avoidance, somatization, & inattention.	• A single informant provided all of the info for the study. • Potential inaccuracies or undetected symptoms of trauma exposure due to parent reports. • Info/details about the traumatic events experienced were not provided.
Shields & Cicchetti (1998) ♥	Comparing aggression, emotion, & attention b/t maltreated vs. non-maltreated low SES children.	O3 Level II Case-control study	Maltreated: n = 141 Non-maltreated: n = 87 Age range: 6-12 yrs. Convenience sample of attendees from same summer day camp. **No I/E indicated.**	Observed social behavior in one summer day camp-convenience sample. -CBCL-TRF -PPVT-R -ERC	Maltreated group had more reactive aggression, attention deficits, dissociation, emotion dysregulation, affective lability/negativity, and inappropriate expression of emotion than non-maltreated. Attentional deficits may negate emotional regulation, worsening effects of maltreatment on reactive aggression.	• Convenience sample & unequal groups impact results & has ltd generalizability. • Quantifying SES status is complex & income varied b/t groups. • Possible misreport of maltreatment hx through parent interviews.

Tabone, Guterman, Litrownik, Dubowitz, Isbell, English, Runyan, Thompson (2011) ♥	Determine trajectories & possible causes of behavioral problems in children w/hx of CT.	O2 Level II, Longitudinal Pre-existing groups Comparison	N = 827 (4-10 yrs) maltreated child–primary caregiver dyads. **I:** Participants from previous study, where parents completed CBCL.	Data gathered from previous LONGSCAN study. Five subgroups were defined using the BIC. Behavioral trajectories of each were algorithmically determined and compared.	Children identified as lowest, low-medium, decreasing, increasing, & high-chronic trajectories. Children w/ hx of CT found to be more resilient to abuse or neglect. Factors contributing to high-chronic behavioral trajectories incl. developmental disabilities, parental alcohol abuse, & community/neighborhood risk factors. Behavioral problems seem to increase in children w/ hx of CT after age 7.	• Data were based on parent observation w/possible bias or errors. • Groupings made may not be generalizable to other samples of maltreated children.
Vissing, Straus, Gelles, & Harrop (1991) ♥	Establishing relationship b/t aggression of parents towards children, & maladaptive behavior of children.	D2, O2 Level III Correlational Study; Pre-existing groups comparisons	Phone survey: N = 3,346 households, ~35 min. interviews. 37% of interviewees were fathers, 63% mothers. **I:** Respondents to SNFVS w/child ≤ 17 yrs old.	Measures incl. SNFVS, CTS, physical aggression index, delinquency index, & interpersonal problem index.	63% families reported some aggression towards children. More aggression towards children was correlated w/ more maladaptive behaviors. Strongest relationship b/t verbal aggression from parents & physical aggression in children. Combined verbal, physical aggression predicted more behavioral problems in children than either verbal or physical aggression alone.	• Results only indicate correlation, not causation; future research needed. • Authors suggested some parental aggression towards children could be b/c of maladaptive behavior from children, rather than vice versa.

Teicher, Anderson, & Polcari (2012) ♣	Compare volumes of specific stress-assoc. brain areas w/& w/o hx of CT.	O3 Level II, Case control study; preexisting group comparison	N = 193 (18-25 yrs) recruited through ads in the Boston, MA area. **I:** Unmedicated, R handed, from Boston community. **E:** drug & alcohol use	CT determined through CTQ & ACE questionnaires. MRI focused on hippocampi.	Participants w/ CT showed smaller volumes of hippocampus & subiculum due to ELS exposure impacting brain development. Authors connected these diff to behavior b/c areas regulate endocrine fxn & response to stress (HPA axis), & substance abuse/psychosis risk.	• Req. in-depth understanding of neuroscience beyond the avg. OT • Exclusion criteria may have ltd. those in 18-25 yr. age range. • Possible misreport of maltreatment hx from memory. • Ltd. generalizability of sample.
Thomason, Marusak, Tocco, Vila, McGarragle, & Rosenberg (2015) ♣	Effect of childhood trauma exposure on brain & the impact on ability to emotionally regulate.	O3 Level II Case-control study	N = 42 urban children (9-15 yrs) recruited from Detroit's Craigslist, flyers, Wayne State University website, & Metro Detroit mental health clinics. Control: n = 21 Trauma-exposed n = 21. **E:** Hx of brain injury, have a movement or neurological disorder, below a 2nd grade reading level, primary language isn't English, or abnormal MRI results.	Measures incl. CTACSC, CDI & SCR questionnaires (administered before & during the MRI). Anxiety or fear during MRI measured w/ VAS in 30 min intervals.	MRI of trauma-exposed group had sig. reduced amygdala-subgenual cingulate connections compared to control group ($P < 0.05$). Lack of amygdala connectivity directly impacts emotional regulation. This is seen in emotional/behavioral disorders.	• Type of trauma & onset not discerned. • Participants selected from a bigger study & not based on specific variables; details of study mentioned not provided. • Authors recognized existence of connections b/t their results & other risk factors, but did not explore risk factors in this study.

Table Summarizing the *Meta-Analyses/Meta-Syntheses/Systematic Review* Evidence

Author, Year, Journal Abbreviation	**Study Objectives**	**Study Design/ Level of Evidence**	**Number of Papers Included, Inclusion and Exclusion Criteria**	**Interventions & Outcome Measures**	**Summary of Results**	**Study Limitations**
Daniels, Lamke, Gaebler, Walter, & Scheel (2013) ♦	Systematic review & meta-analysis of empirical studies looking at "white matter integrity in populations affected by PTSD &/or CT.	O1 Level I Systematic Review & Meta-analysis	25 articles, 10 w/pediatric PTSD, 7 looking at CT effects in adults, & 8 w/adult PTSD. **I:** severe head trauma, brain injuries, & original data exclusively focused on activation diff or gray matter.	Diffusor tensor imaging & fractional anisotropy measured diameter of axons, fiber density, & myelination in brain. GingerAle software package & Activation Likelihood Estimation measured likelihood of activation.	Neglect is biggest predictor for smaller corpus callosum & uncinate fasciculus in the prefrontal cortex in pts w/pediatric PTSD. Boys more affected than girls. Sig. higher volume of white matter in children w/physical abuse, specifically in the cerebellum & left frontal lobe. Increased white matter in the frontal lobe is sig assoc. w/ strong behavioral problems.	● Increases & decreases of volume found in the same brain structures b/t studies led to contradicting results. ● Ltd. number of studies reduce interpretation power & generalizability. ● Studies used diff measurements makes results unreliable. ● Lack of fully controlled studies limits claims of causation.
Wolfe, Crooks, Lee, McIntyre-Smith, & Jaffe (2003) ♥	Effects of childhood exposure to DV on behavioral & emotional outcomes.	D1 Level I, Meta-analysis	41 studies. Age ranges b/t 1-19yrs. **I:** studies either found correlations b/t target groups or consisted of 2+ means & standard deviations for each group.	Synthesized 41 studies by refining the empirical results into clear avgs. to identify potential emerging themes across studies.	Children exposed to or who had direct experience w/ DV resulted in more negative behavioral & emotional outcomes in comparison to peers, specifically conduct issues, depression, & anxiety.	Results of study not intended (by examiners) to be viewed as conclusive data, but to inspire future research.

Table Summarizing the QUALITATIVE Evidence

Author, Year	**Study Objectives**	**Study Design/ Level of Evidence**	**Participants: Sample size, Description Inclusion/Exclusion Criteria**	**Methods for enhancing rigor**	**Themes and Results**	**Study Limitations**
Alisic, Boeije, Jongmans, & Kleber (2011) ♥	Understand how children experience recovery from a traumatic event; identifying the factors that help or hinder the process.	Q2 Level: N/A Group Study w/ More Rigor	N = 25 (15 boys, mean age: 10.7 yrs) 34 children recruited by letter from the University Medical Center Utrecht (Netherlands). **I:** 8-12 yrs, only had single-incident trauma happening at least 6 mos ago, & not currently receiving mental health services.	Interview by experienced trained interviewer w/word monitoring by second person. 21-60 min interviews w/ play first. Stop sign available so child could end interview. Data imported into MAXQDA 2007 & the first 4 transcripts were independently coded by 2 people. Other transcripts coded by 1 & checked by 3 other people to prevent researcher bias. After believed saturation, confirmed it w/5 more interviews.	Four themes: Long-term consequences, slowly feeling better, importance of support, & their own behaviors. Consequences incl. having nightmares, being upset w/triggering reminders, & feeling less safe. W/violence or suicide, some showed sensation seeking. Support from peers, family & stuffed animals made children feel comfortable & safe. Coping mechanism incl. playing, aversion to risk & triggers, seeking explanations, & getting support from family & peers. Most behaviors were the result of not just the traumatic event, but the subsequent long term effects of trauma.	● Ltd sample and cultural bias affecting interpretation of interview answers by examiners limits generalizability. ● May not be relevant for those experiencing recurring trauma. ● Reports may be inaccurate due to memory recall. ● Effects are not measurable due to qualitative nature of study.

Table Summarizing Literature Reviews and other Non-Research based Articles

Author, Year	Type/ Source	Purpose	Pertinent Info to Research	Application for OT	Limitations/Future research needed
Bell, Limberg & Robinson (2013) ♥	Literature review	Review of CT literature to provide educators w/tool for recognizing & addressing classroom behaviors caused by trauma.	Behaviors listed in this article are recognizable in the classroom, such as impacted school performance, lowered self-esteem, regressing (tantrums, in particular), risky behaviors, changes in play patterns, social isolation by choice, mood/attitude changes, problems focusing, seeming easily irritated or overwhelmed/stressed, & reaching out for attention.	Recognizing behaviors that suggest trauma is vital, b/c w/o early intervention, risks increase later in life for dropping out of school, alcohol/drug abuse, & suicide.	Need detailed approaches to intervention when behaviors are recognized.
Gronski, Bogan, Kloeckner, Russell-Thomas, Taff, Walker, & Berg (2013) ♥	Opinion editorial	Determining effects of childhood experience w/ repeated traumas on development.	Exposure to repeated traumas leads to *toxic stress syndrome(TSS)*. TSS increases chance of developing health issues (mental & physical) incl.: depression, chronic obstructive pulmonary disease, liver cancer, cardiovascular disease, asthma, hypertension, autoimmune disease, & diabetes. This heightened exposure to stress alters brain chemistry & structures, potentially resulting in: mood control issues, impaired learning, increased anxiety, impacted executive functioning, & memory difficulties.	This article reviews the impact of trauma on child brain development & provides good background CT affected structures. It primarily serves as implications for future OT research studies.	Future research should gather evidence to support importance of OT intervention for children w/ hx of trauma.
Painter & Scannapieco (2013) ♣	Literature review	Review effect of CT on the brain	CT during critical brain development stages can have lifelong effects on behavior. Children w/ hx of CT might remain in dissociation or hyperarousal b/c brain cannot process memories/info properly. Their baseline for arousal is abnormal. Consequently, outbursts may occur at seemingly inappropriate times. Neurobiological studies show physical diff w/PTSD pts. incl. ANS fxn.	Discussion of normal brain fxn, PTSD, research on brain effects from trauma.	• Evidence of neurobiology & complex issues surrounding CT interpreted through lens of two social workers. • Ltd. audit trail.

Pechtel, Pizzagalli (2011) ♣	Literature review	Review of normative brain development from numerous longitudinal studies. Info was then used as a basis to interpret changes in developmental trajectories following ELS.	Brain areas w/ extensive developmental courses (i.e. prefrontal cortex) are more susceptible to ELS. These damages affect higher-order fxns, incl. executive fxn, which can further the progression of other mental illnesses. Cognitive fxns have been shown to have some degree of recovery, but losses in affective fxn (amygdala) or emotional regulation tend to linger, potentially explaining the high rates of mood & anxiety disorders in adults w/childhood ELS.	Correlation found between abuse occurring earlier and/or longer, and decreased cerebral volumes. ELS associated w/ emotional dysregulation.	● Current understanding of mechanisms behind imaging techniques used to collect data on regional brain changes & abnormalities is ltd. ● Info on diff. developmental trajectories b/t males & females is lacking.
Reyes, Elhai, & Ford (eds) (2008) ♣	Encyclopedia of Psych. Trauma	Comprehensive overview & analysis of all types of psych. trauma.	Psych. abuse can cause desensitization to pain, leading to a lack of concern for pain of oneself or others, thereby reducing appearance of empathy. BT is trauma stemming from people the child trusts, & is highly damaging, possibly leading to PTSD in more instances than other types of trauma.	Resource for background info for all types of trauma.	Wide ranging review of psych. trauma topics, not wholly focused on behaviors or brain changes.
Twardosz & Lutzker (2009) ♣	Literature review	Review of neuroscience surrounding CT.	CT changes the brain & can lead to lifelong heightened responsivity to threats. Exposure to CT affects early development of the hippocampus, amygdala, corpus callosum, cerebellar vermis, & cerebral cortex. Stress hormones released during CT impairs myelination of the corpus callosum & can lead to chronic HPA activation.	Examined topics such as resiliency, plasticity, sensitive periods in development, & stress dysregulation.	While most neuroscience data concurs that CT causes brain changes, some specific points are not agreed upon by all literature (i.e. the exact brain changes directly related to CT & the most effective intervention measures).

Symbols Key	
♦	Articles answering CAT #1: Effect of trauma on brain.
♥	Articles answering CAT #2: Behaviors seen in children affected by trauma
♣	Articles answering both CAT #1 and CAT #2.

Abbreviation Key	
&	and
ACC	anterior cingulate cortex
ACE	Adverse Childhood Experiences Study
ad(s)	advertisement(s)
ADHD	Attention Deficit Hyperactivity Disorder
alex	alexthymia
ANOVA	Analysis of Variance
ANS	autonomic nervous system
assoc.	associated
avg.	average
b/c	because
BAI	Beck Anxiety Inventory
BDI	Beck Depression Inventory
BIC	Bayesian information criterion
BIS/BAS	Behavioral Inhibition and Activity Scales
BRID	Brain Resource International Database
BTA	Brief Test of Attention
b/t	between
BT	betrayal trauma
CANS	The Child and Adolescent Needs and Strengths Tool
CBC	Child Behavior Checklist
CBCL	Achenbach's Child Behavior Checklist
CBCL-TRF	Child Behavior Checklist-Teacher's Report Form
CBEQ	Child Bad Experience Questionnaire
CDA	Co-Morbid Depression and Anxiety Disorder
CDI	Children's Depression Inventory
CECA	Childhood Experience of Care and Abuse questionnaire
CEM	childhood emotional maltreatment
contra	contraindication
CSA	childhood sexual abuse
CTACSC	Children's Trauma Assessment Center Screen Checklist
CT	childhood trauma
CTS	Conflict Tactics Scale
CTQ	Childhood Trauma Questionnaire
diff	difference
DSM IV	Diagnostic and Statistical Manual of Mental Disorders, 4th edition
DV	domestic violence
dx	diagnosis/diagnoses
EF	executive functioning
ELS	early life stress
ELSQ	Early Life Stress Questionnaire
ERIC	Emotional Regulation Checklist
eval(s)	evaluation(s)
FFCWS	Fragile Families and Child Wellbeing Study
Fxn/fxnl	function/functional
GDS	Gordon Diagnostic System
GLM	General Linear Model
h-ALEX	high alexithymia
HPA	Hypothalamic-pituitary-adrenal axis
hx	history
incl.	include, including, or included
ind.	individual
info	information
IPVS	Intimate Partner Violence Scale
l-ALEX	low alexithymia
lab	laboratory
LONGSCAN	Longitudinal Study of Child Abuse and Neglect
Ltd.	limited
LTE-Q	List of Threatening Experiences Questionnaire

MADRS	Montgomery-Asberg Depression Rating Scale
MANCOVA	multivariate analysis of covariates
MDD	Major Depressive Disorder
mos	months
MRI	Magnetic Resonance Imaging
MRS	magnetic resonance scanner
MTE	multiple exposure trauma (exposure to 2+ types of interpersonal traumas)
N/A	not applicable
O&D	one and done
OFC	orbitofrontal cortex
OT	occupational therapy
PACT	Positive Achievement for Change Tool
PMI	post mortem interval
pop.	population
PPVT-R	Peabody Picture Vocabulary Test-Revised
PSS	Perceived Stress Scale
pt/pts	patient/patients
PTSD	posttraumatic stress disorder
re	regarding
req.	required
S-TAIC	State-trait Anxiety Inventory for Children
SCR	Screen for Child Anxiety Related Emotional Disorders
SES	socioeconomic status
sig.	significant
SNFVS	Second National Family Violence Survey
SVC	serious, violent, and chronic (juvenile offenders)
T1	T1 is an MRI term, referring to dark colored cerebral spinal fluid
TAQ	Traumatic Antecedents Questionnaire
TESI-Y/SR	Traumatic Events Screening Inventory-Youth/Self Report
tx	treatment
VAS	Visual analog scale
VBM	voxel-based morphometry
vs.	versus
w/	with
w/i	within
WISC-IV	Wechsler Intelligence Scale for Children 4th Edition
w/o	without
yrs	years

Summary of Key Findings:

Summary of Experimental Studies

When presented with emotional conflict, trauma exposed children show increased amygdala reactivity with simultaneous inability to activate the pregenual anterior cingulate in the prefrontal cortex needed to dampen amygdala activity (Marusak et al., 2015). Similarly, Dannlowski et al. (2013), found increased amygdala reactivity and decreased volumes of the caudate, cingulate gyrus, hippocampus, insula, and orbitofrontal cortex (OFC) in children who experienced maltreatment.

Summary of Outcome Studies

Childhood trauma (CT) exposure has effects on both the grey matter (GM) of the limbic system structures as well as white matter (WM) tracts throughout the brain. De Brito et al. (2013) associated CT with smaller left middle temporal gyrus and medial OFC. Saleh et al. (2017) however, found that only predictive early life stress (ELS) (emotional abuse, sexual abuse, or severe family conflict) showed reduced left OFC volumes while other types of ELS reflected increased OFC volumes. For those with depression, prolonged exposure to childhood sexual abuse (CSA) specifically was associated with smaller caudate volumes while predictive ELS were associated with smaller hippocampus volumes. Teicher et al. (2012) and Aust et al. (2014) also found reduced hippocampal volumes in the MRIs of people exposed to CT. Aust et al. (2014) found that in the absence of alexthymia, a condition of emotional dysfunction, there is an increase in amygdala volume. Saleh et al. (2017) also discovered decreased cortical thickness of the parietal and frontal lobe, and bilateral insula associated with predictive ELS. Decreased volume of corpus callosum and WM tracts in the limbic and frontal lobe were also found to be associated with CT exposure (Daniels et al., 2013, Thomason et al., 2015, & Marusak et al., 2015). In exception to this trend, Daniels et al. (2013) found an increase in WM volume in the frontal lobe in response to physical abuse, but a decrease of WM volume of the uncinate fasciculus in subjects who experienced neglect and post-traumatic stress disorder (PTSD).

Furthermore, the age in which a child is exposed to trauma seems to have different effects on the GM volumes of brain structures (Baker et al. 2013 & Andersen et al. 2008). Baker et al. (2013) found smaller anterior cingulate cortex (ACC) and insula in children who were exposed to trauma after the age of 7. Specifically, Andersen et al. (2008) found that a history of CSA between the ages of 3-5 and 11-13 were associated with reduced hippocampal volume, while exposure between the age of 9-10 was associated with reduced corpus callosum, and exposure between the age of 14-16 correlated with an attenuated frontal cortex.

Apart from brain structures, van Harmelen et al. (2014) associated childhood emotional maltreatment with hypoactivation of the medial prefrontal cortex during word recognition. Both McGowan et al. (2009) and Teicher et al. (2012) also found increased hypothalamic-pituitary-adrenal axis (HPA) activity in subjects with CT. Increased HPA activity is an endocrine response associated with stress. This is in line with the heightened responsiveness to threat and subsequent maladaptive behaviors seen in children who experienced trauma. In general, exposure to trauma is associated with increased stress reactivity, depression, conduct issues, and withdrawal (Liu et al., 2016, Becker et al., 2002, & Mongillo et al., 2009). Research also shows that experience of trauma results in decreased attention (Jimenez et al., 2016, Mongillo et al., 2009, & Becker et al., 2002) and emotional dysregulation (Mongillo et al., 2009 & Thomason et al., 2015).

Evidence suggests that childhood trauma increases the risk of becoming a serious, violent, and chronic juvenile offender (Fox et al., 2015).

Summary of Qualitative Studies

Children's perspectives of experienced traumatic events reflects long lasting effects such as a decreased sense of security, sensation seeking, and PTSD which directly affects their behaviors (Alisic et al., 2011).

Summary of Descriptive Studies

General trends seen throughout descriptive studies suggest higher levels of aggression, anxiety, and depression among study subjects. Jimenez et al. (2016) and Mongillo et al. (2009) suggest that childhood trauma is associated with maladaptive behaviors identifiable in the classroom, such as academic difficulties, attentional deficits, emotional dysregulation, heightened arousal, social avoidance, and somatic symptoms. Briggs-Gowan et al. (2010) found that children exposed to violence are more likely to meet criteria for mental illnesses, such as PTSD, attention deficit hyperactivity disorder (ADHD), seasonal affective disorder (SAD), depression, and conduct disorder (CD). Lemmey et al. (2001), Fasilber et al. (2004), and Wolfe et al. (2003) also found increased anxiety in study subjects.

Vissing et al. (1991), Lemmey et al. (2001), Fasilber et al. (2004), and Shields & Cicchetti (1998) found increased aggression in children exposed to trauma. Aggression displayed by family members towards children in the home has been correlated with increased physical aggression, delinquency, and interpersonal problems for the children, with the strongest correlation between verbal aggression from parents and physical aggression in children (Vissing et al., 1991). However, Vissing, et al. also suggested that tendencies for parents to display aggression towards children may be exacerbated by children's' maladaptive behavior, resulting in a reciprocal cycle of aggression in the household (1991). Additionally, multiple exposures to different types and instances of trauma were shown to increase the risk for the development of maladaptive behaviors in general (Liu et al., 2016, Vissing et al., 1991, Jimenez et al., 2016, & Tabone et al., 2011).

Implications for Consumers:

Indirect consumers of our research topic are children who have experienced trauma and are exhibiting maladaptive behaviors at school. This research could be used to either help identify them as a population who needs earlier intervention to prevent further deficits or, for children who have already been identified such as students in a self-contained classroom, help increase their participation in general education. Occupational performance can be increased for both these populations in the areas of social participation, education, activities of daily living, work, play and leisure, and sleep and rest (AOTA, 2015). For these same populations, consideration of this research may help develop empathy and acceptance from peers, teachers, and administrators by removing the stigma of their behaviors as just "being bad kids." Although this synthesis of the research may not be directly accessible by the children themselves, the direct consumers are parents and educational professionals who could use these findings to increase the understanding of why maladaptive behaviors are exhibited in these children, as well as the support and acceptance needed by this population to develop into successful adults. It is particularly important for caregivers and educators to remember that responding aggressively to a child's aggressive behavior will likely feed into a cycle of continued maladaptive behaviors.

Implications for Practitioners:

This synthesis of the research can be used to develop further understanding of neuroscience surrounding trauma, and how it is linked to behaviors. This could give further insight into clients who are exhibiting these behaviors, who may have a history of trauma. Knowing what may lead to these behaviors can help therapists to develop better treatment plans and programs tailored to the individual, rather than treating the behaviors at the surface. Knowing the types of classroom

behaviors that may indicate exposure to trauma allows educators and therapists to recognize when intervention is needed as early as possible. These behaviors include, but are not limited to, executive functioning deficits, lowered self-esteem, heightened startle reactions, regressing to earlier developmental behaviors (i.e. tantrums, separation anxiety), changes in play patterns, focus, memory, quality of work, or mood, social isolation by choice, appearing easily overwhelmed/stressed/irritated, and negative changes in overall attitude (Bell et al., 2013). Because many occupational therapists and practitioners may not have a strong understanding of the emerging research in trauma affected behaviors, these data can serve as an educational tool. Although our research is not providing data about specific intervention strategies, the information gained here can act as a starting point in generating ideas for new program development. These data can also be used to examine existing programs addressing behaviors to determine if they are outdated, misinformed, or need to be altered in any way to align with new research about the effects of trauma. Furthermore, this synthesis of the research can be used as a tool to advocate for the necessity of early intervention and OT services. OT practitioners can support both educators and students by collaborating with educators to create school environments that foster learning and success, promoting healthy social interaction among students, and helping educators understand the effects of trauma so they can refine their approaches in the classroom (AOTA, 2015).

Implications for Researchers:

Much of the research we found is relatively new, and the ability to develop these kinds of studies have only recently been possible. Therefore, extensive empirical data is lacking to support these findings. Moreover, there is a lack of experimental studies regarding this population and many existing studies are based on self-reports and questionnaires. More valid and reliable instruments and assessments are needed to measure the level of trauma experienced by participants. Further research addressing limitations in sample populations, generalizability, and causation needs to be done to build a greater understanding of the link between brain changes caused by trauma and the behaviors seen in these individuals. In addition, there needs to be more comprehensive data about what specific behaviors are seen with children affected by trauma. Research regarding children who have shown more resiliency to trauma than others is also needed. Research on specific behaviors that occur as a result of trauma will allow for early identification and intervention for childhood trauma victims, which reduces the chances of dropping out of school, alcohol and drug abuse, and suicide later in life (Bell et al., 2013). Examples of questions that still need to be answered are:

1. What variables (genetics, SES status, witnessing vs. experiencing trauma, number of times exposed to trauma, length of time exposed to trauma, severity of trauma, etc.) are the most impactful on behavioral outcomes for children who have experienced trauma?
2. What variables contribute most to the resiliency of certain children to trauma over others?
3. Are there specific childhood behaviors associated with different types of traumas?
4. How can this link be researched in a randomized controlled trial/study to develop causation?
5. What are the most effective ways OTs can support educators and children with a history of trauma (i.e. helping to create routines, promoting positive reinforcement, and providing a combination of sensory and cognitive interventions [AOTA 2015])?

Bottom Line for Occupational Therapy Practice/ Recommendations for Better Practice:

It is important for occupational therapists to understand why maladaptive behaviors occur in children with a history of trauma. This is because a) It is important for occupational therapists to understand the etiology of maladaptive behaviors before providing interventions and b) part of the occupational therapist's role is advocating for the client's best interests by educating parents, educators, and fellow therapists, and enabling necessary supports for these children (AOTA,

2015). Early identification and prevention is key for pediatric populations. To give this population the best chance for success in school, more opportunities for children to participate in general education should be provided through appropriate and effective interventions based on evidence.

Involvement Plan

Intro

In the initial meeting with our clinician, we identified her goals for using the information we gathered. The creation of her clinical questions stemmed from her dissatisfaction with the number of teachers, administrators, paraeducators, and even other students in her district who labeled children in a self-contained program as "bad kids". This labeling and subsequent judgment led to resistance to her occupational therapy (OT) interventions for these students, hindering their participation in general education. Our findings were aligned with what she had already suspected; that the behaviors seen in trauma-affected children are likely not malicious or intentional, but may be connected to organic structural changes in areas of the brain. She hopes to use these findings as evidence that she will present to other educators and administrators. Doing so may foster a better understanding of the root of behaviors seen in these children. She hopes that this understanding will promote empathy, as well as better reception of and support for intervention services provided for these students. Ideally, she will be able to use this information repeatedly in different locations and at different levels of the education system.

To best achieve that goal, we decided that the optimal method of translating our findings is synthesizing our data into a toolkit which will include various resources she can use in multiple situations. The components will include a slideshow built with Prezi containing the information we found, phrased in a way that will be easy to understand for adults in different professions. The focus of the information will be to connect certain behaviors to associated brain areas that may be affected by early childhood trauma. Our slideshow will also include an empathy building exercise to involve our audience(s) in, providing an interactive component to

the written material, as well as insider's perspectives to appeal to emotions of the audience(s). This slideshow can then be used by the collaborating clinician as an in-service presentation to a group, or can be printed off as a resource for individuals unable to attend a presentation. A URL to view our slideshow can be provided on a pamphlet our clinician can give to someone in passing. In the event that an audience is not interested in written/printed materials, or if our clinician is pressed for time, we will also be providing her with some short key statements of the most relevant bits of data to use in everyday conversation.

Context

The purpose of creating our CAT table was to compile information to increase educators' understanding of the effects of childhood trauma on children's brains and behavior. The audience will be educators (locally, to start) and other adults within school systems who work with children affected by trauma. We are offering multiple means of delivering this information to ensure that the message will reach the highest number of people and have the greatest possible impact. The informational toolkit provided allows for a variety of face to face interactions for the collaborating clinician to disseminate information. The model used to disseminate the research information is the *innovation decision process model*, proposed by Rogers (1995, as cited in Law & McDermid, 2014), which breaks the process into five stages: 1) Knowledge, 2) Persuasion, 3) Decision, 4) Implementation, and 5) Confirmation. This study's main objective falls into the second and third stage of this model, Persuasion and Decision, which will allow audiences to form opinions about children affected by trauma and decide when and how to use this new information. Law & McDermid (2014) states that face to face interactions are most effective within these two stages. Using this model may increase effectiveness of our message delivery, and may help promote empathy and understanding amongst audiences.

The context for applying these findings will depend on the setting, the collaborator who is presenting the information, any time constraints on the presentation set by educators, and the willingness of the audience(s) to listen and participate in the exercises. In the ideal scenario, the full presentation would be given to a large group of educators. If educators are unable to set aside time for a presentation, the slides will be available in a hard copy to be given to the educators for review. Pamphlets with a URL to the presentation can be placed in a teachers' lounge or another similar communal area. The abbreviated statements can be memorized by our collaborator so she can speak with confidence about this topic when an opportunity arises.

Facilitators of our project have been the collaborating clinician's passion and involvement in the project, the fact that study findings are in line with her clinical experiences, and her willingness to share these findings by giving presentations to educators. Facilitators to successful implementation of the findings may include compatibility of the researcher's values and those of the educators, and the observability of positive changes in children's behavior over time with adherence to our suggestions (Palinkas & Soydan, 2012).

Due to the variability of how our toolkit can be used and by whom, some barriers to implementation may include the following: the complexity of changing educational approaches depending on the unique needs of each child (Palinkas & Soydan, 2012), a lack of dedicated time to share this information across disciplines, a need for support from staff to promote a shift in thinking about this topic, uncertainty about which children have experienced trauma, inaccuracies during synthesis of our research findings when attempting to make the material easier to understand, and the lack of control we will have over the information once the toolkit has been disseminated. Some educators may be resistant to changing their approaches, particularly those with extensive experience (Hoffman, Bennett, & Del Mar, 2013).

Products, Outcomes, Process, and Recommendations

Tasks/Products, Target Dates, and Interim Dates of Completion

Tasks and Products	Deadline Dates	Steps with Dates to Achieve Final Outcomes	Dates of Completion
Slideshow Presentation (Prezi)	● 3/10/17 for text only. ● 3/19/17 for photographs and outline of empathy exercises. ● Begin slideshow building and survey after 3/19/17. Finish slideshow by 4/1/17.	1) Reformat findings into individual sections to create a text-only slideshow outline. 2) Find images, videos, and other resources to add that may enhance the information. 3) Study empathy building exercises, create at least one exercise to integrate into our slideshow that will elicit audience involvement. 4) Print slideshow for collaborator kit. 5) Build and print short exit survey to assess what was learned. Administer a follow up survey 6 months later to determine whether the information presented impacted how they interact with their students.	1) Text only: 3/31/17. 2) Images, videos, other resources: 3/2/17. 3) Researched empathy building exercises and chose one model to include in presentation on 3/31/17. 4) Printed slideshow for collaborator kit: Projected date 5/6/17. 5) Built and printed short exit survey and follow up survey: Projected date 5/6/17.
Condensed information (pamphlet and sound bytes)	Condense information, obtain host website/url for presentation, schedule interviews with parents of our target population, and get quotes on cost of printing pamphlets, by 4/10/17.	1) Determine information that should be included in the pamphlet and create url for presentation. 2) Determine desired type and paper quality of pamphlets. 3) Design and print pamphlets. 4) Interview parents of our target population and create sound bytes.	1) Determined information to be included in pamphlet and created url (Prezi) for presentation: 4/23/17. 2) Determined type and paper quality for pamphlets: 4/23/17. 3) Designed and printed pamphlet: Projected date 5/6/17. 4) Interviewed one parent and created sound bytes: 4/14/17.
Empathy building exercises/ Insider's Perspective components	Finish empathy building exercises and integrate into presentation, by 4/15/17.	1) Research existing empathy building exercises. 2) Create one that integrates our findings and fits with our goals. 3) Determine length of time that should be allotted to complete such exercises. 4) Practice on friends/family and	Items 1-5: Built and added one empathy building "exercise", along with one interview to provide insider's perspective element. Interview performed on 4/14/17. Projected date to add interview element to presentation: 4/29/17.

		get feedback. 5) Add to presentation.	
Poster (for final presentation)	● Use elements of slideshow that fit onto poster board and build board by 4/29/17. ● Complete and review all aspects and deliver to campus by date of presentation: 5/11/17.	1) Reformat essential components of data to fit on poster board. 2) Choose images, charts, etc. to include. 3) Obtain poster board, either through UPS print services or through an outside service. 4) Print typed segments/pictures and attach neatly to board.	1) Reformatted essential components to electronic template for poster: 4/23/17. 2) Choose images/charts to include: Projected date 4/29/17. 3) Order poster through UPS print services: Projected date 5/4/17. 4) N/A

Monitoring Outcomes and Effectiveness of Tasks and Products

Due to the nature and purpose of our project, outcome measurement will be a unique challenge. The toolkit was developed to be a standalone product that would be implemented by our clinician at the time of her choice rather than as in in-service at a specific date by our group. As such, although outcome measurements are included as part of the toolkit for the clinician to access, we do not currently have established data to measure its effectiveness. Our plan is to include an initial survey to audiences immediately following the presentation slideshow as well as a follow-up survey six months later. Each survey will ask audiences to rate questions on a scale from 1 to 5, with 1 being "not at all" and 5 being "very much". Our initial survey will include the following questions: 1) How useful did you find the information presented, in terms of increasing your understanding of trauma's effect on the brain and behavior? 2) How well equipped did you feel before this presentation to work with children who have experienced trauma and may display problem behaviors as a result? and 3) How well equipped do you feel after this presentation to work with children who have experienced trauma and may display problem behaviors as a result? Our 6-month follow up survey will include the following questions: 1) To what extent do you feel you have been able to apply information learned from

our presentation? and 2) How well equipped do you currently feel to work with children who have experienced trauma and may display problem behaviors as a result? Both surveys will offer a comment section that will ask for specific feedback concerning the presentation of information in the future.

Should this presentation make its way to a more widespread audience, outcomes related to the impact of this project on children with a history of trauma could be monitored. Increasing children's participation in general education is one of the overarching goals Wendi has for disseminating information from this research to educators. If this toolkit ever becomes a training protocol standard within a school a district, another outcome measure could examine the rates of children affected by trauma participating in general education after approaches based on this research are implemented.

Another overarching goal of this project is to improve effectiveness of collaboration between occupational therapists and educators in schools who work with children from this population. Our collaborating clinician cited working as a team with educators as one area of practice made difficult by misinformation and a misunderstanding of how to best serve children with exposure to trauma. Occupational therapists likely have some education about neurological effects of trauma, whereas general educators often do not receive training in this area. This project serves as a tool or method for therapists to effectively present and communicate their knowledge to those who may not have the same background. Therefore, another outcome to be monitored is school-based occupational therapists' perception of changes in conversation and collaboration with educators after this presentation is implemented in their schools. This would be most informative if surveys were given about 6 months after presentation, to allow time for this information to be applied in educators' everyday practices.

Analysis of Overall Process of Project

The process of creating our project began in September 2016 and reached its culmination as of May of 2017. A research topic was brought to our group by an outside clinician and it was determined that this topic lent itself into two researchable questions. Research began utilizing university resources, where information was compiled in the form of a literature review. Data were gathered and synthesized to answer the two research questions. The data were then analyzed to determine how to best deliver this information to increase the knowledge, understanding, and empathy of our intended audience towards the population studied. The research group opted to create a toolkit, which would include a slideshow presentation, pamphlet, and conversational sound bytes that could be utilized by our collaborating clinician in her work setting. This kit was designed to include exercises and insider's perspectives intended to enhance the empathy and emotional impact of our research on our audience to facilitate increased buy-in. Finally, the group created a poster to present our information at events such as symposiums and conferences to reach a broader audience.

There were several barriers which posed a challenge for the research group. First, it was quite difficult to narrow down the topic into researchable questions. And even when there were researchable questions, the parameters of trauma itself required some narrowing be feasibly completed within the limited amount of time. Secondly, the nature of our researchable question did not lend itself to parts of the knowledge translation and outcome measurement aspects due to the question being more directed towards finding the effects of trauma rather than determining the effectiveness of a particular intervention. Historically, other students' projects in our university's program have looked at interventions and outcomes, and have parameters better designed to fit this style of research. This project required some creativity and deviation from

typical procedures to meet the academic requirements of staying within the scope of occupational therapy, answering our collaborator's questions, and translating the knowledge for those without prior knowledge of the topic.

Another issue was being able to make definitive statements about the research findings for knowledge translation. Due to the nature of the subject, almost all of the articles examining brain structures were retrospective outcome or descriptive studies. Without being able to have manipulated independent variables to make true experimental studies, causation statements could not be made between trauma, brain morphology, and behaviors. At best, only associative or correlational statements can be made, which made it difficult to create a knowledge translation presentation that had conviction and sounded persuasive. Furthermore, the group encountered issues finding insider's perspectives to include within the project for the empathy building piece. Many survivors of trauma are part of networks whose information is protected for safety reasons. The group's project chair assisted in providing pre-established community connections.

Several unexpected additions and changes were made involving the knowledge translation. It was determined that the presentation should disseminate the contents of this topic in a way that provides realism for our audiences in order to increase their empathy for children in the population studied. Empathy building exercises were discussed as a method, but realized if not done carefully, could be patronizing for audiences. It was decided to include one exercise adapted from a pre-existing presentation and multiple insiders' perspectives including an interview that was performed with a local foster parent.

It was a privilege to be a part of the effort to expand general educators' knowledge, understanding, and empathy towards children with a history of trauma. Although the process has been lengthy and challenging, the group is proud of our efforts to overcome the above barriers.

The group has worked hard to take advantage of the resources available, including our library's research database and community connections provided by our chair, advisor, and clinician.

Recommendations for the Future

Potential follow-up projects should expand on the definition of trauma to study how childhood trauma experienced beyond the child's microsystem affects brain development and behaviors. Trauma excluded in the current study includes indirectly experienced trauma such as the transgenerational effect of parental trauma, specific national events such as wars and natural disasters, and trauma experienced in-utero. This would lead to a more comprehensive understanding of how children can be affected by different types of trauma. Furthermore, it would also be beneficial to look into factors that could remediate or exacerbate the effects of experienced childhood trauma. Although touched upon in some of the articles presented in this CAT, a closer look at these variables could determine what makes a child more resilient or susceptible to the detrimental effects of trauma. Additionally, further research should be undertaken to bridge the gap between this study's aim at providing evidence for this issue and implementation of effective intervention methods. It is our hope to have this information implemented as a standard training protocol across all school districts. As the program expands and becomes more integrated, future studies should attempt to collect the outcome measures provided in each presentation kit to establish the effectiveness of the educational program on student academic success rates. This information could also be used to make necessary changes and maximize the use and effectiveness of this program in the future.

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*These references delineate the research articles used in the CAT tables, located on pages 11-25.

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