

**USING A NEURODEVELOPMENTAL MODEL OF
THERAPEUTICS (NMT) BASED BEHAVIOUR PLAN IN ELEMENTARY
SCHOOLS**

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ABSTRACT

There is a growing body of evidence that early stress such as neglect, maltreatment and other adverse childhood experiences (ACEs) affect the way a children's brain develops, making them more vulnerable to mental health problems. When these children reach school age, they are more likely to be identified as having learning, behaviour or social problems, and becoming students "at-risk". The literature suggests that one of the reasons why these children have difficulty in school is that their nervous systems may be geared to prioritize managing fear rather than to processing information. In other words, the lower-order stress response system is given priority over the higher-level functions of processing information and learning, including executive functions.

This study was a naturalistic pilot project designed to assess the use of a Neurosequential Model of Therapeutics (NMT) assessment to inform a behaviour plan for elementary school students who have a history of adverse childhood experiences. The study involved two cohorts of four children, ages 6 – 9, who had a history of adverse childhood experiences and had been identified as needing a high level of behavioural support within the mainstream classroom. Over a period of 4 months, one cohort received a trauma-informed behaviour plan based on an NMT assessment, the other cohort received a behaviour plan based on a Functional Behaviour Assessment. Percentage of academic engaged time and heart rate variability were tracked over the course of the intervention. Pre and post measures of executive functions were gathered. For the four students in the NMT cohort, a pre and post NMT metric was produced, as well as a pre- and post NME

mini map.

Neither of the interventions were demonstrated to be effective, which is most likely due to the complex challenges of the naturalistic setting in the school context. However, some interesting trends were identified that would suggest that further research would be warranted.

LAY SUMMARY

Research suggests that adverse childhood experiences, such as neglect and maltreatment, may affect the way a child's brain develops, making them more vulnerable to mental health problems. In school, these children are more likely to have learning, behaviour or social problems. Research suggests that these children's nervous system may be geared to manage fear rather than to process information. The present study investigated the potential benefit of using the Neurodevelopmental Model of Therapeutics (NMT), a relatively new approach to understanding the impact of early stressful experiences on the development of the nervous system, as a means of both assessing and addressing the difficulties experienced by such children in the classroom. The study consisted of a small sample of children. Results were inconclusive, but findings suggest that teachers find the NMT approach helpful, and that further research with larger groups of children and over a longer period may be of value.

PREFACE

The author hereby affirms that she is solely responsible for the present research design and the majority of the data collection and analysis. Assistance was also provided with data collection by Ms. Anna Lemmo, Coordinator of Counselling and Behaviour Support with the Coquitlam School District (#44). Assistance with statistical analysis of a portion of the research data was provided by David Abbott, Research Technician in the Developmental Cognitive Neuroscience Laboratory, Department of Psychiatry, University of British Columbia.

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Chapter 1: Introduction

Child mental health has long been a neglected component of early childhood care and education. A 2006 Senate Committee report on mental health in Canada (Kirby & Keon, 2006) described mental health issues as “the orphan of the health care system” and children’s mental health services as being the “orphan of the orphan.” More recently, the Evergreen Framework for child and youth mental health (Kutcher & McLuckie, 2010) has expanded this perspective. The evidence indicates that the number of youth and children who have a mental illness serious enough to cause significant distress and impair development and functioning at home, at school, and in the community, is estimated to be between 15-30 percent and growing (Kutcher & McLuckie, 2010; Waddell, McEwan, Shepherd, Offord, & Hua,., 2005; Whitley & Gooderham, 2015; Roberts, Stuart, & Lam, 2008).

Children with mental health disorders that go untreated may grow up to become adults with mental health problems, and their impairments negatively impact productivity and functioning (Child and Youth Mental Health Plan for BC, 2003; 2007; Kenny, 2002). It has been estimated that mental health-related issues cost the Canadian economy an estimated \$51 billion in terms of health care and lost productivity (Lim et al., 2008). Mental health disorders account for more lost years of life and productivity than any other illness including cancer (Prince et al., 2007).

It therefore follows that early identification of children who are at risk for mental health

problems, together with appropriate early intervention may result in improving their life trajectories, as well as saving society significant costs in a multitude of areas, not least of which is reducing wasted human potential and enabling children to reach their full potential.

There is a significant and rapidly growing body of evidence indicating that a history of being exposed to adverse early circumstances and experiences (i.e. what has been referred to as “adverse childhood experiences” or ACEs (Blodgett, 2012; Felitti, Anda, & Nordenberg, 1998), such as maltreatment, neglect, and family dysfunction, increases a child’s risk of mental health disorders, including attachment problems, eating disorders, depression, suicidal behaviour, anxiety, alcoholism, violent behaviour, mood disorders, and post-traumatic stress disorder (Heim, Newport, Mletzko, & Nemeroff, 2008; Schilling Aseltine, & Gore., 2007; Rees, 2007; Heim & Nemeroff, 2001; Felitti, et al., 1998).

Events in childhood that Felitti et. al. considered adverse include: recurrent physical abuse or neglect, emotional abuse or neglect, contact sexual abuse, a mother who was/is treated violently, one or no parents, an alcohol and/or drug abuser in the household, an incarcerated household member, and a family member who is suicidal, chronically depressed, mentally ill or institutionalized.

For the sake of simplicity and clarity, the term ACEs will be used below to refer to any of the above stressors or traumatic influences, other than where specific diagnoses are

applicable, such as Post-Traumatic Stress Disorder (PTSD), Reactive Attachment Disorder, Adjustment Disorder etc.

Children who have been exposed to ACEs are often identified in school as having emotional or behavioural difficulties (Haugaard, 2004), attention and learning difficulties (Van der Kolk, Roth, Pelcovitz, Sunday, & Spinazzola, 2005), language problems (Fox, Long, & Langlois, 1988; Allen & Oliver, 1982) and poorer academic performance (Shonk & Cicchetti, 2001; Trickett, McBride-Chang, & Putnam, 1994; Veltman & Browne, 2001).

It has been suggested that a key factor common to all of these adverse outcomes (i.e. emotional, behavioural, cognitive, and academic) is a function of the integrity a child's executive functions and self-regulation (Barkley, 1991; Barkley, 2001; Best, Miller & Naglieri, 2011; Diamond, 2013; Morrison, Ponitz, & McClelland, 2010). Executive functions refer to a set of higher-level mental processes that are necessary in order to allocate attention, sustain attention on the task at hand (concentrate), briefly hold information in working memory in order to work with it to carry out more complex cognitive activities, engage in planning, organization, reasoning and problem-solving processes, exercise flexibility in thinking (i.e. adapt a plan of action in response to feedback regarding its efficacy), and inhibit impulses that are not appropriate in the present context (Diamond, 2013). As executive functions thus essentially direct and organize other cognitive functions as well as behaviour, these may be considered as exercising a "top-down" executive control influence on behaviour (Diamond, 2013).

Executive functions have been identified as being more important for school readiness than IQ (Morrison et al., 2010), and predict reading and math competency (Best et al., 2011; Borella Carretti, B. & Pelegrina. 2010; Duncan et. al., 2007; Gathercole et. al., 2004). Executive functions are important for life success (Eisenberg, Smith, & Spinrad, 2013; Fitzsimons, & Finkel, 2013). Better executive functions in childhood predict physical, mental and financial health 30 years later (Moffit et. al., 2011). Research on resiliency in youth identifies executive functions as a significant factor in those who are resilient (Cicchetti, Rogosch, Lynch, & Holt, 1993; Werner & Smith, 2001).

There is significant evidence that children with a history of ACEs demonstrate impairment of executive functions (Beers & De Bellis, 2002; Mezzacappa, Kindlon, & Earls, 2001; Ziady, 2012; Mueller et al., 2010).

Children with normally developing brains may reasonably be expected to come to school equipped with executive functions at a level commensurate with their developmental stage. This allows them to modulate the lower, survival-based, reactive areas of their brains (Perry, 2006) in order to be able to focus their attention, think, inhibit impulses and learn and process cognitive information within the classroom.

In contrast, children exposed to ACEs often lack the capacity for the level of self-regulation required for success in the academic environment (for the sake of concise and parsimonious language, the term “dysregulated” will be used henceforth to refer to this state). The lower-level, survival-based, reactive areas of their brains are thus prioritized

over the brain's higher regions (Kinniburgh, Blaustein, & Spinazzola, 2005; Perry, Pollard, Blakley, Baker, & Vigilante, 1995). For these children, the top-down mental processes of the executive functions are not able to function and modulate the reactivity of lower brain areas and as a result, such children become caught in a stimulus-response mode (i.e. reacting reflexively instead of thoughtfully and intentionally). This inability to self-regulate makes it difficult for them to learn and to process cognitive information in a classroom (Barkley, 2001; Eisenberg et al., 2013), and contributes to behavioural problems that further disrupts learning and potential for academic success (Jaffee & Maikovich-Fong, 2010).

A recent model developed by Perry (2006; Perry & Hambrick, 2008), the Neurosequential Model of Therapeutics (NMT), appears to provide a comprehensive and potentially practically applicable theoretical framework or lens through which these children can be viewed in such a way as to be able to guide appropriate intervention initiatives. This model suggests that children who are dysregulated by their experience of developmental trauma (i.e. ACEs) may be able to develop the ability to quiet and regulate those lower brain areas from the bottom up by providing organizing stimuli to lower regions of the brain through rhythmic, patterned somatosensory and relational interventions (Perry, 2009). Perry has reported success in using interventions derived from the NMT model in regulating the central nervous system so as to allow executive functions to be improved and strengthened (Perry, 2013). Findings from recent studies which use this type of intervention in preschool environments have shown encouraging

preliminary results, including social and emotional gains (Barfield, Dobson, & Gaskill., 2012; Lobo & Winsler, 2006).

However, this model, thus far, has not been studied within the regular public school setting. For this reason, a more in-depth investigation into how the model may promote self-regulation and strengthen executive functions within the school system would appear to be warranted.

Chapter 2: Review of the Literature

Adverse childhood experiences are traumatic and stressful childhood events such as neglect, maltreatment, and household dysfunction. The Adverse Childhood Experiences Scale (ACE Scale) used by Felitti et al. (1998) has become a tool used by researchers to measure a person's childhood adversity. The short form of this questionnaire is a 10-item checklist that looks at aspects of child maltreatment such as physical abuse, emotional abuse and neglect, sexual abuse, neglect of basic needs, divorce or separation of parents, as well as the family's capacity to care, such as violence against the mother, absence of one or both parents, or family members who were mentally ill, incarcerated or abused substances. The questionnaire can be found in Appendix H. This is not a complete list of childhood adverse experiences, as factors such as poverty, witnessing community violence, problems with peers, and quarreling between adults in the home are not included (Finkelhor Shattuck, Turner, & Hamby, 2015; Taylor et al., 2006).

As outlined above, there is increasing evidence that adverse childhood experiences, tend to increase a child's chances for developing behavioural, emotional, social and physical health problems as he¹ grows older (Cicchetti & Manly, 2001; Felitti et. al., 1998).

Chronic and high levels of stress during the years of a child's development have been shown to disrupt brain development (Carrion & Wong, 2012; Circulli & Alleva, 2003;

¹ For the sake of simplicity, the male gender will be used throughout, and is intended to refer to both male and female individuals unless otherwise specified.

Heim & Nemeroff, 2001; Teicher, Andersen, Polcari, Anderson, & Navalta, 2002). How stress affects brain development in any given child appears to be the result of a number of factors, including genetics, duration and timing of stress, perception of stress, and mediating factors within a child's life such as sources of comfort and support (Coe & Lubach, 2008; Cohen et al., 2012; Gunnar & Quevedo, 2007; Van der Kolk, et al. 2005).

Children exposed to traumatic events do not necessarily develop PTSD but may have a variety of symptoms of PTSD as well as exhibiting a variety of symptoms associated with affective and social/interpersonal self-regulatory functioning such as difficulties with anxious arousal, anger management, dissociative symptoms, and aggressive or socially avoidant behaviours (Cloitre et al. 2009). Children who have experienced adverse childhood experiences and do not meet the criteria for a formal psychological diagnosis also show a higher prevalence for subsyndromal symptoms than those children who have not experienced early trauma (Bücker et al. 2012). Children who have experienced ACEs and are traumatized by those experiences rarely have PTSD and far more commonly have complex trauma or developmental trauma.

An association between a history of developmental trauma and neglect, or having been exposed to what has been referred to as “adverse childhood experiences” or ACEs (Blodgett, 2012; Felitti, et al., 1998) and poor outcomes has been well-established in the literature. A key example is an influential study by Felitti et al., (1998). This was a large scale survey of 17,000 individuals by the US Centers for Disease Control and the Kaiser Permanente health maintenance organization. This remains one of the largest

investigations of the effect childhood adverse experiences have on health and well-being later in life. The study demonstrated that as the number and intensity of ACEs to which a child is exposed increase, so does the risk for adverse outcomes later in life.

Adverse outcomes demonstrated by the study included poor academic performance, poor work performance, financial stress, alcoholism, substance abuse, depression, suicide attempts, adolescent pregnancy, ischemic heart disease, chronic obstructive pulmonary disease, risk for intimate partner violence, and risk for sexual violence.

2.1 Functional Organization of the Brain

To contextualize the role played by neurodevelopmental factors, a brief overview of some basic information about the central nervous system (CNS) and its functions may be useful in order to examine how a child's environment helps to shape the brain's organization.

Perry's NMT assessment provides a functional brain map, which is a graphical depiction of the developmental integrity of a range of neurodevelopmental functions, displayed as a function of degree of similarity to age peers. This therefore provides a readily accessible means of displaying and communicating complex information to a non-specialist audience that may include parents, caregivers, teachers, and educational support aides.

The NMT functional brain map divides the brain into five hierarchically organized functional levels. The levels follow an evolutionary model, where the evolutionarily newer, more complex levels of the brain are conceptualized as having been built upon the

older, more primitive levels. These levels work together in an integrated way for optimum potential.

The oldest, least complex, most primitive level is the **brainstem**. This level involves evolutionarily ancient structures that are similar to the brains of reptiles. The brainstem includes the medulla oblongata where the cells that drive the autonomic nervous system are housed. The pons, tegmentum, reticular activating system, and cranial nerves are part of the brain stem. This level of the brain has to do with the regulation of life-supporting functions such as heart rate, blood pressure, and arousal levels and fear states. (Stien & Kendell, 2004).

At the head of the brainstem is the **diencephalon**, which consists of the thalamus and hypothalamus, which are core to the autonomic nervous system. These structures function to regulate bodily functions and behaviour. This system is involved in regulating physiological functions such as thirst, appetite, digestion, sleep, and body temperature. The thalamus acts as a telephone junction box that receives sensory information from lower subcortical structures, processes it, and sends it on to higher-level cortical structures. The hypothalamus initiates and orchestrates the stress response system regulating both the HPA and SAM systems (discussed in more detail further on). The cerebellum is also included in this level, but is itself a unique and complex structure containing almost 50% of the neurons of the brain (Azevedo et al., 2009). The cerebellum is thought to be the “old brain,” and is important for coordinating movement and sensory information. It matures developmentally late (estimates vary, but almost certainly this

continues through adolescence) and recent findings indicate that it is important to cognitive as well as motor functions (Diamond, 2000; Levesque, 2012; Schmahmann & Sherman, 1998).

The next level is referred to as the **limbic system**. This level governs basic urges, needs, emotions, and memory, and plays an important role in learning. The limbic system consists of a large number of structures with connections to the brainstem, cerebellum and prefrontal cortex, and includes the septum, hippocampus, amygdala, cingulate gyrus (a part of the prefrontal cortex that also plays a role in processing and regulation of emotions as well as pain (Vogt, 2005)), and olfactory bulb. The limbic system is also able to evaluate an experience for emotional significance, and is the centre of our memory system (Siegel, 1999). The amygdala gets very activated the moment there is danger in the environment, reason to be afraid. The prefrontal cortex (PFC) and the anterior cingulate cortex (ACC, the region of the cingulate gyrus particularly involved in emotion regulation as well as autonomic nervous system regulation) are often unable to regulate it (get it to calm down) in people who have experienced ACEs (e.g. Taylor et al., 2007).

The fourth level is the **neocortex**. The neocortex is divided into two hemispheres, each of which is divided into four major lobes: occipital cortex (involved in vision), parietal cortex (involved in somatosensory perception, spatial processing, language processing), temporal cortex (processing visual and auditory input, memory for visual and verbal material, and comprehending language), and frontal cortex (involved in cognition, motor function, symbolic language, and conscious awareness; Stien & Kendal, 2004).

The highest level of the neocortex is **prefrontal cortex**, (the anterior-most region of frontal cortex) whose functions include abstract thought and the executive functions. It is the most recent evolutionary addition to the brain (Teffer & Semendeferi, 2012).

The functions of the upper levels of brain development tend to be more conscious, while the lowest levels of the brain function outside our conscious awareness. The intermediate level, the limbic system, is mostly unconscious as well. When a person receives sensory information from the external world, this information first enters the brainstem and diencephalon, then moves up through the limbic system, and finally to the neocortex as it is made conscious and understood (Perry, 1995).

How a person thinks, feels and behaves is a function of his mental state. This has been referred to as “state-dependent functioning” (Perry, 1995). The calmer a person is, the more effectively he is able to access the higher areas of his brain to think and solve problems creatively and abstractly. As a person becomes more stressed or threatened (discussed in more detail in the section on the stress response below), the more he recruits lower areas of his brain, and his thinking regresses to a more concrete, emotional or reactive way of problem solving. If there is an emotionally intense event, a person may become so anxious or fearful that his functioning may regress to the point that it is controlled primarily by the brainstem (Perry, 2006). For example, if a child is being bullied in school, he will have a difficult time learning, as he is feeling too stressed and unsafe, and the higher levels of his brain are not able to function properly to process information and learn (see e.g., Liston, McEwen, & Casey, 2009; Roth, et al., 1988).

2.2 The Stress Response

The lowest two levels of the brain (brainstem and diencephalon) house the system of neurons called the Autonomic Nervous System (ANS) (Perry, 2006). The ANS consists of two branches, the Sympathetic Nervous System (SNS) and the Parasympathetic Nervous System (PNS). The ANS regulates a number of organs such as eyes, lacrimal, salivary and sweat glands, blood vessels, heart, larynx, trachea, bronchi, lungs, stomach, adrenal glands, kidneys, pancreas, intestines, bladder, and external genitalia and is responsible for controlling the cardiovascular, respiratory, digestive, urinary and reproductive functions. The ANS, in concert with the amygdala and the hypothalamic-pituitary-adrenal (HPA) axis, is also partially responsible for regulating the body's response to stress that is commonly understood as our fight/flight or freeze response (Porges, 2011).

Our body responds to stress or threat by increasing hormones that initiate a cascade of events that ready us to fight, flee or freeze. This is orchestrated through a number of complex systems regulated by the hypothalamus. When a person perceives a threat the amygdala, an almond shaped collection of nuclei housed in the limbic area, responds to the danger by sending neural signals to much of the brain, including the hypothalamus, which then sends neural signals to the ANS.

According to Porges' Polyvagal Theory (2011), the human ANS is made up of three hierarchically organized neural circuits that help to regulate reactivity. One system

immobilizes us (freeze), another mobilizes us (fight/flight), and the third system calms us down through social engagement.

The most primitive system is a subsystem of the Parasympathetic Nervous system (PNS) known as the dorsal vagal complex (DVC). This system immobilizes the body and focuses on conserving energy and restorative functions (i.e. the classic “freeze” response). For example, neurons in this system constrict pupils, slow the heart, inhibit peristalsis, and relax vesical and rectal sphincters. This system is evolutionary ancient and has been shown to have existed in early jawless fish 500,000 million years ago (Levine, 2010).

The next system to evolve is the Sympathetic Nervous System (SNS) that mobilizes the body to expend energy needed for intense muscular work that is required to protect and defend itself in response to challenges in the environment (i.e. the classic “fight or flight” response). For example, the SNS neurons dilate the pupils, accelerate the heart, inhibit intestinal (peristaltic) movements, and contract the vesical and rectal sphincters. This system is thought to be 300, 000 million years old (Porges, 2011).

These two systems work together to regulate homeostatic function in most vertebrates. The third system evolved later (some 80,000 million years ago) and is only found in mammals (Porges, 2011). This is a subsystem of the PNS called the ventral vagal complex, and is involved in social engagement and communication. This system regulates facial expression, vocalization and listening. It allows us to express emotion on

our faces, “gesture with our hands and put intonation in our voices, direct our gaze, and allow us to distinguish human voices from background sound” (Porges, 2011). It also promotes calm behavioural states by inhibiting the influence of the SNS on the heart. In other words, after being startled, the subsystem allows us to be calmed by the presence of other people.

This social regulating neural circuitry has been linked to attachment and bonding (Porges, 2011). A child whose caregiver acts as a “haven of safety” receives loving touch from the caregiver, is comforted by the caregiver when upset, hears cooing, calm speech from the caregiver, is fed when hungry, and other regulatory interactions, which are imprinted into the neurocircuitry of the limbic and autonomic nervous systems. This imprint of people (indeed, the world – human and non-human) as being safe, predictable, and comforting continues to develop during a child’s early years. Therefore, the care a baby receives helps to develop the baby’s stress response system (Levine, 2011; Porges, 2011; Erikson, 1963; Bowlby, 1969).

In a study of the perceptual responses of abused and non-abused children to emotionally charged faces with expressions that ranged from neutral to peak emotional expression (Pollak et. al., 2009), it was found that abused children recognized and reacted to extremely subtle hints of emotional expression implying anger well before non-abused children did. These children thus present as being hypersensitive to, and hypervigilant for, any sign of anger, and may misperceive it as being present when it is not. Similarly, Shackman et al. (2007) found that abused children were more sensitive to any hint of

anger than non-abused children. The abused children in the studies had in effect developed radar for detecting angry faces and other possibilities of harm.

The stress response system is governed by a default hierarchy (Jackson, 1958), which means that when an organism becomes stressed or injured, that organism defaults to a more primitive level of functioning. For instance, when a threat is perceived that is approaching but not imminent, the first response might be to seek out other familiar people to receive support and empathy or take appropriate actions to protect oneself. However, if the threat is perceived as too large or immediate, i.e. overwhelming, a person may default to fight/flight. If the threat is even more severe, the person may default to freeze or faint. The more severe the threat is perceived to be, the more the system will default to the older, more primitive level of functioning, diminish a person's ability to receive and incorporate empathy and support (Levine, 2010) and to problem-solve or think clearly (Arnsten, 1998; Arnsten, Raskind, Taylor, & Connor, 2012). The more primitive the level of response the more it takes over the entire functioning of the organism.

The two major responses to threat seen in children are hyperarousal (fight/flight) and dissociation (freeze) (Perry, 2001). Young children who grow up in environments of threat and/or chaos often have little power over adverse events to which they are exposed, and therefore tend to dissociate (i.e. enter into a state of becoming emotionally disengaged from the environment or, when more severe, from physical or emotional

experience²) as a means of adaptation. Older children usually show a combination of the two, with boys tending somewhat more towards hyperarousal and girls tending towards dissociation (Perry, 2001). Most individuals make use of various combinations of these two distinct response patterns during any given traumatic event. The predominant response patterns appear to shift from dissociative to hyperarousal during development (Perry & Pollard, 1998).

As is evident from the above, the automatic response to threat is a reaction that involves no conscious thought. Two of the main components involved in the stress response system are the sympathetic-adrenomedullary (SAM) system (which is part of the ANS) and the hypothalamic-pituitary-adrenal (HPA) system, (which is not part of the ANS) (Gunnar & Quevedo, 2007).

The SAM functions as part of the sympathetic branch of the ANS. When the SAM system is triggered by stress, it immediately releases mostly epinephrine from the adrenal gland, which ignites the body into a fight or flight response. This causes, among other things, an increase in heart rate, an increase in the amount of blood pumped through the heart, the dilation of blood vessels in muscles and the constriction of blood vessels in the skin and gut. These physiological changes promote an optimal blood supply to the brain and muscles. Another critical physiological change is increased serum levels of glucose that results from epinephrinergetic stimulation of glucogenolysis in the liver, which

² The Diagnostic and Statistical Manual of Mental Disorders (5th Edition) (DSM-5) defines dissociation as “...a disruption of and/or discontinuity in the normal integration of consciousness, memory, identity, emotion, perception, body representation, motor control and behaviour”

provides the energy to carry out the fight or flight defensive actions. Epinephrine does not cross the blood-brain barrier and therefore stays out of neural circuitry (Gunnar & Quevedo, 2007). However, when epinephrine is released into the body, a parallel action occurs in the brain, during which norepinephrine is produced by the locus coeruleus. This response supports vigilance, arousal, and narrowing of attention and, in large doses, acts to turn off PFC. In addition to this, perceived threat and danger activates the other branch of the mammalian stress response system, the HPA axis.

The HPA axis releases hormones called glucocorticoids (GC) into the brain. The most common form of GCs in humans is cortisol. This process of release takes about 25 minutes, and particularly affects the amygdala, hippocampus and prefrontal cortex. GC binds to mineralocorticoid receptors (MR) and glucocorticoid receptors (GR) inside the brain. In the brain, GC binds mostly to MR at basal ranges acting to maintain the function of neurons, circadian rhythms and blood pressure. During the peak of the circadian cycle or after a stressful event, when the amount of GC increases, GCs bind to GRs. There are more GRs in the PFC region of the human brain than in any other brain region (Sánchez et al., 2000). At basal levels, GRs and MRs maintain functions, enhance plasticity and promote resilience, at elevated stress levels GRs impair learning, memory and plasticity (Gunnar & Quevedo, 2007).

Allostasis is the name given to the situation when the HPA and SAM work to maintain favourable conditions so that a person can function and develop through events of stress

and change. Allostatic load refers to the cost of too many or too prolonged stress responses and their adverse effect on development, health and brain function.

There is a wealth of research on the stress response system of rats, and particularly the effect of maternal licking and grooming behaviour on the stress response system of young pups. It has been demonstrated that during the first week of life in a rat, the mother's licking and grooming behaviour determines the extent to which GR genes in the hippocampus become methylated or de-methylated (Weaver et al, 2004). Methylation has been shown to turn off gene expression; de-methylation turns on gene expression.

Maternal licking and grooming induces methylation of the GR gene in rats, allowing for GRs to take up GCs. The more licking and grooming a rat pup receives, the more GRs are likely to be expressed in its hippocampus (in the rodent brain, there are more GRs in the hippocampus than in any other brain region). More GRs expressed in the hippocampus results in more GC taken up quickly and efficiently; when fewer GRs are expressed GCs remain longer and thus the brain is slower to re-establish a calmer state; it takes longer for the stress response to subside and a person is more vulnerable to negative consequences of allostatic load (Weaver et al., 2004).

When rat pups were separated from their mothers for periods of 3-15 minutes, 3 hours, or not at all, the pups who were separated 15 minutes demonstrated more resilience to stress than those who were not separated at all. Those who were separated for 3 hours demonstrated more vulnerability to stress than those not separated at all (Sanchez, Ladd & Plotzky, 2001). Similarly, Cirulli & Alleva (2003) found that compared with the

control group, rat pups exposed to 3 hours of early stress exhibited a larger air-puff induced startle response, more freezing and anxiety behaviours when exposed to cat odour, and 2-3 times as much glucocorticoids in response to restraint when they were adults.

Although moderate and controlled levels of stress are associated with physical and behavioural health, chronic or extremely severe short-term stress has been shown to be neurotoxic (Gunnar & Quevedo, 2007).

A study with monkeys found that the stress response targets different brain structures in primates than in rats (Sanchez et. al., 2000). With primates, GCs target prefrontal cortex, because more GRs are located in PFC than elsewhere, and also the hypothalamus, cerebellum and the hippocampus. This suggests that the prefrontal cortex of primates (including humans) is more vulnerable to stress than the hippocampus. This would appear to be consistent with findings that indicate that the stress response shuts down the higher levels of the brain so as to mobilize the body to react quickly. Another way in which this might be conceptualized is to view the stress response as being a bottom-up reaction that inhibits the ability of prefrontal cortex to deploy the top-down regulatory mechanisms of the executive functions that enable us to cope effectively with environmental stressors and demands. There is significant evidence that stressful early childhood impedes the development of coping processes such as optimism, mastery self-esteem and social support (Taylor & Stanton, 2007; Taylor et al., 2007).

2.3 ACEs and Attachment

Although a baby is born with many billions of neurons, these neurons take time to organize into workable systems through the processes of cell migration, dendritic growth and branching, axonal growth, synapse formation, and pruning. Gene expression is heavily influenced by experience; the effect of experience on gene expression is called “epigenetics”. After a child is born, the environment, mediated by his senses, is a key determinant of neural growth, differentiation and interconnection to form neural networks (Perry, 2002).

Attachment, referring to the quality of the emotional bond between infant and caregiver (Bowlby, 1969) has been shown to be the primary factor in how the body learns to self-regulate emotions such as fear and responses to threat (Porges, 2011). Secure attachment is the result of a “good enough” caregiver who provides safe, positive, responsive, and predictable care. This care helps to develop the self-regulating neuro-circuitry in the brain that builds the child’s capacity for social and emotional interaction with others and self. Insecure attachment results from chaotic care and/or maltreatment. Children from this type of environment often have less ability to regulate affect, trust others, and/or enter into a caring relationship with another person, and therefore have problems developing socially and emotionally as they have not been provided with the foundation needed to develop this potential (Perry, 2002). To them, people may not be rewarding or kind but seen as a threat. The neural circuitry involved in that association will be strengthened with repeated activation, and the child may eventually establish a fear reaction around human intimacy, and may avoid it or experience negative associations or negative

emotional reactions to it. This is in line with what Harry Stack Sullivan describes as “the malevolent transformation.” As a child’s need for tenderness goes unmet, ridiculed or punished, the child develops a sense that he “...lives among enemies” where closeness towards another human being is perceived as dangerous (Sullivan, 1981).

Maltreatment (i.e. ACEs) can lead to disorganized/disoriented or avoidant attachment if the source of the child’s trauma is the person (the caregiver) who is supposed to be the child’s “safe haven” (Sullivan, 1981). Bailey, Moran, & Pederson (2007) found that compared to other forms of adverse childhood experiences, parental maltreatment in childhood was associated with more frequent reports of complex Post-Traumatic Stress Disorder (PTSD) symptoms. As is the case with adults, PTSD is more likely to develop if the traumatic event is interpersonal (Bailey et al., 2007), as is the case in ACEs that lead to disruption of attachment. This is strikingly illustrated by the study by Charuvastra and Cloitre (2008), which reports rates of incidence of PTSD in children as being 11% following accidents, 29%-33% from war, and 65% following childhood physical and/or sexual abuse.

As previously noted, not all individuals exposed to a traumatic event or events develop PTSD. Some people are more resilient to trauma than others. A history of secure attachment may be a factor in resiliency to PTSD (Siegel, 2003). Siegel notes that securely attached children tend to have “enhanced emotional flexibility, social functioning, and cognitive abilities. Some studies suggest that security of attachment conveys a form of resilience in the face of future adversity” (p. 38). Fonagy (2003)

reasons that a secure attachment, and specifically the ability to process social experience, acts to guard against the development of psychopathology in adulthood (see also Peck (1978) and Erikson (1963)).

When both parent and child are exposed to traumatic events, the child's response is very similar to the parents. In a review of 17 studies of children exposed to traumatic events, it was found that higher rates of PTSD in the parents were associated with higher rates of PTSD in their children (Scheeringa & Zeanah, 2001). Studies have also shown that children who have parents with PTSD are at risk for later developing the PTSD themselves (Charuvastra & Cloitre, 2008). In a study of at-risk adolescent mothers, Bailey et al. (2007) found that a history of trauma such as physical abuse, sexual abuse, or maltreatment predicted (though by no means guaranteed) a disorganized/disoriented attachment style. Becker-Weidman (2006) noted that "the best predictor of a child's attachment classification is the state of mind with respect to attachment of the birth mother" (p. 149). He goes on to state that a mother's attachment style before the birth of her baby can predict her child's attachment style at age 6 with 80% accuracy. Parents who develop awareness and come to terms with their childhood adverse experiences are more likely to develop a healthier attachment with their children (Main, Kaplan, & Cassidy, 1985).

Neglect is another type of adverse early experience. Neglect refers to a lack of care or stimulation, and is stressful to infants as they rely on adults for survival. Neglect can have lasting effects on brain development. The earlier and the more global the neglect, the

more permanent and global the deficits (Perry, 2002). A study that randomly placed Romanian orphaned children in quality foster care or had them remain at the orphanage (Nelson et al., 2007) found that those placed in foster care outperformed those who remained in the orphanage in almost every measure including, intellectual performance, secure attachment behaviour, language development and their ability to show positive emotions and pay attention (Nelson et. al., 2009). The authors concluded that the younger a child was when placed in foster care, the better the outcomes for that child. The brain thus has the best chance of recovering from neglect if a child is placed in a predictable and loving environment earlier in development, although, as Sheridan et al. (2012) have demonstrated, the effects of severe early neglect are rarely fully reversible. When Romanian orphans were adopted out by the age of 2 years or later, they were particularly likely to show persisting deficits compared with their peers adopted out earlier.

In a study of adolescents (Mueller et. al., 2010), those who experienced early neglect and abuse and had been removed from their caregiver and adopted into a stable home were fairly comparable to those who had no history of early-life stress, when they were between 1 and 7 years old (mean age 2.5 years), but adolescents who had experienced early stress showed certain cognitive and motor control deficits. The participants were given an fMRI scan while performing an executive functions task; differences in brain activity were found between those who had and had not experienced early stress. The sample of early-life stressed adolescents was characterized by a variety of stressors and years of stress experienced, but also may have been exposed to prenatal drug and/or prenatal stress.

2.4 Outcomes Associated with ACEs

As noted above, there is overwhelming evidence regarding the deleterious relationship between ACEs and outcomes. In brief, studies indicate that children exposed to 2 or more ACEs are more likely to demonstrate poor school performance (Hurt, Malmud, Brodsky, & Gianetta, 2001; Blair, Ursache, Greenberg, et al., 2015; Kataoka et al., 2011; Kinard, 2000; Saigh, Mroueh, & Bremner, 1997; Schwab-Stone et al., 1995), have lower scores on IQ testing as well as reading disorders, lower academic scores, and more days of missing school, (Delaney-Black, et al., 2002), as well as being more prone to developing depression, and behavioural problems (Arnold, 2002; Baker & Shalhoub-Kevorkian, 1999; Stein, et al., 2003) in a dose-dependent manner.

The relationship between anxiety and attentional problems, academic outcomes and cognitive performance is equally well established. Jimerson, Durbrow, Adam, Gunnar, and Bozoky (2006) looked at the relationship between academic achievement problems, attention functioning, and anxiety in a group of low socioeconomic level children in St. Vincent's, in the West Indies. Using morning salivary cortisol levels as an index of anxiety, they found that children with the most attention problems showed greater cortisol elevations at school relative to whom than did other children's. Attention and anxiety behaviour problem ratings by teachers were also strongly negatively related with language and mathematics scores. Ratner et al. (2006) also reported that exposure to violence in the community and victimization in the Detroit area were associated with poorer academic outcomes, and that feelings of safety and positive caregiving was related to more optimal cognitive functioning.

In a study conducted among Khmer refugee adolescents exposed to high levels of violence and war trauma (Berthold, 2008), academic outcomes were significantly negatively associated with level of exposure to violence, which was positively associated with elevated levels of PTSD symptoms, depression, and behavioural problems. The number of violent events to which they are exposed significantly predicted their level of PTSD, risk-taking behaviours, and GPA, but not their level of depression or behaviour problems reported at school. Perceived social support was identified as a protective factor that predicted better outcomes.

Coohey, Renner, Hua et al. (2011) examined the phenomenon of resilience in a probability sample of 702 school-aged children drawn from a national longitudinal survey where the children were followed for 3 years (the National Survey on Child and Adolescent Well-Being). They found that “chronic maltreatment” is associated with lower math and reading scores. Intelligence (IQ) scores and higher scores on a measure of daily living skills were associated with better academic outcomes. It was hypothesized that these skills may result in improved coping mechanisms, and as such, represent a potential protective factor related to resilience. Interestingly, having behavioural problems was also associated with a positive influence on academic outcomes, a counterintuitive finding that was hypothesized as representing a more visible indication of problems, potentially resulting in more attention and assistance.

Joubert, Webster, and Hackett (2012), making reference to attachment theory (Bowlby, 1979), consider the issue of unresolved attachment status and early relational trauma on

psychological and social adjustment, including consequences related to cognitive functioning in the form of cognitive efficiency as measured by working memory, which was demonstrated to be a strong mediator of the link between disorganized attachment and dissociative symptomatology.

Perlman and Fantuzzo (2010) report on a population-based developmental epidemiology study of 12,045 grade 2 students in a large urban school district, using a series of multiple regression models to examine the relationship between first experiences of child maltreatment and homelessness on academic achievement and attendance, controlling for demographic variables, poverty, and birth risks. It was demonstrated that timing of the first instance of child maltreatment and homelessness was negatively related to subsequent academic achievement and attendance. The earlier the experience of homelessness or maltreatment, the greater the impact on school achievement and attendance. Nearly half of the children who experienced maltreatment had experienced this for the first time before entering school. A subsequent peak occurred at the age of 5, when children begin to enter into the public school system. This was considered to be consistent with US National data that demonstrated that teachers represent one of the largest sources of reporting of child maltreatment.

In a subsequent study, the same group of researchers examined the types of maltreatment and co-occurring risks, noting that after controlling for demographics and other risks, substantiated and unsubstantiated reports of child neglect were associated with poorer outcomes than physical abuse. Consistent with the earlier study, earlier occurrence of

such events was associated with poorer outcomes than when these occurred post-kindergarten (Fantuzzo, Perlman, & Dobbins, 2011).

In an earlier study, Fantuzzo and Perlman (2006) examined out-of-home placement, a commonly-used method of intervention for children at risk for child maltreatment and homelessness. Results indicated that children with a history of out-of-home placement were at increased risk for poor literacy and science achievement, when controlling for demographic factors and birth risks, and also demonstrated higher levels of behaviour problems resulting in school suspensions than children with no such placement history. Maternal variables such as depression (Hughes, Roman, Hart, & Ensor, 2012) and mothers with a history of ACEs (Gonzalez, Jenkins, Steiner, & Fleming, 2012) have also been linked to poor outcomes for their children.

Another potential consequence associated with the difficulties experienced by students with ACEs in the school system is the effect on teachers. For example, burnout and attrition has been described as being more common in teachers working with this population (Cancio, Albrecht, & Johns, 2013). Teacher burnout levels have recently been shown to be related to elevated cortisol levels in elementary school students (Oberle & Schonert-Reichl, 2016) and is the first study to connect teachers' stress levels with students' stress physiology.

2.5 Stress, Trauma and Brain Development

As outlined above, the stress response is a primitive survival response that precipitates rapid and intense action, while at the same time shutting down the thought processes of the brain. A child, therefore, who is constantly in a state of threat and chaos develops a baseline homeostasis that is an elevated state of arousal. When a child has grown up in chronic stress, with prolonged and repeated activation of the HPA and SAM systems, his baseline functioning becomes an elevated state of alarm, and the development of the prefrontal cortex is disrupted. A study by Butts et al. (2011), for example, looked at receptors thought to be important for information processing between prefrontal cortex and the limbic system. This communication is identified as being important for working memory, behavioural flexibility and associative learning. The study found that chronic stress disturbed the functioning of these receptors and of communication between prefrontal cortex and the limbic system.

Communication between the different levels of the brain is important for mental health as this helps us make sense of our more instinctual fear reactions. Whalen (2007) makes this point by demonstrating that our amygdala, part of the limbic system that responds to fear, has been shown to respond to unpredictability in the environment. This response takes place in all individuals, not just those who are prone to being anxious. How a person acts on the amygdala's fear response depends on a person's ability to think and evaluate the fear. The amygdala's response is filtered through the prefrontal cortex, which can make sense of the unpredictable event and identify whether it is a threat or not. The more a person can engage his thought processes to make sense of instinctual fear, the less

anxious he is likely to be. However, if a person has been exposed to chronic stress and is in a chronically elevated state of arousal, his prefrontal cortex functioning may be dysfunctional, and may thus be less effective in reducing or inhibiting the fear response (Taylor et al, 2006).

Chronic stress has also been shown to result in physiological pathology. Cohen et al. (2007) demonstrated that chronic stress affects the body's immune and inflammatory processes, which can lead to disease and infection. In a 2012 study, Cohen et al. identify glucocorticoid receptor resistance (GCR), a product of prolonged and repeated activation of the HPA system, as interfering with the regulation of the inflammatory response. In his study, participants who had been exposed to long-term stress were found to demonstrate GCR. Participants were subsequently infected with a virus, and those participants with higher levels of GCR also produced more pro-inflammatory cytokines. Elevated cytokines result in cold symptoms. A similar result was found when 135 female adolescents who grew up in "harsh families" were measured for psychological stress and inflammatory activity four times over 1.5 years. They showed an increasing pro-inflammatory phenotype over time (Miller & Chen, 2010). Repeated activation of the HPA and SAM systems thus result in an increased risk of physical health disorders and chronic disorders of aging.

Hanson et al. (2012) looked at the effect of stress on higher order functions by looking at MRI scans of adolescents who had experienced stress (children who may have experienced maltreatment or who met criteria for psychopathology were not included in

the study). They found that the size of the adolescent's prefrontal cortex was smaller, the more cumulative life stress was reported. Higher levels of life stress were associated with poorer performance on working memory tasks. Poorer performance on working memory tasks was associated with less grey and white matter in prefrontal cortex. Stress generally shuts down communications (see e.g. Liston et al., 2009). A repeated and prolonged stress response results in sensitization of neural pathways involved in the regulation of arousal, vigilance, affect, behavioural irritability, attention, response to stress, sleep, and the startle response (Perry, Pollard, Blakley, Baker, & Vigilante, 1995). The authors reference the role of the locus coeruleus and the ventral tegmental nucleus in the response to stress-mediated hyperarousal, noting that over time (as well as with repeated hyperarousal experiences and/or reminders of the original stressful experience) the use-dependent activation of these brain regions results in sensitization of these areas.

At the same time, activation of the LC/VTN adrenergic response system results in a cascade of associated functional changes in brainstem and mid-brain neurotransmitter systems, which results in the sensitization of the physiological, cognitive, emotional and behavioural functions that re mediated by these brain regions (Vantini, Perry, Guchait, U'Prichard, & Stolk, 1984). Functionally, this results in sensitization of lower, more primitive brain levels while shutting down the higher order, more complex, levels such as prefrontal cortex, and ultimately affecting executive functions such as working memory, emotion regulation, and flexibility. The smaller volumes of grey and white matter thus appear to indicate the lack of use and stimulation those areas likely experienced due to the negative effects of stress on the prefrontal cortex.

In a comprehensive review of the literature regarding neurobiological and neurocognitive consequences of child maltreatment, Wilson, Hansen, and Li (2011) present a research framework that indicates an altered developmental trajectory of information processing and emotion dysregulation following a history of ACEs. They identify evidence of particularly vulnerable brain regions that include the hypothalamic-pituitary-adrenal (HPA) axis, the amygdala, the hippocampus, and prefrontal cortex, noting that these are linked to the compromised ability of these children to process both emotionally laden and neutral stimuli following such exposure. They propose that alteration of the biochemical stress response system in the brain changes the individual's ability to respond efficiently and efficaciously to future stressors, characterizing this as the "traumatic stress response."

Shonkoff et al. (2012), drawing on seminal work by, for example the influential ecological model of Bronfenbrenner (1979) as well as the work of others such as Haggerty (1975; updated in Haggerty, Roghmann & Pless, 1992), provided an integrative review of recent advances in neuroscience, molecular biology, genomics, developmental psychology, epidemiology, sociology, and economics. The authors note that these varied advances are catalyzing an important paradigm shift in understanding of health and disease across the lifespan, with implications that include the proposal that "*... many adult diseases should be viewed as developmental disorders that began early in life and that persistent health disparities associated with poverty, discrimination, or maltreatment could be reduced by the alleviation of toxic stress in childhood.*"

Shonkoff et al. (2014) further develop this perspective in a working paper for the National Scientific Council on the Developing Child, entitled *Excessive Stress Disrupts the Architecture of the Developing Brain*, in which they describe the mechanisms through which excessive or prolonged activation of the stress response systems within the body and the brain result in adverse effects on learning, behaviour, and health in general across the lifespan.

2.6 Effects of ACEs on Specific Brain Regions and Systems

As regards effects of ACEs on specific brain regions and systems, the following findings have emerged:

2.6.1 Stress Response System

Chronic environmental and relational stress results in alterations in brain architecture (Shonkoff et al., 2014), which has been shown to impair cognitive functioning such as memory through interfering with prefrontal and hippocampal functioning and reducing hippocampal volume, interfere with immune system functioning, and alter a number of neurotransmitter systems (Felitti, et. al., 2010; Bruce, Fisher, Pears, & Levine, 2009; Anda et. al., 2006). Children in foster care who have been subjected to significant maltreatment demonstrate abnormally elevated morning cortisol (Jimerson et al., 2016), a marker of increased stress response.

Carrion and his co-workers (Carrion & Wong, 2012; Carrion, Weems, Richert et al., 2010) found that total brain tissue volumes and cerebral grey matter volume in the

hippocampus, and left ventral and left inferior prefrontal cortex were significantly decreased in youth with PTSD symptoms relative to healthy controls, and pre-bedtime cortisol levels were significantly elevated. The authors point out that these areas of the brain are involved in memory processing and executive functions, both important functions for learning and academic success. Cicchetti, Rogosh, Howe, and Toth (2010) investigated memory functioning, cortisol, and dissociation in children with a history of maltreatment, and found no evidence of effects of maltreatment and cortisol regulation on short or long delayed recall performances or recognition memory, but did find that high levels of dissociation were associated with recognition inaccuracies among non-maltreated children, whereas low cortisol in the context of neglect and/or emotional maltreatment was associated with increases in false recognition memory errors.

As noted earlier, there is a substantive body of research linking physiological reactivity related to stress with maladaptive behaviour and academic outcomes in school (Gonzalez et al., 2012; Obradovic, Bush, Stamperdahl, Adler & Boyce, 2010). Obradovic and colleagues used measures of neurobiological stress or reactivity in the form of respiratory sinus arrhythmia and salivary cortisol responses to social, cognitive, sensory, and emotional challenges. Children's level of adaptive behaviour was assessed using child, parent, and teacher reports of externalizing symptoms, prosocial behaviours, school engagement, and academic competence. The researchers found interactions between stress reactivity and adversity, with high stress reactivity being associated with more maladaptive outcomes when seen in the context of high adversity, but with improved adaptive behaviour in the context of low adversity. Results were interpreted as

demonstrating that stress reactivity represents a biological sensitivity to context, demonstrating that high reactivity can hinder or promote adaptive functioning, depending one's present context.

Nolin and Ethier (2007) compared scores on a battery of standard neuropsychological tests, including motor performance, attention, memory and learning, visual motor integration, language, frontal/executive functions, and intelligence. There was a normal control group and a group of children aged 6 to 12 years, receiving Child Protection Services because of 2 types of maltreatment, which were defined as neglect with physical abuse and neglect without physical abuse. Children who had experienced neglect combined with physical abuse demonstrated cognitive deficits in auditory attention, response set, visual-motor integration, problem-solving, abstraction, and planning. Children who were neglected but not physically abused obtained lower scores on attention, response set, and visual-motor integration, but demonstrated a stronger capacity for problem solving, abstraction, and planning than the physically-abused group.

2.6.2 Hippocampus

Long-term stress and exposure to ACEs or child maltreatment have been linked to reduced tissue volume in the hippocampus (Bremner, J.D. et al., 1997; Karl, A et al., 2006; Sheline YI, 2003), a structure involved in important aspects of learning and memory (McCrary, De Brito, & Viding, 2010; McEwen & Gianaros, 2011; Wilson, Hansen, & Li, 2011). Youth with PTSD or post-traumatic stress symptoms (PTSS) have

been shown to have higher levels of cortisol, and pre-bedtime cortisol levels predict decreases in hippocampal volume longitudinally (Carrion & Wong, 2012).

2.6.3 Corpus Callosum

Children and adolescents exposed to ACEs show decreased volume in the corpus callosum (Kitayama et. al., 2007; Choi et. al., 2009) a dense bundle of neural fibres responsible for inter-hemispheric communication between homologous neocortical regions in the two hemispheres of the brain. The genu of the corpus callosum, for example, connects the left and right prefrontal cortex and is thus important for executive functions (McCrory, et al, 2010; Wilson, Hansen, & Li, 2011).

2.6.4 Cerebellum

Maltreated children and adolescents tend to have decreased volume in the cerebellum, which coordinates motor behaviours and is involved in executive functioning (McCrory et al., 2010).

2.6.5 Amygdala

The amygdala is a part of the limbic system, involved in modulating emotional functioning and assessing whether a stimulus is threatening. It has been shown to have a role in triggering emotional responses to perceived threat, including the HPA-axis-mediated stress response (Hanson, Nacewicz, Sutterer, et al., 2015).

Exposure to ACEs has been shown to result in increased activation in the amygdala area of the brain (McEwen & Gianaros, 2011). Dannlowksi et al. (2013) used fMRI imaging to compare the amygdalar emotion-processing bias of healthy subjects with and without childhood maltreatment, and found that child maltreatment was associated with hyperactive amygdala responsiveness to negative facial cues, a finding also associated with major depression (Abler, Erk, Herwig, & Walter, 2007; Peluso et al., 2009).

The amygdala-prefrontal circuitry plays a significant role in threat-reactivity and emotional regulation and has been shown to be impacted by ACEs (VanTieghem & Tottenham, 2017). Amygdala-prefrontal circuitry that is well developed and organized takes the amygdala's sense of a potential threat from the environment through to the prefrontal cortex, which is then able to provide a 'top down' regulation of the amygdala's reactivity. In well-organized amygdala-prefrontal circuitry of healthy groups, PFC activation is accompanied by a reduction in amygdala activation, while for those exposed to ACEs, amygdala activation continues to increase even after PFC activation has increased. In other words, the PFC is trying to tell the amygdala it can calm down, but the message is not getting through (Jedd et. al., 2015; Taylor, Eisenberger, Saxbe, Lehman, & Lieberman (2006); VanTieghem & Tottenham, 2017).

Jedd et. al. (2015) showed that children with a history of maltreatment showed greater amygdala connectivity with the hippocampus and prefrontal cortex, and greater activation of the prefrontal cortex and basal ganglia than comparison participants. In this neuroimaging study, participants were asked to match emotions on faces as well as match

shapes. The findings showed that the children who had been maltreated had a more difficult time with the top-down emotional regulation (the amygdala activation continues to increase even after PFC activation, as the PFC is not getting through to the amygdala to calm it down) and were less efficient in processing emotional information.

The development of the amygdala is tightly linked to HPA axis functioning and is particularly sensitive to environmental input early in life (Callaghan et al., 2014). Early life stress can heighten the reactivity of the amygdala and alter the amygdala-prefrontal connectivity (VanTieghem & Tottenham, 2017). Thus, adverse events in early life and childhood impact the development of the amygdala-prefrontal circuitry implicated in emotional regulation.

The effects ACEs have on the amygdala are also a result of timing and development. Tottenham & Sheridan (2010) reviewed the literature on human developmental neuroimaging, adverse events and the amygdala and hippocampus. They found that both the amygdala and hippocampus are very vulnerable to early adverse environments, although the effects may vary. For instance, the effects of early adverse experiences do not appear to have an effect on the amygdala volume in adulthood. However, the volume of the right amygdala has been shown to be larger in male adolescents who self-reported childhood neglect; a finding which was thought to be related to the association between neglect and anxiety symptoms (Roth et al., 2017).

The hippocampal effects of early adverse experiences do not seem to show until adulthood, which Tottenham & Sheridan (2010) suggest may be due to stress-induced changes in the amygdala.

2.6.6 Prefrontal Cortex

The prefrontal cortex (PFC) is a significant component of the neural circuits underlying the executive functions.

Disruption of integrity of prefrontal cortex functioning has been shown to result in reduced efficiency and effectiveness of executive functions, the higher-level mental processes related to attention, working memory, planning, reasoning and problem-solving processes, flexibility in thinking (i.e. modify a plan of action in response to feedback regarding its efficacy), and inhibition of impulses that are not appropriate in a given context (Gunnar & Quevedo, 2007; McEwen & Morison, 2013; Teffer & Semendeferi, 2012).

Carrion and co-workers demonstrated that cortisol levels were negatively correlated with volume in the PFC. Functional imaging studies demonstrate reduced hippocampal and PFC activation when completing tasks of memory and executive functions in youth with PTSS relative to healthy controls (Carrion et al., 2010; Carrion & Wong, 2012).

Arnsten (2009 & 2015), using animal models, showed that the dorsolateral prefrontal cortex is instrumental in the ‘top down’ regulation of behaviour, attention and emotion as

well as spatial working memory. Arnsten (2009) reports that sustained stress disinhibits stress signalling pathways that lead to PFC dysfunction and impairs higher level cognitive abilities while strengthening the more primitive reactive levels of the brain. Arnsten noted that exposure to acute and uncontrollable stress increases catecholamine release in the PFC, reducing neural firing pathways that promote higher cognitive abilities, and thus impairing cognitive functioning. This increase in catecholamine release also strengthens lower level reactive functioning such as the amygdala and striatum activity. Thus, with increase in levels of stress the "...orchestration of the brain's response patterns switches from slow, thoughtful PFC regulation to the reflective and rapid emotional responses of the amygdala and related subcortical structures" (Arnsten, 2009).

Gamo et al. (2015) carried out research with monkeys, which demonstrated that stress weakens the connections of the PFC network. Gamo and his coworkers note that mental health issues worsen with stress, and symptoms of the dorsolateral prefrontal cortex dysfunction resulting from stress is symptomatic of working memory deficits in psychiatric disorders.

Taylor et al. (2006) used fMRI results to investigate the neural activity of offspring from risky and non-risky families while viewing and labelling the emotions of fearful/angry faces. The offspring from non-risky families showed the expected activation of the amygdala while viewing fearful/angry faces and the expected increase in the activation of the right ventrolateral prefrontal cortex (RVLPFC) and decrease in the activation of the

amygdala when labeling the emotions on the faces. This pattern of increased RVL PFC activity (higher brain areas) and decreased amygdala activity (lower brain areas) through verbalizing the emotions of threatening faces is implicated in emotional regulation. The offspring from risky families showed little amygdala activation when shown angry/fearful faces. When labelling affect associated with the fearful/angry faces, the offspring from risky families showed an increase in amygdala and RVL PFC activity. This pattern suggests that offspring from risky families may not have developed the kind of brain organization that allowed the RVL PFC to regulate the amygdala activity. Thus the ‘top down’ emotional regulation of the offspring from risky families was not as well developed as that of offspring from non-risky families.

Animal studies (Arnsten, 2009), consistent with Taylor et al. (2006) in their study with human subjects related to threatening faces, show that the key to protecting the integrity of the PFC and higher level abilities is to have a sense of control over stressful situations. The participants from ‘non-risky’ families were able to gain a sense of control over their stress reaction to fearful/angry faces through verbalizing the emotion. It thus appears that the stress response is activated by feeling out of control.

2.6.7 ACEs and Executive Functions

There is a significant body of evidence that shows that adverse childhood experiences impairs the development of executive functions (Gould et al., 2012; Lackner et al., 2018; Malarbi et al., 2017. A recent meta-analysis by Malarbi, Abu-Rayya, Muscara, & Stargatt (2017) of 27 studies of the neuropsychological functioning of children exposed

to trauma and those diagnosed with PTSD found that trauma-exposed children and those identified as having PTSD were found to have impaired overall executive functioning when compared to healthy controls, with this effect showing a medium effect size. The PTSD group was found to have slightly worse executive functioning than trauma-exposed participants. A study which divided a group into high and low levels of trauma found that the more trauma in a child's history, the weaker their executive functions. Familial trauma (i.e. trauma that occurred within the family) was found to be associated with weaker executive functions than non-familial trauma; however, caution should be taken in interpreting this finding as there were relatively few studies that looked at non-familial trauma. Gould et al. (2012) found that children who had experienced abuse and neglect showed diminished visual memory, executive functions and spatial working memory, while children who had experienced neglect were found to show slightly poorer emotional processing/inhibition (self-regulation).

As stated above, self-regulation is an aspect of inhibition, which is in itself part of the executive functions. Children who have been exposed to adverse childhood experiences have been shown to have reduced self-regulatory capacity compared to a healthy control group (Lackner et al., 2018; Cloitre et al., 2009). The research of Lackner et al. indicated that the more trauma a child experiences, the less self-regulation he possesses. These deficits in emotional regulation represent one of the factors underlying the heightened risk for psychopathology and other adverse outcomes in individuals who have experienced adverse childhood experiences (Marusak et al. 2017; DePrince et al. 2009).

How an infant is parented affects the development of the child's executive functions. Longitudinal studies across infancy to early childhood have consistently found associations between high levels of sensitivity in parenting and emerging executive functioning in early childhood (Blair et al., 2011; Cuevas et al., 2014; Kraybill & Bell, 2013). The effect of positive parenting on executive functions was been found to be partially mediated through cortisol (Blair et al. 2011; Gonzalez et al. 2012). Attachment security has also been linked to development of executive control in younger children (Bernier, Carlson, & Whipple, 2012; Matte-Gagne et al., 2018) with autonomy support being the strongest predictor of executive functions at each age (Bernier et al. 2010). Bolstering executive functions has been suggested as a resiliency factor to improve children's long and short term health and wellbeing outcomes (Traub & Boynton-Jarrett 2017; Blair & Raver, 2015). Blair et al. (2011) found that the more stressed and less sensitive the parenting, the poorer the spatial working memory and cognitive flexibility in the child.

2.7 Interventions for Reducing Risk of Adverse Outcomes

As is readily apparent from the review above, there has been a significant increase in the recent past in studies evaluating the prevalence of students with ACEs. Given the developmental consequences of ACEs outlined above, it might be considered self-evident that early intervention makes good sense when treating trauma. Treating children who have experienced trauma tends to be a much faster process than when this is done in adulthood (Levine, 2010). During adolescence, and more specifically the onset of puberty, the relatively low response to stress buffered by childhood ends and an increase

in basal cortisol levels and heightened neurobiological responses to stress occur (Gunnar & Quevedo, 2007). Thus, the increase in stress reactivity results in a higher risk of emotional disorder and psychopathology in general at this stage of development.

However, perhaps not unexpectedly, given the complex nature of this population and the factors that affect their functioning, there appears to have been a relatively limited number of attempts to develop comprehensive interventions to assist students considered to be at-risk and/or with a history of ACEs.

2.7.1 Mental Health and Schools

Over recent years, the Canadian government has been expressing an increasing awareness of the prevalence of children with mental illness, the practical aspects of delivering mental health programs in school and the importance of identifying mental health issues and intervening early. In 2013, a report on School-Based Mental Health in Canada was released by the Mental Health Commission of Canada.

An estimated 14-25% of children and youth experience significant mental health issues (Waddell, Offord, Shepherd, Hua & McEwan, 2013). Only 25% of those children and youth receive clinical mental health services (Canadian Institute for Health Information, 2009; Waddell et al., 2002). In a more recent paper, Waddell et al., (2013) conclude that the current delivery model of mental health services is not addressing the needs of children, and that alternate methods need to be found and promoted.

Children spend 5-8 hours of each weekday at school, which makes school an ideal place for the promotion of healthy development, prevention of disorders in at-risk children and treatment for children identified with mental health issues (Waddell, Shepherd, Offord, & Hua, 2005). In a report from a senate committee, Senators Kirby and Keon state, “the development of the school as a site for the effective delivery of mental health services is essential” (Kirby & Keon, 2006, p. 138).

The delivery of mental health services within the school setting has many advantages (Mental Health Commission of Canada, 2012), not the least of which is the ability for early identification of mental health problems. Within schools, children with mental health issues may be recognized early, an intervention applied and life trajectories changed.

Early identification and intervention is the most efficient and cost-effective model of intervention. A survey of mental health programs in schools shows that most of the programs are geared to the older grades (9-12); (Mental Health Commission of Canada, 2013). There are some school programs and initiatives that address child mental health in the primary grades and specifically self-regulation.

There is a number of universal programs that have been studied in a variety of contexts and which appear to lend themselves to being used with primary school students to promote mental health in general. These are classroom-based programs that deliver psycho-educational information in age-appropriate ways. They offer mostly top-down

strategies that use the conscious top levels of the brain to focus on monitoring and managing body sensations that are the domain of the bottom levels. Some programs include bottom-up strategies that focus on the regulation of the ANS through movement and somatosensory activities. Learning to take deep breaths is a strategy that seems to be both top-down and bottom-up and is common to all the programs identified below.

Promoting Alternate Thinking Strategies (PATHS) (Kusche & Greenberg, 1994) is a program that provides instruction and practice in identifying feelings and associated physiological sensations, calming through the use of breathing techniques, and perspective-taking while solving interpersonal problems using an 11-step plan. The program is a three-volume curriculum delivered 2-3 times a week over one school year.

A number of large-scale randomized clinical trials have been conducted with primary-school-aged students in regular and special needs classrooms (Conduct Problems Prevention Research Group, 1999; Greenberg, Kusche, Cook, & Quamma, 2005). The results indicate positive outcomes for the program including reduced aggression and hyperactive-disruptive behaviour and increased emotional literacy. Riggs, Greenberg, Kusche and Pentz (2006) looked at how the PATHS program may promote executive functions. In a study of 318 grade 2 and 3 students, measures of inhibitory control and verbal fluency were taken pre/post and one year after the program was administered. The PATHS program was found to be effective in promoting inhibitory control and verbal fluency.

The Mindfulness Education (ME) program (Schonert-Reichl & Stewart Lawlor, 2010) facilitates self-regulation through top-down strategies, such as mindful attention training, managing negative emotions and thoughts, and promoting awareness of self and others. The program incorporates breathing into the training as well as acts of kindness, community service and teaching about the amygdala and prefrontal cortex. The program is a 10-lesson manualized curriculum with attention training practiced three times a day.

A study of grade 4-7 students showed a significant increase in optimism and social competency (Schonert-Reichl & Stewart Lawlor, 2010). A study comparing two grade 4/5 classes that received the Mindfulness Education program to two grade 4/5 classes that received the regular social responsibility school program found that students who received the ME program showed a significant improvement in executive functions and were less stressed (as measured by cortisol levels) compared to those who received the regular program (Schonert-Reichl et al., 2011). They also demonstrated improvement in stress regulation, empathy, optimism, & emotional control; tended to have better math grades; less school absenteeism; greater decreases in depression and aggression, and were rated by peers as more trustworthy, kind, and helpful than children who received only the regular social-responsibility curriculum.

The ALERT Program (Williams & Shellerberger, 1994) was developed by two occupational therapists, and focuses on cognitive behavioural training (top-down) and movement and sensory integration activities (bottom-up). The program teaches children to identify their arousal states through the use of a car analogy. Sensory activities are

taught as a way to adjust “how their engine is running”. For example, if the child’s engine is running too fast, he needs to slow his engine down by engaging his senses in such things as listening to slow music, doing chair push-ups or dimming the lights. The 12-week program has been found to improve executive functions of children with FASD and improved their behavioural and emotional regulatory control (Nash et al, 2014, Wells et al., 2012) as well as increased cortical grey matter in regions underlying response inhibition, outcome monitoring, and emotional regulation (Soh et al., 2015).

A number of studies have shown positive results in the use of the ALERT program with school populations. This program was studied by Schoonover (2002) with kindergarten and Grade 1 and 2 children. Although the results were not analyzed statistically, group leaders agreed that the children showed an improvement in social skills. Barnes (2008) implemented an 8-week program in a small class of 7 middle-school students with emotional disturbance. Compared with the control group (a class of 5), the children who received the program showed a small, non-significant improvement on measures of behaviour and self-efficacy of self-regulatory behaviour.

The program was studied in Ireland with 118 students aged 12 -13 who were identified as needing behavioural support in schools in areas of social disadvantage. 24 teachers were involved in the study and 92.3% of them felt that the Alert Program had effectively taught students strategies for regulating their own behaviour. The teachers also felt that the program had changed their approach towards students with behavioural difficulties. The students felt that they had learned self-regulation strategies, with 84% (n=69)

reporting that they intend to implement these strategies in the future (Mac Cobb et. al., 2014).

Lobo and Winsler (2006) did a quantitative study of the effects of creative dance on the social competence of Head Start preschoolers. Creative dance is a bottom-up intervention. Forty children were randomly selected to participate in either a creative dance and movement program or a playgroup with a similar adult to child ratio. Those children who participated in the dance program improved more in social competence and internalizing and externalizing behaviours than the group that participated in the control program.

2.7.3 Programs to Address ACEs

As noted above, a number of more general programs intended to address mental health have been developed. These, however, are more broad-spectrum and are not specifically designed to address the complex and multifaceted needs of children with a history of ACEs.

However, there appear to be some potentially promising programs emerging that are designed to address the consequences of a history of ACEs. Stein and colleagues (Stein et al., 2003) conducted a randomized controlled study to assess the effectiveness of a standardized 10-session cognitive behavioural psychological intervention to children diagnosed with or demonstrating symptoms of PTSD as a result of witnessing or being

exposed to violence. The intervention was known as Cognitive-Behavioural Intervention for Trauma in Schools (CBITS) (Jaycox, 2003). Findings demonstrated that such an intervention can successfully decrease symptoms of PTSD and depression in such students, and can be effectively delivered in a school setting by trained school-based mental health clinicians (social workers).

Kataoka et al. (2003) report the results of a similar program, the Mental Health for Immigrants Program (MHIP) in which the same intervention, the CBITS, was delivered to a group of 198 Spanish-speaking immigrant students in Grades 3 through 8 exposed to community violence (although in this instance taking the form of an 8-session group-based intervention). The MHIP program was collaboratively developed by a group of school-based clinicians, educators, and researchers. A waitlist randomized control research design was used. Results indicated that the intervention-group students demonstrated significantly greater reduction in PTSD and depressive symptoms at 3-month follow-up compared to those on the waitlist.

Another promising program which is relatively new with limited research results published to date other than preliminary program evaluation study by Dorado et al. (2016), is the HEARTS (Healthy Environments and Response to Trauma in Schools) program developed by the University of California, San Francisco. Located in 3 San Francisco public schools, this program encourages teachers to reduce behavioural acting out behaviour by using empathy and skill-building instead of punishment, observing when children are becoming tense or agitated, and pre-emptively have them do a soothing

activity. Preliminary results indicated good acceptance, and found that school staff were using more trauma-sensitive skills, and reporting a decrease in discipline referrals to school principals.

Publications provided by the Child Welfare Information Gateway (2011; 2015), a service provided by the U.S. Department of Health and Human Services, Administration for Children and Families Administration on Children, Youth and Families, and the Children's Bureau (drawing in part on the contributions of Bruce Perry), stress the importance of a trauma-informed approach to supporting students with ACEs. They include recommendations for developing a trauma-informed Individualized Education Program (IEP). One of the resources recommended by this service is the Childhood Trauma Toolkit for Educators (2016) developed by the National Child Traumatic Stress Network.

Shamblin, Graham, D, & Bianco (2016) also describe a three-tiered approach to develop trauma-informed collaborative services in schools with early childhood community mental health agencies in rural Appalachia. Tier one included training and consultation for teachers and staff around trauma-informed concepts and the implementation of a social/emotional curriculum. Tier two included consultation for teachers around individual student's challenging behaviours that had not responded to classroom interventions (tier one). The third tier involved intensive interventions which included on-site assessment and evidence-based mental health treatment to students and their families. Results indicate that despite the modest scope of the program, significant pre/post

improvement was found in teacher confidence, decrease in negative attributes in preschool learning environment, and increased teacher ratings of child resilience.

Two small-sample exploratory studies of the use of the Neurosequential Model of Therapeutics (NMT) model in a therapeutic preschool showed promising preliminary findings (Barfield et al., 2012). The first study was a pilot study involving 13 preschoolers who had been identified as having serious emotional disturbances and behavioural problems. The children participated in a 6-week study over the summer months that provided mainly bottom-up interventions. The preschoolers received an NMT assessment, and four 2-hour Filial Play Therapy (play therapy with a trained preschool caregiver) sessions a week, with a focus on individualized somatosensory activities that had been selected based on their ability to provide organizing or regulating input to the underdeveloped and disorganized lower areas of the brain. The ratio of adults to children was 2:5. The preschoolers showed a significant improvement in their social/emotional functioning with large effect sizes. This improvement was retained at 6- and 12-month follow-ups.

The second study compared 15 preschoolers' progress in social-emotional development during the regular school year to their progress over a 10-week NMT-focused summer session. During the NMT summer session, the preschoolers received interventions that included one 2-hour Filial Play Therapy session per week, with a focus on individualized somatosensory activities which were again chosen for their capacity to help regulate the lower brain areas. The ratio of adults to children was about 2:5 in the summer and 1:4.5

in the regular school year. Preschoolers who participated in the NMT summer program showed more improvement in their social/emotional functioning compared to the progress they made during the regular school year.

Recently, the Neurosequential Model of Education (NME) has been developed and designed for implementation within the education system. The program educates teachers and students in basic concepts of neurosequential development and the need to help regulate their students with an emphasis on relational and bottom up regulatory activities and how to apply this knowledge in the classroom. The teacher training involves 5 one-hour sessions accessed through the internet.

A survey of 82 trained teachers who had participated in the program for 1 to 5 years and taught in a variety of alternative and mainstream schools was conducted in 2015 (Viljoen, 2016). The teachers completed a 10-question Likert-style survey and were overwhelmingly positive about the NME training. Teachers communicated that the NME training reduced job stress, assisted them in better understanding students' behaviours and needs, and felt the training enhanced the classroom learning environment.

Although there has been no formal study conducted of the NME approach, there is some incidental evidence collected at various schools that have adopted the approach that indicate positive results. A K-4 public school in a suburb of Edmonton indicated that a tally of office referrals for six of their most challenging students before NME training was 18.4 a month. After the teachers and school had been trained in NME the office

referrals for those same six challenging students were down to 3.6 incidents a month (Brenneis et al., 2016).

Radar, an alternative education program for high school students in Tasmania adopted the NME approach (Drinkwater, 2016). The program services non-attending students or students who are unable to attend school due to behaviour issues. The Radar staff were educated in the NME core concepts, and lessons and daily routines were structured accordingly, NME mini maps were used as part of each student's intake evaluation and Individual Education Plans were created with an NME focus on educating students about how their brain helps them learn. Students involved in the Radar program are routinely given an Australian Council of Educational Research (ACER) survey that has students rate aspects of their mental health. When Radar students were given the survey before the NME-focused program was implemented, the students rated 90% of aspects of their social and emotional well-being as very low or at the lowest level. After 6 months of NME programming, 81% of the Radar students rated themselves in the low to high level of social and emotional well-being.

For children in the school system who display dysregulated and challenging behaviour, Functional Behavioural Assessment (FBA) is often the method used to design and implement interventions. An FBA focuses on the function of a particular behaviour as the mechanism for understanding and changing that behaviour (Steege & Watson, 2008). It is a 6-step process that aims to identify the conditions under which the problem behaviour is likely to occur and then arrange the environment so the problem behaviour is less likely

to occur (Sugai et. al., 2000). A review of the research using FBA within the school system found that most of the research involved individuals with cognitive impairments and the least studied group was students with emotional/behaviour disorders (Ervin et. al., 2001). Of the 148 single case interventions reviewed, all but 2 produced a positive change in behaviour (Ervin, et al., 2001). Another review looked at studies involving problem behaviours in students with any of the following diagnoses of Emotional and Behaviour Disorder (EBD), Serious Emotional Disturbance (SED), ODD, ADHD, mild cognitive deficits, and developmental delay and found only 12 such studies (Scott et al. 2004).

There are inherent problems with conducting FBA assessments in schools, as this requires specialized training of a type that few staff members possess (Ervin et al., 2001). Steege and Watson (2008) points out that even when teachers are trained in FBA, they have difficulty conducting an accurate assessment. Researchers appear to have similar problems. Recently Scott and Alter (2017) reviewed only FBA studies that included students identified as EBD and placed in the general education classroom. The review found 9 studies that met criteria for inclusion, and only 4 of those involved all three parts of a complete FBA. The study concluded that there is insufficient information available and lack of consistency in practice to claim FBA as an evidence-based practice for children identified as EBD in the general classroom.

The single case, non-concurrent multiple-baseline methodology used in the study is well suited to study behavioural interventions such as those developed on the basis of an FBA.

All of the research studies in the literature investigating the use of FBA-based interventions in schools with children identified as having significant emotional or mental health barriers to coping effectively in the educational setting use this methodology (Scott & Alter, 2017). This is because this methodology allows for small sample sizes, which would be too small for more traditional research designs and statistical analyses. This type of design also permits the study of children in various environments, including naturalistic settings such as in the present study. Because children who have high behavioural and mental health needs are often scattered throughout a district, the methodology allows the study of up to four students in different environments. The FBA methodology is designed to identify target behaviours, such as out-of-seat or inappropriate vocalization identify the functions of child problem behaviour, develop a function-based, multicomponent intervention based on FBA results, implement the intervention and then collect data on those target behaviours to see if the intervention is working. The non-concurrent multiple baseline is well suited to schools, as it allows the researcher to study four students in a complex environment where it would otherwise be only possible for one researcher to study one student.

As children enter school at the age of 5, there is a potential for early identification and help for those children who display symptoms of trauma. The school system is not well informed concerning trauma, or what to do about it. In fact, schools often treat trauma as a behavioural issue, which is not only ineffective (Levine & Kline, 2007) but is also often detrimental to the child, as he may be retraumatized by such disciplinary practices (Perry, 2006).

The NMT assessment is based on a set of core principles of neurodevelopment and trauma identified in research. Although the model is manualized, it is not standardized, as the model does not propose that each child receive the same treatment delivered in the same way. The initial assessment, using the NMT metric, outlines the neurodevelopmental strengths and weaknesses of the child for the top and bottom levels of the brain. The assessment provides a score called the Cortical Modulation Ratio (CMR) which indicates the strength of a child's executive functions and whether that child has the capacity to benefit from top-down interventions or whether bottom-up interventions are more likely to help regulate and calm the child. This assessment acts as a neurodevelopmental lens through which people who are in the child's life (teachers, counselors, parents, daycare workers, youth worker, social worker) can receive psycho-education about trauma and learning and can select and organize the enrichment, educational and therapeutic interventions to best fit the child's neurodevelopmental profile. The assessment informs the child's caregivers of the child's developmental capacity and internal "state" of arousal (Perry, 2006).

The NMT model supports a variety of interventions from a variety of agency, community, family and school resources. It encourages the development of a therapeutic web around the child, creating many supportive healthy relationships and interactions (Perry, 2006) similar to the social paediatrics approach to child health as proposed by Spencer and his colleagues (2005).

Appropriate clinical application of the NMT model requires a lengthy period of training of 90 hours. The training program focuses on educating the clinician to help the family and other members of the child's world to see him through the neurodevelopmental lens, by providing psychoeducation in relation to neurodevelopmental concepts and principles (Perry, 2013). This allows the child's family, teachers and other adults to adjust their interactions with the child to better manage and identify areas of weaknesses they can work on so he can progress.

NMT has to date mostly been used in facilities that work with children in care (Perry, 2013), but it has the potential to be used in the educational system as well. However, a detailed search of the available literature failed to reveal any studies to date that have examined this latter area of application.

Chapter 3: Research Design

3.1 Rationale for the Study

As children enter school, early identification and intervention for children who show behavioural difficulties appears intuitively to represent a potential opportunity to institute preventative measures to avert future school and behavioural problems. This, therefore, is clearly the optimal time in a child's school experience to help a child, before the social and academic demands of school become more difficult and negative. Without some form of intervention, a child with poor self-regulating ability may continue to lack the kinds of experiences he needs to develop cognitively, socially and academically. It has been shown that teachers can already identify these children in kindergarten (Ladd, 1990), so it makes sense to intervene when they are young rather than waiting until high school when problems are much more difficult to deal with.

There were very few trauma-informed approaches used in schools when the present study was formulated (2013). At that time, there was very little awareness around ACEs and its effect of learning and behaviour. Students identified as needing behavioural supports and who had backgrounds of trauma were not distinguished from those who did not have backgrounds of trauma. Behaviour modification techniques were the only option for behaviour plans. Classroom programs that focused on self-regulation (ALERT, Minds-up, Zones of Regulation) were just gaining some awareness. The NMT approach offered a trauma-informed evidence-based option which had shown some success in the foster care and family services organizations in other parts of the country, and world.

3.2 Purpose

The overarching goal for the present study was to explore whether children who have been identified as having a history of psychosocial stress and in need of behavioural supports within the classroom develop self-regulation abilities when following a behaviour plan based on an NMT assessment.

3.3 Research Questions

The following research questions were proposed:

- 1) Are students who have a history of ACEs, and are identified as needing behavioural support in the regular classroom, able to develop increased self-regulatory abilities when following a behaviour plan based on an NMT assessment compared to students who follow an FBA-based behaviour plan?
- 2) Do students who have a history of psychosocial stress, and are identified as needing behavioural support in the regular classroom, show an increase in their academic engaged time when following a behaviour plan based on an NMT assessment compared to students who follow an FBA-based behaviour plan?
- 3) Do students who have a history of psychosocial stress, and are identified as needing behavioural support in the regular classroom, show a decrease in their heart rate variability when following a behaviour plan based on an NMT assessment compared to students who follow an FBA-based behaviour plan?
- 4) Are students who have a history of psychosocial stress, and are identified as needing behavioural support in the regular classroom, show a decrease in out-of-

- control incidents when following a behaviour plan based on an NMT assessment compared to students who follow an FBA-based behaviour plan?
- 5) Do teachers feel that the NMT-based behaviour plan is a suitable and useful tool to use in the mainstream classroom compared to a FBA-based behaviour plan?

3.4 Method

The NMT assessment model, as described above, and the subsequent use of a behaviour plan derived from the results of the NMT assessment, has not been researched within the mainstream school system before. The delivery has previously been within alternate school settings, with teachers being trained in the reading of the NMT metric and the associated developmental concepts through a program of videos, “staffings” (a structured method of instruction using case studies to convey the core concepts to teachers in a given setting), and case conferences. However, again, this has not yet been done within the mainstream school system.

In the delivery model employed in the present study, the researcher, who is trained in the NMT model, acted as the trainer to the school personnel, parents and any community members involved, through sharing the NMT metric on the identified child and the development of the behaviour plan. (Note, the researcher was obviously then not blind to each child’s group assignment.)

Educating the adults who have relationships and interact with the child on a daily basis about the neurodevelopmental concepts on which the NMT metric is based is a key principle, paramount in developing and implementing a behaviour plan for the identified child. Because of the relative newness of, and limited familiarity within the broader educational community with, the NMT model, it was proposed that an exploratory research investigation into the feasibility and effects of this method within the education system would be of value in demonstrating the value of the NMT method and spurring further, more in-depth study.

3.4.1 Participants

Eight children who were identified by their classroom teacher or other school personnel as demonstrating self-regulation difficulties and as having had a history of adverse childhood experiences (ACEs) participated in the study. The participants were recruited through the school district's itinerant behaviour team and elementary school counsellors who distributed to prospective families an introductory letter providing an overview of the study and how to contact the researcher if interested in participating in the study (Appendix A). Families who contacted the researcher were provided with information regarding the study, and invited to provide informed consent for participation in the initial screening process (Appendix B). After a parent agreed to have their child participate in the study, the study was explained to the teacher and principal and their permission requested. Assent was obtained from the participants verbally before the study began (Appendix C).

3.4.2 Selection Criteria

Selection criteria for the study were as follows: (a) the child was between 6-9 years old; (b) the child has a history that indicates a history of possible psychosocial stress (e.g. neglect, maltreatment, witnessing domestic violence, extreme poverty) or attachment issues; (c) the child was identified by the school or teacher as having difficulties with self-regulation and in need of behaviour support – having an ‘R’ or ‘H’ designation with the BC Ministry of Education; (d) the school and teacher agreed to participate in the study (e) the child was of average intelligence and did not have a diagnosis of developmental disability (e.g. autism, PDD-NOS) (f) the child’s parent(s) speak sufficient English to ensure that the supports provided would be understood and potentially helpful; (g) the child’s parent(s) agreed to an in-depth interview with the researcher about their child’s developmental history; (h) initial screening observation of the child during a classroom lesson.

All participants had some documented and/or parent concern regarding adverse childhood experiences. Four participants had documented early deprivation or neglect. Two participants were in families with a history of multiple or on-going involvement from the Ministry of Family and Children. One had spent time in a safe house for woman of domestic abuse. One child had a difficult family history of foster-siblings, and parents with medical concerns.

Of the eight students who participated in the study, three were in Grade 1. Three participants were in Grade 2, and two participants were in Grade 3. There were seven

male participants and one female participant. Five of the participants were only attending school part-time as a result of behavioural issues. Each of those five children had a Special Education Assistant (SEA) assigned to them from the behaviour team. Three of the participants attended school all day and were in a classroom with an SEA who was not specifically assigned to them, but sometimes worked with them. One of the participants who attended school all day had a SEA from the behaviour team assigned to him for 2 hours a day.

The eight participants were assigned to two groups of four. The first group was named the “NMT cohort” as they received the NMT intervention, and included Frank, Gary, Emma, and Jack². The second group was named the “FBA cohort” as they received the FBA intervention, and included Max, James, Andy and Dan. Data were collected over a period of 4-5 months depending on when participants began the study.

Descriptive information about the participants in the NMT cohort is summarized in Table 1 and those in the FBA cohort in Table 2³.

3.5 Setting

The study was conducted within the elementary school setting in the Coquitlam School District (SD#43). Eight elementary schools were involved, as each student attended a

³ All names have been changed to pseudonyms.

different school. Participant screening and all other assessment and intervention sessions occurred in the participants' respective schools.

All aspects of the study involving direct contact with participants were conducted by their classroom teachers, SEAs or the researcher. The study took place between January and June of 2014. Due to a teachers' strike that took place early in the school year, the study duration had to be shortened from the originally planned 7 months to 5 months.

3.6 Materials

Heart rate variables were measured using:

- Two EmWave2 heart rate recording devices.
- EmWave2 software installed on two computers.
- Two ear sensors (heart beat detectors).

Measures of executive functions included:

- Touch screen monitor, handle bar, and computer that was loaded with the two sets (pre and post) of programs for the Hearts and Flowers and Flanker/Reverse Flanker tasks.
- PC compatible computer loaded with Automated Working Memory Assessment (AWMA, 2007) software and internet access.

3.7 Measurement

3.7.1 Dependent Variables

The study measured four dependent variables related to self-regulation. These were: Percentage of Academically Engaged Time (PAET), Percentage of Low Heart Rate Coherence (LHRC), and Executive Functions (EF). In addition, Social (Real World) Validity was assessed once by means of a brief questionnaire filled out by the teachers.

3.7.1.1 Percentage of Academically Engaged Time (PAET)

If a participant is academically engaged, he is “on-task.” On-task behaviour was defined as being visually focused on an activity relevant to the context and time frame, and engaging in the required behavioural or cognitive process(es) to complete the activity. If the child is directing his eye gaze at the teacher (or classroom assistant), the instructional activity, or toward appropriate instructional materials, the child is classified as being on task. Handling or reaching for materials no longer needed are rated as off-task. Dropping something on the floor is allowed once, but are rated as off-task if more frequent. Talking to other children, unless continuing to work, are rated as off-task.

Table 1. Overview of characteristics of participants in NMT cohort

Participant (support)	Gender	Age	Grade	Hours in school	Diagnosis	Trauma	Behaviour	History
NMT Cohort								
Frank (Behaviour SEA assigned)	M	7	2	1:00-3:00	Reactive Attachment Disorder	Early deprivation, parental conflict	Non-compliance Tantrum, yelling, throwing things Running out of classroom	Only child to parents who are refugees from Iran. Mother was severely depressed for first 5 months of Frank's life. Father not in Frank's life consistently until Frank was 3.5. Parents are constantly in conflict.
Gary (Classroom SEA)	M	8	3	Full day	Post Traumatic Stress Disorder, Reactive Attachment Disorder, Anxiety Disorder, ADHD (Rx)	inconsistent and inappropriate parenting, physical abuse, neglect, parental conflict, and exposure to his mother's suicide attempt	Sexualized behaviours Threatening and intimidating peers Aggression towards peers (kicking, hitting, choking)	Ministry of Children removed Gary from his mother when Gary was 4 years old. Mother has addiction issues. Gary has lived with his father and step-mother for the last 4 years. His mother has been in and out of rehab and is successfully pushing through the courts for more and more visitation
Emma (Classroom SEA)	F	7	2	Full day	Disinhibited Social Engagement Disorder	Early deprivation	Touches everything and everybody. Gets in other space, steals, pokes. Inattentive and often needs instructions given one-on-one.	Lives with parents and adopted older brother who has a diagnosis of FASD. Emma was adopted at 3.5 years of age from a Russian orphanage.
Jack (Behaviour SEA assigned)	M	6	1	9:00-12:00	ADHD	Psychosocial stress	Non-compliance. Aggression towards peers. Impulsive. Inattentive. Tantrums, throwing things, yelling, running out of classroom	Jack is the youngest of four children to a single mother. All children have different fathers. Zach's father is not involved and never has been. Chaotic home and poverty.

Table 2. Overview of characteristics of participants in FBA cohort

Participant	Gender	Age	Grade	Hours in school	Diagnosis	Trauma	Behaviour	History
FBA Cohort								
Max (Behaviour SEA assigned)	M	8	3	9:00-12:00	Oppositional Defiant Disorder	Early deprivation, extended family conflict, parental conflict,	Non-compliance Escalating behaviours (tantrum, yelling, throwing things) around transitions, lack of choice, unexpected change in schedule, writing activities.	Max lives with his mother at his grandparent's house. There is a lot of tension and conflict in the home. Mother is currently unemployed. Max is on a wait list for counseling. His father is in and out of his life and his mother and his father do not get along.
James (Behaviour SEA assigned)	M	6	1	9:00-10:30	Language Disorder	Witnessing Domestic abuse	Interrupting /Calling out Touching and hitting others.	The family recently moved here from a neighbouring province. Mom is pregnant with her third child. Mother has spent time in a shelter for domestic abuse where James was identified as having a language delay. James spent three years in a special needs preschool and kindergarten due to his language difficulties.
Adam (Behaviour SEA assigned)	M	7	2	9:00-12:00	Reactive Attachment Disorder	Early deprivation	Non-compliance and leaving the room without permission or telling anyone.	Adam lives with his father and two older brothers who both have special needs. His father is overwhelmed. His mother is an addict who is not currently in his life. Chaos and poverty are present.
Dan Classroom SEA	M	6	1	9:00-12:00	ADHD (Rx part way through study)	Psychosocial stress	Non-compliance. Defiance/arguing and not doing as directed. Touching and hitting others.	The family recently moved here from a neighbouring province. A foster brother who has since been removed from the family was abusive to Dan.

Data were collected in the classroom in 10-minute sessions, 3 times a visit over multiple activities when possible (morning routine, instruction, carpet time, desk work) using momentary time sampling (Appendix D). Every 10th second, the observer looked at the participant and recorded if the child was on-task. PAET was calculated by the number of on-task observation points divided by the total number of observation points (i.e. 180).

3.7.1.2 Percentage Low Heart Rate Coherence (LHRC)

Percent LHRC was used as an index of physiological arousal or stress. This was measured using the EmWave HeartMath computer-based biofeedback program, which makes use of a transducer that detects heartbeat signals, and records these electronically. Heart rate variability (HRV) is calculated using a metric based on beat-to-beat variations in heart rate, which represents a measure of autonomic nervous system integrity (vagal tone). The EmWave HeartMath program calculates the level of heart rate coherence.

Tiller, McCraty and Atkinson (1996) introduced the term “physiological coherence”, drawing upon the concept of coherence, well-established in physics and physiology, where it is used to describe the degree of synchronization between complex oscillatory systems such as respiration, craniosacral rhythms, blood pressure variations, and cardiac rhythms. They describe heart rate coherence as being a measure of heart rate variability (HRV) derived from a Power Spectral Analysis of a standard electrocardiographic (ECG) recording, which is then converted to a heart rate tachogram (a plot of the sequence of time intervals between heartbeats (i.e. between the R waves of each PQRST complex of the ECG; Tiller, McCraty & Atkinson, 1996).

On this basis, the HeartMath software produced an analysis of the heart rate variability recorded during each of the sessions with the subjects in the present study and calculated a coherence value. As such, the level of coherence may be viewed as a proxy for HRV. For the purpose of the present study, the percentage of low coherence (representing an elevated level of emotional arousal or a stress-like presentation) over the course of the sampling period (%LHRC) was reported.

Heart rate data was collected once a month after baseline was established. An EmWave2 program was installed in each of the observers' computers. When gathering data a sensor was connected to the computer and then clipped to the participant's ear lobe for 3 minutes while the participant played on an iPad with the game Restaurant 2 (a game that has the participant preparing and feeding food to animals). The PLHRC is the percent of time during the three minutes that the participant was in low heart rate coherence.

3.7.1.3 Measures of Executive Functions

Pre and post measures of executive functions (EF) were conducted in January/February and May/June. The following computer-based tests were administered:

- **Alloway Working Memory Assessment -2nd Edition (AWMA-2)** – Short form. The software is published by Pearson and developed by Dr. Tracy Alloway. This is a computer-based assessment completed by the student online. It consists of 4 tests, Digit Recall, Listening Recall, Dot Matrix, and Spatial Recall, providing measures of

verbal short term memory, verbal working memory, visual-spatial short-term memory and visual-spatial working memory respectively (Alloway, 2007). It has been standardized on children aged 5-9 (Alloway et al., 2009) and found to be stable when primary-aged children were tested at the beginning and end of the year (Alloway et al., 2008). The correlation coefficients for the test-retest reliability for the AWMA verbal working memory items are between .84 -.89. For the visual spatial working memory items the correlation coefficients are between .76 - .85. The AWMA shows a high degree of convergence in performance with the WISC-IV Working Memory Index in students with low and high working memory scores (Alloway et al, 2008). The four AWMA tests are as follows: For Digit Recall, the child hears a sequence of digits and attempts to recall each sequence in the correct order. For the Dot Matrix, the child is shown the position of a red dot in a series of four by four matrices, and attempts to recall this position, recording this by tapping the squares on the computer screen. For the Listening Recall test, the child hears a series of sentences and judges if each sentence is true or false. At the end of trial, the child attempts to recall the final word of each sentence, in the correct order. For the Spatial Recall test, the child views a picture of two shapes where the shape on the right has a red dot above it. The child identifies whether the shape on the right is the same or opposite of the shape on the left. The shape with the red dot may also be rotated. At the end of each trial, the child attempts to recall the location of each red dot on the shape, in correct order, by pointing to the picture with three possible positions marked.

- **Flanker/Reverse Flanker** (Eriksen & Eriksen, 1974; Diamond et al., 2007; Munro et al., 2006) is a test of selective attention and task switching (cognitive flexibility) in

the context of working memory demands. It is appropriate for ages 4 and up.

Validation of the Flanker Fish task was carried out as part of the general standardization of the National Institutes of Health Toolbox Cognition Battery (NIHTB-CB) (Zelazo et al., 2013). Convergent validity was examined by comparing the Flanker Fish results with the Block Design subtest of the Wechsler Preschool and Primary Scale of Intelligence, 3rd Edition (WPPSI-III) for 3 to 6 year olds, and the Delis-Kaplan Executive Function System (D-KEFS) Color-Word Interference Inhibition raw score for 8 to 15 year olds. Discriminant validity was evaluated using the Peabody Picture Vocabulary Test, Fourth Edition (PPVT-IV). High correlations were obtained between the Flanker Fish task and the PPVT-IV scores, although it was noted that the magnitude of the correlations declined notably with age. For the younger children (3 to 6 years), the PPVT-IV scores were strongly related to Flanker Fish scores ($r(85) = 0.67, p < 0.0001$), whereas for older children (8 to 15), the correlation was ($r(82) = 0.44, p < 0.0001$). Overall, however, the test was considered to have appropriate validity. Test-retest reliability (using Intraclass Correlation (ICC), which the authors noted is robust for small samples) was found to reflect excellent test-retest reliability, with an ICC coefficient of 0.92 (95% CI = 0.86 - 0.95).

- **Hearts and Flowers** (Davidson et al., 2006; Diamond et al., 2007; Wright & Diamond, 2014) is a test of response inhibition and task switching (cognitive flexibility) with a working memory component. It is appropriate for ages 4 and up. Validation of the Hearts and Flowers Task (formerly known as the Dots task (Davidson, Amso, Anderson, & Diamond, 2006)), was carried out as part of the

validation process of the Arizona Cognitive Test Battery (ACTB) of which the Dots task forms a component (Edgin et al., 2010). Concurrent validity was established by correlating each neuropsychological measure of the ACTB with general IQ (using the Kaufman Brief Intelligence Test-Second Edition (KBIT-2)), participants' ages, and caregiver ratings of behaviour and development that included the Scales of Independent Behaviour-Revised (SIB-R), (Behaviour Rating Inventory of Executive Functions (BRIEF) school-age version, Nisonger Child Behaviour Rating Form (NCBRF), and Conners 3 ADHD indices. Both the Dots task Incongruent condition referred to by Edgin and colleagues as the "inhibitory control phase" (requiring both working memory and the ability to inhibit task-inconsistent behaviour) percent correct score and the mixed condition (referred to by the authors as the "combined phase") percent correct score correlated significantly with the K-BIT II total raw score ($p < 0.01$), as well as with the BRIEF Working Memory and Inhibition scores. The SIB-R adaptive behaviour standard score also correlated significantly with the number correct in the inhibitory control phase of the Dots task ($p < 0.01$). Test-retest reliability was calculated using a subset of 10 participants (mean age = 12.50, SD 2.52, 5 males, 5 females) who were retested over an interval of 1.55 years (SD = 0.44). The Dots inhibitory control phase percent correct test-retest ICC coefficient was 0.79, and the Dots combined phase percent correct ICC coefficient was 0.60.

Both the Flanker/Reverse Flanker and the Hearts and Flowers task are made up of three blocks of trials, increasing in level of executive functioning demands. For the Hearts and Flowers test, the first block represents a congruent condition in which the child is

instructed to “press the button on the same side” as the stimulus (heart). This block requires no significant executive functioning component. The second block represents an incongruent condition in which the child is instructed to press the button on the opposite side from the stimulus (flower), and thus requires the executive function of inhibition (i.e. resisting the more direct, primary or dominant response, which in this case would be to respond on the same side as the stimulus). The third block is a longer, mixed block where the child is required to switch between the two rules, depending on whether the stimulus was a heart or a flower. This mixed block thus requires inhibitory control, much higher demands on working memory than either single-task block, and cognitive flexibility.

For the Flanker/Reverse Flanker task, the child is instructed to focus on the stimulus in the centre, while inhibiting attention to the stimuli flanking it on both the left and right. Sometimes the middle stimulus would be pointing in the same direction as the “flankers” (congruent), and sometimes in the opposite direction (incongruent).

In the first block, representing the classic Flanker task, the stimuli are blue and the child is instructed to press the button in the direction in which the middle fish was facing (ignoring the outside fish). This first block requires selective attention. In the second block, the stimuli are pink and the child is instructed to press the button in the direction that the outside fish are facing (ignoring the center fish), representing a “reverse” Flanker condition. The second block requires switching to a different rule and switching where one focuses one’s attention, inhibiting the previous rule. The third block is a mixed block where sometimes the stimuli are blue and the classic Flanker task rule applies, and

sometimes the stimuli are pink and the Reverse Flanker rule applies. The mixed block thus requires inhibitory control, working memory and cognitive flexibility. The Flanker/Reverse Flanker task also provides an additional measure of inhibitory control: the degree of discrepancy between participants' speed when inhibitory control is not required (congruent trials) and when inhibitory control is required (incongruent trials). That measure is called the Flanker Effect, and was also incorporated in the present study.

Clearly, the Flanker/Reverse Flanker task represents the most complex version of this test and represents the highest level of EF demands in that it requires not only a high level of sustained and selective attention as well as cognitive flexibility, but also places significant demands on working memory in order to keep track of the dominant rule (i.e. Flanker or Reverse Flanker) in effect at any given moment.

Each of the EF tests takes about 10 to 15 minutes to administer. The researcher ("the trainee") received a one-hour training session with an experienced test administrator ("the trainer"). The trainee then viewed videotaped administrations of the two tasks, including excellent administration and examples of common mistakes to avoid.

Two hours of practice by the trainee were followed up with a videotaped practice session of the trainee administering the tests and its evaluation by the trainer, who provided feedback and correction. This process was repeated until the administration was judged to be at an excellent level by the trainer.

3.7.1.4 Interobserver Agreement

Occurrence/non-occurrence agreement was used, as this is resistant to inaccuracies arising due to extremely high or low probability events (Hawkins & Dotson, 1975). To calculate the occurrence agreement, each time a response is recorded by the primary observer, a check is made regarding whether the secondary observer also recorded the same response, and an agreement is tallied. If observer 1 scored an occurrence and observer 2 scored a non-occurrence, then an occurrence disagreement is tallied (Kennedy, 2005, pg. 117).

Two observers were used in the study. One observer was the author of the study and the other was a trained counselor assigned to the District behaviour team. Both observers took part in interobserver training that was conducted in an elementary school not involved with the study. The observers used their phones to time and a coding sheet (Appendix D) to practice coding behaviour on random students on or off-task according to the criteria previously defined. Four students were coded after which we compared results and reviewed and clarified the definition of off-task behaviour. We continued to practice coding and timing observations until interobserver agreement was established on 6 consecutive students with agreements of 90% or better (range 92% -98%).

Interobserver agreement was again established in April, partway through the study. Both of the observers observed two of the participants and compared observation until they established 6 consecutive agreements greater than 90% (range 94%-100%).

3.7.2 Independent Variables

3.7.2.1 NMT-Based Behaviour Plan

The Neurosequential Model of Therapeutics (NMT) Metric is a graphically displayed summary of a set of comprehensive developmentally sensitive, neurobiology-informed assessment. The graphic depiction is calculated using proprietary web-based software owned by the Child Trauma Academy. The NMT metric is a neurodevelopmentally-informed, biologically respectful perspective on human development and functioning that provides a functional brain map. The NMT metric may be considered as a metaphor or lens through which children can be viewed to identify the area of development or functional organization in which a child may have experienced chaos, threat or stress developmentally, and what kind of intervention may be most useful to help organize that area. The purpose of the metric is to educate and provide a lens through which people can understand a child's behaviour from a neurodevelopmental perspective.

The metric is designed to provide an in-depth account of the child's developmental history (Appendix E) as well as assess Central Nervous System (CNS) functioning of the child in accordance with the area of the brain that functioning would be associated with. The metric reports on 6 items from each brain level, with an additional two from the lower area associated with the cerebellum and an additional 6 from the upper areas associated with frontal cortex. In this manner, the metric creates a visual representation of the hierarchical areas of the brain.

It provides a summary of a child's strengths and vulnerabilities in an array of key domains of functioning: sensory integration, self-regulation, relational, and cognitive (Perry, 2009). One of the measures provided by the NMT is the Cortical Modulation Ratio, an index that "indicates the relative power of the mature brain to modulate the more primitive, reactive, reflexive output of the brainstem and midbrain" (Perry, 2009). In the present study, the NMT metric for each of the 4 NMT subjects was used as the basis for individualized behaviour plans to support interventions developed for each child.

The NMT assessment report provided recommendations according to the strengths and vulnerabilities of the child's profile. For instance, a child who scores low on self-regulation is given recommendations such as these: "Children in this category require structure and predictability provided consistently by safe, nurturing adults across settings. Examples of essential activities in this category include: developing transitioning activity (using a song, words or other cues to help prepare the child for the change in activity), patterned, repetitive proprioceptive OT activities such as isometric exercises (chair push-ups, bear hugs while child tries to pull the adults arms away, applying deep pressure), using weighted vests, blankets, ankle weights, various deep breathing techniques, building structure into bedtime rituals, music and movement activities, animal assisted therapy and EMDR."

Recommendations were made for each domain of functioning (sensory integration, self-regulation, relational, and cognitive) and assessed to be essential, therapeutic, or

enrichment. The school team reviewed the recommendations and discussed which of the recommended activities could be realistically worked into the day given the child's personality and the resources they had available. The behaviour plan also involved the researcher teaching the NMT concepts (pp. 88-97) to those staff who were involved in providing support to the child.

3.7.2.2 The Neurosequential Model of Education (NME) Mini Map Rubric.

The NME Mini Map is web-based and is a quicker and simpler version of the NMT, with which a teacher can assess a child by answering 10 questions about their functioning. The graphic depiction is calculated using proprietary web-based software owned by the Child Trauma Academy. The NME mini map draws upon the NMT. This is a simplified version of the NMT metric that is intended to help educators understand student behaviour and performance. The NME mini map can be completed with a 15-minute interview with the child's teacher (Appendix F).

NMT/NME Training – The researcher is trained as a school psychologist and clinical counsellor. She has also completed training in play therapy and 50 hours of basic training in EMDR, as well as 1600 hours of training in NMT, as required to complete Phase 1 training in NMT.

3.7.2.3 FBA-Based Behaviour Plan

The Functional Behavioural Assessment is the standard metric used by the District Behaviour Support team, and is similar to that used by most behaviour support teams in

other districts in Canada and the USA. A standard 6-step process was followed (Sugai et al., 2000).

These steps are as follows: 1) Collect information regarding conditions under which problem behaviour is and is not observed and more appropriate behaviour is required. 2) Develop testable hypotheses. 3) Collect direct observation information. 4) Design behaviour support plans – specification of (a) desired and acceptable alternate behaviour, (b) antecedent strategies and manipulations, (c) consequence strategies and manipulations, (d) strategies for teaching desired and acceptable alternative behaviour, and (e) setting event/establishing operation strategies and manipulations. 5) Develop implementation scripts that specify how, when, where, and by whom the behaviour support plan is to be implemented. 6) Collect information on effectiveness and efficiency of the behaviour support plan and redesign based on evaluation information (the data are collected continuously through the study).

3.7.2.4 FBA Training

The FBA assessments were conducted by 12 student services teachers who received a 2-hour training by one of the District's Itinerant Behaviour Team teachers, who was university trained in the use of the FBA methodology. Of the 12 student services teachers, 3 were teachers who were part of the District Itinerant Behaviour team. These teachers have training in behavioural support and their job involves supporting schools who have children with behaviour issues by assessing and recommending strategies. Four teachers were part of the district's autism support program. Four teachers were zone

coordinators who were responsible for the special needs students within the district. All 12 teachers were specialists, and most had a Master's degree in Special Education.

After the training, the teachers were divided into 4 groups of 3 with a member of the behaviour team heading each of the four groups. The trainer oversaw the process of conducting the FBAs and reviewing each FBA for integrity. The results of the FBA assessment are reported in Table 4.

The Special Education Assistants (SEA), who were attached to the district itinerant behaviour team, work with high needs children. They had to have basic training to qualify as an SEA, as well as undergoing a 30-hour introductory course on Applied Behavioural Analysis and a course in Nonviolent Crisis Intervention. These individuals are known in the school setting as Behaviour SEAs. Both of these training courses are provided by the Provincial Outreach Program for Autism and Related Disorders (POPARD). Conversely, individuals who do not have this training are referred to simply as SEAs in the school setting. Behaviour SEAs are District-based and attached to the Itinerant Behaviour Team and work closely with the Behaviour Teachers on that team, whereas regular SEAs are school-based. Both types of SEAs were involved in the support of the children involved in the study.

3.7.2.5 Treatment Integrity

Evaluation of adherence to the treatment protocols and overall treatment integrity was conducted through weekly contact with the teachers and Special Education Assistants to

ensure the plan was in place and being followed and the underlying concepts were being understood. The researcher made regular contact with the teacher and/or the Special Education Assistant who were working with the participants in the NMT cohort. The district Itinerant Behaviour Team also made contact with the teacher and/or Special Education Assistants who worked with the participants in the FBA cohort. This check-in involved reviewing the interventions and concepts involved in the behaviour plan as well as the data being collected as part of the present study, and also problem solving any issues that may have come up. It should nevertheless be recognized that there was no formal measurement of treatment integrity. The check-in with the teacher and/or Special Educational Assistant was intended to be an informal evaluation of treatment integrity and student outcomes in order to ensure that the intervention was being delivered as intended, but it was limited by the nature and constraints of the setting.

Because this is a naturalistic study conducted in general school classrooms, it is also important to point out that the school was ultimately responsible for the behaviour plan, as these are the people who provide support to the child every day. The researcher and the itinerant behaviour team engaged in the informal evaluation of behaviour plan implementation described above and then supported the school in implementing the plan. However, the school was largely in control of the day-to-day implementation of the behaviour plan.

3.8 Research Design

The present study makes use of a single-subject research design, using a non-concurrent multiple baseline across participants design. Single subject research is a scientific method that lends itself well to the study of behavioural change in individuals (Kazdin, 1982; Watson & Workman, 1981). In addition, this type of design allows researchers to conduct true experimental studies involving a small number of participants, and permits controlling for threats to internal validity, such as history and maturational factors (Kazdin, 1982).

Non-concurrent multiple baseline designs permit collection of data in a manner that is not simultaneous (i.e. each subject does not need to be available at the same time for baseline and intervention), and allows for collection of data related to multiple baselines (i.e. PAET, PLHRC, and OCI in the present research design) (Watson & Workman, 1981).

Table 3. NMT assessment data at intake

Subject	Functional Domain Chart	Functional Domains Values	Interpretive Description																														
Frank		<table border="1"> <thead> <tr> <th></th> <th>Client Age</th> <th>Age Typical</th> <th>Mature</th> <th>% Age Typical</th> </tr> </thead> <tbody> <tr> <td>Sensory Integration</td> <td>62</td> <td>84</td> <td>96</td> <td>73.81</td> </tr> <tr> <td>Self Regulation</td> <td>49</td> <td>73</td> <td>96</td> <td>67.12</td> </tr> <tr> <td>Relational</td> <td>42</td> <td>72</td> <td>96</td> <td>58.33</td> </tr> <tr> <td>Cognitive</td> <td>52</td> <td>63</td> <td>96</td> <td>82.54</td> </tr> <tr> <td>Cortical Modulation Ratio</td> <td>1.06</td> <td>3.14</td> <td>24.00</td> <td>33.64</td> </tr> </tbody> </table>		Client Age	Age Typical	Mature	% Age Typical	Sensory Integration	62	84	96	73.81	Self Regulation	49	73	96	67.12	Relational	42	72	96	58.33	Cognitive	52	63	96	82.54	Cortical Modulation Ratio	1.06	3.14	24.00	33.64	<ul style="list-style-type: none"> - Therapeutic - Therapeutic - Essential - Enrichment - Minimal capacity to self-regulate
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Two separate studies were conducted, each using four subjects, with each set of four subjects having a different independent variable:

- One set of four subjects followed a behaviour plan based on a NMT assessment that involves home, community and school involvement.
- The other set of four subjects followed a behaviour plan based on a functional behavioural assessment that is school-based.

The design consisted of two phases (a) baseline; and (b) intervention.

In each study, when a particular participant became available, the participant was randomly assigned to one of the predetermined baseline lengths. Baseline observations were then carried out, and, assuming that a stable pattern of behaviour was demonstrated through the course of these observations, the intervention was then introduced, when the completed consent forms were returned to the researcher and the subject had been determined to meet selection criteria.

Students began the study two at a time (one from each set of four). As the next two students became available and the previous two completed baseline measures, the next pair began to establish baseline. This repeated until all eight students had established baselines.

3.9 Research and Intervention Procedures

3.9.1 Preliminary Screening

The screening process included a brief interview with the teacher about the child and the child's self-regulatory behaviours, as well as a classroom observation to verify the child's difficulty with self-regulation. As the child had already been identified as needing behavioural support, this process was not extensive.

3.9.2 Baseline

Baseline procedures involved obtaining the collection of baseline PAET, PLHRC, and OCI data, as follows:

- PAET – student was observed and data collected until a stable baseline of three points was established.
- PLHRC- student was assessed a minimum of 3 times to establish baseline.
- OCI – students out of control incidents were recorded throughout the intervention.

Table 4. FBA assessment data at intake

Participant	Setting Events	Antecedent	Problem Behaviour	Desired Behaviour	Alternative Replacement Behaviour	Maintaining Consequence to Problem & Alternative Behav.	Maintaining Consequences to Desired Behaviour
Max	- Transitions from preferred activities (break) to non-preferred activities (work)	-Decreased sense of control - Being directed - Increased effort - Replacement of preferred with non-preferred activity - Unknown expectations - Out of routine	- Non-compliance to schedule - Escalation of behaviours - Difficult transitions	- Able to successfully and independently transition throughout schedule	Jointly make decisions on scheduling in order to satisfy need for control	- Dictates the schedule and goes back to choice time - Uses avoidance to delay work time	- Pride in completing activities - Success in task completion - Increased confidence
James	- Impulsivity - Speech and Language difficulties - Sensory processing difficulties	- Group settings where student is getting little or no individual attention from the teacher	- Interrupting/calling out - Touching others - Hitting others	- Student will put up his hand and wait to be called on before he shares an idea or asks a question	- Student will be given a certain # of tickets that he can use to make comments or ask questions. - Student will use break/help card	- Attention - Avoid/Escape tasks	
Andy	- Conflict at home - Social deficits - Language skills - Written work - Physiological needs not met (diet)	- Teacher request - Academic task	- Leaving Room - Non-compliance	- Complying with request - Task attempt at completion	- Asking for a break/help - Calming strategy	- Escape/avoid - Adult attention - Control - Preferred activity - Work avoidance	- Verbal praise - Positive reinforcement - Adult attention
Dan	- Transitions from preferred activities (play) to non-preferred activities (not play)	- Decreased sense of control - Being directed - Increased effort - Out of routine	- Defiance /arguing and not doing as directed - Touching others - Hitting others	- Able to successfully and independently transition throughout schedule		- Dictates the schedule and goes back to choice time - Uses avoidance to day work	- Success/ accomplishment in task completion - Increased confidence

3.9.3 Intervention

3.9.3.1 NMT Assessment

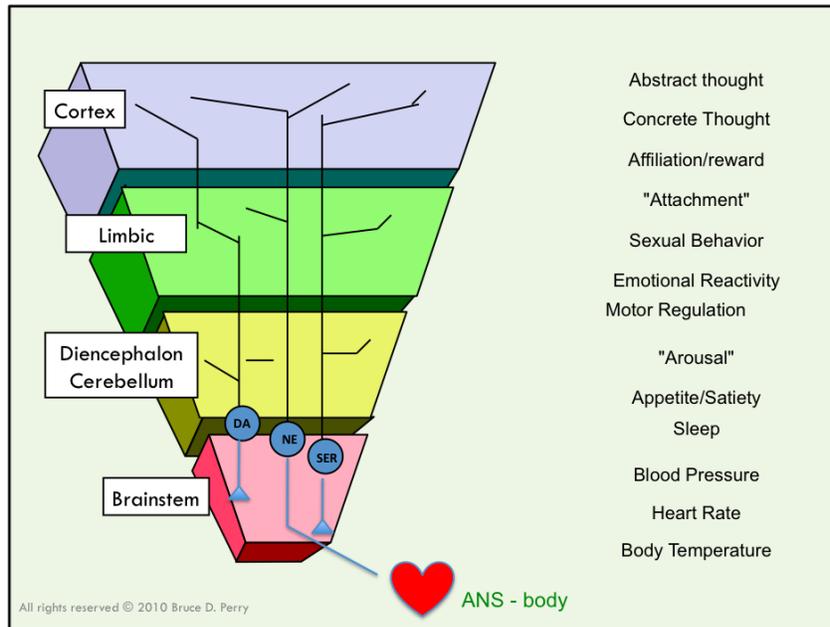
Each child received an NMT assessment. The assessment included an in-depth interview with the parent about the child's developmental history and present functioning (Appendix B). The results of this assessment were shared with parents and recommendations were made in consultation with the parent. In addition, an NME (Neurosequential Model of Education) assessment was conducted with the teacher (Appendix C).

The behaviour plan was created using the recommendations from the NMT and NME assessments in consultation with the parents, teachers, principals and any other agency or service that the family/child was involved with. (Any behaviour strategy that the team was currently using and felt was useful was kept in place. The behaviour plan was followed for about four months. Adjustments to the plan were made in accordance with the child's needs. The NMT behaviour plans are described in Table 5.

The NMT & NME informed behaviour plan focused on creating supports within the classroom, school, community, and home. Adults who work with the participant were educated about NMT core concepts using a visual and verbal explanation.

The concepts that were taught are outlined below.

Fig. 1 NMT Model of Brain Organization



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Table 5.

NMT Behaviour Plan Intervention

Participant	Concepts taught to adults	Individual	Family	School/Classroom	Therapeutic Web
Fred	Basic brain Development Bottom Up Regulation Arousal Continuum	<ul style="list-style-type: none"> - Visual schedule - Somatosensory breaks (Heavy work or jobs) - Social stories - Preload for transitions - Breathing Exercises (six sided breathing) - Work toward gym time with friends at end of the day - Oral regulation – beads around his neck - Sandplay therapy once a week - Increase time in Music and Gym classes - Ipad reward time for following directions - Use of the ALERT program car metaphor to communicate and build awareness around states 	<ul style="list-style-type: none"> - 5 sessions of EMDR with mother to address incidence of trauma from her homeland. - Ipad borrowed and instruction on Choiceworks to help sequence routine to get him to school and other transitions and routines - Social stories - Teaching Arousal continuum through ALERT metaphor 	<ul style="list-style-type: none"> - 5 instructional lesson on the Alert Program taught to the class - Presentation to school on Arousal Continuum and Bottom up Regulation and Co-regulation 	<ul style="list-style-type: none"> - swimming
Gary	Basic Brain Development Arousal Continuum Intimacy Barrier	<ul style="list-style-type: none"> - 5 sessions equine guided development - Visual schedule of day - Duty schedule to manage transitions between structured and unstructured times (holds door when coming in from outside rather than lining up with peers) - Incentive plan for “Keeping hands in own space” and “using kind words” - 1;1 supervision plan through out day and especially non-structured times (recess & lunch) 	<ul style="list-style-type: none"> Support with preparation for court (mother kept taking father to court and asking for more and more unsupervised time) 	<ul style="list-style-type: none"> - Zones of Regulation taught in the classroom (try and make him a helper or leader) - Part of small group that worked on social skills - Classroom levels plan for non-compliant behaviour 	<ul style="list-style-type: none"> - karate - soccer tutor who is older

Table 5.

NMT Behaviour Plan Intervention

Participant	Concepts taught to adults	Individual	Family	School/Classroom	Therapeutic Web
Emma	Basic Brain Development Arousal Continuum Bottom Up Regulation	- Animal assisted child-centered play therapy once a week. - Work in quiet room as alternative space - If disruptive given a warning and then asked to go outside the classroom and count to 30 before coming back in.	- "I love you" bed time rituals - "if I had been there when you were born" statements - 1 session of EMDR with mother to address trauma involved in the adoption process. - OT consulted for sleep routine & recommendations given to mother	- Individual Social Skills coaching	Soccer
Jack	Basic Brain Development Arousal Continuum Bottom Up Regulation	- Sensory room established with swing, music, games, tent - Visual schedule and routines - Timer - learns calm down song - Child-centered play therapy once a week - parallel play with an adult working toward parallel play with another child. - encouragement to use his words	- Family support was accessed through community agency that works with aboriginal families.	- Training of other adults (principal, counselor, youth worker, aboriginal youth worker) who work with Jack about sensory activities, routines, visuals,	- developing safe and positive relationships with people within the school (secretary, lunch ladies)

The NMT model divides the brain into four broad functional areas, starting with the lowest and most primitive area, and building to the highest and most advanced. These four areas of the brain are the brainstem, diencephalon, limbic system, and cortex. These levels are hierarchical in nature and development, and are organized from the simplest to the most complex (Perry, 2006).

The brainstem is the lowest and simplest level. It develops *in utero* and regulates life-supporting functions such as cardiovascular tone and the regulation of arousal, sleep, and fear 'states' (Perry & CTA, 2011). In the NMT approach, it is accepted that the child's brainstem is not fully developed until 9 months of age.

The diencephalon develops most actively from 6 months to 2 years. The NMT metric includes the cerebellum in this level. This level is responsible for the integration of sensory input such as the visual-motor integration required for fine motor control.

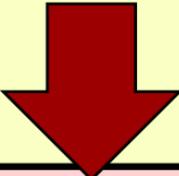
The functions of the lower two levels of brain development are largely automatic and not conscious.

The next area is the limbic system, which develops most actively between 1 and 4 years of age, and governs emotional states and the interpretation of non-verbal communication such as gestures, facial expressions and body language (Perry, 2006). The limbic system is able to evaluate an experience for emotional significance, as well as being the centre of our memory system (Siegel, 1999).

The fourth region is the neocortex (commonly simply referred to as the cortex). It is the highest and most complex region of the brain, with the most cells and most synapses. Its functions include abstract thought, social-emotional integration and sensory integration (Perry, 2006). The neocortex is where integration across senses occurs. There is no area below the cortex that receives projections from more than one type of sensory information. The primary cortical sensory areas develop between 0-3 years of age. It is most actively growing between the ages of 3 and 6 years of age, and the prefrontal cortex and cerebellum are not fully developed until late adolescence to early adulthood.

Fig. 2. Arousal Continuum

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Hyperarousal Continuum	Rest <i>(M > F Child)</i>	Vigilance	Resistance	Defiance	Aggression
Dissociative Continuum	Rest <i>(F > M Child)</i>	Avoidance	Compliance	Dissociation	Fainting
Primary secondary Brain Areas	NEOCORTEX <i>Subcortex</i>	SUBCORTEX <i>Limbic</i>	LIMBIC <i>Midbrain</i>	MIDBRAIN <i>Brainstem</i>	BRAINSTEM <i>Autonomic</i>
Cognition	Abstract	Concrete	Emotional	Reactive	Reflexive
Mental State	CALM	ALERT	ALARM	FEAR	TERROR

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The functions of the upper two levels of brain development are more conscious and thoughtful. When a person receives sensory information from the external world, this information first enters the brainstem and diencephalon, then moves up through the limbic system, and finally the subcortex and neocortex as it is made conscious and understood (see Fig. 2).

How a person thinks, feels and behaves is a function of their mental state. This is called “state-dependent functioning” (Perry, 1995). The calmer a person is the more they can access the higher areas of their brain to think and solve problems creatively. As people become more stressed or threatened, they access only lower areas of their brain, and their thinking regresses to a more concrete, emotional or reactive way of problem solving. If there is an emotionally intense event, a person may become so anxious or fearful that his/her functioning may regress to the point that it is controlled primarily by the brainstem (Perry, 2006). In such a situation, the behaviour is not responsive to conscious verbal (cortex) interaction as a way to change.

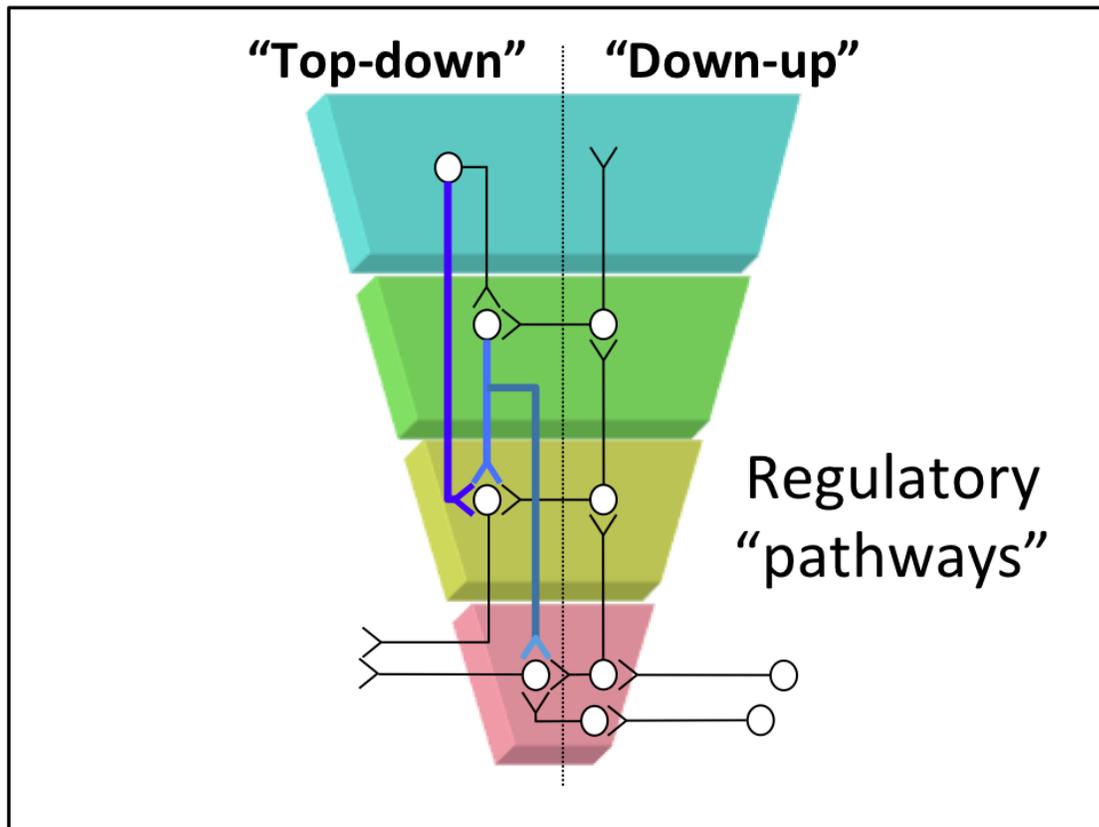


Fig. 3. Top-down vs Bottom-up Regulation © Bruce Perry, reproduced with permission

As described above, the brain is built from the bottom up. The stress response system originates in the lower areas of the brain. If that system becomes dysregulated early in development, that dysregulation will be carried through to the upper brain areas. Thus, the effects of trauma on infants and young children can be more damaging than on adults because they are still growing and developing their response systems. People who are exposed to threat and trauma early in life are more susceptible to the dysregulation of a group of neurotransmitters which include dopamine, serotonin and norepinephrine based

in the brainstem that are responsible for regulating functions such as mood, appetite, motivation, attention, immune function, sleep cycles and anxiety.

There are two ways that a person can help to regulate a dysregulated system. One way is from the top down. This method uses the conscious, influential higher-level brain functions to regulate the lower brain functions. Cognitive Behavioural Therapy is an example of a top-down treatment that functions in this way. The other way in which regulation may be re-established is from the bottom up. This can be achieved through the use of rhythmic, patterned, repetitive somatosensory activity (Kleim & Jones, 2008).

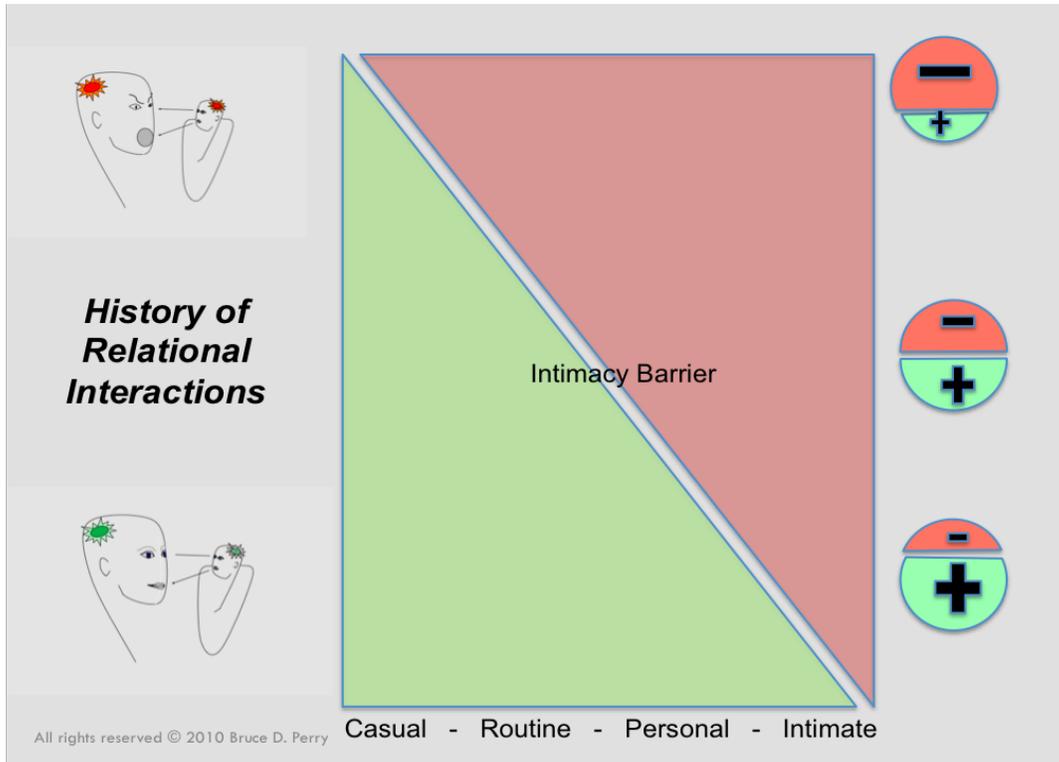
The key to therapeutic intervention is to remember that the stress response system originates in the brainstem and diencephalon. Therapeutic and enrichment experiences must be provided to a child in an appropriate sequence and matched to the child's level of neurodevelopment. In turn, this matching process is dependent upon adequate assessment of the child's development in the key areas of physical/motor, behavioural, emotional, social, and cognitive domains.

How comfortable someone feels with varying degrees of intimacy is a reflection of the template created in their early life about human interaction. A person who grew up in a home with an attentive, attuned caregiver will find casual (person on a bus), routine (the counter girl at Tim Horton's you see every day), personal (friend or teacher), and intimate (close friend or relative) relationships rewarding and pleasurable. A child who grew up

with a neglectful, chaotic or stressed caregiver may find any relationship more demanding than a casual acquaintance stressful and dysregulating.

Fig. 4. Role of Relational Interactions

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Most people are usually somewhere between these two extremes. A child in a classroom that has difficulties with their intimacy barrier may be fine with casual and routine interactions with others, but may become stressed with the relational demands of a personal relationship or too much face-to-face interaction. Such children may react negatively to a teacher trying to engage or connect with them on a personal level. These children may do best when the teacher works with them side-by-side rather than face-to-

face. Parallel interaction rather than face-to-face interaction may be less stressful and deregulating for them.

The child needs to control any interaction that crosses his intimacy barrier. When working with such a child be present, parallel and open to his invitation to engage.

The intimacy barrier is also state-dependent and mobile. A child who is in a calm state may be better able to engage at higher levels of intimacy than a child who is more tuned-up.

Interventions focused on creating healthy relational connections in the context of patterned rhythmic somatosensory activities chosen for their capacity to help regulate the lower brain areas: this included an hour therapy session once a week with a focus on individualized somatosensory activities. A “dose” of somatosensory activities such as walking, bouncing a ball, jumping on a trampoline was worked into the school day. At home a child worked on developing more regulating routines. Activities within the community such as swimming, martial arts, equine therapy etc. were also be worked into behaviour plans.

3.9.3.2 Functional Behaviour Assessment

Each group of three trained student services teachers headed by a behaviour teacher (a teacher who works with children who have behavioural challenges and is familiar with an FBA) was assigned a participant from the FBA cohort and a date by which they needed to

have the assessment completed and ready to provide feedback to the school staff and parents involved. Each group conducted the assessment sequencing through the steps outlined above. The behaviour teacher within each team attended a meeting and explained the assessment and recommendations to the teacher, principal and SEA. The assessment and recommendations were developed into a behaviour plan. The results are described in Table 6.

3.9.3.3 Communication Book

A communication book was provided, with the expectation that this would travel with the child between school and home to facilitate communication between the parent(s) and teacher. In this book ‘out of control incidents’ were recorded and schedules for dosing activities were kept and recorded.

3.9.3.4 Executive Function Testing

Hearts and Flowers and Flanker/Reverse Flanker

The computer and monitor were brought in and set up in a quiet room in the participant’s school. The monitor was placed beside and a little angled away from the computer so the child could only see the monitor in front of them. The chair for the participant sat in front of the monitor while the chair for the researcher sat in front of the computer. Each child was entered as a number. The participant was fetched from his or her classroom or quiet room and before starting, the participant was given a juice box. The touchscreen monitor was set up with a bar in front of it for the participants to rest their hands. The bar was adjusted for each participant so it was an appropriate distance from the touch screen

where the “buttons” were located. Each participant completed a Dino task and a button pushing task before the testing in order to familiarize them with the equipment and task characteristics. The testing included three blocks of the Hearts and Flowers test and three blocks of the Flanker Fish test. The child worked their way through the testing as the researcher gave the instructions printing on the screen and the child performed the tasks. Participants were able to choose a prize at the end of the testing period. When all the pre- and post-testing was complete the computer was returned to the UBC lab and results were printed.

AWMA tests

The computer was set up in front of the child while the researcher sat beside him or her. Each participant was entered into the computer as a pseudonym with their date of birth. The computer gave all the instructions verbally in an English accent. The child responded verbally or by pointing to a spot on the screen. Then researcher evaluated the child’s answer and pressed the right arrow key if the child answered correctly and the left arrow key if not. The test discontinued after the child answered 3 questions wrong in a row. The program then shifted to the next test and the researcher clicked on “start next test” to begin the next test. After the four tests were complete the researcher saved the results on the computer.

Table 6.

FBA Behaviour Plan Intervention

Participant	Setting Event Strategies	Preventative Strategies	Teaching Strategies	Consequence Strategies
Max	<ul style="list-style-type: none"> - Consistent expectations on curricular demands - Create routine and repetitive curriculum (same expectation each day:# of pages, amount of time , etc) - Use the schedule as visual reinforcer of activities planned & indicate that each activity is completed (checked off, placed on another strip, put in a box) - Natural transitions - Mixture of timer & completion point transitions (ie. "in 5 minutes," "after we finish reading this book") - Map out each transition in detail and try to make this repetitive and non-verbal 	<ul style="list-style-type: none"> - "Snack packs" - Creation of healthy snack choices immediately before beginning math work - This switches his request for food from avoidance to helpful - Increasing structure in visual schedule. Laminate specific routines rather than Velcro pics - Simple directive and choices - Clearly define the behaviours you expect. Make them explicit and visual - Practice disengaging from preferred tasks -This will get him accustomed to stopping, starting, making choices, and/or given directives - Try to find/develop curricular buy-in 	<ul style="list-style-type: none"> - Peer work groups - Utilize older peers in a math group - Use timely specific praise as much as possible - Reinforce the daily/weekly goal that he is to work towards -this explicitly states what he is working on and we can therefore provide timely and specific feedback - Token economy -Provide clear expectations and award tokens when this is completed - Provide opportunities to use these - Use this as an indicator of success and communicate this with father 	<ul style="list-style-type: none"> - Daily communication with dad - Success Folder - pictures of 2/3 successful parts of his day - Star Board - display pictures of Max complying and/or being successful
James	<ul style="list-style-type: none"> - Home communication - Regularly scheduled sensory breaks - BWN Classroom (identify areas that he can work comfortably with lots of personal space - Small group/Co teaching opportunities 	<ul style="list-style-type: none"> - Visual work-break schedule - Pre-correct strategy - Social Stories - Front load expectations and routines - Contingency statements 	<ul style="list-style-type: none"> - Friendship group - Social thinking (expected/unexpected) - Incentive plan/Token reinforcement - DRL (differential reinforcement of low rates of behaviour) 	<ul style="list-style-type: none"> - Ignore - Redirect the group or individuals - If student is able to raise his hand and use tickets, the teacher will provide immediate verbal praise - If student is able to stay within desired amount of tickets for the predetermined amount of time, provide praise as well as the chosen reward or reinforcement - Minor: Call out 1) Contingency statement (redirect to ticket system/reward) 2) If continues: response cost warning: student won't receive a check for the time period 3) Follow-through with response cost

Table 6.

FBA Behaviour Plan Intervention

Participant	Setting Event Strategies	Preventative Strategies	Teaching Strategies	Consequence Strategies
Andy	<ul style="list-style-type: none"> - Reduce # of different adults providing support - Tri-cities Mental Health follow with peer play group - Breakfast and Lunch program and extend his day will offer him more social opportunities - Give more time to process verbal directions - Create a "First/Then" routine with choices - Make predictable work/break schedule -Use I pad activities for fine motor - adapted curriculum - complete sensory profile check list 	<ul style="list-style-type: none"> - Scheduled attention breaks - Social skills /self-regulation instruction - Sensory Breaks - Incorporate student preferences - use non distracting location for work - Visual supports /pictorial directions - use computer and ipad - extend day through lunch to build attachment to peers 	<ul style="list-style-type: none"> - Regular check in with teacher - provide security/stability/sensitivity - Zones of Regulation to class - Calming strategies - Shape of the day organizer - Verbal pre-corrects "remember to . . ." - Adapt/modify expectations - Incentive plan - Visual cues/Timer - Review daily schedule - Social skills instruction - Teach recreation skills or socially acceptable behaviours that have similar sensory consequence as behaviour (hide and seek) - Identify preferred activities for incentive plan (computers) 	<ul style="list-style-type: none"> - Immediate praise/reward - Positive reinforcement - Incentive plan - Sticker system - Computer/ipad time - Time with significant adult - Debrief - Social Stories - Articulate visually - Safety plan - IEP update
Dan	<ul style="list-style-type: none"> - Home Communication - Regularly scheduled sensory breaks Body break in the morning - Use of the schedule as a visual reinforcer of activities planned (make one for his desk) - Natural transitions (use timer with clear expectations for each transition) -Social skills- support navigating social interactions with peers 	<ul style="list-style-type: none"> - Visual work-break schedule - "Snack packs" (schedule in healthy snack choices) - Front load expectations and routines - Choice zone - Connection – quick check in the morning from teacher - Limit distractions at the carpet - Alternative activity for transitions from centers to clean up. 	<ul style="list-style-type: none"> - Token economy (sticker chart, clear goal/expectations and reward when completed, short periods of time) - Use timely specific praise as much as possible - Identify opportunities to connect one on one - Written activities – provide small white board for him to copy from. 	<ul style="list-style-type: none"> - Ignore - If student is able to get desired number of stickers then receives a predetermined reward or reinforcement - Success folder (pictures of Dan being successful/complying)

3.9.4 Data Analysis and Interpretation

3.9.4.1 Visual Analysis of Single-Subject Multiple Baseline Design Data

The study investigated whether there is a functional relationship between the implementation of a child following a behaviour plan based on an NMT assessment and the child's behaviour following the introduction of the intervention, as compared to the child's behaviour during the baseline period (i.e. prior to the intervention).

Data were collected and information graphed and analyzed continually until the study was completed. Information was collected according to the schedule set out above, and plotted in graphic display. The patterns in the data were studied as they are determined and any adjustments to the intervention were made according to the data collected.

Level, trend, and variability of the pattern was evaluated upon completion of data collection. Generally accepted rules with regard to evidence obtained from single-subject multiple baseline research designs were followed in interpretation of the findings. These are as follows:

1. If there is a clear visual change in the direction of treatment during the intervention phase showing an improvement over the baseline phase, then there is a basic effect.

2. The degree of a basic effect is determined by the extent, in this case, to which data points recorded during intervention (i.e. participant) reflect a change in the desired direction (i.e. improvement) over baseline.

3. When evaluating 4 single-case studies which have been subjected to the same intervention, it is generally accepted that if 3 out of 4 of those studies demonstrate a basic effect, it would be concluded that experimental control has been established, in other words, that a significant effect has been demonstrated for that intervention.

3.9.4.2 Social Validity Evaluation

The construct of social validity is a key feature of single-subject research (Kazdin, 1982). As this research is being done in an educational setting, the impact of the intervention within the classroom context is important to assess. The aim of the evaluation is to receive feedback about how effective and functional the interventions were in helping the classroom teacher understand and support the child's regulatory difficulties. Social validity was measured by a 10-item questionnaire using a Likert scale format (Appendix G). Each classroom teacher who had a student involved in the study was asked to complete the questionnaire in May (near the end of the intervention). The questionnaire was developed by the researcher with questions aimed at identifying how the teacher viewed the suitability of the assessment, how effective they found the assessment for the child and how effective they found the process for themselves.

3.9.4.3 Analysis of Social Validity

Data were analysed by summarizing the number of response options that were selected for each of the research questions as pertains to both the NMT and FBA cohort. The mean and range of responses for each cohort is reported.

3.9.5 Executive Functions Measures

For the Hearts and Flowers and Flanker/Reverse Flanker tests, accuracy and response time were compared. Calculations were made for each trial in each block for each child, as well as calculating an average for both the NMT and FBA cohort. For all calculations, response times of less than 250 ms and practice sessions were excluded. For the response time analyses, only trials on which a correct response was given were used, the first trial of each block was excluded, and response times that exceed an upper or lower threshold of two standard deviations outside the average were excluded.

Flanker Effect was calculated by subtracting the speed on the congruent trials from the speed on the incongruent trial on the Flanker/Reverse test. Only correct responses were included in the calculation.

The two data sets (i.e., Hearts & Flowers and Flanker/Reverse) were analyzed separately. A within-subjects analysis (trials within subjects) of the difference between the pre- and post-session tests was made by a repeated measures ANOVA with both groups combined.

When comparing the FBA and NMT groups, the data were analyzed with trials nested within subjects for each participant. Accuracy (dichotomous at the individual trial level) was analyzed using a generalized estimating equation with a binary logistic model to account for correlation in repeated binary measurements of individuals. RT (a continuous variable) was analyzed using a linear mixed model that took into account multiple trials per participant. A log transform was computed for post- and pre-session RT. When comparing sessions, the untransformed difference value of RT (post-session minus pre-session RT at the trial level) was computed. (As accuracy is a binary value at the trial level, the post-session value was entered as the dependent value, with the pre-session value entered as a covariate.)

The AWMA provided standardized scores with a mean of 100 and a standard deviation of 15 (85-115). A low standard score is within the range of 70 and 85 while a high standard score is within the range of 115 and 130. As described in more detail below, the AWMA yielded inconclusive results and proved to be beyond the capabilities of any of the participants, none of whom completed an acceptable protocol. For this reason, no analysis was conducted.

3.9.6 NMT/NME

The participants in the NMT cohort were given pre and post NMT and NME assessments. The pre and post NMT metric of each participant was compared. The pre and post NME mini maps of each participant were compared.

For each participant the Cortical Modulation Ratio calculated by the NMT metric was compared to the Executive Functioning Score calculated by the NME mini map.

Chapter 4: Results

4.1 Assessment and Behaviour Plan Data by Cohort and Participant

To provide a more detailed perspective on the roles of the team members in development and implementation of the program for each of the child participants, a more detailed description is provided here with regard to the assessment and the behaviour plan subsequently developed. Information is provided about each child's diagnosis, history and background. For the Intervention section a summary of key activities and events that occurred during the intervention is provided for each child.

4.1.1 NMT/NME Cohort

4.1.1.1 Frank

- **Diagnosis:** Reactive Attachment Disorder (RAD). ACEs score estimated at 5.
- **History:** At the time of the study Frank was a seven-year-old boy in grade 2. He enjoyed Lego, technology and music. He enjoyed playing sports. He lived with his mother and father. He attended school from 1:00-3:00 each day.
- **Background:** Both Frank's mother (Kate⁴) and his father (Adam) were refugees from Iran, with a history of trauma in their home country. When Kate got pregnant with Frank she was living alone, couldn't pay the rent, and went to live at her brother's house which had been empty for some time as he was in jail. Kate was depressed

⁴ Names of all the participants, including parents and school personnel have been changed to preserve privacy and confidentiality.

after Frank's birth, and was not identified as such until Frank was 5 months old. At that time, she was connected to a group of mothers and learned about toys and play. At 17 months of age, Frank was taken to the doctor because of concerns with his language development, and accessed services from Infant Development. He received Theraplay and psycho-educational sessions until he was three. Frank was given an aide to help him in preschool groups. He was asked to leave three preschool placements due to his aggression. Frank had difficulty in kindergarten due to his aggression. Kate took him out of school for kindergarten to home school him. He was back in a different school for grade 1, but was pulled out again at Christmas to be home-schooled. Adam was addicted to drugs and was not a consistent father figure in his life until Frank was 3.5 years old, when Adam quit drugs and Kate and Adam began to live together. Kate and Adam had a complicated relationship, with opposing parenting styles and seemed to have very little they agreed on. Kate had connections to her family, although her relationships with her sisters and brothers tended to be problematic. Frank had a series of lung infections starting at 2 months, 14 months, 29 months and 3 years. After each lung infection Frank would take 7-8 months to recover. Frank has had chronic constipation and frequent vomiting throughout the day since he was 2.5 years old. However, this has gotten better with the removal of gluten from his diet.

- **Problems in school at intake:** Frank escalated quickly within the school setting when he did not get his way. He had difficulty with transitions and had a need to finish one thing before he began another. He liked peers but did best with boys who were "passive" as he liked to have things his way. When he escalated, he would

throw things (chairs, shoes), or tantrum. Sometimes he could be distracted from his negative focus, but at other times it was much more difficult to divert his attention. His teacher noted that his mood was unpredictable and sometimes he would have a good day and sometimes he would be “off”. Frank was sent home regularly for his explosive behaviour. Mother was concerned that the school did not promote her son’s creativity, and would sometimes blame the school. She stated that Frank is aggressive to others because he is protecting what he has and she supports this as he is not allowing others to bully on him.

- **Problems in home environment at intake:** Frank’s mother, Kate, repeatedly pulled him out of school in order to home-school him, typically after escalating conflicts with the school. This appeared generally related to her disagreeing with the school’s responses to her son’s behaviour. He went back to school for grade 1, though in a different school, but was pulled out again at Christmas to be home schooled. At the time of starting the intervention, Adam wanted Frank in school and Kate wanted him home-schooled.
- **Assessment and behaviour plan:** Ms. Smith (teacher), Ms. Ellis (behaviour SEA), Mr. McGregor (principal) and Mr. Murray (district behaviour teacher) were all at the feedback meeting about the NMT/NME assessment. The 3 school staff members were responsible for carrying out the behaviour plan. They were concerned about taking Frank out of the class for somatosensory breaks as they felt they had spent the first part of the school year getting him to stay in the room. They agreed to try some bottom-up activities on a regular basis in the afternoon, in conjunction with what they already had going on. All the strategies/interventions listed in Table 5 were carried

out within the next four months. A separate feedback was done with the mother. She appreciated the arousal continuum concept, and felt it accurately reflected of her son's issues.

- **Intervention (February – May)**

- **February** (Out of control incidents = 3)

- I met with Kate to see if I could help with working some routines into Kate and Frank's home to school schedule. Although Frank was reported to like school, his mother dressed him for school as he did not want to stop what he was doing to get dressed. We used a visual schedule on an iPad. We worked on a routine aimed at getting Frank to dress himself, taking his backpack, getting into the car, and getting out of the car with only his backpack. We worked on that for about two weeks.
- Frank appeared to have some oral sensory issues, so we tried to get him something to put in his mouth that was age appropriate and that he could suck on during school which might of helped regulate him. His mother got him a necklace that he liked, and seemed to work well enough, until Kate reported that the father told Frank that he would get cancer from sucking on the necklace, and following this, he would no longer use the necklace.
- We tried to work some regulating activities into Frank's routine. The transition to the activities and back from the activities was an issue as it tended to escalate him. The type of sensory motor activity was also an issue. Several prior unsuccessful attempts included ball bouncing in the gym and

feeding the paper into the paper shredder. Frank seemed to need an activity that involved heavy lifting or pressure. Giving Frank “jobs” seemed to work best. For instance, collecting the recycling from classrooms, putting the lunch time gym equipment away after lunch, carrying books back to the library, taking the attendance to the office. The issue with these tended to be the lack of routine, somedays it would happen and other days it would not.

- I tried to get Frank to the pool once a week, as this seemed a good activity to help him regulate his emotional state before school, but the transitions out of the pool and to school continued to be challenging for him, and school staff reported this not to benefit Frank’s afternoon at school.

March (Out of control incidents = 2)

- Kate seemed to spend some time talking about her experiences in Iran and was quite emotional about it. I asked her if she wanted to do some EMDR around those events. She agreed. After the two sessions, she came back looking like a different woman. Her hair was done and she was smiling. After the third session, she was telling me she was getting to the gym regularly and showed me the meditation apps she had downloaded onto her phone. When I ended the sessions, she was interested in upgrading her training so she could go back to work (I was subsequently informed that this did happen the following school year).
- I put together a number of social stories for Frank around expectations in the school. The social stories seemed to work well with Frank for home routines or events like going swimming, however, the school did not find them useful.

April (Out of control incidents = 1)

- The school decided to have Frank join more somatosensory activities in his afternoon in the form of a gym or music class which would allow for bottom-up regulation.
- The teacher in the classroom was using the Minds-Up program.

Unfortunately, Frank missed most of the lessons on this as he only came in the afternoon. I did four lessons from the ALERT program with the class. The teacher stayed for three of the lessons, and she did incorporate the concepts and vocabulary into the classroom discussions. I also taught the program concepts and vocabulary to Kate. She found the concepts useful and used them to describe her own feelings as well as those of her son.

May (Out of control incidents = 5)

- Frank had a scare at a neighbour's house while they were watching a scary show on the TV. After this, he started to become quite fearful, especially of the dark and was having a good deal of difficulty with sleeping alone. His father ended up having to sleep in the closet in Frank's room. He started to bring toys to school. He was quite attached to a yellow Pikachu toy. On some days he would be able to put it in his backpack when asked and on other days he would not do that and the toy would make its way into the classroom and disrupt the lesson and the classroom learning.
- The behaviour teacher, behaviour SEA, teacher and principal worked together on a safety plan as Frank had started running outside and onto the road when escalated. The team used the concepts of arousal continuum idea with the

ALERT vocabulary to make up a safety plan which identified Frank's state on the arousal continuum and what activities or interactions bring him down into the 'green zone' and what activities or interactions escalate him up into the 'red zone'. The focus was on co-regulation and for the adults who worked with him to identify his state and to intervene to bring him down the arousal continuum rather than move him up the continuum to an elevated state where he is running into the road.

- I gave a talk at the school's staff meeting about the arousal continuum, identifying a student's state of ANS arousal, and actions that would likely de-escalate behaviour and those that would likely escalate behaviour.
- **Overview:** Out of control incidents before intervention: Nov.=3, Dec.=4, Jan.=5.
 - Although I was scheduled to see Frank once a week for play therapy, this was not consistent. Although I had organized a room to be available for me on a scheduled day, it was not always available, and attendance, special events, and willingness of the school made the process difficult to get a good routine in place.
 - Frank increased his time at school to 4 hours 15 minutes (10:45 AM – 3:00 PM) by the end of the school year.
- **Successes:** Kate seemed to benefit from the work we did and Frank was not pulled from the school to be home schooled as he had been in the past, and appeared to be at imminent risk of when I started the intervention (after another confrontation, on this occasion with a school district superintendent). The district behaviour teacher who was working with the school was able to adopt some of the Neurosequential Model

concepts and use them with the other schools he was working with. He reported that he really liked the model, found it useful and wanted to learn more about it.

4.1.1.2 Gary

- **Diagnoses:** Post-Traumatic Stress Disorder (PTSD), Reactive Attachment Disorder, Anxiety Disorder, ADHD. ACEs score estimated at 8.
- **History:** At the time of the study, Gary was an eight-year-old boy in grade 3. He enjoyed Lego, technology, and animals. He enjoyed playing sports and running. He liked looking at books and watching movies. He lived with his father and step-mother. He attended school for a full day.
- **Background:** Tammy (mother) immigrated to Canada from India when she was a small child and lived with her Uncle or Aunt. She was living with John at the time she became pregnant. John reports that he was drinking heavily and was working night shift. Gary was a difficult baby. He was colicky and he cried non-stop for 3 months. Tammy was diagnosed with post-partum depression when Gary was 4 months old. John's parents became involved. The relationship between John's mother and Tammy was strained and there was arguing. When Gary was 9 months old, John came home and Tammy and Gary were gone. John claimed that he had no warning of her departure nor a reason why she left. When Gary was about 1 year old, John was able to locate them through the Ministry of Children and Family Development. Gary was removed from his mother's care when he was 5. The file indicates that he was exposed to 'inconsistent and inappropriate parenting, physical abuse, neglect, parental conflict, and exposure to his mother's suicide attempt.' He was then placed with his

paternal grandmother, and two months later, Gary was placed in the care of John and his common-law wife Ruth, where he has been ever since. Ruth, reports that when Gary came to live with them he was not toilet trained and did not dress himself. She said he was like a little doll who would just stand there while you dressed him. She reported that when she was spray cleaning the windows one day he told her that he did not want that in his eyes. Gary received 3 years of play therapy. Tammy has been in and out of treatment facilities. More recently, she reported having undergone a religious conversion, and during the year prior to the present intervention, she had been pushing for more unsupervised visitations through the courts. Gary is reported to be scared of his mother. Currently, she has him every second weekend and Wednesday afternoons. Gary was in a very structured classroom with an attuned teacher. She taught four out the five days with a second teacher working the fifth day. On the day the regular teacher was not there the classroom lost its structure and tended more towards chaos.

- **Problems in school at intake:** Gary had difficulty keeping his hands and feet to himself and positively interacting with others. He intimidated other students. He had a history of aggressive behaviours (e.g., the previous year he took a pencil and stabbed another child in the arm, causing the child's arm to bleed; recently, he was found choke-holding a child in the washroom). He threatened others and showed sexualized behaviours (for example on one occasion he grabbed at another boy's privates and made pumping actions while grabbing him from behind.). The other children were afraid of him. When I spoke to John (father), he expressed the belief that his son was bullied at school, and that is why Gary got in trouble.

- **Problems in home environment at intake:** Gary's mother has repeatedly taken the father to court, asking for more and more visitation time with Gary, and the court tended to grant her these requests. The father was worried that this increase in visitation time was causing his son stress. John had lost two jobs that year because of having to deal with his son's misbehaviour and meetings and times that his son was sent home as well as the constant court appearances and interactions with Gary's mother which tended to be explosive. John felt like he was run out of resources to deal with his child and his child and family still needed supports.
- **Assessment and behaviour plan:** Ms. Green (teacher), Mr. Cart (counsellor), Ms. Kelly (principal), John (father), and Ruth (step-mother) were all at the feedback meeting about the NMT/NME assessment. The three school staff listed were responsible for creating the behaviour plan. The majority of Gary's problems occurred during unstructured time at recess and lunch, which made the behaviour plan more focused on those times and the responsibility of the principal and the counsellor. The school was being trained in the Zones of Regulation, which encourages 'body breaks' throughout the day. Other dosing activities were proposed, but Gary could not be out of the classroom unsupervised. The SEA who was in the classroom was there for another special needs child and there had been some issues about Gary's negative influence on this child, so pairing them up for a schedule of breaks was not appropriate. Karate and soccer were suggested for community activities. The father felt at the time that this was not possible due to scheduling issues. All the other strategies/interventions listed on Table 5 were carried out within the next four months.

- **Intervention:** 2nd week in February – 2nd week in June

February (Out of control incidents = 0)

Gary had difficulty with escalating when doing physical activities. The first times I met him we played outside with a ball. By the end of the sessions he was escalated rather than calmed down. This would come into play during recess and lunch when he would want to play soccer but would end up hurting others or getting into a conflict to the point of being banned from playing soccer at break time.

- The feedback to the school centered around the Intimacy Barrier. In order for Gary to deal with his need to be in control of his interactions, he tended to feel safe only when he was in control or being controlled by others. He played best with younger children or older children. Also he was socially and emotionally much younger than his peers. The principal seemed to understand this to mean that she should talk with him using simple sentences and concepts around behaviour, and to talk to him about his interactions like he is four years old. It was my impression that this was a useful perspective for her to take.

March (Out of control incidents = 2)

- The school was being trained in the “Zones of Regulation” program. My recommendation was to involve Gary as a helper or leader when the counsellor came in and taught it. The teacher was also very good at integrating the program into the day and taking “body breaks” on a regular basis throughout the day which is a recommendation of the program. These are

somatosensory breaks that fit with the Neurosequential Model's recommendations.

- At home, his father and step-mother were very disturbed by Gary's mother who kept taking them to court and asking for more visitation, which was generally granted. Their concern related to their observations that Gary seemed to do well as long as the visitation was not too long, but as the visits had become more frequent, including overnight, Gary had become more anxious, with more incidents at school as the visitation became more frequent.
- There were some attempts to get Gary involved with a big buddy for some soccer skills or get some funding for Martial Arts, but neither of these ideas worked out.

April (Out of control incidents = 1)

- As regards potential interventions, play therapy was considered as an option, but was rejected as not only had he already had 3 years of play therapy, but I did not believe he felt safe enough in a school or with me to make it a useful intervention. Gary liked animals and animal assisted therapy seemed a more promising option. He was granted 10 sessions of Equine Guided Social Development, funded by the school, where he would learn to interact, guide and care for a pony. Once a week, I would drive him to equine therapy. He was very anxious while driving in my car so I would set up the back seat with a bottle of water and two snacks that he could eat on the way to his horse session. This routine seemed to work well and seemed to help manage his anxiety. He really liked to go each week.

May (Out of control incidents = 1)

- Concern regarding sexualized behaviour became more prominent, and Gary was referred to the SHIFT program in the community to deal with his sexualized behaviours.
- Gary threw a rock which hit a female classmate in the spine. She was taken to the hospital for x-rays. Gary threw a stick at another girl that scratched her face. He was suspended for a day and was then permitted to return to school after a meeting with the parents. The girl was now very clearly frightened by him and moved schools. After this incident, he was watched very closely by adults at all the time. It was of note that Gary responded well to that kind of structure and surveillance.
- **Notes:** Additional reported incidents: Dec.=2, Jan.=2.
- **Successes:** Gary enjoyed the horses and continued with equine therapy and learned to ride a horse the following year. The school was willing to fund this. He had a very good instructor. He made a connection to the horse he was riding and the staff at the therapeutic riding academy were very supportive. He successfully participated in a horse show and his grandmother, step-mom and father came to watch. The staff at the school tried to understand the concepts. They said that they found the Intimacy Barrier concept very useful in understanding Gary. I ultimately had to explain it a number of times in different contexts. I believe that the incident around the rock throwing would likely have gotten him moved to a different school, if the school had not been so invested in him and the family. By the end of the intervention, Gary was

able to begin to take some responsibility for his actions, again representing a significant change compared to the start of the intervention.

4.1.1.3 Emily

- **Diagnosis:** Disinhibited Social Engagement Disorder. ACEs score estimated at 4 (early life was spent in a Russian orphanage with minimal care or attention).
- **History:** At the time of the study, Emily was an 8-year-old girl in grade 2. She enjoyed using the computer, playing Minecraft, Lego, and doing her Rainbow Loom. She was good at soccer and played on a recreational team. She lived with her parents and older brother, who was also adopted and has a diagnosis of FASD. She attended school full-time.
- **Problems in school at intake:** She had difficulty with focus and self-control. In Kindergarten and Grade 1 she was regularly sent home due to her inability to control herself (hitting, screaming, poking). This year she was doing better. Her afternoon was more difficult to get through than her morning. According to her teacher, Emily had some difficulty at the beginning of the year. She tended to gravitate towards another student and together they dysregulated each other and caused all sorts of problems. Since this student had moved and left the school, Emily was more focused and regulated. She had difficulty socially. She tended to touch everything and everybody. When she wanted to interact with others she would repeatedly get in their space, touch and poke them. The other children get tired of her. She does not seem to register this. In the classroom in the mornings, Emily often sat on the carpet with her two fingers in her mouth and her arms

intertwined. When she was having difficulty, the teacher asked her to go outside and count to 30 and then return. This seemed to work. During Gym she had difficulty following the rules of the game and spent some time spinning in a spot away from others.

- **Problems in home environment at intake:** Emily's mother, Martha, was more concerned with Emily's behaviour at school than at home as her older son was her main concern at home. Martha was very aware of international adoptions and was in contact with agencies and supports. Emily did have some sleep issues.
- **Background:** Little is known about the birth mother except that she was Russian, and was 15 years old at the time of giving birth. Emily was born in a hospital and was immediately put into the orphanage. The orphanage was very large and had three different levels with 6 or 8 different groups of 20-30 children each. Each group had about 3 adult caregivers. The staff at these orphanages were not paid well and there is a high turnover. "Sad" is the word Emily's mother used to describe the place. At the age of 3, Emily was the oldest in her group. Emily's mother reports that many of the babies and children had obvious special needs. Emily's mother said the facility was nice with a playground all around and a lovely playroom inside. She later learned that Emily never played in the playroom as it was reserved for therapy for children with mobility issues. The parents (Brent and Martha) met Emily at the orphanage when Emily was 3 years old. Her mother described her as a "spitfire". She had been on anti-psychotic drugs (so she wouldn't scream and screech) up until her 3rd birthday when they took her off the medication because she was going to be adopted. When her parents first met her,

she was really tiny but very alert. She was a fast talker and fast mover. She was underweight. The orphanage had identified her as hyperactive, language-delayed, and had perinatal encephalopathy (Martha reports that all Russian babies in orphanages are given this diagnosis). Emily was told at this time that Brent and Martha would be her parents and then had no contact with them for 6 months. After 6 months (a lot of stress over badly handled adoption bureaucracy and delay), the parents returned to the orphanage to pick Emily up and take her back to Canada. Emily was angry because they had not taken her with them the last time they left. Emily was still small for her age, but her hair was longer because they had let it grow out. There was some unprocessed paper work and there was a further 2-week delay. Brent had to return home. Emily stayed for 2 weeks in a hotel room with Martha, with no translator present, while the custody order went through. Martha found this very stressful. On the plane ride to Canada, Emily screamed the whole time (laughing, screaming, laughing-screaming), and her mother felt she liked to hear the echo of the sound in the plane. A Russian woman on the plane reportedly said that Emily swore like a sailor, and called her mother a stupid foreigner. At home there was a brother who was then 5 years old, who was also an international adoptee. The family bonded well. Emily picked up English quickly and was talking only in English after one month. Mom stayed home for a year. She tried putting Emily in various activities such as swimming and dance but she was always asked to leave due to her behaviour. In Preschool, Emily couldn't sit still and was constantly touching and poking others. Kindergarten

presented similar difficulties. She was sent home regularly. Teachers suggested that she had ADHD.

- **Assessment and behaviour plan:** Ms. Corner (teacher), Ms. Silver (counsellor) were at the feedback meeting about the NMT/NME assessment. The counselor and teacher were responsible for creating the behaviour plan. Emily's social relationships were the larger concern of both the counsellor and her teacher. Her teacher ran a very structured classroom and had a calming presence. There was no interest in dosing, however, Emily was aloud breaks to the water fountain when asked. The teacher's classroom strategy was to warn a child once about their behaviour and then if the behaviour continued she asked the child to go outside the classroom and count to 30 and then come back in. All the other strategies/interventions listed on Table 5 were carried out within the next four months. A separate feedback was done with the mother.
- **Intervention:** 3rd week in February – 2nd week in June

February (No out of control incidents were reported (throughout, Emily's difficulties appeared to be primarily social in nature)).

- Martha had no great concerns with Emily besides school. In the interview she talked about Emily's sleep problems. Emily's self-soothing with her fingers in her mouth was something I suggested a necklace but after looking at it Martha felt Emily would not go with it so it was never tried.
- I worked with Emily doing play therapy with a dog. The therapy was not consistent due to fieldtrips, room confusion and such. She did love to come to play with me. She was a bit indifferent about the dog but eventually warmed

to her a little. Her themes were centered around family and the home. Play also included themes around the early experiences of lining up to breakfast and going to the beach with the family.

March (Out of control incident = 1; social, in playground)

- There were also some bullying issues at school that seemed to come up, with Emily being bullied by another girl.
- After talking to our district OT about the sleep issues, I sent some suggestions on to Martha, including, a water bottle with a narrow opening so she can suck the water out which may provide an alternative self-regulating activity to the fingers in the mouth. Things to try in regards to sleep with Emily included a warm bath before bed, limiting screen time, white noise, and a heavy sleeping bag or blanket. I also suggested some rituals from the book *I love you rituals* by Becky Bailey to be included in the routine. Another suggestion was to model some self-calming techniques like breathing, progressive relaxation and yoga.

April

- The counsellor at the school did some social coaching with Emily around social interaction and help with conflict. These usually were based in real world situations. The counsellor found that a very concrete, black and white style of coaching seemed to work best with Emily.

May (Out of control incidents = 2; social, in playground)

- I asked if Martha was interested in doing some EMDR with the trauma that was associated with the adoption process. She agreed and we had one session

which she was very happy with, and felt had cleared away much of her distress in this regard. At the beginning she said she was frustrated with Emily's behaviour during the adoption process, but at the end she seemed to appreciate how the adoption process was traumatic for her daughter, as she was being taken from the only home she knew into a world that did not speak her language.

- I suggested including some “If I had been there when you were born” statements for the bedtime routine.
- **Successes:** The EMDR session seemed to work well with Martha and she was pleased with it. At the end of this process, she was able to demonstrate more compassion with her daughter's trauma history after she had dealt with her own.

4.1.1.4 Jack

- **Diagnoses:** ADHD; Developmental Coordination Disorder, Language Disorder. (ACEs score estimated at 4)
- **History:** At the time of the study, Jack was a six-year-old boy in grade 1. He liked to count. Enjoyed pretend/imaginative play. He lived with his mother and three older sisters. He was given a diagnosis of ADHD by two different pediatricians before he was 6 and a diagnosis of a Language disorder and Developmental Coordination disorder by Sunnyhill Hospital. His behaviour was better when on medication but he was still aggressive towards peers. He was in school all morning. He attended school from 9:00 – 12:00 each day. He had an SEA from 9:00-10:30 each day. He worked well one-on-one but continued to have difficulty

with peers. He interacted best with peers when outside with one or two other children. He had more difficulty in the classroom in larger groups.

- **Background:** Jack was of aboriginal ancestry on this mother's side. Jack was the fourth child of a single mother on a limited income. Each of the children had a different father who was not in their life. All of his siblings were girls. The oldest was in high school. The second oldest was in middle school, had a diagnosis of ADHD and was being home schooled due to issues of bullying. The third child was in grade 4 and was moderately intellectually impaired. Social Services had been involved with the family on and off for years. At one time one of the children was removed for a number of months. Mother noted that for the first 3 months Jack never slept. She noted that he always needed something in his mouth (breast, formula bottle, soother) in order to stop crying. Mother said he was "always attached" to her. He was always hungry and jumpy and easily startled. The mother was distressed with the crying baby and didn't know what was wrong with him. He did not make cooing noises. He received physiotherapy at the local hospital for the torticollis from the age of 3 to 9 months. At age 3, the family moved to a bigger apartment in the same complex. He had no problems being toilet trained (did not like the feel of a wet or dirty diaper says his mother). When Jack was 5 years of age, he was taken to hospital for a high fever. According to his mother he never slept more than 1 hour a night between the ages of 4-5.5 and now takes melatonin that had helped a lot. He entered kindergarten and had great difficulty. He was often sent home. His mother says during this time he would kick and hit her and the daycare worker "they had bruises". She said sometimes

he would be in this elevated state until bed time. When Jack was 5 the family moved in with mother's parents for 6 months. Mother explains that this situation was abusive (a lot of yelling, verbal fighting, put-downs) and a social worker arranged another place for her family to move. Jack started grade 1 going to school from morning to recess with no SEA and a random schedule of staff looking after him with little consistency between the staff. In January he began to attend school from 9:00 to 12:00 with a similar random schedule of staff. At the beginning of February he received an SEA from morning to recess. His SEA is very attuned and knowledgeable about sensory issues.

- **Problems in school at intake:** Jack was described as aggressive towards his peers. He did not follow directions, and would walk out of the class. He had been on medication twice for short periods of time (in the fall of kindergarten and in the fall of grade 1).
- **Problems in home environment at intake:** He is the 4th child of a single mother. His mother reports that he is very cruel to the cats that live in his home but not to the large lizard pet. She would like to have him diagnosed with autism. She is very unhappy about him not being in school full-time.
- **Assessment and behaviour plan:** Ms. Tanner (teacher), Ms. Gold (behaviour SEA) were at the feedback meeting about the NMT/NME assessment. The SEA was essentially responsible for Jack's plan as he rarely was in the classroom. The SEA worked with Jack from morning to recess and there was a list of 5 other adults (counsellor#1, counsellor#2, youth worker, aboriginal education youth worker, principal) scheduled throughout the week who took him from recess to

lunch. I never had any contact with the other adults and they were not at the initial feedback meeting. All the other strategies/interventions listed on Table 5 were carried out within the next four months from morning to recess.

- **Intervention:** 4th week in February – 2nd week in June

February (No out of control incidents recorded)

- Jack had a very attuned SEA, who was well trained in sensory needs. The school was able to follow the sensory needs and suggestions made by the District Occupational Therapist. A room was created for Jack with a swing, so he could take sensory breaks. The SEA created structured sensory games within the room, where Jack was able to go throughout his day to help to regulate himself. She demonstrated the ability to observe him carefully and provide him what he needed in a timely fashion. The SEA made use of sensory integration activities integrated repeatedly into his day. She also would get him to use his words when he wanted something, rather than acting out as had been his tendency prior to the intervention, and helped him develop a vocabulary around asking for what he needed. Her interactions with Jack, in essence, served to co-regulate him and assisted him in developing a more functional sense of agency.

March

- Play therapy was very consistent with Jack. He loved it and at the end of the year when the class was doing Father's Day cards, his SEA asked who his favourite person was at school so he could make a card for them, and Jack made a card for me. Jack loved dramatic play. We would play out themes of

monsters, progressing over time, with guidance, to incorporate themes of safety and things he liked, such as birthday parties.

- The SEA began to notice that he was sometimes hungry when he came to school and that some fruit or yogurt in the morning or at recess often helped him have a better day.

April

- The SEA made an attempt to train the other staff members who had the responsibility to take Jack from recess to lunch to use some of the transition routines, language, and somatosensory activities in order to help regulate him from recess to lunch. This showed limited success.

May

- As Jack's functioning improved, the SEA used the knowledge of the arousal continuum to move him up to regulatory activities and again the attunement of the SEA made it possible for her to personalize this intervention. Together they created a story of "fire boy" (his words) and the "dragon's den" (his words). When he was feeling like he needed a break then they would come into the dragon's den (well-structured routine with rules) where he would feed the dragon some water and food if he wanted it and then go inside his tent and shut out the lights and sing the calm down song. He was taught to go into the dragon cave when he needed a nap or to feel safe.
- Other regulatory activities included expanding his "web of safe people." Jack had a number of choices which he could look at on a board. Some of these activities included socially regulating activity such as going to talk with the secretary or the

cafeteria ladies, sensory regulating activities such as playing with playdough, playing with ball, or picking up garbage outside. These were all put on a chart with visuals so that if he was not regulated enough to follow the regular schedule of the classroom, he could choose a regulating activity.

- **Successes:** The SEA received more training the following September and continued to adapt her practice with Jack and other students with ACEs she worked with. When talking with her students, she used the concept of “cooling the dinosaur brain” or “calming” activities that were relevant, relational, repetitive and rewarding. Students would build some awareness around their emotional state and she would have choices of regulating activities that together they had come up with for when the child was needing a break. Ms. Gold also found the concepts useful when talking to mothers about how to help their child. She started to integrate breathing and singing into the somatosensory regulating routines. When Jack first started using the dragon cave the next year at school, he used it many times a day, but as the months went on he used it less and less, choosing to spend more time in the classroom.

4.1.2 FBA Cohort

The functional assessment, behaviour support plan development and weekly check-ins that involved reviewing the interventions and concepts and problem solving any issues that came up were the responsibility of the District Itinerant Behaviour Team. The researcher monitored the District Itinerant Behaviour Team to ensure that weekly support was being given. The researcher made weekly contact with the member of the district Itinerant Behaviour Team who was responsible for supporting each of the four FBA-

informed behavior plans and asked if he/she connected with the school that week and what support or problem solving was needed.

4.1.2.1 Max

- **Diagnoses:** Oppositional Defiant Disorder, sensory needs. ACEs score estimated at 5.
- **Background:** At the time of the study, Max was an eight-year-old boy in grade 3. He liked Transformers, robotics, exoskeletons, dogs, and trucks. At the start of the study, he lived with his mother and grandparents. His father entered his life again during the time frame of the study, and he started having visitations with his father. His mother got a job during this time frame and moved out. These changes were challenging for Max, particularly given that transitions were an identified area of difficulty for him. He attended school from 9:00 – 12:00 each day.
- **Problems in school at intake:** Max had difficulty being in the classroom. During the study he was not in the classroom or with his class for any part of his day. Max had difficulty following instructions. He wanted to have control of his time. He would tantrum, swear, throw things, and run off when he did not get his way. At the beginning of the study he was doing very little academic work. Most interactions turned into conflict.
- **Problems in home environment at intake:** Mother was on a wait list for counseling. She lived with Max and her parents and did not have a job. Her parents are verbally abusive to her. She was trying to get a job so she could move out of her parent's house.

- **Assessment and behaviour plan:** Ms. Stark (teacher), Ms. Corner (SEA), Ms. Moss (Special Education teacher), Ms. Parker (principal) were the school staff that were at the feedback meeting. Mr. Hill was the district behaviour teacher who presented the FBA along with Ms. Lee (teacher from student services). Table 6 lists interventions and strategies based on the results of the FBA assessment.

- The following deviations from the plan were noted:

- Timer (Max did not work well with a timer but was better with completion point transitions),
- The snacks given were not always healthy, but what had been sent with him to school in his lunch.
- They tried practicing disengaging from a preferred task and it didn't work out.
- A token economy was not used, but a reward system was worked out between the school, and his mother and father.
- Peer work groups worked for a while, but he tended to do better on his own

- **Intervention: February-May**

Once the plan was in place, Max seemed to do well up until Spring Break in March. He was on a reward system that was worked out between home and school. The father showed up and wanted to be involved as well. He was doing visits with his father, who had been out of the picture for a number of years, and who was not very pleased that his child was not in school full time. At Spring Break, his mother moved out of his grandparents' house and into an apartment which was shared with a girlfriend. The move and change in living situation was

difficult for Max. His mother was working and his grandmother sometimes looked after him. After this move, Max had a harder time with getting work done and following his schedule. He started to have more angry outbursts and oppositional behaviours.

- **Successes:** Some benefit was achieved from his teacher and SEA structuring his academics in a more cyclical way, allowing him to be able to know the start and end of each “package” of work tasks. This was associated with fewer oppositional/defiant events and more cooperative behaviour, as well as being able to complete more work.

4.1.2.2 James

- **Diagnosis:** Language Disorder. ACEs score estimated at 6
- **Background:** At the time of the study, James was a six-year-old boy in grade 1. He liked to be outside and playing soccer and run and climb. He lived with his parents and older brother, and his mother was pregnant with her third child at the start of the study, giving birth in early May of that year. James attended school from 9:00 to 12:00.
- **Problems in school at intake:** James was aggressive towards his peers and adults. He had difficulty with play in a large group; being expected to share toys or wait for his turn escalated him. He had difficulty with transitions. He was easily distracted and impulsive. He had difficulty following instructions. He had a history of speech and language difficulties, and attended a special needs preschool and kindergarten program for three years in a neighbouring province, from which

the family had recently moved to BC. When he was 3 years old, it was noted that he was not speaking and he was referred to a language program. At this time, he was living with his mother in a shelter for domestic abuse where his difficulties were observed.

- **Problems in home environment at intake:** His mother was pregnant with her third child. The family had recently moved from the neighboring province in an attempt to get a fresh start. The family did not see the same behaviours at home.
- **Assessment and behaviour plan:** Ms. Simpson (teacher), Ms. Markle (SEA), Ms. Todd (Special Education teacher), Mr. Kelp (principal) were the school staff that were at the feedback meeting with the district behaviour teacher, Ms. Lamb, who presented the FBA.
- Table 6 lists interventions and strategies based on the results of the FBA assessment. The following components of the FBA were not used;
 - Small group activities were tried, but he was having difficulty working with even small groups of children. Sometimes with one other child would work.
 - Work-break-work strategy progressed over time to the use of First/Then visual PICs
 - Friendship group did not work out as he did not work with others; however, he did very well outside on the playground.
 - Used a reward system using stickers and communication book that went home and back.
 - DRL – not done
 - Ticket reward system for raising his hand did not work

- **Intervention:** 2nd week in February – 2nd week in June (Out of control incidents: February – 15, March – 20, April – 12, May – 6.)

James had switched behaviour SEAs three times and was on his third SEA by the time the intervention started. The SEA was replaced one more time in March. A sensory room was set up in the school for James to take breaks. The interventions seemed to change with the SEAs. The one that was working with him from March onward used a lot of PIC symbols for communication and to help him with transitions. James's mother had a baby boy in May.

4.1.2.3 Adam

- **Diagnoses:** Reactive Attachment Disorder & Anxiety Disorder. ACEs score estimated at 6.
- **Background:** At the time of the study, Adam was a seven-year-old boy in grade 2. He liked computers, and food. He lived with his father and two older brothers who both have special needs. At the beginning of the intervention, he attended school from 9:00 – 10:30 each day.
- **Problems in school at intake:** Adam had difficulty staying in the classroom. He was a safety risk as he would abscond from the classroom without warning, often doing so very quietly so that his absence is not immediately discovered. He would disappear out of the classroom and onto the field or off school property without anyone knowing. He had difficulty following the routines of the classroom and following instructions.

- **Problems in home environment at intake:** Father is overwhelmed with the special needs of all three of his children. They live in poverty. He has sole custody of the children, and the mother sometimes comes into the children's lives, but she has a history of substance abuse and has not been in Alex's life for a number of years.
- **Assessment and behaviour plan:** Ms. Collins (teacher) was the only school staff that was at the feedback meeting. Mr. Simple was the district behaviour teacher who presented the FBA and Ms. Forth was the student services teacher who helped.
- Table 6 lists the FBA interventions and strategies based on the results of the FBA assessment. The following were not used;
 - Teach recreational skills or socially acceptable behaviours that have similar sensory consequence as behaviour
 - Social Stories
- **Intervention:** 3rd week in February – 2nd week in June
- Adam's teacher interpreted reactive attachment to mean that he needed to attach to peers, and she therefore sat him beside two socially 'gifted' children in her class. They then increased his time to lunch before Spring Break in March and then to a full day after Spring Break. He stopped running at about the same time he was in school full time. The teacher felt that it was the two socially gifted friends that he was sitting with that really helped pull him into the class and made him feel part of the group. He followed the routines of the class, no longer ran away or left the room, and no longer required an SEA.

- **Successes:** Adam was eventually able to stop running away/leaving the classroom without permission, and was able to start following the routines of the class.

4.1.2.4 Dan

- **Diagnosis:** ADHD. ACEs score estimated at 1 (but his mother & the school counsellor felt he had some trauma issues from foster-care siblings)
- **History.** At the time of the study, Dan was a six-year-old boy in grade 1. He liked Lego and computers. He had a diagnosis of ADHD. He lived with his parents, biological brother and adopted sister. Dan attended school from 9:00 to 12:00.
- **Problems in school at intake:** Dan liked to do his own thing, and had difficulty following the routine of the classroom. He had difficulty transitioning from one task to the other. He was impulsive and had difficulty attending to a task for any length of time. The teacher had given up on him and just tried to teach while he wondered around the class or played in another area of the class. He attended a supported kindergarten program last year in the neighbouring province from which the family have recently moved.
- **Problems in home environment at intake:** Dan was the youngest of a two-parent family that has recently moved to the province. His adopted sister had a brother who was fostered by the family for two years. The foster brother was moved to an alternative setting as the family could not deal with his behaviour. The brother remained in the other province. Dan was very close to the foster brother, although the brother was often abusive towards Dan. There have been several foster babies in and out of the home in recent history. Mom has seizures.

Dad has recently been diagnosed with MS. Dan often talked about missing his foster brother and his friends in his old school.

- **Assessment and behaviour plan:** Ms. Barns (teacher) and Ms. Tobus (school counsellor) were the school staff that were at the feedback meeting. Ms. Lemon was the district behaviour teacher who presented the FBA. Table 6 lists the interventions and strategies based on the results of the FBA assessment. All the strategies and interventions listed were used.
- **Intervention:** 4th week in February – 2nd week in June
- Dan received a behaviour SEA at the beginning of February from morning to recess. Dan was put on ADHD medication at the end of April, following which he achieved notable improvement in his ability to attend and participate in classroom activities.

4.2 Multiple Baseline Data

For each participant in both sets of multiple baseline data, the percentage academically engaged time and heart rate coherence were graphed and visually analyzed. Criteria for multiple baseline design were used to evaluate whether a functional relationship existed between intervention and changes in child behaviour and heart rate. Specifically, the researcher visually examined the changes in level, trend, and variability of each independent variable when comparing the baseline and intervention phases across the four participants.

As outlined in the Methods section, within the context of a multiple baseline single-subject design, the data are evaluated with reference to whether a basic effect has been established, that is, for each baseline in the multiple baseline design (i.e. each participant) whether there is a clear visual change in the direction of treatment during the intervention phase showing an improvement over the baseline phase; and, if present, the degree of such a basic effect (i.e. whether the change in direction (improvement) of treatment is evident at the point of intervention) with little to no overlap with baseline data. When evaluating 4 baselines (i.e. participants) which have been subjected to the same intervention, and 3 out of 4 of those baselines demonstrate a basic effect, it is concluded that experimental control has been established (in other words, that a significant effect has been demonstrated for that intervention). This is referred to as a functional effect or the documentation of a functional relationship between the intervention and the outcome measure.

4.2.1 Percentage Academic Engaged Time (PAET)

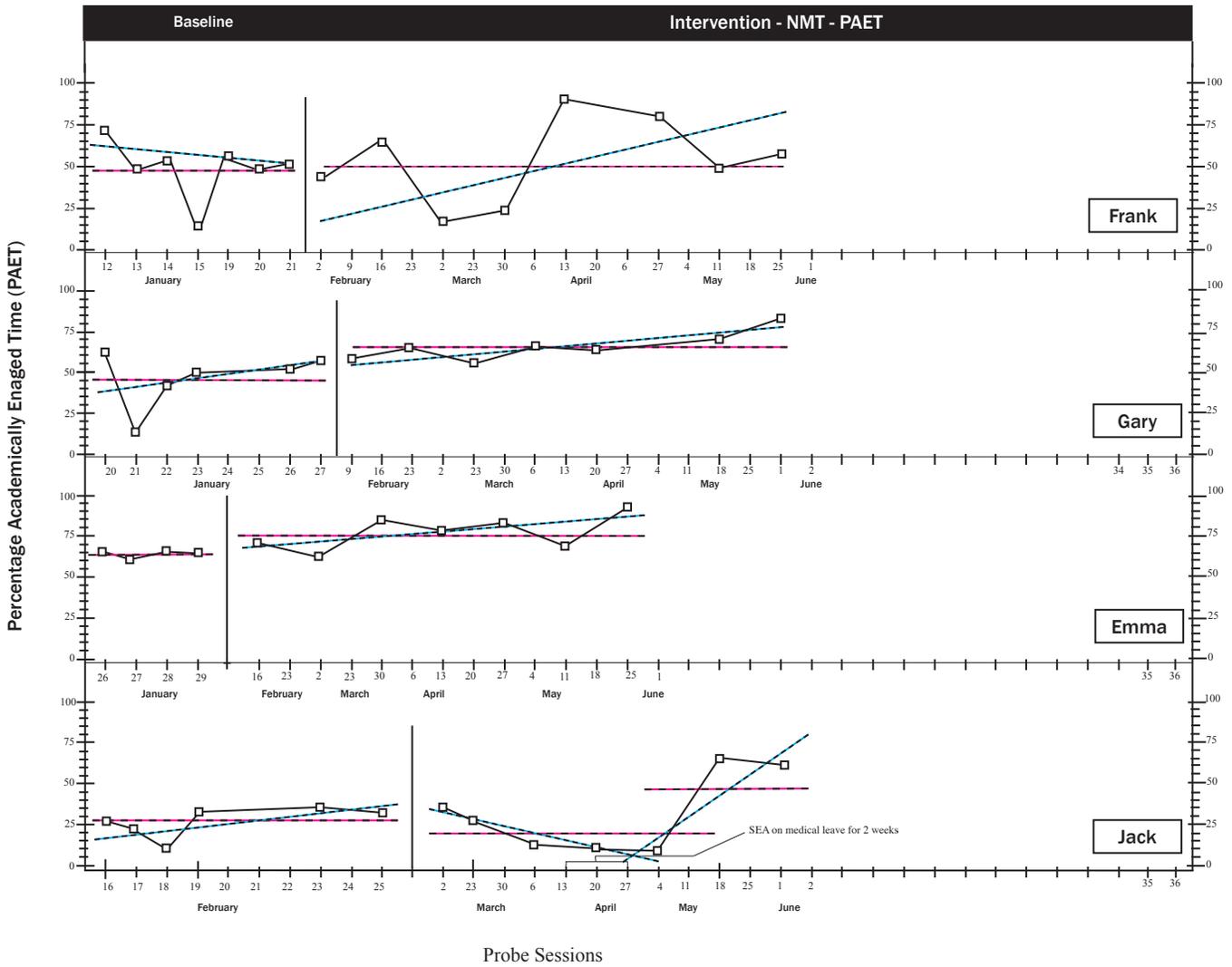
NMT Cohort (Figure 5)

During the baseline phase, the first participant, Frank, was engaged in academic tasks an average of 49% of the time (range, 13%-72%) with a slightly decreasing trend. During the intervention phase, Frank evidenced a slight increase in academic task engagement to an average of 51% of the time (range, 13%-93%) with an increasing trend. The very slight change in level between baseline and intervention phases was not significant and a basic effect was not documented.

The second participant, Gary, during the baseline phase was engaged in academic tasks an average of 46% of the time (range, 11%-63%) with an increasing trend. During intervention Gary evidenced an increase in academic task engagement to a level of 64% (range, 58%-81%) with an increasing trend. Although the average academic engaged time was moderately better during the intervention, since an upward trend had already begun during baseline, it was felt that no clear conclusion that the intervention was responsible for the continued improvement could be drawn.

The third participant, Emma, was engaged in academic tasks an average of 64% of the time (range, 61%-65%) during the baseline phase, with a stable trend. During the intervention, Emma's average engaged time increased to 75% (range, 63%-93%) and

Fig. 5 NMT Cohort – Percent Academically Engaged Time



showed an increasing trend. Her improvement was not immediately evident at the point of intervention. Thus, the NMT intervention appears to have produced a weak basic effect.

The fourth NMT participant, Jack, during the baseline phase was engaged in academic tasks an average of 28% of the time (range, 14%-37%) with a slight increasing trend. During the intervention Jack showed a small increase in engaged time to 32% (range, 9%-66%) across observations. Two trends were evident in the intervention phase for Jack, with the first data points showing a decreasing trend while the last three data points evidencing a steeply increasing trend. The initial decreasing trend during the first half of the intervention phase was associated with the student's Specialized Education Assistant (SEA) going on medical leave for 2 weeks. The sudden increase in engaged time across the last three data points was associated with the SEA's return. Overall, these data suggest a delayed basic effect.

Overall, of the four participants who received the NMT intervention, two showed no effect, one showed a weak basic effect and one showed a delayed basic effect when his SEA returned. evidenced an increase in level. As only two out of the four participants showed a basic effect, the NMT intervention evidenced no functional effect.

FBA Cohort (Figure 6)

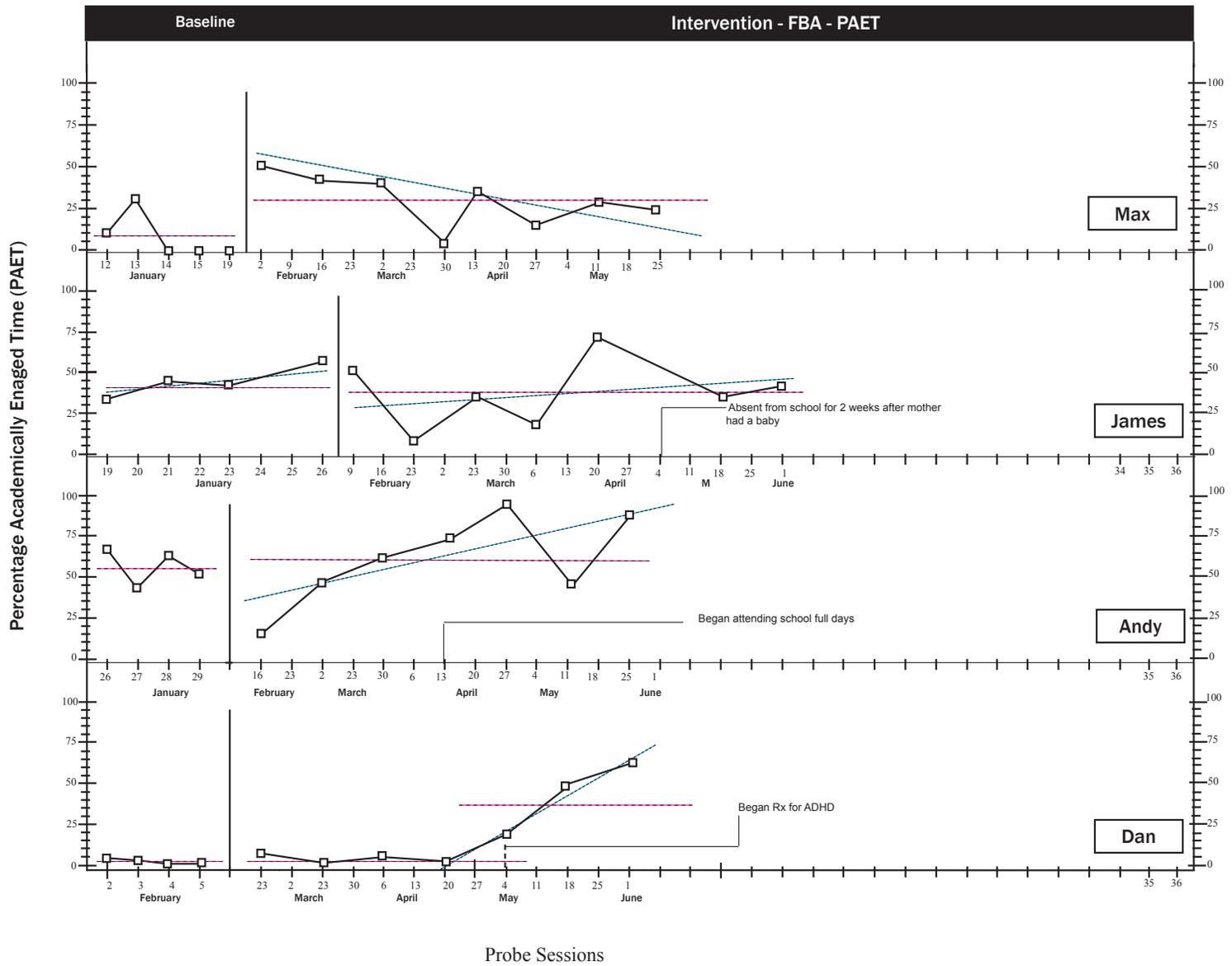
During the baseline phase, the first participant, Max, was engaged in academic tasks an average of 7% of the time (range, 0%-27%) with a decreasing trend. During the

intervention Max evidenced a moderate increase in academic task engagement to an average of 27% of the time (range, 0%-46%) with a decreasing trend. The intervention showed a moderate basic effect immediately after the point of intervention that then decreased; his improvement was not maintained.

During the baseline phase, the second participant, James, was engaged in academic tasks an average of 46% of the time (range, 43%-58%) with an increasing trend. During the intervention James showed a decrease in academic task engagement to an average of 36% of the time (range, 7%-68%) with a very slight increasing trend. Given that James showed a decrease in average academic task engagement from baseline to intervention phase, no basic effect was evidenced from the FBA intervention.

During the baseline phase, the third FBA participant, Andy, demonstrated academic task-engaged behaviour an average of 56% of the time (range, 47%-65%) with a stable trend. During the intervention Andy's academic task engagement increased to an average of 61% (range, 16%-98%) with an increasing trend. This effect was moderated by there being no immediate improvement at the point of intervention. The intervention thus showed a weak basic effect.

Fig. 6 FBA Cohort – Percent Academically Engaged Time



The fourth FBA participant, Dan, during baseline was engaged in academic tasks an average of 2% of the time (range, 0%-4%) with a stable trend. During intervention, Dan's percent of academically engaged time increased to an average of 22% (range, 0-62) across sessions. Two trends were evident in the intervention phase; the first 4 data points showed a low and stable trend and the last four data points showing a steeply increasing trend. The delayed steeply increasing trend during the last half of the intervention phase was associated with the student going on medication for ADHD. Overall, these data suggest a delayed basic effect. The introduction of medication, however, confounded the cause of the delayed effect. The medication, rather than the intervention, could easily have been responsible for the observed improvements.

Overall, of the four participants who received the FBA intervention, one evidenced little or no effect, one evidenced a weak basic effect, one showed a moderate basic effect which was not maintained, and one showed a delayed effect that could have been due to the start of medication. It cannot be concluded that FBA improved PAET, but one child, Dan, seemed to show the most benefit of any child who received either intervention NMT or FBA. Neither NMT nor FBA showed clear evidence of increasing academic engaged time.

4.2.2 Percentage of Time in Low Heart Rate Coherence

NMT Cohort (Figure 7)

During baseline, the first participant, Frank, evidenced low heart rate coherence an average of 65% of the time (range, 52%-76%) with a decreasing trend. During

intervention Frank showed a slight decrease in the average percentage of time his heart rate coherence was low, with it being low an average of 59% of the time (range, 36%-76%) with an increasing trend. Given the slight improvement in level in percentage of low heart rate coherence between baseline and intervention phases, no basic effect of the NMT appears to be seen here.

During baseline, the second participant, Gary, evidenced low heart rate coherence an average of 61% of the time (range, 46%-84%) with a decreasing trend. During intervention, the percentage of time that Gary's heart rate coherence was low, decreased to an average of 50% of the time (range, 36%-62%) with a stable trend. Although Gary showed a decrease in percentage of time he was in low heart rate coherence from baseline to intervention, it is unclear whether that was due to the intervention or to a decreasing trend that began during baseline.

Fig. 7

NMT Cohort – Percent Low Heart Rate Coherence

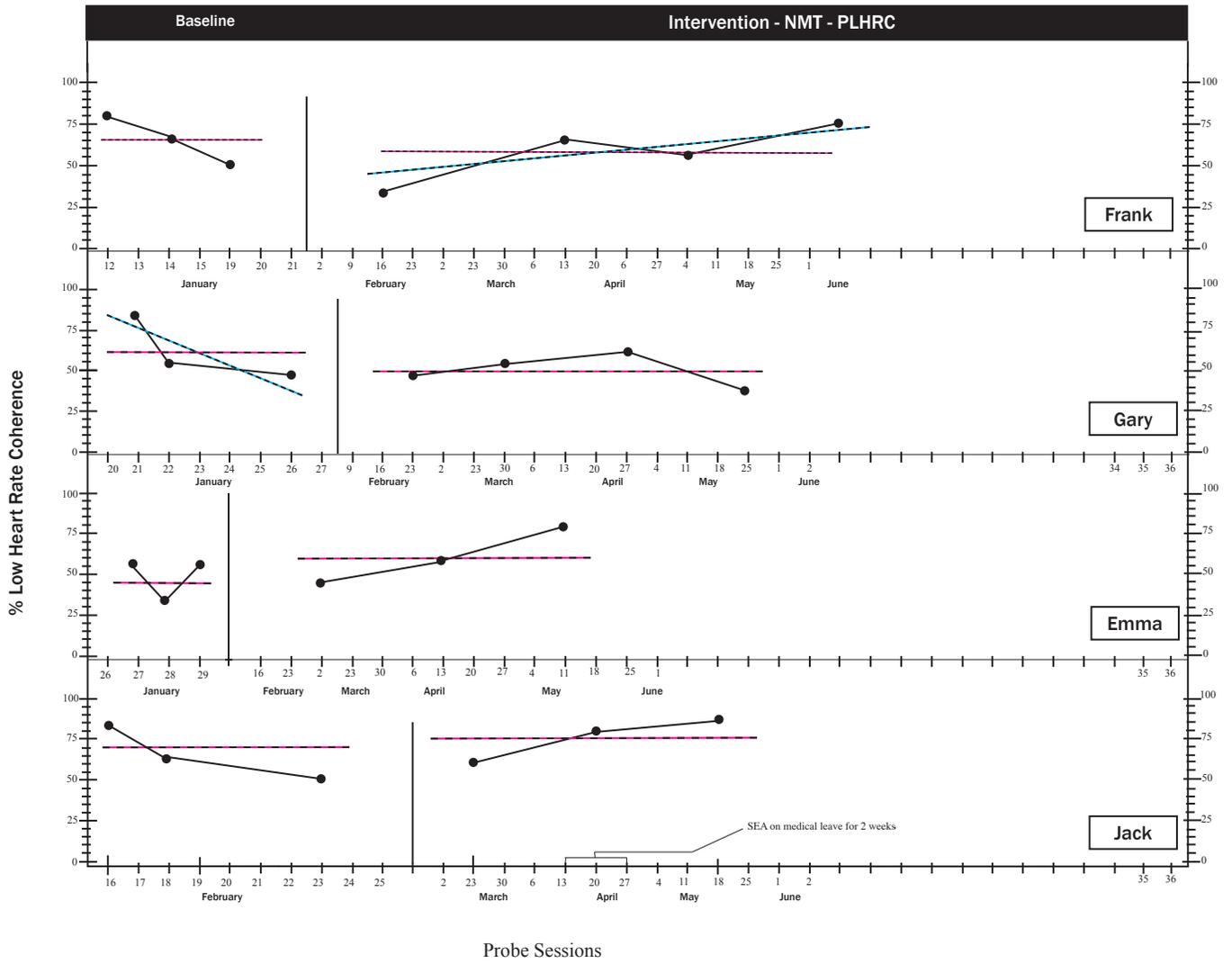
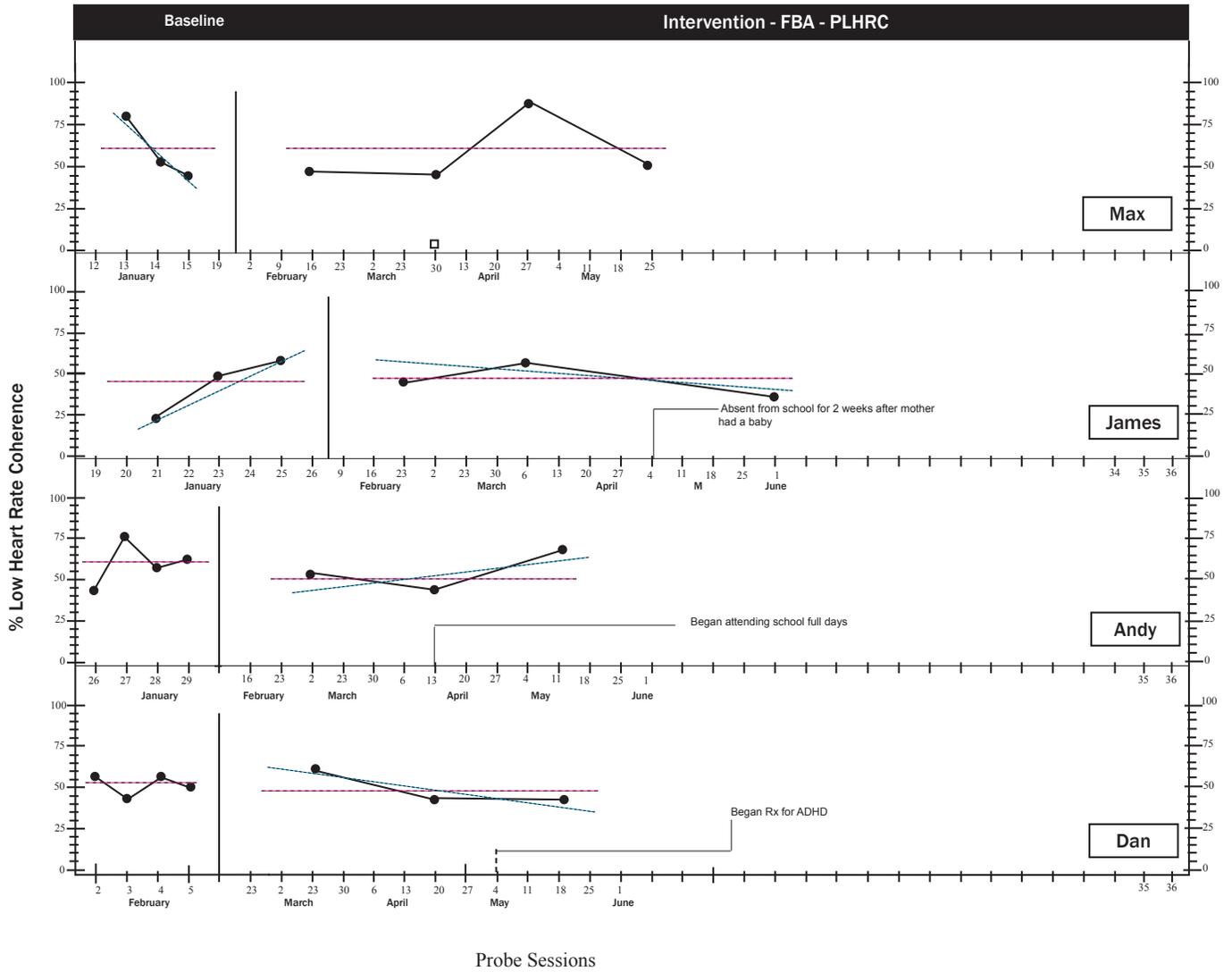


Fig. 8

FBA Cohort – Percent Low Heart Rate Coherence



During the baseline phase, the third participant, Emma, showed low heart rate coherence an average of 45% of the time (range, 30%-53%) with a stable trend. During intervention the percentage of time that Emma's heart rate coherence was low increased to an average of 60% (range, 46%-78%) and showed an increasing trend. She showed an effect but in the opposite direction from that of the second participant, and, most importantly, in the opposite direction expected of the treatment provided. While the second participant's decrease in the percentage of low heart rate coherence suggests that he was less stressed during the intervention compared to the baseline phase, Emma evidenced an increase in the percentage of low heart rate coherence during the intervention compared to the baseline phase, which suggests that she was more stressed.

During the baseline phase, the fourth participant, Jack, evidenced low heart rate coherence an average of 69% of the time (range, 52%-84%) with a decreasing trend. During intervention Jack showed a slight increase in the percentage of time his heart rate coherence was low to an average of 75% (range, 66%-86%) with an increasing trend in the opposite direction of treatment. Like participant one, given the slight deterioration in level between baseline and intervention phases, there was no basic effect of NMT on his heart rate coherence.

Overall, of the four participants who received the NMT intervention, two evidenced no basic effect, and two evidenced small basic effects, in opposite directions (i.e. while one showed a slight improvement, the other showed a slight deterioration). Of the two participants who evidenced small basic effects, one showed a decrease in the percentage

of time in low heart rate coherence, but it is not clear whether that continued a trend begun in baseline. This participant may have experienced less stress in the intervention than during the baseline phase. In contrast, the other child showed an increase in the percentage of time in low heart rate coherence, thus suggesting she might have experienced more stress in the intervention than during the baseline phase. As there were two participants who evidenced no basic effect and two who evidenced opposing basic effects, the NMT intervention evidenced no functional effect on the percentage of time participants spent in low heart rate coherence, and thus no effect on this indicator of their stress levels.

FBA Cohort (Figure 8)

During baseline, the first participant, Max, evidenced low heart rate coherence an average of 58% of the time (range, 42%-80%) with a decreasing trend. During the intervention Max's heart rate coherence was low an average of 59% of the time (range, 46%-86%) with a stable trend. There was no difference between the baseline and intervention phases and thus no basic effect was evidenced.

During baseline, the second participant, James, showed low heart rate coherence an average of 45% of the time (range, 22%-67%) with an increasing trend. During the intervention James's heart rate coherence was low an average of 47% of the time (range, 36%-58%) with a stable trend. Again, no difference between the baseline and intervention phases was found and thus no basic effect was evidenced.

During baseline, the third participant, Andy, evidenced low heart rate coherence an average of 59% of the time (range, 43%-72%) with a stable trend. During the intervention Andy's heart rate coherence was low an average of 51% of the time (range, 41%-60%) with a slight increasing trend. This difference was driven solely by one high data point during baseline and one low data point during the intervention. For this participant, the pattern of data between baseline and intervention is insufficient to conclude that there was a difference between the baseline and intervention phases and thus again, no basic effect was demonstrated.

During baseline, the fourth participant, Dan, averaged low heart rate coherence 53% of the time (range, 45%-59%) with a stable trend. During the intervention Dan's heart rate coherence was low, within an average of 49% (range, 41%-62%) and a slightly decreasing trend. Given the very slight change in level between the baseline and intervention phases, no basic effect was demonstrated.

Overall, the four participants who received the FBA-based intervention showed no basic effect on heart rate coherence and thus no functional effect of the FBA-based intervention on their level of stress was documented.

4.2.3 Social Validity

Social validity refers to perceptions regarding how appropriate, acceptable and useful the FBA or NMT based intervention and implementation process were from the point of view of the teacher. Social validity data were collected in May to help determine All

eight teachers completed the 10-item questionnaire that used a Likert scale format where “1” represented “strongly disagree” and “5” represented “strongly agree” (Appendix G). The mean and range of responses for each cohort is reported in Table 7.

Table 7. Social validity survey mean and range of responses

Survey Item	FBA	NMT
1.	3.75 (1-5)	3.5 (2-5)
2.	3.5 (1-5)	4.0 (4-5)
3	3.0 (1-4)	3.75 (2-5)
4	3.25 (1-5)	3.0 (1-4)
5	3.25 (1-5)	3.75 (2-5)
6	3.25 (1-5)	2.75 (1-4)
7	2.75 (1-5)	4.25 (2-5)
8	3.25 (1-5)	3.0 (2-4)
9	3.5 (1-5)	4.0 (4)
10	3.25 (1-5)	3.25 (2-4)
Total	3.28	3.53

Overall, the teachers rated both the NMT and FBA assessments and interventions to be somewhat acceptable in regard to suitability and effectiveness.

4.2.4. Executive Function Scores

4.2.4.1 Hearts & Flowers

NMT Cohort

Frank, the first participant, got more trials correct in the first two blocks at the post-test (9% higher) (results are reported in Table 8 below) and was very slightly slower by 2% and 3% respectively (results are reported in Table 9 below). In the mixed trial block, Frank showed a slight decrease in the percent correct at the post-test which means he performed slightly worse on the post-test when compared to the pre-test and was slightly faster. Frank took more time to respond to the items as the complexity of each block increased.

Gary, the second participant, showed no change in the percent correct on the first two blocks of tasks from pre-test to post-test, although he took slightly less time to respond in the post-test. On the mixed block, Gary performed much better at the post-test (correct on 33% more trials) than he had at pre-test and took 6% more time to respond.

Emma, the third participant, showed essentially no change on accuracy from pre to post test on blocks 1 and 2 and she got more trials correct on the mixed block (15% improvement) after the intervention than before. Emma performed faster on all the post-tests by 14%, 13%, and 10% respectively.

Jack, the last participant, was not able to get past the training session when he did the pre-test but was able to complete the test at the end of the intervention in June. His

performance on the post-test was comparable to the other participants achieving 87% correct on block 1 and 73% on block 2. On the mixed block trial, Jack completed about half the number of items as other participants, getting about 75% correct. He responded more quickly as the complexity of the blocks increased, which is the opposite of how other participants performed.

Table 8. Hearts & Flowers: Pre & post scores and difference in percent correct Responses

	Block 1 (minimal working memory) (11 trials)			Block 2 (minimal working memory, inhibition) (11 trials)			Block 3 (working memory, inhibition, cognitive flexibility) (48 trials)		
	Pre	Post	% diff.	Pre	Post	% diff.	Pre	Post	% diff.
NMT									
Frank	10	11	9.1	10	9 (9)	9.1	45(47)	41(43)	-2.7
Gary	11	9 (9)	0	11	10 (10)	0	23(43)	42(47)	33.3
Emma	8(10)	9	1.8	10	9 (10)	-0.9	28(42)	37 (45)	15.5
Jack	-	7 (8)	N/A	-	8	N/A	-	17 (23)	N/A
Mean (%)	90.3	94	4.1	94	96.7	2.8	73.0	88.7	21.5
FBA									
Max	10(10)	9	-18.2	10 (10)	10	-9.1	37(46)	18(30)	-18.2
James		5 (9)	N/A		6 (10)	N/A		26(37)	N/A
Andy	9 (9)	11	0	6 (6)	11	0	19(28)	25(45)	-8.7
Dan	11	9 (9)	0	8 (8)	10 (10)	12.5	15(31)	29(42)	-1.9
Mean (%)	100	94	-6.0	96	97	1.0	71.7	61.7	-14

*NOTE: Brackets () indicate the number of trials attempted after trials with response times of less than 250ms were eliminated.

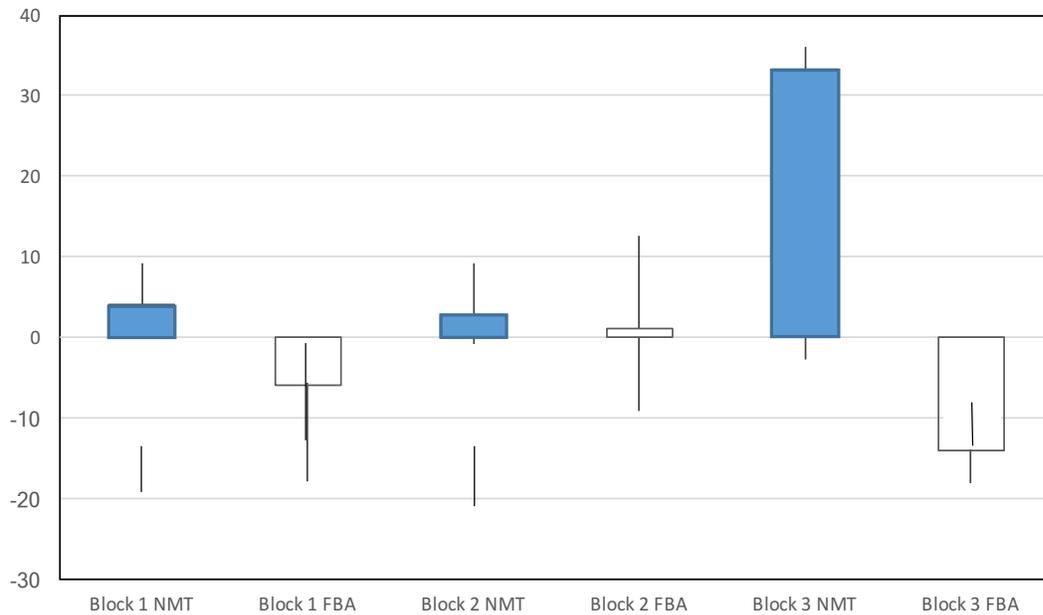


Fig. 9. Hearts & Flowers: Difference in Accuracy on Post-test vs Pretest

Table 9. Hearts & Flowers: Pre & post response time scores (in milliseconds)

	Block 1 (minimal working memory) (11 trials)			Block 2 (minimal working memory, inhibition) (11 trials)			Block 3 (working memory, inhibition, cognitive flexibility) (48 trials)		
	Pre	Post	% diff.	Pre	Post	% diff.	Pre	Post	% diff.
NMT									
Frank	579.6	590.5	-2%	675.2	697.4	-3%	925.1	834.2	10%
Gary	741.2	663.9	10%	843	697.9	17%	822.3	771	6%
Emma	698.3	601.9	14%	716.5	623.9	13%	856.4	767.3	10%
Jack	N/A	982.9	N/A	N/A	882.4	N/A	N/A	798.2	N/A
Mean RT	673.0	618.8	7%	744.9	673.1	-9%	867.9	790.8	-9%
FBA									
Max	575.3	699.6	-22%	682.1	620.9	9%	750.1	729.9	3%
James	N/A	524.5	N/A	N/A	529.5	N/A	N/A	737.5	N/A
Andy	502.3	601.2	-20%	809.7	589.7	27%	755.9	735.8	3%
Dan	739.1	644.1	13%	732.3	757.5	-3%	677.4	814.7	-20%
Mean RT	605.6	648.3	-9%	741.4	656.0	11%	727.8	760.1	-5%

Calculating the mean percentage change in number of correct responses for the three NMT participants who completed the pre and the posts tests, they were very slightly better on Blocks 1 and 2 at post-test. On the mixed block the percentage average increased by 21.5% at the post –test. One child was able to complete the post-test but not the pre-test, which indicates an improvement in that child. Of the participants who completed the pre and post-tests, they took more time to respond to the items as the items increased in complexity and took slightly less time to respond in the post-test.

FBA Cohort

Max performed worse on the Hearts and Flowers test at post-test than he had at pre-test. This was evident on all blocks, but especially in Blocks 1 and 3; he was correct on 18% fewer trials on both blocks. As regards response time, Max was slower during the post-test on Block 1 and slightly faster on the post-test for Blocks 2 and 3.

James was not able to get past the training session on the pre-test, but did complete the post-test. On the post-test, he answered fewer items correctly and responded more quickly than the other participants on the first 2 trial blocks. On the mixed block, his speed and accuracy was similar to other FBA participants on the items he attempted. He was able to complete the post-test which indicates an important improvement.

Andy, the third FBA participant, showed no change on the first 2 blocks and performed worse on the mixed block after the intervention. When comparing his pre and post-test

speed, he was slightly slower in Block 1, slightly faster in Block 2 and somewhat similarly paced in the mixed block.

Dan, the fourth participant, showed no change on Blocks 1 and 3, but performed better on Block 2 (12.5% improvement in percent correct). Dan's speed of response varied when comparing his pre and post-test performance. He was slightly slower in Block 1, faster in Block 2 and somewhat similarly paced in the mixed block. Dan went on medication for ADHD during the study, and his post-test results may have been influenced by the effects of the medication.

Overall, the children who received the FBA performed worse on Blocks 1 and 3 of the Hearts and Flowers test after the intervention than they had before. (Results are reported in Table 8). The exception to this trend was one subject (James) who was only able to complete the post-test, which in itself is an important improvement. The speed at which they responded to the items varied relatively widely.

4.2.4.2 Flanker/Reverse Flanker

NMT Cohort

Frank, the first participant, showed no change in the percent correct on Block 1 and very minimal worsening of performance on Block 3, but on Block 2 he got more answers correct on the post-test than he had on the pre-test. When comparing the speed of his pre and post-test response times, he was slightly slower on Block 1 post-test and slightly faster on Block 2 and Block 3 post-test.

Gary, the second participant, performed better and faster on all of the blocks of the Flanker/Reverse Flanker task after NMT than before, especially on Block 2.

Table 10. Flanker/Reverse Flanker: Pre & post scores and difference in percentage of correct responses

	Block 1 (selective attention) (16 trials)			Block 2 (selective attention & inhibition) (16 trials)			Block 3 (working memory, inhibition, & cognitive flexibility) (64 trials)		
	Pre	Post	% diff.	Pre	Post	% diff.	Pre	Post	% diff.
NMT									
Frank	16	16	0	12	14	12.5	52 (63)	51	-2.8
Gary	12	13	6.3	11(15)	14	14.2	50	54	6.3
Emma	14	16	12.5	15	15	0	21 (54)	46	31.9
Jack	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Mean (% correct)	87.7	93.7	6.8	80.7	90.0	11.6	66.7	78.7	18.0
FBA									
Max	13	6 (9)	-14.6	14	11	- 18.7	46 (63)	43 (63)	-5.1
James	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Andy	14	14 (15)	5.8	11	14	18.7	41	55	21.8
Dan(Rx)	12	16	0	14	16	12.5	44 (62)	55	15.0
Mean (% correct)	81.3	86.7	6.6	81.7	85.7	4.9	69.3	80.0	15.4

Table 11. Flanker/Reverse Flanker: Pre & post response time scores (in milliseconds)

	Block 1 (selective attention) (16 trials)			Block 2 (selective attention & inhibition) (16 trials)			Block 3 (working memory, inhibition, & cognitive flexibility) (64 trials)		
	Pre	Post	% diff.	Pre	Post	% diff.	Pre	Post	% diff.
NMT									
Frank	832.2	960.3	-15%	1258.1	983.7	22%	1081.4	987.5	9%
Gary	1099.1	758.4	31%	1125.5	947.1	16%	989.9	891.5	10%
Emma	980.4	788.1	20%	884.4	658.4	26%	810.9	1033.9	-28%
Jack	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Mean RT	970.6	835.6	12%	1089.3	863.1	21%	960.7	971.0	-3%
FBA									
Max	1030.8	370.7	64%	924.6	791.7	14%	966.0	1018.6	-5%
James	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Andy	884.5	770.2	13%	837.3	952.7	-14%	961.5	957.7	0%
Dan(Rx)	1057.0	933.1	12%	1033.9	888.7	14%	880.1	923.2	-5%
Mean RT	990.8	691.3	30%	931.9	877.7	5%	935.9	966.5	-3%

Emma, the third participant, performed better on Blocks 1 and 3 on the post-test compared to the pre-test, and on the mixed block (Block 3), the improvement was a marked 32% improvement in accuracy. She performed faster on the first two blocks

Jack, the final participant, was not able to get past the training session when he did the pre-test or the post-test and we therefore have no comparisons.

Calculating the average percentage change in number correct for the children who received the NMT intervention, there was a slight improvement on Blocks 1, 2 and 3. In each block they were faster to respond to the questions in the post-test.

FBA Cohort

Max, the first participant, performed worse on all blocks of the Flanker/Reverse Flanker tasks compared to the pre-test. More so on the first two blocks and slightly worse on the mixed block. He responded to the items on the first two blocks faster in the post-test.

While he took negligibly more time to respond in the mixed block.

James, the second participant, was not able to get past the training session for the pre-test or the post-test and therefore, there is no comparison.

Andy, the third participant, showed an increase in his performance on all three of the blocks. On Blocks 2 and 3 he increased his performance by about 20%. Andy responded to the items slightly faster in the first block, slightly slower in the second block and with similar speed in the mixed block.

Dan, the fourth participant, showed no change in the percent correct on Block 1 but on Block 2 and 3 he got more answers correct on the post-test than he had on the pre-test.

Dan was slightly faster at responding to the items in the post-test in block 1 and 2. In Block 3, Dan took negligibly more time to respond in the mixed block.

Calculating the average percentage change in number correct for the children who received the FBA intervention showed a slight improvement on Blocks 1, 2 and 3. They were quicker to respond to questions in Block 1 and 2, and took slightly longer to respond in the mixed block.

4.2.4.3 Flanker Effect

NMT Cohort

Frank was consistently faster on all three post-test trial blocks. His accuracy was the same or higher on the first two blocks while on Block 3 he made slightly more mistakes.

Gary was consistently slower and more accurate on all three post-test trial blocks when compared to pre-test results.

Emma's performance varied when comparing her post-test to her pre-test. On Block 1 she was faster and slightly more accurate in Block 2 she was slower and got the same number correct. In Block 3 she took about the same amount of time but was much more accurate.

Averaging the Flanker Effect for all three participants who received the NMT intervention indicates that they took more time and answered slightly more items correct on Blocks 2 and 3, while they were faster and answered a comparable number of items correct on Block 1.

FBA Cohort

Max performed more slowly and less accurately on all three blocks.

Andy became slower and more accurate on all three blocks.

Dan’s performance varied when comparing his post-test to his pre-test. On Block 1, Dan was faster and maintained the same accuracy. In Block 2, he became faster and more accurate. In the mixed block, Dan became slower and more accurate.

Table 12. Flanker Effect pre & post (response time on incongruent trials minus response time on congruent trials in milliseconds)

	Block 1 (selective attention)		Block 2 (selective attention & inhibition)		Block 3 (working memory, inhibition, & cognitive flexibility)	
	Pre	Post	Pre	Post	Pre	Post
NMT						
Frank	154	-24	145	87	157	104
Gary	-57	97	-7	471	65	245
Emma	140	53	51	112	257	282
Jack	N/A	N/A	N/A	N/A	N/A	N/A
Average	79	42	63	223	160	210
FBA						
Max	106	247	394	62	240	137
James	N/A	N/A	N/A	N/A	N/A	N/A
Andy	-157	137	-132	33	-54	95
Dan(Rx)	173	28	158	-108	94	176
Average	40.7	137.3	140	-4.3	93.3	136

Averaging the Flanker Effect for all three participants who received the FBA intervention indicates that they took more time and answered slightly more items correct on Blocks 1 and 3, while they were faster and answered slightly more of the items correct on Block 2.

4.2.4.4 Hearts and Flowers Statistical Analysis

Under the Hearts and Flowers test, there is no significant difference between how well or how fast the NMT group performed in comparison to the FBA group (Table 13).

Table 13. Hearts & Flowers: difference between NMT vs FBA

	Block 1	Block 2	Block 3
Accuracy (post accuracy controlled by pre-accuracy)	NS Wald Chi-Square (df=1, N=6) = 1.51	NS Wald Chi-Square (df=1, N=6) = 0.104	NS Wald Chi-Square (df=1, N=6) = 0.102
Response Time	NS F(1,4) = 0.30	NS F(1,4) = 0.32	NS F(1,4) = 0.01

4.2.4.5 Flanker/Reverse Flanker Statistical Analysis

Analysis of the Flanker/Reverse Flanker task reveals no significant difference between how well or how fast the NMT group performed in comparison to the FBA group.

Table 14. Flanker/Reverse Flanker: difference between NMT vs FBA

	Block 1	Block 2	Block 3
Accuracy (post accuracy controlled by pre accuracy)	NS Wald Chi- Square (df=1, N=6) = 1.02	NS Wald Chi- Square (df=1, N=6) = 0.38	NS Wald Chi- Square (df=1, N=6) = 0.08
Response Time	NS F(1,4) = 0.59	NS F(1,4) = 1.49	NS F(1,4) = 0.03

Overall, results of statistical analysis on the 6 subjects in 2 groups indicated that no analysis was significant. With only 3 subjects in each group, this is not too surprising.

4.2.4.6 Alloway Working Memory Assessment

The AWMA showed inconclusive results. Qualitative observations indicated that this proved to be a particularly challenging test to administer to this population, with several students simply not being able to even get started with the trials, together with a high risk of human error on the researcher's part as the researcher had to assess the correctness of the student's response as the student went through the test. This, in conjunction with having to manage the student's emotional and behavioural reactivity while providing encouragement, proved to be difficult and resulted in many errors. Thus the data are not reliable and I would not recommend using this test with this population.

4.2.5 NMT Metric

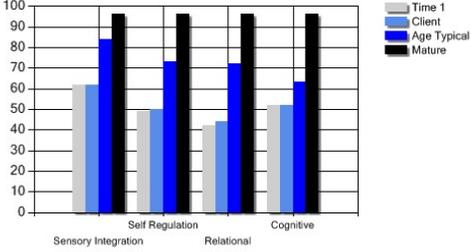
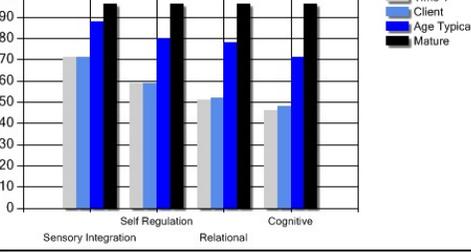
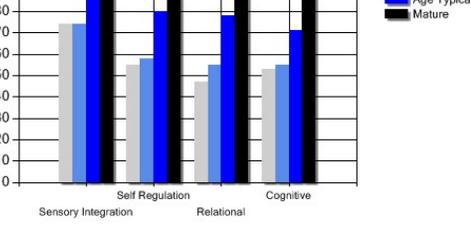
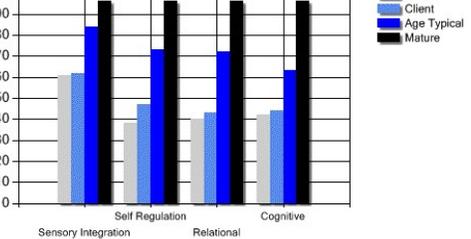
The four participants in the NMT cohort received the pre and post NMT metric measure. The results are depicted in Table 11.

Frank showed an improvement in his ability to interact with others. He increased the amount of time he was able to stay at school from 1:00 pm to 3:00 pm at the start of the study, to attending from 10:30am to 3:00 pm. Frank's NMT metric showed very little change. He minimally increased his CMR from 1.06 to 1.09. His Sensory Integration domain score remained unchanged, as did his Self-Regulation domain. His Relational domain score minimally increased from 42 to 44. His Cognitive domain score remained unchanged.

Gary showed an improvement in his ability to take responsibility for his actions and was seen following some of the "Zones of Regulation" strategies at recess, such as taking a break. Gary's NMT metric showed very little change. Gary's CMR increased very slightly from 1.39 to 1.43. His Sensory Integration, Self-Regulation, and Relational domain scores remained essentially unchanged. His Cognitive domain score increase very slightly from 46 to 48.

Emma showed some improvement in her ability to work in the classroom in the afternoon as well as playing with a number of girls in her classroom. The teacher said that their friendship was not steady but was seen as on and off. Emma's NMT metric showed little change. Emma's CMR increased from 1.41 to 1.62. Her Sensory Integration, Self-Regulation and Cognitive domain remained essentially unchanged. Her Relational domain score increased slightly from 47 to 55.

Table 15. NMT assessment data pre and post intervention

Subject	Functional Domain Chart	Functional Domains Values																				
Frank	 <p>Bar chart for Frank showing NMT scores for Sensory Integration, Self Regulation, Relational, and Cognitive domains. The Y-axis ranges from 0 to 100. The legend indicates: Time 1 (grey), Client (light blue), Age Typical (medium blue), and Mature (black). For Sensory Integration, Client is ~62 and Age Typical is ~62. For Self Regulation, Client is ~49 and Age Typical is ~50. For Relational, Client is ~42 and Age Typical is ~44. For Cognitive, Client is ~52 and Age Typical is ~52.</p>	<table border="1"> <thead> <tr> <th></th> <th>Pre</th> <th>Post</th> </tr> </thead> <tbody> <tr> <td>Sensory Integration</td> <td>62</td> <td>62</td> </tr> <tr> <td>Self Regulation</td> <td>49</td> <td>50</td> </tr> <tr> <td>Relational</td> <td>42</td> <td>44</td> </tr> <tr> <td>Cognitive</td> <td>52</td> <td>52</td> </tr> <tr> <td>Cortical Modulation Ratio</td> <td>1.06</td> <td>1.09</td> </tr> </tbody> </table>		Pre	Post	Sensory Integration	62	62	Self Regulation	49	50	Relational	42	44	Cognitive	52	52	Cortical Modulation Ratio	1.06	1.09		
	Pre	Post																				
Sensory Integration	62	62																				
Self Regulation	49	50																				
Relational	42	44																				
Cognitive	52	52																				
Cortical Modulation Ratio	1.06	1.09																				
Gary	 <p>Bar chart for Gary showing NMT scores for Sensory Integration, Self Regulation, Relational, and Cognitive domains. The Y-axis ranges from 0 to 100. The legend indicates: Time 1 (grey), Client (light blue), Age Typical (medium blue), and Mature (black). For Sensory Integration, Client is ~71 and Age Typical is ~71. For Self Regulation, Client is ~59 and Age Typical is ~59. For Relational, Client is ~51 and Age Typical is ~52. For Cognitive, Client is ~46 and Age Typical is ~48.</p>	<table border="1"> <thead> <tr> <th></th> <th>Pre</th> <th>Post</th> </tr> </thead> <tbody> <tr> <td>Sensory Integration</td> <td>71</td> <td>71</td> </tr> <tr> <td>Self Regulation</td> <td>59</td> <td>59</td> </tr> <tr> <td>Relational</td> <td>51</td> <td>52</td> </tr> <tr> <td>Cognitive</td> <td>46</td> <td>48</td> </tr> <tr> <td>Cortical Modulation Ratio</td> <td>1.39</td> <td>1.43</td> </tr> </tbody> </table>		Pre	Post	Sensory Integration	71	71	Self Regulation	59	59	Relational	51	52	Cognitive	46	48	Cortical Modulation Ratio	1.39	1.43		
	Pre	Post																				
Sensory Integration	71	71																				
Self Regulation	59	59																				
Relational	51	52																				
Cognitive	46	48																				
Cortical Modulation Ratio	1.39	1.43																				
Emma	 <p>Bar chart for Emma showing NMT scores for Sensory Integration, Self Regulation, Relational, and Cognitive domains. The Y-axis ranges from 0 to 100. The legend indicates: Time 1 (grey), Client (light blue), Age Typical (medium blue), and Mature (black). For Sensory Integration, Client is ~74 and Age Typical is ~74. For Self Regulation, Client is ~55 and Age Typical is ~48. For Relational, Client is ~47 and Age Typical is ~55. For Cognitive, Client is ~53 and Age Typical is ~55.</p>	<table border="1"> <thead> <tr> <th></th> <th>Pre</th> <th>Post</th> </tr> </thead> <tbody> <tr> <td>Sensory Integration</td> <td>74</td> <td>74</td> </tr> <tr> <td>Self Regulation</td> <td>55</td> <td>48</td> </tr> <tr> <td>Relational</td> <td>47</td> <td>55</td> </tr> <tr> <td>Cognitive</td> <td>53</td> <td>55</td> </tr> <tr> <td>Cortical Modulation Ratio</td> <td>1.41</td> <td>1.62</td> </tr> </tbody> </table>		Pre	Post	Sensory Integration	74	74	Self Regulation	55	48	Relational	47	55	Cognitive	53	55	Cortical Modulation Ratio	1.41	1.62		
	Pre	Post																				
Sensory Integration	74	74																				
Self Regulation	55	48																				
Relational	47	55																				
Cognitive	53	55																				
Cortical Modulation Ratio	1.41	1.62																				
Jack	 <p>Bar chart for Jack showing NMT scores for Sensory Integration, Self Regulation, Relational, and Cognitive domains. The Y-axis ranges from 0 to 100. The legend indicates: Time 1 (grey), Client (light blue), Age Typical (medium blue), and Mature (black). For Sensory Integration, Client is ~61 and Age Typical is ~62. For Self Regulation, Client is ~38 and Age Typical is ~47. For Relational, Client is ~40 and Age Typical is ~43. For Cognitive, Client is ~42 and Age Typical is ~44.</p>	<table border="1"> <thead> <tr> <th></th> <th>Pre</th> <th>Post</th> </tr> </thead> <tbody> <tr> <td>Sensory Integration</td> <td>61</td> <td>62</td> </tr> <tr> <td>Self Regulation</td> <td>38</td> <td>47</td> </tr> <tr> <td>Relational</td> <td>40</td> <td>43</td> </tr> <tr> <td>Cognitive</td> <td>42</td> <td>44</td> </tr> <tr> <td>Cortical Modulation Ratio</td> <td>0.81</td> <td>0.96</td> </tr> </tbody> </table>		Pre	Post	Sensory Integration	61	62	Self Regulation	38	47	Relational	40	43	Cognitive	42	44	Cortical Modulation Ratio	0.81	0.96		
	Pre	Post																				
Sensory Integration	61	62																				
Self Regulation	38	47																				
Relational	40	43																				
Cognitive	42	44																				
Cortical Modulation Ratio	0.81	0.96																				

Jack showed improvement in his ability to remain in class and spend more time in class. He was much calmer, was able to go outside at recess, and was able to parallel play with other boys for short periods of time with an adult nearby. Jack's NMT metric showed little change. His CMR increased slightly from .81 to .96. His Sensory Integration, Relational, and Cognitive domain remained essentially unchanged. His Self-Regulation domain increased slightly from 38 to 47.

4.2.6 NME Mini Map

The NME mini map is made up of 10 domains that the teacher has rated from 1 to 4, where 1 is consistent with "Needs significant improvement/Serious challenges" and 4 being "Advanced/ Superior." The Executive Functioning Score (EFS) is a measure of the child's capacity for self-regulation when compared with his or her peers. A score of 2.5 indicates grade-typical self-control and executive functioning capacity. A score of less than 1.5 indicates significant difficulties learning in traditional academic settings.

Frank showed an increase in his EFS from .90 to 1.00. His Reading/Verbal skills and Reactivity/Impulsivity scores increased from 2 to 3 and 1 to 2 respectively, suggesting an improvement in these areas. Frank's Communication/Language score decreased from 2 to 1, indicating that this area may have become weaker or the teacher simply assessed him more accurately in the post intervention after she had had more experience with him over the school year.

Fig. 10. Frank NMT Metric & Mini Map Pre- and Post

NMT Metric

Client (7 years, 5 months) Report Date: 1/24/2015

5	6	7	4	6	4
7	8	7	5	4	8
5	5	4	4	6	8
	7	6	5	7	
	8	7	6	7	
		8	6		
		8	10		
		9	8		

Client (7 years, 8 months) Report Date: 5/10/2015

5	6	7	4	6	4
7	8	7	5	4	8
6	6	4	4	6	8
	7	6	6	7	
	8	7	6	7	
		8	6		
		8	10		
		9	8		

Report Date: 1/26/2015
Classroom: Goodheart

	2	2	1	2	
		2	1	2	
		3	3		
			2		

Report Date: 6/10/2015
Classroom: Cape Horn

3	1	2	2	
	2	1	2	
	3	3		
			2	

NME Mini Map

Fig. 11. Gary NMT Metric & NME Mini Map Pre- and Post

NMT Metric

Client (8 years, 9 months) Report Date: 2/5/2015

4	4	8	4	4	3
7	9	9	5	4	8
6	6	8	7	5	6
	8	7	7	10	
	7	8	8	9	
		10	9		
		9	9		
		9	10		

Client (9 years, 0 months) Report Date: 6/10/2015

4	4	8	4	4	5
7	9	9	5	5	8
6	6	8	7	5	6
	8	7	7	10	
	7	8	8	9	
		10	9		
		9	9		
		9	10		

Report Date: 2/9/2015
Classroom: Grade 2/3 Glen

	2	2	2	2	
		1	2	2	
		3	3		
			2		

Report Date: 6/10/2015
Classroom: Glen

	2	2	2	2	
		1	2	2	
		2	4		
			1		

NME Mini Map

Fig. 12. Emma NMT Metric & NME Mini Map Pre- and Post

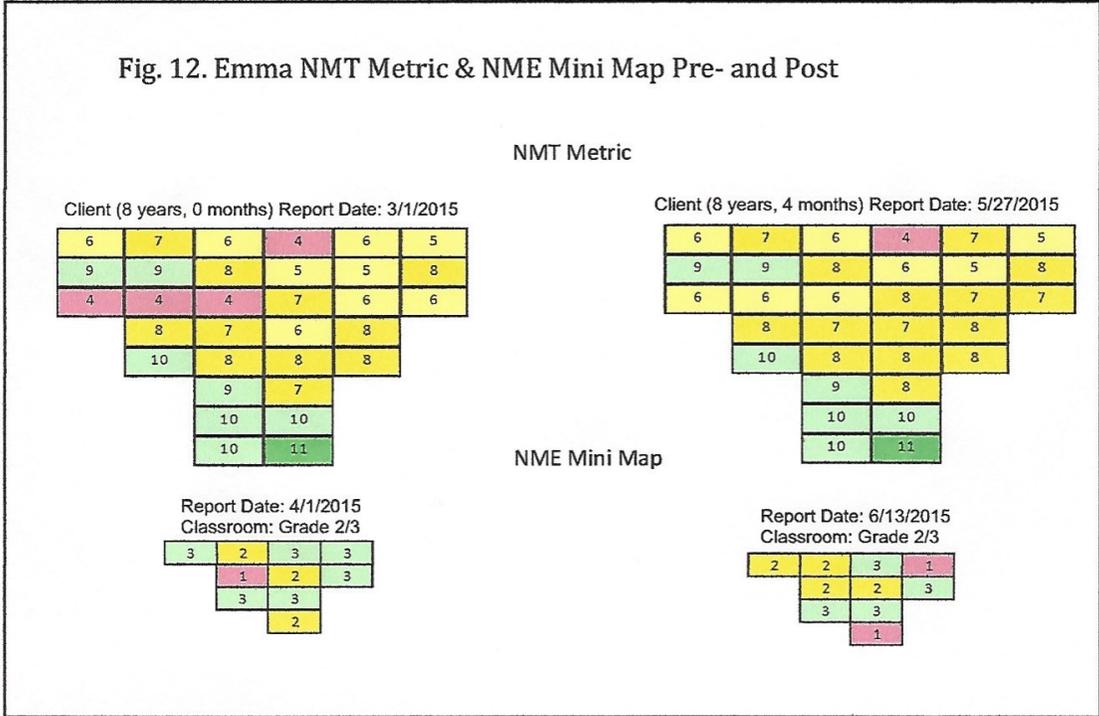
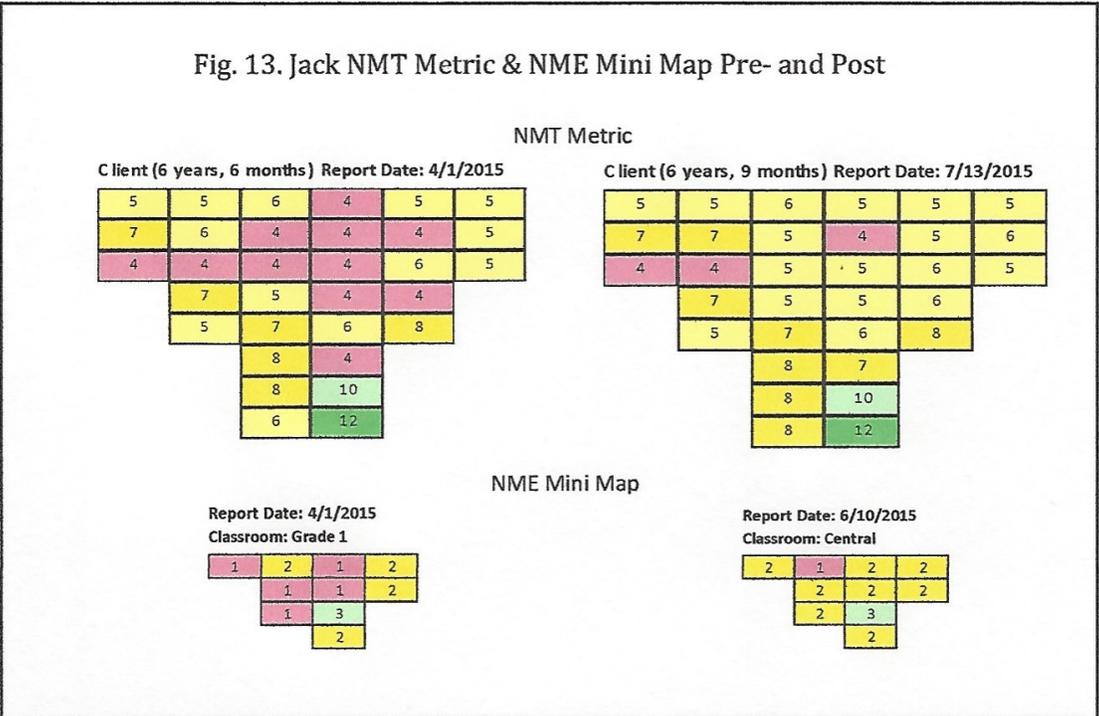


Fig. 13. Jack NMT Metric & NME Mini Map Pre- and Post



Gary was the only participant whose teacher rated his EFS as lower after the intervention. Gary's EFS decreased from 1.00 to .90. His teacher noted no change in most areas except Attention/Distractibility and Fine Motor which both went down a point from 2 to 1 and from 3 to 2 respectively. The teacher increased her rating on Gary's Coordination/Large Motor skills from 3 to 4.

Emma's teacher noticed no change in Emma's EFS as her ratings stayed steady at 1.44. The teacher however, did report that in various areas Emma did meet some of the descriptors in the upper ratings, but not enough to move her up to that area.

Jack showed a solid improvement in his EFS from .58 to .91. His teacher rated him as improved in many areas. His Reading/Verbal skills, Reactivity skills, Communication/Language skills and Relational skills, Threat Response and Fine Motor skills all went from 1 to 2.

Overall, one participant (Jack) was rated as having markedly improved, one participant (Frank) was rated as having generally improved and the third participant (Emma) was rated as showing very slight improvement but essentially remaining the same. One child (Gary) was rated by his teacher as having deteriorated during the NMT intervention.

4.2.7 NMT Cortical Modulation Ratio/NME Executive Functioning Score

The pre and post NMT Cortical Modulation Ratio (CMR) calculated for each child was compared to the pre and post NME Executive Functioning Score (EFS) calculated for

each child. These measures are relatively new, but there is some anecdotal evidence by people who use them that they can be discrepant.

Frank's CMR and EFS were reasonably close. His pre-intervention CMR and EFS measures showed a difference of .16 points while his post intervention CMR and EFS measures showed a difference .09 points.

Gary's CMR was consistently higher than his EFS. His pre-intervention CMR and EFS measures showed a difference of .39 points while his post intervention CMR and EFS measures showed a difference .53 points.

Emma's CMR and EFS were reasonably close. Her pre-intervention CMR and EFS measures showed a difference of .03 points while her post intervention CMR and EFS measures showed a difference of .18 points.

Jack's CMR and EFS were reasonably close. His pre-intervention CMR and EFS measures showed a difference of .23 points while his post intervention CMR and EFS measures showed a difference .05 points.

Three of the four participants showed a CMR that was reasonably close to their EFS. One participant (Gary) consistently showed a significantly greater CMR than EFS. (See Table 16).

Table 16. Cortical Modulation Ratio and Executive Functioning Score pre and post intervention

	NMT Cortical Modulation Ratio		NME Executive Functioning Score	
	Pre	Post	Pre	Post
Frank	1.06	1.09	0.90	1.00
Gary	1.39	1.43	1.00	0.90
Emma	1.41	1.62	1.44	1.44
Jack	0.81	0.96	0.58	0.91

Chapter 5: Discussion

The present study was designed to be a preliminary investigation into the feasibility of creating and implementing a behaviour plan based on a trauma informed assessment (NMT) for children in public elementary schools who had a history of early psychosocial stress (i.e. Adverse Childhood Experiences or ACEs), comparing this to a function-based, multicomponent behaviour support plan based on a Functional Behaviour Assessment (FBA), which emphasizes preventative teaching and positive reinforcement strategies. A function-based behaviour plan is standard practice for children who have been identified with behavioural issues in B.C. schools.

The present study addressed four experimental research questions intended to evaluate the efficacy of this intervention on improving self-regulation abilities operationalized as academic engaged time, variable heart rate, out of control incidences, and performance on executive function tasks. For the participants who received the NMT intervention, pre and post NMT metric and NME mini map assessments were compared. The study also addressed social validity from the perspective of classroom teachers.

5.1 Summary of Results

A non-concurrent, multiple baseline single-subject experimental design was used across two cohorts of four participants to determine the effects of the NMT and FBA-based intervention respectively. The results revealed no functional relationship between the implementation of either of the two interventions and the dependent variables of Percent

Academic Engaged Time or Heart Rate Variability. Both interventions were rated similarly, with somewhat acceptable social validity, which means that teachers found both interventions as acceptable in regard to suitability for the school environment and effectiveness.

Two tests of executive functions, Hearts and Flowers and the Flanker/Reverse Flanker tasks, were given before and after the intervention to both the NMT and FBA cohort. The NMT cohort showed more improvement in accuracy on the Hearts and Flowers task which was a trend but not statistically significant.

On the Flanker/Reverse Flanker tasks both the NMT and FBA groups improved, and their degree of improvement was comparable. On the Flanker/Reverse Flanker task both cohorts showed an improved ability to think before they act (i.e. improved self-control) as evidenced both by their taking more time to respond and getting more answers correct on the post-test. It is not clear whether their improvement was due to the intervention or maturation as there was no control group. The improvement both groups showed was not statistically significant. The lack of significant findings on all executive functions measures was not surprising given the small sample size.

The pre- and post-intervention NMT metrics and NME mini maps showed little to no change. The NMT Cortical Modulation Ratio was found to be of similar magnitude to the NME Executive Functioning Score in 3 out of the 4 participants.

The findings obtained suggest a relatively (and perhaps surprisingly) low but positive degree of impact on the children in both NMT and FBA groups, particularly given that both interventions are relatively well established clinically, as well as having a respectable research evidence base. Some of the neuropsychological measures and the teacher's reports show some evidence that the participants did show improvement over the four month intervention.

There would appear to be several potential factors that need to be considered in understanding the lower than expected impact of the two interventions.

First, the duration of the study was ultimately much shorter than intended due to a teacher strike in the province at the beginning of the school year, which resulted in delays in conducting all of the necessary steps for assessment (as this required observation in the classroom) as well as being able to communicate with all of the stakeholders (i.e. teachers, SEAs, counsellors, principals and Student Services staff). In addition, it was not possible to identify students suitable for the project until these students could be referred through the usual district processes, and appropriate consents and other documentation could be obtained. In addition, due to the delays in starting the academic year, systems and processes remained relatively inefficient for some time after the strike ended. In retrospect, delaying the study a year would have allowed more time for preliminary organization and a longer study.

A second factor relates to the types of influences that exist in the families of children with a history of ACEs. This includes instability in home life, unexpected changes in parental access and visitation, changes in medication (starting or discontinuing medications on a schedule that is not necessarily aligned with the study interventions), and most of these children not attending school full time or attending on variable and at times unexpectedly changing schedules. For example, one child was put on ADHD medication part way through the study which significantly improved his behaviour, while another had his SEA go off on medical leave for two weeks which resulted in a deterioration of his behaviour.

A third factor relates to the less than optimal opportunity to appropriately educate all school staff who were involved in working with the students participating in the study with regard to the nature of the intervention, as well as assisting them in understanding more fully both the potential benefits and costs to the staff affected (for example being able to provide classroom teachers with sufficient education and advance notice with regard to the various individuals involved in the study who might be in the classroom and their roles, as well as the ways in which such changes to the routines of these students, who are by definition, reactive to change and prone to emotional acting out, may affect student behaviour in the short term, yet also providing a clear expectation of potential benefits with regard to behaviour and emotional regulation should students demonstrate the expected responses to the intervention provided.) For example, without a good grasp of the concepts behind the strategies and interventions suggested by the assessments, teachers may perceive emotional acting out behaviour as being deliberate, ill-intentioned, or instrumental (i.e. intended to achieve a particular goal such as to avoid

responsibility for carrying out assigned tasks), rather than appreciating that for many of these children, they are simply not equipped to regulate their level of emotional arousal within the band required to be able to be quietly focused on a task and to maintain their focus, attention, and effort long enough to complete the task. In retrospect, more thorough education of the staff in regards to both the FBA and NMT concepts before the start of the study would likely have helped this issue.

A fourth barrier to successfully implementing such interventions relates to the constraints of the naturalistic setting. In the context of this naturalistic setting, given the complexity of these multiple responsibilities, the teacher as well as any SEA assisting a student has to find the opportunity to apply strategies that may have been provided to them during feedback and training by the researcher. Typically, teachers and SEAs are looking for tools and strategies that they can rely on to obtain a desired result, as they are the responsible parties for delivering the required outcomes. This is a collaborative effort at all times, and the researcher not only has to respect the complexities of the demands faced by these front-line staff, but also has to be cognisant of the extent to which the needs of other students may limit the ability of these front-line staff to implement specific strategies or recommendations. This includes the complex demands faced by the classroom teacher who has to keep track not only of the children with the types of emotional regulation needs as described above, but is also faced with his or her own cognitive attributions regarding the purpose and intention attributed to the child's behaviour.

5.2 Considering the Present Findings in Relation to the Literature

In the present study, an attempt was made to change the way teachers viewed behaviour, in this case by providing them with a perspective derived from recent advances in understanding brain development, in other words, what may be conceptualized as a neurodevelopmental “lens,” a lens that provides a view that can readily incorporate other disciplines such as occupational therapy, speech-language pathology, and school psychology, which has the potential to provide more evidence-based, up to date, and goal-directed ways of helping to manage student behaviour by helping students reduce anxiety and hyperarousal.

Changing how a teacher views a child’s behaviour can be crucial to changing how a teacher deals with that behaviour. For example, in the study done in Ireland with the Alert program which uses both a ‘top down’ and ‘bottom up’ approach to emotional regulation (MacCobb, et.al., 2014), teachers were given a two-day training by an occupational therapist, and speech pathologists were also involved with the training. The research questions focused on whether the Alert program training changed the teacher’s perspective of a student’s behaviour. The idea of changing teachers’ perspectives on behaviour is at the base of this approach. It was also noted that collaboration with other disciplines such as occupational therapists led to changes in attitudes towards students due to having increased their level of understanding and awareness of the contributory factors to student behaviour as well as developing an increased knowledge of sensory processing factors affecting student engagement in classroom activities. By changing the

lens through which they viewed the child's behaviour, they may then be able to select more relevant and effective strategies for interaction and intervention.

The present study did not allow for enough time to adequately educate teachers around the Neurosequential Model's concepts. I relied heavily on programs that were already in the district and people were more familiar with that promoted 'bottom up' regulation and the ideas around the arousal continuum (e.g. Alert, Zones of Regulation). The people involved with the child in many cases were quite stressed themselves with trying to manage the behaviours, and were not really in a place to take on new concepts. A better plan would have been to educate the school staff in trauma-informed concepts and strategies through psycho-education during a number of professional days when staff are more relaxed and focused on learning.

The trauma-informed approach taken by the HEARTS program (Dorado et al., 2016) appears to recognize the challenges outlined above, and proposes a 3-tier approach with increasing level of supports as complexity of needs and level of support required increases. Shamblin et al. (2016) has also shown success with a 3-tier approach and collaborating with community mental health supports to deliver individualized intervention to families of the highest needs children.

Another approach that may be better suited to this type of population, and which would be consistent with the goal of the present study of helping to change the lens through which teachers view these children to one that is more trauma-informed and better suited

to intervening at a level where such intervention might be expected to be accessible to these children, would appear to be the recently developed Neurodevelopment Model of Education or NME (Brenneis et al., 2016) put forward by the Child Trauma Academy.

The NME provides 5 hours of psychoeducational instruction to school staff and would be a more comprehensive model for studying the effectiveness of the Neurosequential Model in schools.

Students with behaviour issues and difficulty with self-regulation are factors in teacher stress and burnout. Increases in stress levels experienced by teachers in the classroom are often driven by children with behaviour challenges (Naylor, 2012). As Oberle and Schonert-Reichl (2016) showed recently, the stress of the teacher and students in this type of situation is highly correlated. When a highly reactive child is introduced into the classroom and the teacher is not provided with a lens through which to view the child's behaviour in a way that is helpful in addressing the child's difficulties, the resulting toll on the system, classroom teacher, principal, SEAs, the student in question, and other students, is high.

Teachers rated both interventions as somewhat acceptable. As previously noted, children with a high level of behavioural needs can be very stressful for a teacher. The teachers in the present study tended to rate the intervention according to how much the child improved. For instance, Adam's teacher gave the highest ratings, and within the classroom Adam showed the biggest improvement. Adam resolved his problem

behaviour (running away), and increased his time in the classroom from only a few hours per day to a full day. Both interventions may have been rated higher by the teacher if there had been a bigger improvement in their students' behaviour.

It is interesting to look at the difference in teachers' perceptions of stress in their job between those who had received NME training and those who experienced the concepts of the Neurosequential Model through the study. For teachers who had received NME training, 64% agreed or strongly agreed with the statement "I have found that understanding and implementing the Neurosequential Model approach has reduced my job stress" and 70% agreed or strongly agree with the statement "I find that working within a school that has adopted a Neurosequential Model approach is less stressful than working in a school that utilizes a more conventional approach to behaviour and learning." Of the four teachers who participated in the study, two agreed with the statement, "I felt having a child on this type of behaviour plan reduced my stress." It would thus appear that the more training teachers and the school receive regarding these principles, the more effective they are able to be, and the more supported they perceive themselves to be, in supporting students. The delivery method and schoolwide focus of the NME program is likely also a factor in the difference in the teacher's perceived stress.

With the current trend towards students with behavioural challenges being integrated into regular classrooms, research on a program's effect on teachers' perception of job stress would be good information to have as it has the potential of save the education system many thousands of dollars in stress-related costs.

Many of the participants experienced a difficult first 6 months of life due to maternal addictions, depression, or deprivation. Their self-regulatory difficulties appear to be consistent with the Ansten's (2009) work on stress and the amygdala suggesting that early life is when the amygdala and the stress response system are developing and that high stress (neglect) at this period is very disruptive to the development of self-regulation abilities. Similarly, emerging research finds that a lack of appropriate attachment during the first five months of life with a present and attuned caregiver can contribute to emotional self-regulation dysfunction (Fay-Stammbach et al. 2014).

This seems to result in a significant mismatch with the type of intervention that is more typically provided in the school system, making use of behaviour modification-focused strategies, frequently drawing on the tools of Applied Behaviour Analysis. This is more typically used with children with an autism spectrum diagnosis, which is quite different from the type of sensitive, attentive, and emotionally attuned attention that would be required to reach and effectively engage children in a process of co-regulating their emotional reactivity until they are able to develop the capacity for regulating their emotional arousal themselves.

5.3 Unique Contributions and Clinical Implications

There are several clinical implications of the present findings for teachers, schools, districts and other stakeholders.

It is interesting that 3 of the 4 participants in the NMT cohort showed a Cortical Modulation Ratio (CMR) calculated from their NMT functional brain map that was similar to their Executive Function Score (EFS), calculated from their NME mini map. Gary was the participant who showed a discrepancy between his CMR and EFS with his CMR about 40 points higher than his EFS. Gary likely cycled between hyperarousal (stress response fight/flight) and dissociation (freeze) with little capacity for social engagement as he seemed to view social interaction as relating to a need either to dominate others or be dominated by them. Gary did well if he was given structure and was monitored by an adult. He was in a very structured class and was under the eyes of an adult most of the time when he was at school. He also showed little acting out at home, with most of the concern about Gary's behaviour being related to his aggression and threatening behaviour towards his peers when an adult was not attending.

Gary's CMR was likely measured to be too high and his dissociation underestimated and his emotional regulatory functions overestimated. Hyperarousal is easier to observe objectively than dissociation. Consistent with the propositions of Porges' (2011) Polyvagal Theory as this relates to social engagement, providing Gary with the opportunity to engage in positive and rewarding social and interpersonal experiences through the therapeutic riding program helped him to strengthen his capacity for social interaction, improved his self-concept, and helped to reduce the negative social impact of his past experiences that had reinforced a perception that people were not safe.

5.4 Limitations and Future Directions

Interrater reliability was established to 90% before the commencement of data collection and again half way through the study which represented 12.5% of all sessions. However, given the constraints of the naturalistic setting of the educational environment, the generally accepted requirement of completing IRR ratings for 20% of all sessions with each child proved impractical, and therefore it cannot be determined with confidence whether IRR was maintained at the intended levels throughout the study.

The AWMA showed inconclusive results as this test proved very difficult to administer with this population. An alternate test would involve a lower range of verbal and spatial working memory items that would be suitable for children ages 4 through 12. The test would need to be self-scoring, and be visually appealing to children.

Reporting of Out-of-Control Incidents and the use of the Communication Book proved to be highly inconsistent among school staff, parents, and caregivers. This was compounded by challenges associated with frequent changes in caregivers and staff, and variable incidents across environments and school days. As such, these data sources were ultimately concluded not to provide reliable data. However, it is also important to note that the conditions described are relatively common in the school system, and if the study were repeated in a similar naturalistic setting, similar circumstances would likely be encountered. Given that the students were so complex and their needs high, it seems that a more individualized measure of success would need to be found dependent on the

child's behaviour profile, or the research would need to be done on less needy students who attend school full-time.

The study was conducted over a 5-month period. Given the complexity of clinical and behavioural presentations, as outlined above, it is probable that a longer time frame, likely covering the full school year and potentially even longer than that, would be required in order to obtain more robust effects. However, even within the relatively limited time frame of the present study, the extent to which the role of events and individuals entering and leaving the immediate social sphere of the participants and how they appeared to influence the results obtained, was striking.

For example, Max's FBA-based intervention was evaluated to have a moderate basic effect when using the multiple baseline single case study methodology, which was the strongest effect that any of the interventions showed among all of the eight single case studies; however, this was not maintained. Max also obtained the lowest results in regards to the executive functions testing. This suggests that although he made good progress at first, he had difficulty maintaining that change over the four months. His teachers noticed that after Spring Break it was very difficult to get Max "...*back on track*," noting that his living arrangement had changed, his father was back in his life and he was having a very difficult time.

The pronounced negative effect associated with Jack's SEA leaving for 2 weeks on medical leave midway through the study, and then demonstrating a significant positive effect following her return, provides another example.

Conversely, Gary's NMT-based intervention was evaluated to have no effect over the four months that the study took place. However, Gary continued with the equine therapy over the summer and through the following year. During that year, it proved to be possible for him to be removed from the top tier of the principal's list of the most challenging children. He was now able to play with groups of students at recess and lunch without too much trouble. He developed a relationship with a classmate whom he considered a "friend". Although he continued to struggle with relationships and bullying behaviour, boys in his class began to interact with him in a more relaxed and friendly way. By the end of the year, the school was very pleased with his progress, and continued to fund and support his horse riding sessions.

The single case, non-concurrent multiple-baseline methodology really focuses on behaviour whereas the present study was intended to aid in developing the executive function of inhibition (also known as self-regulation) (i.e. an NMT-based behaviour plan). For instance, the methodology suggests that an immediate positive change in behaviour indicates an effect, while a gradual upward trend towards more positive behaviour is not considered as effective. Yet if the goal of the intervention is to help develop regulatory capacity, a positive upward trend towards more regulated behaviour would be expected to indicate effectiveness.

The perspective of the present study is to not view behaviour as simply behaviour but rather as a lens through which to learn about emotional regulation and mental health. For these children, it is not about a specific behaviour that can be targeted and modified by behavioural means. Rather, this represents a cumulative collection of multiple dysregulated behaviours that depend on many variables that are often very difficult to identify and control in the general classroom environment. The idea is thus to provide children with experiences that would help them calm their nervous system down and develop greater regulatory control. This is a much more complex task, and would take longer to develop than an intervention focused on, for example, getting a child to raise his hand before he speaks.

The study was conducted in a naturalistic environment, with treatment fidelity that was not rigorously implemented or monitored. Consistent with the constraints of the classroom environment, it was decided that formal evaluation of treatment fidelity would not be carried out. However, it is also important to recognize that the methods used in this naturalistic setting are more realistic to that setting (Scott & Alter, 2017). Onwuegbuzie (2000) points out that this may be viewed as being more akin to an external validation of treatment fidelity, whereas the more rigorous approaches may provide more internal validity, but at the cost of having to artificially control the context by limiting or eliminating some of the complex aspects of the classroom environment.

There was a limited level of control over treatment integrity. Typically, the classroom contains between 20 and 25 children, of which one or more other children may also have

an SEA assisting them. The classroom teacher has the responsibility for ensuring that all the children in the classroom have appropriate access to educational experiences, which may result in a child who is acting out and disrupting the classroom temporarily being excluded from the classroom setting by, for example, being referred to the principal's office.

Within the naturalistic school context, school staff demonstrated a wide range of levels of acceptance of the principles involved in both assessment and intervention, as well as variability in levels of experience in incorporating this information into the regular educational activities of these students. For instance, Jack's SEA was trained in sensory needs (bottom up regulation), was attuned to his needs and helped to co-regulate him through effective use of routines, choices, movement, sensory experiences etc. Jack made good progress with her. Frank's school was very focused on making Frank compliant in following directions, despite the researcher's efforts to change that mindset, and Frank's progress was limited.

It should nevertheless be emphasized that my experience working with all of these front-line professionals was that they were mostly enthusiastic and eager to be provided with any additional strategies or a different perspective (such as the practical implications of a diagnosis) that may assist them in supporting these students.

A further potential confounding factor is the limited extent to which interventions and data collection methods could be fully standardized, as well as adding to the extent to

which random or non-research related events may have affected outcomes. A research design based on a school based approach (i.e. located within a single school) may have been more effective.

The complexity and constraints described above clearly represent significant limitations as regards to interpreting the findings or being able to generalize the finding across other settings.

Percentage of Academically Engaged Time (PAET) would be considered an appropriate variable when applied to a student in a classroom. However, a large portion of the students in this study only attending school a portion of the time. The measure can be deceiving as a child who is on a computer, or with a preferred activity, PAET could be very high despite limited overall engagement or attendance. For these children, a measure of actual time in the classroom each day may have been a more meaningful measure. Several of these children had more social interaction difficulties, manifesting during recess or lunch rather than in the classroom.

Another limiting factor that must be considered, especially in regard to the pre and post executive functions testing, was that the two groups were not equal. The NMT group had higher executive functioning scores at the pre-test level. The NMT group had more participants who were in school full-time, which is another indicator of their higher executive functions. This may also have been a factor in the Hearts and Flowers task

results where the NMT cohort showed more improvement in accuracy. The NMT may have been better able to benefit from the interventions in regard to improving their executive functions as they were at a higher ability to begin with.

For statistical analysis of the executive functions testing the sample size was too small. Each group consisted of 4 and often 3 participants (one child in each cohort had difficulty getting past the sample tasks) which was too small to get statistically significant results.

The researcher did the testing and the students who were in the NMT cohort were more familiar with the researcher and had seen her more times, and may therefore have felt more comfortable with her during the executive function tests. The researcher was not blind to the condition each child was in, and thus it was not possible to fully guard against potential expectations that the NMT-based intervention would work better.

One of the items on the survey was *“I found concepts outlined in the initial assessment easy to understand”*. The FBA teachers viewed their concepts to be more difficult to understand than the NMT teacher viewed theirs. Interestingly, however, it was noted in practice that the front-line staff often did not appear to understand the concepts of the NMT, or perhaps more relevantly, how to adapt other, pre-existing ideas and practices toward introducing the NMT principles. It seemed that many of the teachers, SEAs and staff did not understand the basic NMT concepts and that the training that could be provided within the constraints of an ongoing academic term and active classroom

schedule proved to be inadequate and too brief to have any effect on how they viewed the student's behaviour.

For instance, I arrived for a scheduled session with one of the participants one afternoon to find him outside waiting for his mother. As I traced back what had happened, it turned out he had been disrespectful and defiant with the teacher and was sent to the principal's office, and the principal was just leaving him to sit outside. I took him for the planned play therapy session and subsequently debriefed with the staff, thankful for the opportunity to bring him down and possibly build some awareness around the event. The SEA was not very supportive of this, and expressed the view that I was rewarding the child's perceived bad behaviour. This impression was later reinforced by the teacher who emailed me and asked that I meet with the child earlier in the afternoon. Throughout the study, I was never successful at fostering an understanding among the primary school staff of the basic message that the child needed to learn to regulate himself and that he was not going to learn by consequences.

The study was intended to look at using a NMT assessment to create a behaviour plan. The findings appear to indicate that this was not a successful model of delivery to support the highest of high-needs students. I was overwhelmed by the psychosocial and clinical issues of some of these participants. Some of these participants were the most complex students in the district, and were being attended to by the least educated personnel in the district. It would seem that there is something missing from the equation. The finding that these children were sometimes in their third year of only coming to school for half a day

is a concern in and of itself.

The extent and potential consequences of this complex combination of behavioural, emotional, and academic limitations of these students would seem to provide a strong appeal for a more multidisciplinary approach to intervention, coordinated efforts at the school level, and community mental health involvement. Often the files of these children have a good number of reports in them from various district and community specialist (Occupational Therapist, Speech and Language Pathologist, Sunny Hill Hospital, BC Children's Hospital), but it does not appear that these voices are being systematically coordinated, put together or really understood by anyone in the school, and the information tends to sit in child's G4 file.

In conclusion, therefore, although the present findings failed to demonstrate evidence of effectiveness of a trauma-informed approach to intervention for children with a history of ACEs, there appear to be significant unanticipated extraneous factors that have contributed to this negative outcome.

It would be recommended that future studies that look at trauma-informed approaches should study school-wide models of delivery, where schools that have been trained in the trauma-informed psychoeducation are compared to schools that have not. Looking at variables such as teacher and student stress levels, student office referrals, and ratings of the teacher and student's social and emotional wellbeing may represent the most useful indicators of success.

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Appendix A. Initial Contact Form



Adele Diamond, PhD, FRSC
Canada Research Chair Professor of Developmental Cognitive Neuroscience
University of British Columbia (UBC) Department of Psychiatry
2255 Westbrook Mall, Room G842
Vancouver BC V6T 2A1 Canada
Phone: 604.822.7220 Fax: 604.822.7232

January 1, 2015

PROPOSED RESEARCH PROJECT – INITIAL CONTACT FORM

Title of Project: Using an Neurosequential Model of Therapeutics (NMT) based behaviour plan in elementary schools

Principal Investigator: Dr. Adele Diamond
Canada Research Chair in Developmental Cognitive Neuroscience
Department of Psychiatry
University of British Columbia
Phone: 604 822 7220
Email: adele.diamond@ubc.ca

Co-Investigator: Kim Viljoen M.Ed., M.A.
Interdisciplinary Studies, UBC

Dear Elementary School Counsellors,

The purpose of this email is to tell you about our proposed research study, and to invite teachers, students and parents involved in developing and implementing behaviour plans to participate. If you currently have a student who has been identified as needing behavioural support under the Ministry of Education category “R” or “H”, who is in grade 1, 2 or 3, and who has a history of psychosocial stress or attachment issues, that child may be a possible participant in the study. The study is looking for 8 participants.

Participation in the study would involve the use of a developmentally sensitive and neurobiologically informed assessment (Neurosequential Model of Therapeutics – NMT) or a Functional Behavioural Assessment (FBA) to inform the student’s behaviour plan. The assessment would be conducted by one of the two researchers (Kim Viljoen, School Psychologist in the Coquitlam District who is currently a Ph.D. student at UBC) or the district behaviour team. The behaviour plan would be created with input from the team and the student’s progress tracked over the school year.

The timeline for the study is as follows:

Nov-Dec 2014 – students are identified and screened (classroom observation and brief interview with the teacher) to ensure the intervention is right for them. As students are identified for the study, they will be alternately assigned to either the NMT or FBA group.

NMT based behaviour plan	FBA based behaviour plan
<p>Jan-Feb NMT assessment completed which requires</p> <ul style="list-style-type: none"> • parent interview and feedback to parent • classroom observation <p>NME assessment completed which requires</p> <ul style="list-style-type: none"> • 15 minute interview with teacher <p>Student is administered 3 computer based tests (about 30 minutes long)</p> <p>5 X10 min. classroom observations (study) 3X3 min. finger on sensor pad (study) Daily recording of 'out of control' incidents (teacher)</p> <p>Meeting at school with all those involved with the child to explain assessment and develop behaviour plan.</p> <p>Jan-May Student' progress is tracked and adjustments to the behaviour plan can be made.</p> <p>Tracking consists of: 3 X 10 min. observations every 2nd week (study) 1 X 3 min. finger on sensor every month (study) Daily recording of 'out of control' incidents (teacher)</p> <p>Communication Book – goes back and forth between home and school to track progress, interventions and out of control incidents. (teacher/parent/study)</p> <p>Student will receive one to two hours of one-on-one counseling a week with an NMT focus (study)</p> <p>April – May Student is administered 3 computer based tests (about 30 minutes long)</p> <p>Teacher will need to complete a brief questionnaire</p>	<p>Jan-Feb FBA assessment completed which requires</p> <ul style="list-style-type: none"> • classroom observation • teacher interview <p>Student is administered 3 computer based tests (about 30 minutes long)</p> <p>5 X10 min. classroom observations (study) 3X3 min. finger on sensor pad (study) Daily recording of 'out of control' incidents (teacher)</p> <p>Meeting at school to explain assessment and develop behaviour plan.</p> <p>Jan-May Student's progress is tracked and adjustments to the behaviour plan can be made.</p> <p>Tracking consists of: 3 X 10 min. observations every 2nd week (study) 1 X 3 min. finger on sensor every month (study) Daily recording of 'out of control' incidents done (teacher)</p> <p>Communication Book – goes back and forth between home and school to track progress, interventions and out of control incidents. (teacher/parent/study)</p> <p>April-May Student is administered 3 computer based tests (about 30 minutes long)</p> <p>Teacher will need to complete a brief questionnaire</p>

about their experience with the behaviour plan	about their experience with the behaviour plan
NMT & NME assessments updated requires <ul style="list-style-type: none">• parent interview• brief teacher interview	
Final results and summaries of the child's progress will be reviewed at the year-end behaviour plan (IEP) meeting.	Final results and summaries of the child's progress will be reviewed at the year-end behaviour plan (IEP) meeting.

If you have a student with a parent and teacher who you feel may be interested in participating please share the above information. If they both express an interest in participating in the study please contact Kim Viljoen at kviljoen@sd43.bc.ca or 604 512 5725.

Thank you in advance for considering our request.

Kind regards,

Dr. Adele Diamond

Kim Viljoen

Appendix B. Parent Consent Form



Adele Diamond, PhD, FRSC
Canada Research Chair Professor of Developmental Cognitive Neuroscience
University of British Columbia (UBC) Department of Psychiatry
2255 Westbrook Mall, Room G842
Vancouver BC V6T 2A1 Canada
Phone: 604.822.7220 Fax: 604.822.7232

November 12, 2014

PROPOSED RESEARCH PROJECT – PARENT CONSENT FORM

Title of Project: Using an Neurosequential Model of Therapeutics (NMT) based behaviour plan in elementary schools

Principal Investigator: Dr. Adele Diamond
Canada Research Chair in Developmental Cognitive Neuroscience
Department of Psychiatry
University of British Columbia
Phone: 604 822 7220
Email: adele.diamond@ubc.ca

Co-Investigator: Kim Viljoen M.Ed., M.A.
Interdisciplinary Studies, UBC
Phone: 604 517-5775
1

Dear Parent or Guardian:

Kim Viljoen is conducting this research as part of her dissertation for her Philosophy of Arts Degree in Interdisciplinary Studies. The information obtained from the study will be used in the dissertation that will be read by the UBC faculty and will later become a public document.

Listed below are several aspects of this project that you need to know.

Purpose of the study: The purpose of the study is to see if children who follow a behaviour plan based on a developmentally sensitive, neurologically informed assessment improves their ability to manage their attention and behaviour.

Study Procedures: Participation in the initial screening and participant selection for this research study would involve a brief observation of your son or daughter in the classroom and a brief interview with your child's teacher to determine whether this type of behaviour plan would be suitable for him or her. This type of observation is routinely done in classrooms and requires no interaction with your son or daughter.

Should the behaviour plan appear suitable for your child, he or she will be eligible to participate in the full study. Participation in the full study would involve being assigned to one of two groups. One group would receive a behaviour plan based on a Functional Behavioural Assessment (FBA) that is standard practice in the school district. The other group would receive a behaviour plan based on a Neurosequential Model of Therapeutics (NMT) assessment. If your child is in the NMT group you would need to participate in an interview in regard to your child's developmental history. From this information a NMT assessment will be created and shared with you individually. Your child's teacher would need to answer some questions in regard to your child's classroom skills and behavior. From this information a Neurosequential Model of Education (NME) assessment would be created. Both of these assessments will inform your child's behaviour plan which will be developed in consultation with all parties involved. In summary, if your child participates in the study they will have a 50% chance of getting the NMT assessment and treatment and 50% chance of getting the FBA assessment and treatment which your child would get anyway if they did not participate in the study.

If your child is in the NMT assessment group, you will need to participate in an interview, and meet with the examiner to review the results of the assessment. This will take about 3 hours of your time.

If your child is in the NMT assessment group they will receive 60 minutes of NMT-informed counselling once a week.

All children who participate will need to complete a 30 minute computer-based assessment of executive functioning at the beginning and end of the school year. All children participating will periodically (3-5 times in the first week and then once a month after that) need to place a clip on their earlobe for 3 minutes while doing a calming activity in order to measure the variability of their heart rate. Throughout the school year your child's progress will be tracked with regard to attention, and behaviour and adjustments in his/her program may be made in response to that information.

A communication book will go back and forth between the school and home as a way of tracking the progress and implementation of the behaviour plan.

If you choose to not participate in the study, there will be no negative consequences and your child will continue to receive services from the Coquitlam school district as required and provided for children identified as needing behaviour supports.

Potential Risks: There are few potential risks and many potential benefits for the children who participate. Risks include the potential for being identified by others as participation in an intervention, but given that your child has already been identified for intervention within the school system, this is unlikely to be of added risk of stress or adverse effects. Students will be taken out of the classroom for brief periods (approximately 60 minutes in total) in order to undergo the intake and conclusion assessment measures.

Potential Benefits: The potential benefits include an assessment that would be used to identify interventions that may help a child develop self-regulation, and participation in one to two sessions a week of developmentally appropriate counselling, grounded in NMT principles.

Confidentiality: We recognize your right to privacy should you decide to give consent for your child to participate in this process. Your identity, the identity of your child, his or her school, and teacher will be kept strictly confidential. No identifying information will appear in any written or oral presentation of this research.

Should you decide to participate in this study, all information collected for research purposes will be identified only by code number and kept in a locked filing cabinet in Dr. Diamond's office at UBC. Only Dr. Diamond and Kim Viljoen will have access to the information.

Remuneration/Compensation:

There are no costs or remuneration associated with participation of this study

Contact for information about the study:

If you have questions or desires further information with respect to this study, you may contact me, Kim Viljoen, at

Contact for concerns about the rights of research subjects:

If you have any concerns about your treatment or rights as a research subject, you may contact the Research Subject Information Line in the UBC Office of Research Services at 604-822-8598 or if long distance e-mail to RSIL@ors.ubc.ca

Consent:

Participation in the research is completely voluntary, and you may withdraw from the study at any time, even after signing the consent form. If you choose to withdraw from the study your child will continue to receive service from the school district and the behaviour supports typically provided to children who are identified as needing behaviour supports. The results from this study will be presented in a dissertation at UBC and potentially at conferences and in a journal article. However, your identity information and that of your student will remain confidential.

Your signature below indicates that you consent to participate in this study and have received a copy of this consent form for your records.

Thank you very much for considering this request.

Sincerely,

Adele Diamond, Ph.D., FRSC
Kim Viljoen M.A., M.Ed. (Doctoral student)

PARENT CONSENT FORM

Study Title: "Using an NMT based behaviour plan in elementary school"

Principal Investigator: Dr. Adele Diamond, Ph.D., Professor, Department of
Psychiatry, Department of Psychiatry, University of British
Columbia, 2255 Westbrook Mall, Vancouver, BC V6T
2A1
Phone: 604 822 7220
Email: adele.diamond@ubc.ca

I have read and understand the attached letter regarding the study entitled "Using an
NMT based behaviour plan in elementary school"

Your signature below indicates that you have received a copy of this consent form for
your own records.

_____ Yes, my son/daughter has my permission to participate.

Parent or Guardian Signature

Date

Please print your name here

Appendix C. Assent Format



August 29, 2014

NMT Research Study – Assent Format

The following script will be used in order to obtain assent from students who are invited to participate in the study:

“You are invited to join our project. In this project, we will see how quickly your heart beats, and you will learn how you can relax when you are feeling stressed out. You will also do some puzzles and play some games. We are doing this project because we think it is good for students to learn about relaxing because this might help them do better in school. You get to decide whether you want to be in the project. Even if you want to be in the project now, you can always change your mind later. Nobody will be mad if you choose not to be part of this project.”

Appendix D. Interval Sampling Recording Form

Interval Sampling Recording Form

Student: _____ Date/Time: _____

Teacher: _____ Observer: _____

Observation Activity: _____

DIRECTIONS

Momentary time sampling procedures will be used to code on-task (+) or off-task (-) behaviours. Using a stopwatch, observe target student, and record the observed behaviour on the 9th second of a 10 second interval.

On-task behaviour (+) is defined as being visually focused on an activity relevant to the context and time frame, and engaging in the required behavioural or cognitive process(es) to complete the activity. If the child is directing his eye gaze at the teacher (or classroom assistant), the instructional activity, or toward appropriate instructional materials, the child is classified as being on task.

Off-task behaviour (-) include handling or reaching for materials no longer needed. Dropping something on the floor is allowed once, but will be rated as off task if more frequent. Talking to other children, unless continuing to work, will be rated as off task.

Interval	1	2	3	4	5	6	7	8	9	10	11	12

Interval	13	14	15	16	17	18	19	20	21	22	23	24

Interval	25	26	27	28	29	30	31	32	33	34	35	36

Interval	37	38	39	40	41	42	43	44	45	46	47	48

Interval	49	50	51	52	53	54	55	56	57	58	59	60

Appendix E. NMT Parent Interview



HISTORY

FAMILY HISTORY

GENETIC FACTORS

GENETIC FACTORS MAY PLAY A ROLE IN THE CHILD'S CURRENT FUNCTIONING. INCLUDE KNOWN OR SUSPECTED GENETIC PROBLEMS IN THE CHILD OR CHILD'S BIOLOGICAL FAMILY (I.E., HUNTINGTON'S, FRAGILE X, TURNER'S OR DOWNS SYNDROME). FAMILY HISTORY OF DISORDERS WITH KNOWN OR SUSPECTED GENETIC FACTORS SHOULD ALSO BE CONSIDERED INCLUDING BIPOLAR, SCHIZOPHRENIA, AND AUTISM SPECTRUM DISORDERS.

FAMILY HEALTH HISTORY

Please check "Yes" or "No" for each of the medical conditions below to show if any family members have them. In the space provided below, please indicate who has the illness (mom, dad, grandparents, sisters or brothers, aunts or uncles...)

Yes	No	Condition	Yes	No	Condition
<input type="checkbox"/>	<input type="checkbox"/>	Thyroid	<input type="checkbox"/>	<input type="checkbox"/>	Kidney Disease
<input type="checkbox"/>	<input type="checkbox"/>	Heart Disease	<input type="checkbox"/>	<input type="checkbox"/>	Cancer
<input type="checkbox"/>	<input type="checkbox"/>	High Blood Pressure	<input type="checkbox"/>	<input type="checkbox"/>	Sudden Death
<input type="checkbox"/>	<input type="checkbox"/>	Vision Problems	<input type="checkbox"/>	<input type="checkbox"/>	Hearing Problem
<input type="checkbox"/>	<input type="checkbox"/>	Seizures	<input type="checkbox"/>	<input type="checkbox"/>	Cerebral Palsy
<input type="checkbox"/>	<input type="checkbox"/>	Birth Defects	<input type="checkbox"/>	<input type="checkbox"/>	Arthritis
<input type="checkbox"/>	<input type="checkbox"/>	Lupus	<input type="checkbox"/>	<input type="checkbox"/>	Other

If "Yes", please explain who has the illness: _____

Are there any other diseases that run in the family? Please describe: _____

FAMILY PSYCHIATRIC HISTORY

Please check "Yes" or "No" for each of the medical conditions below to show if any family members have them. In the space provided below, please indicate who has the illness (mom, dad, grandparents, sisters or brothers, aunts or uncles...)

Yes	No	Condition	Yes	No	Condition
<input type="checkbox"/>	<input type="checkbox"/>	Schizophrenia	<input type="checkbox"/>	<input type="checkbox"/>	Emotional Problems
<input type="checkbox"/>	<input type="checkbox"/>	Bipolar Disorder	<input type="checkbox"/>	<input type="checkbox"/>	Drug Abuse
<input type="checkbox"/>	<input type="checkbox"/>	Anxiety Disorder	<input type="checkbox"/>	<input type="checkbox"/>	Alcoholism
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Depression	<input type="checkbox"/>	<input type="checkbox"/>	Hyperactivity
<input type="checkbox"/>	<input type="checkbox"/>	Tics/Tourettes	<input type="checkbox"/>	<input type="checkbox"/>	Bed Wetting (after 5 yrs)
<input type="checkbox"/>	<input type="checkbox"/>	Mental Retardation	<input type="checkbox"/>	<input type="checkbox"/>	Learning Problem(s)
<input type="checkbox"/>	<input type="checkbox"/>	Delinquency Problems	<input type="checkbox"/>	<input type="checkbox"/>	Other

If "Yes", please explain who has the illness: _____

Are there any other emotional/mental health problems that run in the family? _____

Has any blood relative to your child experienced problems similar to those your child is currently experiencing? Yes No

If yes, please describe: _____

EPIGENETIC FACTORS
 FACTORS IN THE LIFE OF THE MOTHER AND FATHER PRIOR TO CONCEPTION HAVE THE ABILITY TO INFLUENCE CHROMOSOMAL PROTEINS AND THEREFORE CAN IMPACT THE GENETIC EXPRESSION IN THEIR CHILDREN

PARENTAL HISTORY - MOTHER

Mother:
 Date of Birth: _____ Marital Status: _____ Occupation: _____
 Highest Grade Completed: _____

Please check "Yes" or "No" for each of the conditions below to show if the child's mother has experienced any of the following.

Yes	No		Yes	No	
<input type="checkbox"/>	<input type="checkbox"/>	Learning Problems	<input type="checkbox"/>	<input type="checkbox"/>	Alcohol use in family of origin
<input type="checkbox"/>	<input type="checkbox"/>	Behavior Problems	<input type="checkbox"/>	<input type="checkbox"/>	Drug use in family of origin
<input type="checkbox"/>	<input type="checkbox"/>	Attention Problems	<input type="checkbox"/>	<input type="checkbox"/>	Arguments in family of origin
<input type="checkbox"/>	<input type="checkbox"/>	Medical Problems	<input type="checkbox"/>	<input type="checkbox"/>	Domestic violence in family of origin
<input type="checkbox"/>	<input type="checkbox"/>	Placed out of her own home (kinship/foster placement)	<input type="checkbox"/>	<input type="checkbox"/>	Neglect in family of origin
<input type="checkbox"/>	<input type="checkbox"/>	Adopted If yes, what age?	<input type="checkbox"/>	<input type="checkbox"/>	Lack of food
<input type="checkbox"/>	<input type="checkbox"/>	Consistent caregiver during her first 3 yrs	<input type="checkbox"/>	<input type="checkbox"/>	Excessive physical discipline in family of origin
<input type="checkbox"/>	<input type="checkbox"/>	Exposure to environmental chemicals	<input type="checkbox"/>	<input type="checkbox"/>	Other

Did mother ever experience the following during childhood?:

Yes	No		Yes	No	
<input type="checkbox"/>	<input type="checkbox"/>	Physical abuse If yes, by whom	<input type="checkbox"/>	<input type="checkbox"/>	Sexual abuse If yes, by whom
<input type="checkbox"/>	<input type="checkbox"/>	Rape If yes, by whom	<input type="checkbox"/>	<input type="checkbox"/>	Drug use in family of origin

PARENTAL HISTORY - FATHER

Father:
 Date of Birth: _____ Marital Status: _____ Occupation: _____
 Highest Grade Completed: _____

Please check "Yes" or "No" for each of the conditions below to show if the child's father has experienced any of the following.

Yes	No		Yes	No	
<input type="checkbox"/>	<input type="checkbox"/>	Learning Problems	<input type="checkbox"/>	<input type="checkbox"/>	Alcohol use in family of origin
<input type="checkbox"/>	<input type="checkbox"/>	Behavior Problems	<input type="checkbox"/>	<input type="checkbox"/>	Drug use in family of origin
<input type="checkbox"/>	<input type="checkbox"/>	Attention Problems	<input type="checkbox"/>	<input type="checkbox"/>	Arguments in family of origin
<input type="checkbox"/>	<input type="checkbox"/>	Medical Problems	<input type="checkbox"/>	<input type="checkbox"/>	Domestic violence in family of origin
<input type="checkbox"/>	<input type="checkbox"/>	Placed out of his own home (kinship/foster placement)	<input type="checkbox"/>	<input type="checkbox"/>	Neglect in family of origin
<input type="checkbox"/>	<input type="checkbox"/>	Adopted	<input type="checkbox"/>	<input type="checkbox"/>	Lack of food

If yes, what age?

<input type="checkbox"/>	<input type="checkbox"/>	Consistent caregiver during her first 3 yrs	<input type="checkbox"/>	<input type="checkbox"/>	Excessive physical discipline in family of origin
<input type="checkbox"/>	<input type="checkbox"/>	Exposure to environmental chemicals	<input type="checkbox"/>	<input type="checkbox"/>	Other

Did father ever experience the following during childhood?:

Yes	No		Yes	No	
<input type="checkbox"/>	<input type="checkbox"/>	Physical abuse If yes, by whom	<input type="checkbox"/>	<input type="checkbox"/>	Sexual abuse If yes, by whom
<input type="checkbox"/>	<input type="checkbox"/>	Rape If yes, by whom	<input type="checkbox"/>	<input type="checkbox"/>	Drug use in family of origin

Are there any other known ethnic, cultural and/or community issues that may have impacted the child's parents or family? _____

INTRAUTERINE/PRENATAL HISTORY

Does the child have siblings? Yes No
 If yes, please list number of pregnancies: _____
 How many siblings are older than this child? _____ How many are younger? _____
 Please describe any key events occurring during the pregnancy or prenatal period (consider social, medical, educational and legal history):

ADVERSE EVENTS

Please answer which of the following may have occurred during the pregnancy with this child and explain in the space below:

Yes	No		Yes	No	
<input type="checkbox"/>	<input type="checkbox"/>	Emotional Stress/Distress	<input type="checkbox"/>	<input type="checkbox"/>	Medical Issues
<input type="checkbox"/>	<input type="checkbox"/>	Drug/Alcohol (if yes, choose from below)	<input type="checkbox"/>	<input type="checkbox"/>	Edema (swelling of hands/feet)
<input type="checkbox"/>	<input type="checkbox"/>	Alcohol	<input type="checkbox"/>	<input type="checkbox"/>	Toxemia
<input type="checkbox"/>	<input type="checkbox"/>	Marijuana	<input type="checkbox"/>	<input type="checkbox"/>	Vaginal Bleeding
<input type="checkbox"/>	<input type="checkbox"/>	Cocaine	<input type="checkbox"/>	<input type="checkbox"/>	Fever
<input type="checkbox"/>	<input type="checkbox"/>	Heroin	<input type="checkbox"/>	<input type="checkbox"/>	Operations (Specify)
<input type="checkbox"/>	<input type="checkbox"/>	Methamphetamine	<input type="checkbox"/>	<input type="checkbox"/>	Medications used
<input type="checkbox"/>	<input type="checkbox"/>	Cigarettes (Avg #/day)	<input type="checkbox"/>	<input type="checkbox"/>	Epilepsy/Seizure
<input type="checkbox"/>	<input type="checkbox"/>	Other Drugs (list here)	<input type="checkbox"/>	<input type="checkbox"/>	Hospitalization
<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	X-ray Studies
<input type="checkbox"/>	<input type="checkbox"/>	Domestic Violence	<input type="checkbox"/>	<input type="checkbox"/>	Infection(s) (colds/flu, urinary tract, rubella, vaginal)
<input type="checkbox"/>	<input type="checkbox"/>	Other (Please specify)	<input type="checkbox"/>	<input type="checkbox"/>	Other illnesses
<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	
<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	

For each of the main areas listed please rate the level of impact during the pregnancy:

	Normal	Mild	Moderate	Severe
Stress/Distress	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Drug/Alcohol	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Domestic Violence	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Medical	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

RELATIONAL HEALTH

Please consider the following areas related to this pregnancy and rate according to the scale below:

Was the pregnancy wanted? Yes No

Was the mother supported emotionally during her pregnancy? Yes No

If "Yes", please list who provided this support: _____

Was the father present and supportive during this pregnancy? Yes No

If "Yes", describe the father's support during the pregnancy (e.g., inconsistent, financial only, consistently present and supportive): _____

Did the mother receive emotional support from other groups within the community (i.e., religious groups, community organizations)? Yes No

PERINATAL PERIOD (BIRTH – 2 MONTHS)

Please describe any key events occurring during the child's first two months of life (consider social, medical, educational and legal history): _____

ADVERSE EVENTS

Please answer which of the following may have occurred during the child's first 2 months of life and explain in the space below:

Yes	No		Yes	No	
<input type="checkbox"/>	<input type="checkbox"/>	Issues in the mother's early childhood that impact her ability to parent (abuse/neglect, drug/alcohol use by caregiver, caregiver mental illness, cps placement)	<input type="checkbox"/>	<input type="checkbox"/>	Other Drugs (list here)
<input type="checkbox"/>	<input type="checkbox"/>	Drug/Alcohol by primary caregiver (choose from below)	<input type="checkbox"/>	<input type="checkbox"/>	
<input type="checkbox"/>	<input type="checkbox"/>	Alcohol	<input type="checkbox"/>	<input type="checkbox"/>	Domestic Violence
<input type="checkbox"/>	<input type="checkbox"/>	Marijuana	<input type="checkbox"/>	<input type="checkbox"/>	Medical Issues
<input type="checkbox"/>	<input type="checkbox"/>	Cocaine	<input type="checkbox"/>	<input type="checkbox"/>	Depression
<input type="checkbox"/>	<input type="checkbox"/>	Heroin	<input type="checkbox"/>	<input type="checkbox"/>	Presence of other children (siblings) in the home
<input type="checkbox"/>	<input type="checkbox"/>	Methamphetamine	<input type="checkbox"/>	<input type="checkbox"/>	Other trauma
<input type="checkbox"/>	<input type="checkbox"/>	Cigarettes (Avg #/day)	<input type="checkbox"/>	<input type="checkbox"/>	

For each of the main areas listed above please rate the level of impact during the child's first two months of life:

	Normal	Mild	Moderate	Severe
Maternal History*	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Drug/Alcohol	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Depression	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Siblings**	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Domestic Violence	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other Trauma	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

*Mother's caregiving experience during her childhood that may affect the way she cared for this child
 **Other siblings the mother/caregiver also cared for during this time

RELATIONAL HEALTH

For each of the questions listed below please answer in relation to the child's first two months of life:

	Yes/all of the time	Most of the time	Sometimes	No/Never
Is/was the mother/primary caregiver safe?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Is/was the mother attuned and responsive to the child?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Are/were there multiple caregivers?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Are/were there kinship/family supports that were available for the child?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Is/was the father present and supportive during this period?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Are/were there supports within the community for the child?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Please describe and rate (positive, adequate, interrupted/episodic, poor) the quality of caregiving provided to the child during the first two months of life: _____

INFANCY (3 MONTHS TO 1 YEAR)

Please describe any key events occurring during the child's first year of life (consider social, medical, educational and legal history): _____

Please indicate whether any of the following describe this child to a significant degree during infancy:

Yes	No	Condition	Yes	No	Condition
<input type="checkbox"/>	<input type="checkbox"/>	Did not enjoy cuddling	<input type="checkbox"/>	<input type="checkbox"/>	Was not calmed by being held or stroked
<input type="checkbox"/>	<input type="checkbox"/>	Difficult to comfort	<input type="checkbox"/>	<input type="checkbox"/>	Excessively restless
<input type="checkbox"/>	<input type="checkbox"/>	Excessively irritable	<input type="checkbox"/>	<input type="checkbox"/>	Frequent head banging
<input type="checkbox"/>	<input type="checkbox"/>	Difficult to feed	<input type="checkbox"/>	<input type="checkbox"/>	

ADVERSE EVENTS

Please answer which of the following may have occurred during the child's first year of life and explain in the space below:

Yes <input type="checkbox"/>	No <input type="checkbox"/>	Issues in the mother's early childhood that impact her ability to parent (abuse/neglect, drug/alcohol use by caregiver, caregiver mental illness, cps placement)	Yes <input type="checkbox"/>	No <input type="checkbox"/>	Other Drugs (list here)
<input type="checkbox"/>	<input type="checkbox"/>	Drug/Alcohol by primary caregiver (choose from below)	<input type="checkbox"/>	<input type="checkbox"/>	
<input type="checkbox"/>	<input type="checkbox"/>	Alcohol	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Domestic Violence
<input type="checkbox"/>	<input type="checkbox"/>	Marijuana	<input type="checkbox"/>	<input type="checkbox"/>	Medical Issues
<input type="checkbox"/>	<input type="checkbox"/>	Cocaine	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Depression
<input type="checkbox"/>	<input type="checkbox"/>	Heroin	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Presence of other children (siblings) in the home
<input type="checkbox"/>	<input type="checkbox"/>	Methamphetamine	<input type="checkbox"/>	<input type="checkbox"/>	Other trauma
<input type="checkbox"/>	<input type="checkbox"/>	Cigarettes (Avg #/day)	<input type="checkbox"/>	<input type="checkbox"/>	

For each of the main areas listed above please rate the level of impact during the child's first two months of life:

	Normal	Mild	Moderate	Severe
Maternal History*	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Drug/Alcohol	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Depression	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Siblings**	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Domestic Violence	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other Trauma	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

*Mother's caregiving experience during her childhood that may affect the way she cared for this child

**Other siblings the mother/caregiver also cared for during this time

RELATIONAL HEALTH

For each of the questions listed below please answer in relation to the child's first year of life:

	Yes/all of the time	Most of the time	Sometimes	No/Never
Is/was the mother/primary caregiver safe?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Is/was the mother attuned and responsive to the child?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Are/were there multiple caregivers?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Are/were there kinship/family supports that were available for the child?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Is/was the father present and supportive during this period?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Are/were there supports within the community for the child?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Please describe and rate (positive, adequate, interrupted/episodic, poor) the quality of caregiving provided to the child during the first two months of life: _____

Please describe any relationships with other adults during the child's first year of life: _____

EARLY CHILDHOOD (2-5 YEARS)

Please describe any key events occurring during the child's second through fifth year of life (consider social, medical, educational and legal history): _____

ADVERSE EVENTS

Please answer which of the following may have occurred from the child's second through fifth year of life and explain in the space below:

<table border="0"> <tr> <td style="width: 10%;"><input type="checkbox"/></td> <td style="width: 10%;"><input type="checkbox"/></td> <td style="width: 80%;">Issues in the mother's early childhood that impact her ability to parent (abuse/neglect, drug/alcohol use by caregiver, caregiver mental illness, cps placement)</td> </tr> <tr> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td>Drug/Alcohol by primary caregiver (choose from below)</td> </tr> <tr> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td>Alcohol</td> </tr> <tr> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td>Marijuana</td> </tr> <tr> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td>Cocaine</td> </tr> <tr> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td>Heroin</td> </tr> <tr> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td>Methamphetamine</td> </tr> <tr> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td>Cigarettes (Avg #/day)</td> </tr> </table>	<input type="checkbox"/>	<input type="checkbox"/>	Issues in the mother's early childhood that impact her ability to parent (abuse/neglect, drug/alcohol use by caregiver, caregiver mental illness, cps placement)	<input type="checkbox"/>	<input type="checkbox"/>	Drug/Alcohol by primary caregiver (choose from below)	<input type="checkbox"/>	<input type="checkbox"/>	Alcohol	<input type="checkbox"/>	<input type="checkbox"/>	Marijuana	<input type="checkbox"/>	<input type="checkbox"/>	Cocaine	<input type="checkbox"/>	<input type="checkbox"/>	Heroin	<input type="checkbox"/>	<input type="checkbox"/>	Methamphetamine	<input type="checkbox"/>	<input type="checkbox"/>	Cigarettes (Avg #/day)	<table border="0"> <tr> <td style="width: 10%;"><input type="checkbox"/></td> <td style="width: 10%;"><input type="checkbox"/></td> <td style="width: 80%;">Other Drugs (list here)</td> </tr> <tr> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td></td> </tr> <tr> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td>Domestic Violence</td> </tr> <tr> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td>Medical Issues</td> </tr> <tr> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td>Depression</td> </tr> <tr> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td>Presence of other children (siblings) in the home</td> </tr> <tr> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td>Other trauma</td> </tr> <tr> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td></td> </tr> </table>	<input type="checkbox"/>	<input type="checkbox"/>	Other Drugs (list here)	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	Domestic Violence	<input type="checkbox"/>	<input type="checkbox"/>	Medical Issues	<input type="checkbox"/>	<input type="checkbox"/>	Depression	<input type="checkbox"/>	<input type="checkbox"/>	Presence of other children (siblings) in the home	<input type="checkbox"/>	<input type="checkbox"/>	Other trauma	<input type="checkbox"/>	<input type="checkbox"/>	
<input type="checkbox"/>	<input type="checkbox"/>	Issues in the mother's early childhood that impact her ability to parent (abuse/neglect, drug/alcohol use by caregiver, caregiver mental illness, cps placement)																																															
<input type="checkbox"/>	<input type="checkbox"/>	Drug/Alcohol by primary caregiver (choose from below)																																															
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<input type="checkbox"/>	<input type="checkbox"/>	Cocaine																																															
<input type="checkbox"/>	<input type="checkbox"/>	Heroin																																															
<input type="checkbox"/>	<input type="checkbox"/>	Methamphetamine																																															
<input type="checkbox"/>	<input type="checkbox"/>	Cigarettes (Avg #/day)																																															
<input type="checkbox"/>	<input type="checkbox"/>	Other Drugs (list here)																																															
<input type="checkbox"/>	<input type="checkbox"/>																																																
<input type="checkbox"/>	<input type="checkbox"/>	Domestic Violence																																															
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<input type="checkbox"/>	<input type="checkbox"/>	Depression																																															
<input type="checkbox"/>	<input type="checkbox"/>	Presence of other children (siblings) in the home																																															
<input type="checkbox"/>	<input type="checkbox"/>	Other trauma																																															
<input type="checkbox"/>	<input type="checkbox"/>																																																

For each of the main areas listed above please rate the level of impact occurring from the child's second through fifth years of life:

	Normal	Mild	Moderate	Severe
Maternal History*	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Drug/Alcohol	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Depression	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Siblings**	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Domestic Violence	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other Trauma	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

*Mother's caregiving experience during her childhood that may affect the way she cared for this child
 **Other siblings the mother/caregiver also cared for during this time

RELATIONAL HEALTH

For each of the questions listed below please answer in relation to the child's second through fifth year of life:

	Yes/all of the time	Most of the time	Sometimes	No/Never
Is/was the mother/caregiver safe?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

<i>Is/was the mother/caregiver attuned and responsive to the child?</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<i>Are/were there multiple caregivers?</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<i>Are/were there kinship/family supports that were available for the child?</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<i>Is/was the father present and supportive during this period?</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<i>Are/were there supports within the community for the child?</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<i>Are/was there other female/male supports for this child?</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<i>Does/did the child have positive relationships with their siblings?</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<i>Does/did the child have positive relationships with their peers/classmates?</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<i>Are/were there supports within the community for the child?</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Please describe and rate (positive, adequate, interrupted/episodic, poor) the quality of caregiving provided to the child during the second through fifth year of life: _____

Please describe any relationships with other adults during the child's second through fifth year of life: _____

CHILDHOOD (5 – 12 YEARS)

Please describe any key events occurring during the child's fifth through twelfth year of life (consider social, medical, educational and legal history): _____

Please answer which of the following may have occurred during child's fifth through twelfth year of life and explain in the space below:

Yes	No		Yes	No	
<input type="checkbox"/>	<input type="checkbox"/>	Neglect	<input type="checkbox"/>	<input type="checkbox"/>	Methamphetamine (Caregiver <input type="checkbox"/> Child <input type="checkbox"/>)
<input type="checkbox"/>	<input type="checkbox"/>	Multiple transitions/moves or chaos	<input type="checkbox"/>	<input type="checkbox"/>	Cigarettes (Ave #/day) (Caregiver <input type="checkbox"/> Child <input type="checkbox"/>)
<input type="checkbox"/>	<input type="checkbox"/>	Problems in primary caregiving	<input type="checkbox"/>	<input type="checkbox"/>	Other drugs (list here) (Caregiver <input type="checkbox"/> Child <input type="checkbox"/>)
<input type="checkbox"/>	<input type="checkbox"/>	Drugs/Alcohol Use	<input type="checkbox"/>	<input type="checkbox"/>	Exposure to Domestic Violence
<input type="checkbox"/>	<input type="checkbox"/>	Alcohol (Caregiver <input type="checkbox"/> Child <input type="checkbox"/>)	<input type="checkbox"/>	<input type="checkbox"/>	Depression in primary caregiver
<input type="checkbox"/>	<input type="checkbox"/>	Marijuana (Caregiver <input type="checkbox"/> Child <input type="checkbox"/>)	<input type="checkbox"/>	<input type="checkbox"/>	Other children (siblings) in the home
<input type="checkbox"/>	<input type="checkbox"/>	Cocaine (Caregiver <input type="checkbox"/> Child <input type="checkbox"/>)	<input type="checkbox"/>	<input type="checkbox"/>	Other trauma*
<input type="checkbox"/>	<input type="checkbox"/>	Heroin (Caregiver <input type="checkbox"/> Child <input type="checkbox"/>)	<input type="checkbox"/>	<input type="checkbox"/>	Community or School Violence

*Please list other trauma here: _____

For each of the main areas listed above please rate the level of impact during child's fifth through twelfth year of life :

	Normal	Mild	Moderate	Severe
Neglect	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Drug/Alcohol	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Depression	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Siblings	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Domestic Violence	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other Trauma	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Community or School Violence	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

For each of the questions listed below please answer in relation to the child's second through fifth year of life:

	Yes/all of the time	Most of the time	Sometimes	No/Never
Is/was the mother/caregiver safe?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Is/was the mother/caregiver attuned and responsive to the child?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Are/were there multiple caregivers?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Are/were there kinship/family supports that were available for the child?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Is/was the father present and supportive during this period?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Are/were there supports within the community for the child?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Are/was there other female/male supports for this child?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Does/did the child have positive relationships with their siblings	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Does/did the child have positive relationships with their	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

peers/classmates

Are/were there supports within the community for the child?

Please describe and rate (positive, adequate, interrupted/episodic, poor) the quality of caregiving provided to the child during the fifth through twelfth year of life: _____

Please describe any relationships with other adults during the child's fifth through twelfth year of life: _____

Please describe any key events occurring during the child's adolescent years (consider social, medical, educational and legal history): _____

Please answer which of the following may have occurred during child's adolescent years and explain in the space below:

- | | | | | |
|---|--|--|--|---|
| <input type="checkbox"/> <input type="checkbox"/> Neglect | <input type="checkbox"/> <input type="checkbox"/> Methamphetamine (Caregiver <input type="checkbox"/> Child <input checkbox"="" type="checkbox/>)</td> </tr> <tr> <td><input type="/> <input type="checkbox"/> Multiple transitions/moves or chaos | <input type="checkbox"/> <input type="checkbox"/> Cigarettes (Ave #/day) (Caregiver <input type="checkbox"/> Child <input checkbox"="" type="checkbox/>)</td> </tr> <tr> <td><input type="/> <input type="checkbox"/> Problems in primary caregiving | <input type="checkbox"/> <input type="checkbox"/> Other drugs (list here) (Caregiver <input type="checkbox"/> Child <input checkbox"="" type="checkbox/>)</td> </tr> <tr> <td><input type="/> <input type="checkbox"/> Drugs/Alcohol Use | <input type="checkbox"/> <input type="checkbox"/> Exposure to Domestic Violence |
| <input type="checkbox"/> <input type="checkbox"/> Alcohol (Caregiver <input type="checkbox"/> Child <input checkbox"="" type="checkbox/>)</td> <td><input type="/> <input type="checkbox"/> Depression in primary caregiver | | | | |
| <input type="checkbox"/> <input type="checkbox"/> Marijuana (Caregiver <input type="checkbox"/> Child <input checkbox"="" type="checkbox/>)</td> <td><input type="/> <input type="checkbox"/> Other children (siblings) in the home | | | | |
| <input type="checkbox"/> <input type="checkbox"/> Cocaine (Caregiver <input type="checkbox"/> Child <input checkbox"="" type="checkbox/>)</td> <td><input type="/> <input type="checkbox"/> Other trauma* | | | | |
| <input type="checkbox"/> <input type="checkbox"/> Heroin (Caregiver <input type="checkbox"/> Child <input checkbox"="" type="checkbox/>)</td> <td><input type="/> <input type="checkbox"/> Community or School Violence | | | | |

*Please list other trauma here: _____

Appendix F. NME Mini Map Rubric Working Draft

1. Attention/Distractibility

4 Almost always attentive, may drift away to think over something shared but will always return with eye contact and body language that says, “I’m engaged.”

3 Usually attentive, eye contact and body language show interest most of the time, maintains a decent level of engagement over time

2 Attention is sporadic, takes a concerted effort to keep child engaged for long periods of time, one on one is better than in groups where the environment provides stimuli that takes attention away.

1 Rarely if ever stays engaged, tends to drift even in one on one interactions, easily triggered to disengage either by dissociation or becoming overactive.

2. Fine Motor Skills

4 Neat handwriting, skillfully handles pens, pencils, crayons, shows dexterity while working with small objects, handles musical instruments with some confidence

3 Legible handwriting, manipulates small objects without frustration, enjoys working with hands

2 Sloppy but readable handwriting, sometimes struggles working with small objects, not always positive about working with hands

1 Handwriting sometimes illegible, gives up easily when manipulating small objects, not interested in working with hands or playing an instrument, easily frustrated

3. Coordination/Large Motor Skills

4 Shows exceptional balance in games or on the playground, runs/walks with a rhythmic

gait, enjoys a variety of sports/games,

3 Usually demonstrates good balance, no noticeable hitches in running/walking gait, enjoys sports/games especially when they are familiar

2 Sometimes appears off balance, not comfortable with balancing activities in gym or on the playground, hesitates to participate in games due to perceived lack of coordination, running/walking gait appears labored

1 Loses balance easily, running/walking appear to be arrhythmic, rarely participates in games, fearful of having to balance

4. Threat response

4 Almost always calm and creative or alert and ready to learn, not easily provoked by other students, manages transitions without incident

3 Usually calm and creative or alert and ready to learn, not often provoked by other students, manages transitions with few incidents of acting out

2 Sometimes difficult to calm down in classroom setting, needs reminders often to refocus on lessons, gets provoked by others to act out, especially during times of transition

1 Very difficult to calm down or to motivate in class, needs constant reminders to engage, easily provoked by other students, thrives on conflict or shuts down when provoked, especially during transitions

5. Affect regulation/Mood

4 Almost always cheerful, has an infectious positive spirit, consistently energetic 3
Usually cheerful, smiles easily, energetic most of the time

2 Unpredictable moods, mood swings can occur in short intervals of time, unpredictable

energy level

1 Usually negative, low energy most of the time, unpredictable demeanor towards others

6. Relational Skills

4 Has healthy number of friends, liked by almost all classmates, makes new friends easily, good at sharing time and attention, works well in groups

3 Has healthy number of friends, liked by many classmates, needs some encouragement to welcome newcomers, shares time and attention, usually works well in groups

2 Has some friends, liked by some classmates, threatened by newcomers, has trouble sharing time and attention, may bully when threatened, struggles with group work

1 Has few if any friends, not well liked by classmates, threatened by newcomers, either bullies classmates or withdraws from most of them, non-participant in small groups

7. Communication/Language

4 Writing contains a variety of age appropriate word choices or sentence structures, can write creatively or in expository fashion with skill, enjoys expressing self in writing

3 Writes using age appropriate word choices and sentence structures, most written passages show organization, willing to participate fully when given a writing assignment

2 Sentence structure or word choice are inconsistent, written passages are sometimes disorganized, reluctant to write passages that take much time and consideration

1 Rarely writes in complete sentences, rarely uses age appropriate word choices, no organization evident in written passages, often refuses to write at all

8. Reactivity/Impulsivity

4 Consistent demeanor in class, able to debate constructively, can take constructive

criticism from adults or peers, flexible enough to handle change

3 Usually displays good demeanor in class, constructive debate is difficult but can be attempted in small doses, usually listens to constructive criticism from adults but less likely to handle it well from peers, can handle change most of the time

2 Inconsistent demeanor shown in class and around school, cannot debate without being threatened, struggles with constructive criticism from adults and will not accept it from peers, change in routine is difficult to manage

1 Very unpredictable demeanor in class and around school, easily threatened by adults or peers trying to offer help, either explosive or withdrawn when interacting with peers, change triggers negative behaviour

9. Math/logic

4 Math skills are above age level expectations, excellent at solving puzzles, mysteries, and logic problems, enjoys the challenge of new and difficult tasks involving numbers or logical thought

3 Math skills are at age level expectations, willing to try solving puzzles, mysteries, and logic problems, sometimes enjoys the challenge of difficult tasks if it doesn't take too much time

2 Math skills are below age level expectations, usually hesitant to try solving puzzles, mysteries or logic problems, can get frustrated easily when tasks seem too difficult

1 Math skills are far below age level expectations, refuses to do puzzles, mysteries or logic problems, may get angry or disengage if pushed to do seemingly difficult tasks

10. Reading/Verbal Skills

4 Reading skills are above age level expectations, excellent oral reader, excellent sight

word vocabulary, comfortable expressing self in speeches or giving answers in class, strong conversational skills including the ability to listen and respond appropriately

3 Reading skills are at age level expectations, good oral reader, good sight word vocabulary, willing to try giving speeches and will give answers in class, easy to talk to though listening skills still need to develop

2 Reading skills are somewhat below age level expectations, sight word vocabulary is below average, hesitant to speak or read in class but will when called upon, sometimes shy about conversation or appears distracted

1 Reading skills are far below age level expectations, often refuses to read aloud, sight word vocabulary is far below grade level, rarely speaks in class in appropriate fashion, avoids conversation if possible

Appendix G. Social Validity Questionnaire

Social Validity Questionnaire for Teachers

Please rate these responses using a 5 point Likert scale:

strongly disagree

strongly agree

1 2 3 4 5

1. I found this type of behaviour plan to be suitable for a school setting.
2. I found the basic concepts outlined in the initial assessment easy to understand.
3. I found the basic concepts outlined in the initial assessment easy to implement.
4. I felt the identified child improved his/her ability to regulate his/her emotions.
5. I felt this type of behaviour plan helped promote a positive relationship between me and the identified child.

6. I felt this type of behaviour plan helped promote a positive relationship between other staff members and the identified child.
7. I felt well supported throughout the process
8. I felt that having a child on this type of behaviour plan reduced my stress
9. I felt this type of behaviour plan helped me understand behaviour in a useful way
10. I felt being involved in this type of behaviour plan improved my ability to do my job

Appendix H. Adverse Childhood Experience Questionnaire

While you were growing up, during your first 18 years of life:

1. Did a parent or other adult in the household **often** ...
Swear at you, insult you, put you down, or humiliate you?
or
Act in a way that made you afraid that you might be physically hurt?
Yes No If yes enter 1 _____
2. Did a parent or other adult in the household **often** ...
Push, grab, slap, or throw something at you?
or
Ever hit you so hard that you had marks or were injured?
Yes No If yes enter 1 _____
3. Did an adult or person at least 5 years older than you **ever**...
Touch or fondle you or have you touch their body in a sexual way?
or
Try to or actually have oral, anal, or vaginal sex with you?
Yes No If yes enter 1 _____
4. Did you **often** feel that ...
No one in your family loved you or thought you were important or special?
or
Your family didn't look out for each other, feel close to each other, or support each other?
Yes No If yes enter 1 _____
5. Did you **often** feel that ...
You didn't have enough to eat, had to wear dirty clothes, and had no one to protect you?
or
Your parents were too drunk or high to take care of you or take you to the doctor if you needed it?
Yes No If yes enter 1 _____
6. Were your parents **ever** separated or divorced?
Yes No If yes enter 1 _____
7. Was your mother or stepmother:
Often pushed, grabbed, slapped, or had something thrown at her?
or
Sometimes or often kicked, bitten, hit with a fist, or hit with something hard?
or
Ever repeatedly hit over at least a few minutes or threatened with a gun or knife?
Yes No If yes enter 1 _____
8. Did you live with anyone who was a problem drinker or alcoholic or who used street drugs?
Yes No If yes enter 1 _____
9. Was a household member depressed or mentally ill or did a household member attempt suicide?
Yes No If yes enter 1 _____
10. Did a household member go to prison?
Yes No If yes enter 1 _____

Now add up your "Yes" answers: _____ This is your ACE Score