EFFECTS OF A DUAL-GENERATION INTERVENTION ON SUPPORTIVE PARENTING BEHAVIORS AND THEIR RELATION TO CHILD BRAIN FUNCTION FOR SELECTIVE ATTENTION IN FAMILIES FROM LOWER SOCIOECONOMIC STATUS BACKGROUNDS

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DISSERTATION ABSTRACT

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Title: Effects of a Dual-Generation Intervention on Supportive Parenting Behaviors and their Relation to Child Brain Function for Selective Attention in Families from Lower Socioeconomic Status Backgrounds

Parents and Children Making Connections – Highlighting Attention (PCMC-A) is a dual-generation intervention program for families from lower socioeconomic status backgrounds that includes parenting training for parents and attention training for preschool-aged children. PCMC-A has been shown to impact brain function for selective attention in children, the ability to enhance relevant information and suppress competing, distracting information. With the goal of increasing our understanding of how PCMC-A operates to promote gains in child brain function for selective attention, the main objective of this dissertation was to test intervention-related changes in supportive parenting behaviors as an explanatory mechanism for the effect of PCMC-A on neural indices of selective attention. To better understand the profile of those who benefit from PCMC-A to different extents, we also examined moderators of the effect of PCMC-A on supportive parenting and on child brain function for selective attention.

These questions were examined as part of the randomized controlled trial to evaluate the impact of PCMC-A on Head Start preschoolers and their parents, employing a multi-method approach. We found that participation in PCMC-A led to increases in specific aspects of supportive parenting behaviors coded from observed parent-child

interactions, which were moderated by child and mother characteristics at the pre-assessment, including mother reports of child behavior problems, child age, and maternal interactive language use. We also replicated with a larger sample an effect of PCMC-A on child selective attention measured using the event-related potential technique, which was moderated by mother reports of child social skills at the pre-assessment. Even though we documented changes in both of these outcomes as a function of PCMC-A, we did not find evidence that changes in supportive parenting explained gains in child selective attention, suggesting that other explanatory mechanisms may be at play. Together, the findings of the present dissertation characterize the effect of PCMC-A on supportive parenting behaviors and child selective attention, begin to paint a picture of the families who benefit most and least from this intervention, and contribute to our understanding of the mechanisms through which PCMC-A impacts child brain function for selective attention.

This dissertation includes unpublished co-authored material.

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CHAPTER I

INTRODUCTION

Socioeconomic Status and Cognitive Development

The academic achievement gap between children growing up in lower socioeconomic status (SES) families and their more socioeconomically advantaged peers is well documented (Brooks-Gunn & Duncan, 1997; Duncan & Murnane, 2011; Sirin, 2005). The SES achievement gap is explained, in part, by differences in cognitive abilities that are important for academic success (Pearce et al., 2016). There is now compelling evidence documenting that the SES in which children grow up has profound implications for their cognitive development (for a review, see Hackman, Farah, & Meaney, 2010). Compared to their higher SES peers, children from lower SES families show, on average, lower performance on tasks measuring multiple aspects of cognition (Evans & Schamberg, 2009; Kishiyama, Boyce, Jimenez, Perry, & Knight, 2009; Mezzacappa, 2004; Noble, McCandliss, & Farah, 2007). The neurocognitive systems supporting executive function have been identified as particularly vulnerable, both in early (Noble, Norman, & Farah, 2005) and middle childhood (Farah et al., 2006).

Executive function (EF) refers to a host of interrelated cognitive abilities necessary for the regulation of thoughts and behavior in a goal-directed way (Garon, Bryson, & Smith, 2008; Hughes & Graham, 2002; Miyake et al., 2000). SES-related disadvantage is associated with deficits in EF development that are already evident in early childhood, before children enter formal schooling (e.g. Hackman, Gallop, Evans, & Farah, 2015; Hughes, Ensor, Wilson, & Graham, 2009; Raver, McCoy, Lowenstein, & Pess, 2013; Rhoades, Greenberg, Lanza, & Blair, 2011; for a review, see Lawson, Hook, Hackman, & Farah, 2016). Furthermore, longitudinal evidence documents that the chronicity of exposure to poverty and financial hardship during early childhood predicts later EF performance (Raver, Blair, & Willoughby, 2013).

Such early disparities in EF as a function of SES are particularly concerning given that EF has been established as an important predictor of school readiness and academic success (Blair & Diamond, 2008). During preschool, performance on EF tasks predicts emerging math and literacy skills (Espy et al., 2004; Shaul & Schwartz, 2014). Moreover, early individual differences in EF appear to influence children's academic trajectory, as EF during preschool is longitudinally associated with math and literacy skills in kindergarten (Clark, Pritchard, & Woodward, 2010; McClelland et al., 2007; Ponitz, McClelland, Mathews, & Marrison, 2009). Importantly, these early school readiness skills are strong indicators of later academic achievement (Duncan et al., 2007; Pagani, Fitzpatrick, Archambault, & Janosz, 2010). The longitudinal relationship between early EF and indices of school readiness at school entry is also evident among children from lower SES backgrounds (Blair & Razza, 2007). Notably, EF partially mediates the relationships between SES and measures of school readiness during preschool (Dilworth-Bart, 2012; Fitzpatrick, McKinnon, Blair, & Willoughby, 2013), highlighting the contribution of individual differences in EF to the SES academic achievement gap.

Together, this evidence indicates that the deficits in EF that tend to be observed early on in children from lower SES backgrounds puts them at risk for school failure. However, the etiology of SES-related disparities in EF remains poorly understood, underscoring the need to better characterize the roots of this problem in order to be able to take action to address it. The scientific community is in a unique position to contribute to this effort by generating evidence to inform practice and by rigorously evaluating the impact of programs designed to close the achievement gap. In particular, there has been a call for the cognitive neuroscience community to engage in this endeavor (Raizada & Kishiyama, 2010). This has motivated researchers to identify: 1) the impact that SES has on brain systems supporting cognitive abilities; 2) the mechanisms through which SES disadvantage has deleterious effects on cognitive development; and 3) ways to foster healthy cognitive development in children exposed to SES adversity.

A growing body of research has documented that SES disadvantage has deleterious effects on brain development, impacting both brain structure (for a review, see Brito and Noble, 2014) and brain function (for a review, see Ursache & Noble, 2016). In children, diverse proxies for SES, such as income-to-needs ratio and parental education, are associated with differences in brain structure. These include differences in hippocampal volume, a brain region that has been implicated in learning and memory (Hanson Chandra, Wolfe, & Pollak, 2011; Jednoróg et al., 2012; Luby et al., 2013; Noble, Houston, Kan, & Sowell, 2012) and amygdala volume, a brain region that has been implicated in learning and socio-emotional processing (Luby et al., 2013; Noble et al., 2012). Both of these brain regions are involved in the stress response and have been identified as vulnerable to stress, particularly early in life (for a review, see Tottenham & Sheridan, 2009). Notably, SES experienced during childhood predicts some of these differences in brain structure in adulthood, above and beyond the contribution of concurrent SES (Cavanagh et al., 2013; Staff et al., 2012). Cortical prefrontal thickness during childhood also differs as a function of SES (Lawson, Duda, Avants, Wu, & Farah, 2013). This neuroanatomical index has been associated with aspects of EF, including attention (Ducharme et al., 2012) and self-regulation (Shaw et al., 2011). Together, these findings highlight the effects of early experience on the development of neuroanatomy and provide converging evidence for SES-related deficits in EF observed at the behavioral level. The impact of SES on brain development is further supported by evidence from studies employing neurocognitive techniques to assess brain function.

One technique to measure brain function is by using event-related potentials (ERPs). ERPs allow for the quantification and comparison of electrical brain responses elicited by events or stimuli of interest (Luck, 2014). The time course of ERPs can be measured at the millisecond level, making it a technique with high temporal resolution. For this reason, and because they can be recorded non-invasively, ERPs have been employed with children to measure aspects of rapidly occurring cognitive processes that cannot be detect with other techniques. A number of studies have used ERPs with children to investigate differences as a function of SES in different aspects of attention processing. For example, SES disadvantage is associated with reductions in ERPs elicited by attention to target and novel stimuli (Kishiyama et al., 2009). Furthermore, SES-related deficits in the modulation of attention to selectively enhance the brain response to relevant information and suppress the brain response to irrelevant information have been documented in young children (Hampton Wray et al., in press; Isbell, Hampton Wray, & Neville, 2016; Neville et al., 2013; Stevens, Lauinger, & Neville, 2009) and in preadolescents (D'Angiulli, Herdman, Stapells, & Hertzman, 2008; D'Angiulli et al., 2012).

SES disparities in brain function have also been documented with functional magnetic resonance imaging (fMRI), a neurocognitive technique that allows for the assessment of brain activation indexed by relative changes in blood oxygenation levels. The temporal resolution of this technique is limited by the time course of the hemodynamic response. However, it has high spatial resolution, as it allows to localize neuronal activity with millimeter precision (Matthews & Jezzard, 2004). Thus, fMRI studies are better suited to examine where in the brain activity is taking place, complementing what we can learn from ERP studies. Evidence from fMRI has documented differences in neural activation of the prefrontal cortex (PFC) during rule learning and acquisition as a function of SES (Sheridan, Sarsour, Jutte, D'Esposito, & Boyce, 2012). Children from lower SES families showed greater neural activation during learning relative to their counterparts from higher SES families. Given that this pattern of activation was accompanied by poorer task performance, this finding was interpreted as indicative of inefficient recruitment of PFC to complete the rule learning task (Sheridan et al., 2012). Furthermore, like with brain structure, brain function measured by fMRI during adulthood is also associated with the SES experienced during childhood. For example, childhood SES predicts the activation and connectivity of brain areas associated with reward processing, even when accounting for adult SES (Gianaros et al., 2011). Together, this evidence underscores the important role that early experience plays in shaping brain development, both structurally and functionally, and the need to identify mechanisms to explain how SES gives rise to neural disparities.

Multiple mechanisms have been proposed to explain the relationships between SES and a variety of outcomes (Conger & Donnellan, 2007; Evans, Chen, Miller, & Seeman, 2012; Hertzman & Boyce, 2010). Based on findings from non-human animal research showing effects of maternal care behaviors on brain development in rodents

(Caldji et al., 1998; Champagne & Meaney, 2006), parental nurturance has been proposed as one explanatory mechanism for the relationships between SES disadvantage and brain systems supporting key cognitive abilities in human children (Hackman et al., 2010; Lawson et al., 2016). In rodents, individual differences in behaviors indexing maternal care are associated with differences in offspring cognitive skills and hippocampal development (Liu, Diorio, Day, Francis, & Meaney, 2000). Notably, when biological offspring of mothers displaying low maternal care are reared by mothers displaying high maternal care, they do not differ on these outcomes from offspring born to and reared by mothers high on maternal care (Liu et al., 2000), highlighting the importance of the early rearing environment. Furthermore, experimental manipulations show that exposing rats to stress reduces their maternal care behaviors, which in turn has negative consequences for the development of their offspring (Champagne & Meaney, 2006). This evidence is in line with the family stress model, one model proposed to explain the social causes of the effects of SES on child outcomes (Conger & Donnellan, 2007).

The family stress model poses that the strain derived from experiences associated with SES disadvantage exacerbates stress in the family, which compromises parenting quality, leading to adverse consequences for the parent-child relationship that negatively impact child development. There is empirical support for this model, with a number of studies showing evidence for the proposed mediating pathways (for a review, see Conger & Donnellan, 2007). Differences as a function of SES have been documented for the two main components of the model: exposure to stress and parenting quality, understood as variability in caregiving behaviors that promote favorable child outcomes (Shonkoff & Phillips, 2000). Lower SES is associated with higher exposure to psychosocial stressors (e.g. family turmoil, low social support, exposure to violence) and physical stressors (e.g. crowding, substandard housing conditions, exposure to toxins; for a review, see Evans, 2004), which have been shown to be detrimental to development in a cumulative fashion (Evans & English, 2002). It has also been well documented that the quality of parenting differs as a function of SES. Variations in dimensions of parenting including discipline harshness, responsiveness, warmth, and cognitive stimulation have been documented, with parents from lower SES backgrounds showing, on average, lower parenting quality (for reviews, see Bradley & Corwyn, 2002; Evans, 2004; McLoyd, 1998).

Some of the stressors characteristic of lower SES homes have been directly associated with aspects of parenting quality. For example, among mothers from lower SES backgrounds, parental responsiveness is negatively associated with home crowding (Evans, Maxwell, & Hart, 1999) and with perceptions of lack of social support (Ceballo & McLoyd, 2002). Furthermore, the levels of psychological distress experienced by parents from lower SES backgrounds have been related to their parenting behaviors (for a review, see McLoyd, 1990). Together, these findings indicate that parents facing SES adversity are exposed to higher levels of stress and tend to show lower levels of parenting quality, with correlational evidence for a relationship between the two. Along with findings from experimental studies with rodent models showing causal relationships between stress exposure, maternal care, and offspring development, this evidence suggests it is plausible that the deleterious effects of SES-related stress on parenting partly explain the relationships between SES and neurocognitive development observed in human children.

In sum, SES is associated with cognitive abilities that predict academic achievement and with the development of the brain systems that support them. The fact that the academic achievement gap by SES is evident even before children enter formal schooling (Lee & Burkam, 2002) highlights the influence of early experiences on the development of cognitive abilities important for academic success. Interactions with parents provide some of the earliest input that shapes child development. Given that multiple dimensions of parenting quality have been shown to vary with SES, parenting quality has been proposed as a mechanism through which SES disadvantage has deleterious effects on cognitive development. This explanatory mechanism presupposes that parenting quality is associated with child cognitive outcomes. As reviewed in the following section, multiple studies have already documented this relationship.

Parenting Quality and Cognitive Development

Studies examining parenting have conceptualized the construct in a multiplicity of different ways (for a review, see O'Connor, 2002). Yet, there is consensus that parenting behaviors can be considered to be valenced. Thus, parenting behaviors are typically characterized as negative or positive, also referred to as destructive or constructive, depending on whether they are theorized to hinder or promote favorable child outcomes (Simons, Whitbeck, Conger, & Melby, 1990). Negative parenting behaviors include harshness, directiveness or intrusiveness, detachment, and inconsistent discipline (Fuligni & Brooks-Gunn, 2013). Negative parenting behaviors have been shown to be inversely associated with favorable child outcomes (Tamis-LeMonda, Shannon, Cabrera, & Lamb, 2004), including different components of EF (Cuevas et al., 2014; Hopkins, Lavigne, Gouze, LeBailly, & Bryant, 2013; Rhoades et al., 2011). Positive parenting behaviors include responsiveness or sensitivity, warmth, affection, or positive regard, encouragement, scaffolding, or autonomy support, and cognitive stimulation or teaching (Fuligni & Brooks-Gunn, 2013; Roggman, Cook, Innocenti, Jump Norman, & Christiansen, 2013a). There is evidence that these domains of positive parenting are positively associated with the development of cognitive abilities, including the development of EF (for a review, see Fay-Stammbach, Hawes, & Meredith, 2014) and are malleable to intervention with parents from lower SES backgrounds (Knoche et al., 2012). For the rest of this manuscript, these positive dimensions of parenting will be referred to collectively as supportive parenting.

Supportive parenting has been shown to be associated with diverse cognitive abilities related to EF. Supportive parenting is associated with performance on tasks tapping working memory, cognitive flexibility, and inhibitory control (Matte-Gagné & Bernier, 2011), a relationship that can be seen with children's EF performance before they reach their second birthday (Bernier, Carlson, & Whipple, 2010). This form of parenting has also been associated with different forms of attention, including attentional flexibility (Bibok, Carpendale, & Muller, 2009) and attentional control (Belsky, Fearon, & Bell, 2007; Mezzacappa, Buckner, & Earls, 2011). The relationship between supportive parenting and EF is also evident when examining composites that simultaneously measure multiple aspects of EF (Blair et al., 2011; Hughes & Ensor, 2009; Rhoades et al., 2011; Hammond, Muller, Carpendale, Bibok, Liebermann-Finestone, 2012). Furthermore, the development of effortful control, a form of self-regulation related to EF but considered to be temperament-based rather than cognitive-based (Posner & Rothbart, 2000), has also been associated with supportive parenting

(Kochanska, Murray, & Harlan, 2000; Lengua, Honorado, & Bush, 2007; Lengua et al., 2014).

Longitudinal studies focusing on families from lower SES backgrounds document that higher parenting quality, characterized by high levels of supportive parenting and low levels of negative parenting, is positively associated with child cognitive outcomes. Parenting quality predicts performance on measures of cognitive abilities both concurrently and prospectively, with supportive parenting being a stronger predictor than aspects of negative parenting (Tamis-LeMonda et al., 2004). Furthermore, different patterns of supportive parenting over time are associated with differences in cognitive development growth between infancy and the preschool years. Supportive parenting during infancy predicts multiple aspects of school readiness during preschool, as do changes in supportive parenting from infancy to preschool, with increases in supportive parenting over time associated with improvements in child school readiness (Chazan-Cohen et al., 2009). In a different study, mothers who showed consistently high levels of supportive parenting during infancy and during the preschool years had children with better cognitive outcomes and steeper growth over time than mothers who showed consistently low supportive parenting. Importantly, their children also outperformed those of mothers how showed high levels of early supportive parenting during infancy, but low levels during preschool. These longitudinal findings indicate that consistent supportive parenting that adapts to the child's changing developmental needs is associated with better child cognitive outcomes; high supportive parenting during infancy that fails to extend to the preschool years does not promote cognitive development to the same extent as parenting characterized as consistently supportive (Landry, Smith, Swank, Assel, & Vellet, 2001). Such evidence highlights the need to support parents so they are able to adapt their parenting behaviors as their child continues to develop. This might be particularly important for families from lower SES backgrounds, given that supportive parenting has been identified as a mediator of the effects of SES on child outcomes.

There is evidence that variation in parenting is not only associated with cognitive child outcomes, but that it is one of the mechanisms through which SES impacts cognitive development. For example, the relationship between cumulative risk, including multiple demographic and psychosocial risk factors, and effortful control in preschoolers is mediated by supportive parenting (Lengua et al., 2007; Lengua et al., 2014). Notably, the mediating role of supportive parenting is evident across development. During the first three years of life, parenting quality mediates the effects of cumulative risk on early cognitive development at each birthday, even when controlling for family demographic factors and prior parenting quality (Lugo-Gil & Tamis-LeMonda, 2008). Longitudinal evidence also shows that parenting quality mediates the relationships between SES and child outcomes when examining variables that index different aspects of SES, including income and material hardship (Gershoff, Aber, Raver, & Lennon, 2007; Mistry, Vandewater, Huston, & McLoyd, 2002). This is also the case when taking a person-centered approach that considers profiles of different combinations of cumulative risk factors rather than a single index of SES (Rhoades et al., 2011). Furthermore, this mediational relationship is evident longitudinally across racial and ethnic groups (Raver, Gershoff, & Aber, 2007), and holds when controlling for correlated mediators (Guo & Harris, 2000; Hackman et al., 2015). These findings provide empirical support for theoretical models suggesting that the effects of SES on child outcomes operate via parenting quality, including the family stress model (Conger & Donnellan, 2007).

Importantly, parenting quality has been shown to impact brain development. To date, most of the research on the effects of parenting on brain development has focused on the context of extreme adversity, such as severe deprivation (i.e. institutionalization) and trauma (i.e. maltreatment). In this context, evidence for variations in brain structure, including volume and white matter tract connectivity, and brain function, including alterations in processing and activation, has been documented as a function of adverse parenting-related experiences (for a review, see Belsky & de Haan, 2011). For example, children diagnosed with PTSD resulting from a history of maltreatment exhibited smaller brain volume compared to matched, healthy controls. Notably, smaller brain volume was associated with longer duration of maltreatment and with younger age of PTSD onset (De Bellis et al., 2002). Similarly, children raised in orphanages characterized by severe deprivation before being adopted exhibited smaller cerebellar volumes compared to never-institutionalized controls, which was associated with lower performance on tasks tapping memory and planning (Bauer, Hanson, Pierson, Davidson, & Pollak, 2009).

In terms of brain function, both children with a history of maltreatment and children with a history of institutionalization show evidence of altered processing of emotional information as measured by ERPs, albeit in different ways. Children with a history of maltreatment show heightened attention allocation to angry facial expressions relative to non-maltreated children (Pollak, Klorman, Thatcher, & Cicchetti, 2001). In contrast, children with a history of institutionalization show hypoarousal to facial expressions, indexed by smaller ERP amplitudes and longer latencies (Moulson, Fox, Zeanah, & Nelson, 2009). Together, this evidence indicates that the lack of consistent and reliable supportive parenting characteristic of these extreme disturbances in caregiving has deleterious effects on the developing brain and shapes neurodevelopment, both structurally and functionally.

Parenting quality within the 'normal range', referring to variations not associated with extreme adversity, is also associated with differences in broad neurocognitive systems and specific brain structures in typically developing children. Building on research with non-human animal models, Farah and colleagues (2008) examined the associations between variations in different aspects of childhood experience and the neurocognitive systems supporting language and memory in middle schoolers from lower SES families who were followed longitudinally. Two aspects of childhood experience were measured via home observations. These were environmental stimulation, operationalized as the availability of cognitively stimulating materials and activities in the home, and parental nurturance, operationalized as observed warm and responsive parenting behaviors towards the child. A composite for each neurocognitive system was created using valid behavioral measures that have been linked to precise brain structures in imaging or lesion studies. They found that environmental stimulation was associated with the language composite, while parental nurturance was associated with the memory composite (Farah et al., 2008), suggesting a specificity of the effect of childhood experience on neurocognitive systems.

A separate study using a subsample of the sample used by Farah and colleagues (2008) examined the effect of the same aspects of childhood experience, environmental stimulation in the home and parental nurturance, on brain structure. Rao and colleagues

(2010) tested the effects of early, assessed at age four, and late, assessed at age eight, parental nurturance and environmental stimulation on hippocampal volume during adolescence. They found that early parental nurturance was negatively associated with hippocampal volume. This finding was interpreted as suggesting that adolescents who received higher parental nurturance during early childhood had more accelerated hippocampal maturation, given that the developmental trajectory of hippocampus size is characterized by decreases in volume during adolescence and into adulthood (Rao et al., 2010). Furthermore, parenting quality has been identified as a mediator of the effects of SES on hippocampal volume (Luby et al., 2013). Together, this evidence indicates that the influence of parenting, particularly early in life, has consequences for children that can be observed at the brain level in addition to at the behavioral level. However, it must be noted that this evidence is correlational in nature. In order to establish causation, studies that experimentally manipulate parenting quality and examine the effects on cognitive and brain outcomes are needed. Intervention studies with experimental designs that seek to increase parenting quality represent a step in this direction.

To summarize, variations in parenting quality are associated with cognitive outcomes and brain development. These relationships have been documented for lower SES samples, indicating that parenting quality accounts for at least some within-group variability in the cognitive development of children from lower SES families. Multiple studies have identified supportive parenting as a mediator of the deleterious effects of SES disadvantage on cognitive skills, providing support for its role as an explanatory mechanism for this relationship. Given the strong relationships between parenting quality and child outcomes, leaders in the field have made a call for intervention programs to focus on targeting parents with the goal of increasing parenting quality as a means to improve outcomes in children facing adversity (Shonkoff & Fisher, 2013).

Parenting Interventions to Improve Child Outcomes

The abundance of evidence documenting the important role that parenting plays in child development has motivated intervention programs designed to promote academic readiness and boost cognitive skills in young children to adopt a dual-generation approach, engaging the parents in addition to intervening at the child level (Chase-Lansdale & Brooks-Gunn, 2014; Smith, 1995). Thus, many programs aiming to improve child outcomes use strategies that target their parents, under the rationale that to benefit children it is necessary to improve their most direct environments, particularly the caregiving relationship (Benasich, Brooks-Gunn, & Clewell, 1992). However, considerable variability exists across multiple dimensions of dual-generation programs, including the form of parent engagement employed, the duration, intensity, delivery mode, and cost of the program, and the characteristics of the target population, among others (Benasich et al., 1992; St. Pierre, Layzer, & Barnes, 1995).

It is important to note that simply adding a parent education component to an early childhood program does not guarantee improvements in child outcomes. A meta-analytic review of the effects of center-based early childhood programs across North America, Asia, and Europe on child cognitive development documented that those including parent support or engagement components did not necessarily show robust advantages over those that did not take this approach (Burger, 2010). Another meta-analysis focusing on preschool programs in the United States found that providing parenting education in this context was not associated with increases in cognitive and school readiness outcomes. However, characteristics of the program, such as the frequency of points of contact with the family and the use of interactive opportunities for parents to model and practice skills were identified as positive predictors (Grindal et al., 2016). Given this evidence, leaders in the field have recommended that new dual-generation initiatives apply lessons learned from previous efforts. Some such recommendations include engaging parents in active skill-building, as opposed to simply providing information, and integrating the parent and child components into a unified strategy that targets a clearly identified mechanism of change (Chase-Lansdale & Brooks-Gunn, 2014; Shonkoff & Fisher, 2013).

The exact approaches dual-generation programs take have evolved over time. Programs in the early 1960's put the lens on intervening to improve child outcomes by: 1) providing high quality early education; and 2) engaging the parents. This was achieved by establishing early childhood centers, including the creation of Head Start, and engaging the parents to different degrees, such as by providing parent resources, educational and job training, or home visits in which an interventionist worked directly with the parent in the home (Chase-Lansdale & Brooks-Gunn, 2014). One of the most widely cited early examples of these programs is the Perry Preschool Project, which was designed as an intervention to improve the outcomes of preschool-aged children from lower SES backgrounds. Those who participated in the program received high-quality, centered-based preschool education for 12.5 hours per week, which was supplemented by 1.5-hr weekly home visits. During the home visits, highly trained teachers worked with the parents on strategies to support their children's learning. Family involvement in the program lasted for one to two school years (Schweinhart & Weikart, 1981).

The High/Scope Perry Preschool study found that, compared to a control group that did not receive any form of early education or any other additional services, the intervention group showed positive short-term outcomes, including higher IQ and school achievement at school entry, as well as lower special education needs and deviant behavior in the classroom (Schweinhart & Weikart, 1981). Benefits persisted into adulthood, including increased earnings, higher high school graduation rates, and reduced crime engagement and job instability (Schweinhart et al., 2005). The Perry Preschool Project was shown to be cost-effective, with strong rates of return for the investment (Heckman, Moon, Pinto, Savelyev, & Yavitz, 2010). However, the program was both staff and resource intensive, and required a substantial and sustained commitment from the family, making it operationally and financially challenging to implement on a larger scale. The lessons learned from the Perry Preschool Project have led to efforts to develop programs that are more feasible to implement, but also more strategic about investing human resources with the goal of building human resources. One such approach has been to target building specific parent capabilities to have the parent achieve self-reliance over reliance on service providers to enact change in the home environment (Shonkoff & Fisher, 2013).

The Oregon Social Learning Center (OSLC) has been a pioneer in developing programs that take the approach of coaching the parent to become an agent of change, as well as in adapting such programs for specific populations and evaluating their impact using rigorous research designs (for a review, see Forgatch & Martinez, 1999). Early evaluations of this approach showed that focusing on training the parent as an agent of change to decrease child conduct problems is effective (Patterson, Chamberlain, & Reid, 1982). The origins of this approach can be traced back to the Parent Management Training – Oregon model (PMTO; for a review, see Forgatch & Patterson, 2010). The PMTO intervention was developed as a parent training program with the goal of improving child behavior by means of changing the way parents respond and react to their children. The core components of the program are five parenting strategies designed to increase positive and decrease negative parenting practices, which include: 1) positive reinforcement, 2) effective limit setting, 3) monitoring, 4) family problem solving, and 5) positive involvement (Forgatch, Patterson, & Gewirtz, 2013; Patterson, 2005). PMTO has been shown to be effective in reducing conduct problems in children by improving parenting practices in their parents (for reviews, see Forgatch & Patterson, 2010; Patterson, 2005). Given its evidence-based efficacy, this program has been adapted to be integrated into statewide and nationwide community systems to be implemented at a wide scale (Forgatch et al., 2013). Furthermore, the theory that gave rise to PMTO and its core components have served as the basis for other OSLC programs that have been tailored for specific populations and contexts. The section that follows reviews three such programs that have informed and inspired the development of Parents and Children Making Connections – Highlighting Attention, the program evaluated in the present dissertation. These programs are Linking the Interests of Teachers and Families, Multidimensional Treatment Foster Care – Preschool, and the Incredible Years Series.

Linking the Interests of Teachers and Families (LIFT; Reid, Eddy, Fetrow, & Stoolmiller, 1999) is an intervention program designed to address conduct problems in elementary school-aged children. This program was based on the evidence that early child conduct problems are associated with later delinquent behavior, and that parental discipline and supervision, along with interactions with teachers and peers at school, play an important role in the developmental trajectory of these behaviors (Reid & Eddy, 1997). Therefore, LIFT intervenes both in the home environment and the school environment, including a parent component, a classroom component, and a peer component. The parent component is delivered in small group format to 10-15 families who meet on a weekly basis for six weeks. The content of the parent component focuses on improving discipline practices, such as consistency and contingency, and on strategies to strengthen important parenting skills, such as giving encouragement and making effective requests. Additionally, LIFT encourages parent-teacher communication and family involvement in the child LIFT activities. As part of the child component, a trained teacher delivers the curriculum in the classroom during bi-weekly sessions over the span of 10 weeks. Sessions focus on discussing, practicing, and reviewing appropriate social skills, such as following rules and dealing with anger, and problem-solving skills, such as clearly stating problems and effectively evaluating solutions. Children then get to practice the skills on the playground as part of a group cooperation game in which they receive rewards for positive behaviors and lose points for negative behaviors.

The impact of the LIFT program was evaluated in a randomized control trial (RCT) with 1st and 5th graders, in which 12 schools were randomly assigned to receive LIFT or to serve as comparison control sites. Positive changes on measures across different domains were observed for both grade levels. During the school year following the intervention period, teachers who had not been involved with LIFT rated children who had participated in the program as showing more positive behaviors with peers compared to controls. Children who participated in LIFT also showed decreased physical aggression as rated by observers blind to group assignment. This change was most pronounced for 1^{st} graders who showed high levels of physical aggression at baseline. Mothers' aversive verbal behavior toward their child was also reduced as a function of participating in LIFT, especially for mothers who showed high rates of aversive verbal behavior at baseline (Reid et al., 1999; Stoolmiller, Eddy, & Reid, 2000).

At a three-year follow-up, long-term impacts were found for each grade group on factors associated with delinquency. Specifically, 5^{th} graders who participated in LIFT were less likely to affiliate with deviant peers, to have been arrested by the police, and to engage in frequent alcohol use relative to controls. Teachers of LIFT 1^{st} graders rated them as having less severe inattentive, impulsive, and hyperactive behaviors in the classroom (Eddy, Reid, & Fetrow, 2000; Eddy, Reid, Stoolmiller, & Fetrow, 2003). When examining substance use across adolescence, having participated in LIFT predicted lower average use of tobacco, alcohol, and illicit drugs, and reduced the rate of growth in use of tobacco and illicit drugs between 5^{th} and 12^{th} grade. These effects were mediated by intervention-related increases in family problem-solving skills and reductions in child aggression (DeGarmo, Eddy, Reid, & Fetrow, 2009). Together, this evidence indicates that an intervention program that targets specific skills and behaviors that have been associated with negative child outcomes can have positive short- and long-term impacts on key behaviors. In turn, these impacts can alter the developmental trajectory of the targeted negative outcomes. It also highlights the importance of intervening across the different environments that can exert influence on a child's development.

Intervening at the parent level, with the goal of strengthening key parenting skills, in addition to intervening at the child level, has also been found to be effective with preschoolers and families in the foster care system. Multidimensional Treatment Foster Care – Preschool (MTFC-P; Fisher, Ellis, & Chamberlain, 1999) is an early intervention program designed for foster parents of preschool-aged children in the foster care system. It is a developmental adaptation of OSLC's Multidimensional Treatment Foster Care program, which was designed for foster care-involved adolescent boys with a history of delinquency (Chamberlain & Reid, 1998). With the goal of decreasing behavior problems and promoting emotion regulation, the main components of MTFC-P include training and support for foster parents before and during placement, as well as a therapeutic play group for their foster care preschoolers. The foster parent training focuses on strategies to manage behavior problems and promote positive behaviors, including positive reinforcement, contingent discipline, and clear limit-setting. This intensive training occurs prior to placement. After placement, foster parents receive ongoing individualized support from the multidisciplinary intervention team and participate in a weekly support group with other foster parents in the program. The weekly therapeutic play group is designed to give children an opportunity to practice behavioral strategies in a peer group context (Fisher et al., 1999).

A small-scale quasi-experiment compared changes in parenting strategies, parenting stress, child behavior problems, and child physiological stress between families receiving MTFC-P, families receiving regular foster care services, and a community control group of children living with their biological families (Fisher, Gunnar, Chamberlain, & Reid, 2000). Foster parents in regular foster care showed lower levels of supervision, positive discipline, and positive reinforcement than foster parents receiving MTFC-P, who exhibited levels on these parenting practices comparable to those of parents in the community control group. Children in the MTFC-P group showed higher levels of problem behavior at pre-assessment, but also greater reductions in behavior problems from pre- to post-assessment, while problem behavior levels remained constant for children in the regular foster care group. Furthermore, preliminary evidence was reported for an impact of MTFC-P on child stress physiology, as measured via salivary cortisol, and self-reports of parenting stress (Fisher et al., 2000).

A subsequent RCT demonstrated that children who received MTFC-P showed patterns of cortisol activity overtime that resembled those of a non-maltreated community control, while children who received regular foster care developed a flattened response over time, associated with chronic stress exposure (Fisher, Stoolmiller, Gunnar, & Burraston, 2007). Furthermore, compared to regular foster care, participation in MTFC-P predicted a higher permanent placement success rate (Fisher, Burraston, & Pears, 2005), as well as increases in secure attachment behaviors and decreases in avoidant attachment behaviors toward the foster parent over time (Fisher & Kim, 2007). The evidence-base for MTFC-P shows that the approach implemented in PMTO and LIFT of improving child behaviors via strengthening parenting practices can be successfully adapted for parents of younger children. MTFC-P proved to be beneficial for preschoolers in the foster care system and their foster parents, which is a population with specific characteristics facing a unique set of challenges (for a review, see Bass, Shields, & Behrman, 2004). This raises the question of whether the documented benefits of this approach would generalize to families with children of the same age who are not foster care-involved.

The Incredible Years Training Series, a program with a focus on younger children, was based on the same theory that gave rise to the PMTO intervention (Webster-Stratton & Jamila, 2010). The series includes different modules designed for parents, teachers, and children during early and middle childhood. The parent training program for the early childhood component focuses on play, including how to enhance play and support child learning, use of effective praising and tangible rewards, effective limit setting and ways to deal with non-compliance, and strategies to handle misbehavior. The training is delivered to groups of parents by trained leaders who use videotaped vignettes of parent-child interactions to facilitate discussion. Parents are encouraged to practice skills learned during group through role-play and in the home. The Incredible Years also includes a child training component designed for four to eight year olds with conduct problems. It includes video and puppet modeling, role-playing, and structured activities to practice skills, which are encouraged through feedback and reinforcement. The objectives of the child training include learning how to make friends and follow rules, understanding and identifying feelings, problem-solving, developing friendship skills, and promoting positive school behaviors.

Evaluation of the Parent Training Program demonstrated positive impacts for families of children with and without conduct problems from varying levels of risk, including reductions in child behavior problems and improvements in parenting behaviors (for a review, see Webster-Stratton & Jamila, 2010). An RCT compared families of four- to eight-year-old children with early-onset conduct problems that received parent training only, child training only, both parent training and child training, and a wait-list control group. All treatment groups showed improvements in child behavior immediately after the intervention period and at a one-year follow-up, but the combination of child and parent training led to larger improvements along more outcomes for both parents and children (Webster-Stratton & Hammond, 1997). This evidence highlights the added benefits of a dual-generation approach that intervenes at the parent and child levels using an integrated strategy, suggesting that it can act as a force multiplier. The findings from this program with families of children with conduct problems raise the question of whether such an approach could benefit families from lower SES backgrounds facing the stressors associated with SES disadvantage.

The Incredible Years program has been adapted for Head Start families, the target population of the studies that make up this dissertation. Head Start preschools were randomly assigned to receive the adapted version of the Incredible Years intervention or Head Start services as usual. The adapted intervention consisted of the parenting training component, plus a short (two-day) teacher training intended for teachers to learn the content of the parenting training so they could employ the same strategies to manage behavior and support the development of social skills in the classroom. Mothers who participated in the intervention showed improvements in parenting practices, including less critical and harsh parenting, and more positive and contingent discipline. Their children showed higher levels of social competence and lower levels of behavior problems relative to their control counterparts (Webster-Stratton, 1998). These results show that a program originally designed for families of children with conduct problems can be effective with families from lower SES backgrounds not necessarily reporting child conduct problems, but who face other stressors related to SES that may interfere with family functioning.

Since the inception of the Perry Preschool Project, multiple intervention programs aiming to improve child outcomes have employed a dual-generation approach. Initially, this approach primarily took the form of adding some form of parental engagement to established child services. However, the parent training components of dual-generation intervention programs have evolved. Rather than mainly providing parents with general resources and information, now more intervention programs involve integrated skill-building that seeks to improve parenting practices and equip parents with the tools to become self-reliant in changing their child's behaviors. This approach is at the core of pioneering parent training programs developed at OSLC, which have proved effective in modifying parenting behaviors as a means to change child behaviors with multiple populations. The present dissertation project focuses on an adaptation of this parent training approach that was integrated into a dual-generation intervention program for families from lower SES backgrounds with preschool-aged children. A unique aspect of this dual-generation program is that it was explicitly designed to target a specific neurocognitive system that has been shown to be vulnerable to SES disadvantage: selective attention.

Selective Attention as a Neurobiological Target for Intervention

Selective attention is the ability to focus attention on, or enhance, relevant information while simultaneously inhibiting, or suppressing, distracting non-relevant information. Thus, selective attention is characterized as having two primary components: signal enhancement and distractor suppression (for reviews, see Desimone & Duncan, 1995; Hillyard, Vogel, & Luck, 1998). ERP studies have provided neurocognitive evidence for this model of selective attention. In a seminal study, Hillyard and colleagues (1973) concurrently presented participants with the same tone pips to each ear, and instructed them to attend to the tones presented to one ear and ignore the tones presented to the other ear. The amplitude of the first negative ERP component (N1) elicited by the same tones (i.e., same physical stimulus) was modulated by attention, such that the N1 elicited by the attended tones was larger than the N1 elicited by the unattended tones (Hillyard, Hink, Schwent, & Picton, 1973). This finding has been replicated when the tones are embedded in speech passages, and the task is to monitor the passage as opposed to listen to the tones in isolation (Hink & Hillyard, 1976). This ERP paradigm has been adapted for younger children, in which children's stories are used instead of speech passages (Coch, Sanders, & Neville, 2005). Children as young as preschool age show modulation of attention similar to adults, characterized as an enhancement of the brain response to the attended story and a suppression of the response to the unattended story within 100 ms of presenting the stimulus (Sanders, Stevens, Coch, & Neville, 2006). Thus, ERPs represent a powerful technique for investigating selective attention and the factors that shape its development during early childhood.

Brain systems supporting selective attention show protracted development and exhibit a high degree of neuroplasticity (Stevens & Neville, 2013). Notably, selective attention is enhanced in congenitally deaf individuals compared to typical hearing individuals as measured by ERPs to attended and unattended visual stimuli (Neville & Lawson, 1987). Deficits in brain function for selective attention have been documented in children with specific language impairment (Stevens, Sanders, & Neville, 2006) and children at risk for reading disabilities (Stevens et al., 2013). Yet, interventions in the form of computerized training or classroom activities that train selective attention can enhance this ability in children with these developmental conditions (Stevens, Fanning, Coch, Sanders, & Neville, 2008; Stevens et al., 2013). Together, this evidence indicates that selective attention is modifiable by experience, which makes it both vulnerable to lack of appropriate stimulation, but also enhanceable by factors in the developmental environment that provide positive input.

Growing up in a family facing socioeconomic disadvantage has been identified as a vulnerability factor for the development of neural mechanisms of selective attention. Children from lower SES backgrounds show deficits in selective attention characterized by reduced distractor suppression skills that can be observed at the brain level as early as the preschool years (Hampton Wray et al., in press; Stevens et al., 2009; Stevens, Paulsen, Yasen, & Neville, 2015). Critically, such deficits have the potential of placing these children at an early disadvantage for academic success. Specific brain systems have been described as foundational for academic success, as they support the cognitive abilities that provide the foundation upon which later learning will depend. The brain systems supporting selective attention are considered foundational systems (Stevens & Bavelier, 2012), as this ability has been implicated in a number of school readiness outcomes (Checa & Rueda, 2011; Rueda, Checa, & Rothbart, 2010). In preschoolers from lower SES backgrounds, selective attention is associated with performance on measures of math, language, literacy, and fluid intelligence (Welsh, Nix, Blair, Bierman, & Nelson, 2010), as well as non-verbal IQ (Isbell et al., 2016). Thus, given their documented neuroplasticity and their relationship to academic achievement outcomes, the brain systems supporting selective attention have the characteristics to be an effective target of interventions aimed at promoting school readiness in children from lower SES backgrounds.

Parents and Children Making Connections – Highlighting Attention

Having identified selective attention as vulnerable in children from lower SES families, Parents and Children Making Connections – Highlighting Attention (PCMC-A) was developed as an intervention program with the goal of improving school readiness by promoting selective attention skills in these children. In this way, PCMC-A responds to the call for intervention programs to be informed by cognitive neuroscience and target specific neurocognitive systems (Belsky & de Haan, 2011; Bryck & Fisher, 2012; Raizada & Kishiyama, 2010; Shonkoff & Fisher, 2013). PCMC-A takes a dual-generation approach to target selective attention and was designed for preschoolers enrolled in Head Start programs and their families. This approach consists of a parenting training component for parents or primary caregivers, which seeks to increase positive parenting practices and leverage the home environment, and an attention training component for children.

The PCMC-A parent training component is based on the parenting curriculum of the LIFT program (Reid et al., 1999), which has its roots in the core components of the Parent Management Training – Oregon model (PMTO; for a review, see Forgatch & Patterson, 2010) developed by OSLC and reviewed above. The adapted parenting training curriculum focuses on teaching strategies to manage family stress, encourage contingency-based discipline, increase parental responsiveness, and improve child-directed language use, as well as ways to promote in the home the skills children are practicing as part of the child training. The child training consists of scaffolded activities and strategies to promote self-regulation, focusing attention and dealing with distractions, and identifying and coping with emotional states. During eight weekly sessions, trained interventionists deliver the curricula of the parenting training (two hours) and the child training (45 minutes) concurrently but separately to small groups of parents and children. A detailed description of both components of PCMC-A, including operational details, is provided in Chapter II.

The impact of PCMC-A has been evaluated in an RCT (Neville et al., 2013). Families recruited from Head Start sites in the state of Oregon were randomly assigned to one of three groups: 1) the PCMC-A intervention group, which received parenting training and child training, 2) the Attention Boost for Children (ABC) active control group, which focused on child training and included only limited contact with the parents (three training sessions as opposed to eight), or 3) a Head Start-alone control group, which received Head Start services as usual. Given that PCMC-A was designed to target the neurocognitive systems supporting selective attention, the primary outcome of interest in this study was an ERP index of selective attention. This index was measured employing the child-friendly selective attention task described above, previously validated with preschoolers (Sanders et al., 2006). Briefly, children were simultaneously presented with two different children's stories and were asked to attend to one story and ignore the other. Brain responses elicited by identical sound probes embedded in both stories were compared when they appeared in the attended story to when they appeared in the unattended story. At the pre-assessment, none of the groups showed an attention effect, characterized as the modulation of the brain response elicited by the same sound probes when attended vs. unattended. This pattern was consistent with previous findings of deficits in this neural index of selective attention in children from lower SES backgrounds (Stevens et al., 2009). After the intervention, children assigned to the PCMC-A group showed improvements in the attention effect that were characterized by increases in signal enhancement over the intervention period. Such improvements were not observed in the Head Start-alone control group nor in the child-focused active comparison group, ABC. These gains in brain function for selective attention in the PCMC-A group were accompanied by increases in social skills, receptive language abilities, and non-verbal IQ performance, and by reductions in parent-reports of behavior problems compared to the other two groups.

The finding that the behavioral and neural benefits seen in the PCMC-A group did not extend to the group that received primarily child training suggests that parenting training contributes to gains in selective attention over and above child training, highlighting the importance of the parenting training component. This study also documented that some aspects of parenting changed as a function of PCMC-A, including decreases in self-reports of parenting stress and increases in appropriate parent-child language use (Neville et al., 2013). However, the relationship between changes in parents and changes in children as a function of participating in PCMC-A remains an open question. Furthermore, the mechanisms of change that explain the documented gains in child brain function for selective attention have yet to be identified.

Previous studies have shown that changes in supportive parenting behaviors as a function of intervention mediate changes in behavioral child outcomes (e.g. Gardner, Hutchings, Bywater, & Whitaker, 2010; Landry, Smith, & Swank, 2006; Landry, Smith, Swank, & Guttentag, 2008; Obradović, Yousafzai, Finch, & Rasheed, 2016). These findings motivate the hypothesis that PCMC-A parenting training leads to increases in supportive parenting, which in turn promote improvements in child brain function for selective attention. This hypothesis could help explain the lack of improvements seen in the ABC comparison group, which did not receive the same level of parenting training. However, to date, neither the impact of PCMC-A on supportive parenting nor the consequences it may have for child outcomes have been investigated. Thus, to examine this hypothesis two critical questions must be addressed: 1) do objectively measured supportive parenting behaviors show malleability to the PCMC-A intervention; and 2) do such changes explain observed improvements in child brain function for selective attention.

Overview of the Present Dissertation

The overall objective of the present dissertation was to determine the extent to which change in supportive parenting behaviors is one of the mechanisms through which the dual-generation PCMC-A intervention leverages brain function for selective attention in preschoolers from lower SES backgrounds. The central hypothesis was that supportive parenting behaviors observed during parent-child interactions, defined as parenting behaviors that promote a healthy cognitive and socioemotional development during early childhood (Shonkoff & Phillips, 2000), are malleable to this intervention and partially mediate the effect of PCMC-A on a neural index of child selective attention. Three interrelated research questions were formulated to test this hypothesis employing data acquired as part of the RCT to evaluate the impact of PCMC-A.

The first research question, presented in Chapter III, examined whether supportive parenting behaviors coded from observations of a parent-child interaction showed change as a function of PCMC-A relative to a control group receiving Head Start services alone. Parent and child characteristics were examined as potential moderators of intervention-related changes on supportive parenting behaviors. Moderators were examined with the goal of identifying whether PCMC-A had a differential impact on this outcome, showing greater or lesser benefits for dyads with certain profiles (Shonkoff & Fisher, 2013).

The second research question, presented in Chapter IV, sought to characterize the relationship between intervention-related changes in supportive parenting behaviors and in child brain function for selective attention as measured by a well-validated ERP index. First, it examined whether PCMC-A led to improvements in this neural index of selective attention in Head Start preschoolers, as was previously documented with a smaller sample (Neville et al., 2013). Second, it tested whether intervention-related changes in supportive parenting behaviors predicted changes in child brain function for selective attention.

The third research question, presented in Chapter V, tested the explanatory mechanism proposed by examining whether intervention-related changes in supportive parenting behaviors mediated the effect of PCMC-A on child brain function for selective attention. This chapter also examined whether the levels of supportive parenting observed at baseline were associated with the extent to which children showed intervention-related changes in brain function for selective attention. Additionally, it investigated whether other potentially relevant parent and child characteristics moderated the effect of PCMC-A on this neural index, resulting in differential impacts. The findings for all of these questions and their implications are discussed in Chapter VI, and the general methodology employed for all studies reported is detailed in Chapter II.

Together, these research questions sought to empirically test specific components of one mechanism hypothesized to explain child responsiveness to PCMC-A: parenting training leads to increases in supportive parenting behaviors, which in turn partially account for the improvements the intervention confers on child selective attention. This dissertation project constitutes the first attempt to test a theory-driven mechanism to explain why a dual-generation approach, including parenting training in addition to child attention training, is necessary to achieve gains in child brain function for selective attention. As such, it addresses a fundamental gap in our understanding of how the PCMC-A intervention program operates to elicit changes in the neurocognitive system it targets.

This dissertation contains co-authored material. The studies described in Chapter III, Chapter IV, and Chapter V are in preparation for publication and were co-authored with A. Hampton Wray, E. Pakulak, and H. J. Neville.

CHAPTER II

METHODOLOGY

This chapter details the methodology employed for the studies reported in Chapter III, Chapter IV, and Chapter V. The sample described here consists of the full sample drawn from for all studies. Chapter III used the full sample, while Chapter IV and Chapter V focused on a subset of this sample. Details of this subsample are described in Chapter IV. The materials and procedures used for all of the studies are described in this chapter, while the analytical strategy for each study is outlined in its corresponding chapter.

Participants

The sample consisted of a subset of families who participated in the RCT of Parents and Children Making Connections - Highlighting Attention (PCMC-A) between the fall of 2008 and the winter of 2013. All families were recruited from 12 Head Start sites in Lane County, Oregon. Inclusionary criteria for the present sample were that the child had acceptable ERP data quality (operationalized as low EEG artifacts and a minimum of 75 trials per condition) for at least the pre-assessment, and that the free-play interaction task was completed by the mother. The latter criterion was established given that the system employed to code for supportive parenting behaviors differs for fathers (Anderson, Roggman, Innocenti, & Cook, 2013), of whom there were very few in the full sample. For this reason, the present sample was restricted to mothers.

These selection criteria yielded a sample of 86 mother-child dyads. The children (62% female) ranged in age from 3.44 to 5.54 years (M = 4.52, SD = .52) and were 66.3% White, 3.5% Black, 4.7% American Indian or Alaska Native, 18.6% indicated more than one category, and 7% did not report. Furthermore, 12.8% were identified as Latino/a. All of the children were enrolled in Head Start programs and came from lower SES status backgrounds, as coded by the Hollingshead Index of Social Status, described below (M = 29.78, SD = 11.71). They were all right-handed and monolingual speakers of English who passed a hearing screening at 20 dB at 1000, 2000, and 4000 Hz in both ears, which suggested normal hearing thresholds, and had not been diagnosed with behavioral or neurological problems. Of the 86 dyads, 42 were randomly assigned to participate in PCMC-A and 44 to the Control group, which received Head Start services as usual. The RCT of PCMC-A also included an active control group referred to as Attention Boost for Children (ABC), which focused on child training and included only limited contact with the parents. This group was not included in the present dissertation because it was discontinued in subsequent cycles of the intervention implementation.

PCMC-A Program Description

Following a dual-generation model, PCMC-A included a parent component and a child component, and was specifically designed for families enrolled in Head Start programs (Neville et al., 2013). The program lasted for 8-weeks, with one session scheduled per week for both of the components. During each weekly session, trained interventionists delivered the curricula of the parent component (two hours) and the child component (45 minutes) concurrently but separately to small groups of parents and children (four to six parents/children). Sessions took place at Head Start facilities and were scheduled during a time that was convenient for the families in the group, usually during evenings or weekends. Child care and food were provided at every session, and transportation assistance was provided when necessary.

Parent Component. The curriculum for the parent component was adapted from the Linking the Interests of Families and Teachers (LIFT) curriculum, a preventive intervention to address conduct problems in elementary school children (Reid et al., 1999). The adapted curriculum focused on teaching strategies to manage family stress, encourage contingency-based discipline, increase parental responsiveness, and improve child-directed language use, as well as ways to promote the skills children are practicing as part of the child component in the home. The curriculum of the parent component is structured around the following themes: 1) using language differently to boost child attention, 2) establishing clear communication and predictable routines, 3) encouraging preferred behaviors, 4) setting limits and practicing contingency-based discipline, 5) monitoring emotional saturation and responding appropriately, and 6) optimizing play to boost learning and enhance the parent-child relationship.

During every session, a new theme was covered and concrete strategies designed to facilitate achieving the goals of that theme were introduced. For example, providing the child with choices was one of the strategies suggested to use language differently with the goal of boosting child attention. This strategy is intended to avoid using empty questions, defined as questions that are not really asking for information because they will only accept one answer (e.g. "do you want to go to bed?"). Instead, parents were encouraged to use clear statements and provide choices they are comfortable with for the child to choose how the request will happen (e.g. "It's time to go to bed. Are you brushing your teeth first or putting your PJs on first?"). The rationale behind this strategy was that using choices instead of empty questions communicates to the child that their opinion is valued. This gives them a sense of control and makes them feel involved in the process, increasing the likelihood that they will cooperate with the request. It also tunes their attention to what the parent is saying so they can evaluate the choices they have, which provides an opportunity to practice their thinking skills.

The interventionists introduced the strategies as suggestions of things parents could try out to achieve specific goals when they considered them to be a good fit for their family. The rationale behind each strategy was explained in an accessible way with the support of materials, including handouts, posters, and props. Every session, parents received handouts that summarized and illustrated the main points discussed, provided examples and guidance for how to implement the strategies, and served as a place to take notes.

Each two-hour session began with a review of the material covered in the previous session and an opportunity for parents to share with the group their experiences trying out the strategies in the home. This group dynamic allowed for parents to hear success stories from one another, which was intended to increase their motivation to try out the strategies and to create a sense of social support through shared experience. Another important aspect of the parent component sessions was the time allotted for parents to practice the strategies and prepare for implementing them in the home. To achieve this, the interventionists would model how to use the strategies and engage the parents in role-play. They would also assist each parent with creating a concrete plan for how and when they could try out the strategies in the home, and together they would identify in advance potential implementation challenges and brainstorm ways to address them. The purpose of this process was to reduce obstacles to implementing the strategies in the home by helping the parents feel prepared and confident. At the end of each session, parents were provided with the necessary materials (e.g. posters, charts, stickers, etc.) to be able to implement the strategies and were encouraged to try them in the home. A mid-week phone call was scheduled with each family to provide on-going support and collect information about how the strategies were working for them in the home.

Child Component. The child component, referred to as Brain Train, consisted of scaffolded activities to promote self-regulation, focusing attention and dealing with distractions, and identifying and coping with emotional states. A series of strategies to foster self-regulation were introduced and encouraged throughout the duration of the program. For example, children learned to take a deep "Bird Breath" when they need to control their body, focus their attention, or manage their emotions. Visuals, such as a poster of a bird taking a deep breath, and props, such as a pin-wheel, were used to illustrate the strategies and to act as reminders for the children to use them.

A lead interventionist and an assistant delivered the curriculum for each weekly session. The main role of the lead interventionist was to cover the curriculum material, while the main role of the assistant was to help manage the behavior of the group through the use of pedagogical strategies, such as providing specific praise for children following directions and modeling desired behaviors. Each session included activities and games during which the children had opportunities to practice the strategies learned. For example, an activity during which they had to walk a line while balancing a small object on a spoon allowed them to practice taking a "Bird Breath" to control their bodies and focus their attention. If they dropped the object, they could practice the strategy to say "Oh Well" as a way to manage their frustration and think of viable alternatives. The activities increased in complexity as the weeks progressed, ensuring they continued to provide a challenge that fostered opportunities to practice self-regulation. For example, as part of the next level of the activity to walk the line, the other children in the group were instructed to use puppets to try to get the attention of the child completing the activity. This was designed to allow the child to experience being distracted, learn to identify distractions, and practice strategies to manage or work through them.

Throughout Brain Train, interventionists used with the children the same behavioral management strategies that their parents were taught as part of the parent component. They also used some of the same materials that parents were encouraged to use in the home, such as a weekly calendar and a rules poster. The goal of first introducing these strategies and materials in the context of Brain Train was to get children familiarized with them in order to make it easier for their parents to implement them in the home context.

Materials

Brain Function for Selective Attention. Event-related potentials (ERPs) were recorded during a child-friendly dichotic listening task to assess auditory selective attention. As depicted in Figure 2.1, participants were simultaneously presented with narratives of two different children's stories, one coming from a speaker located to their left and the other coming from a speaker located to their right. Children were instructed to attend to the narrative coming from one side, and ignore the one coming from the opposite side. ERPs were time-locked to identical sound probes embedded in both narratives.

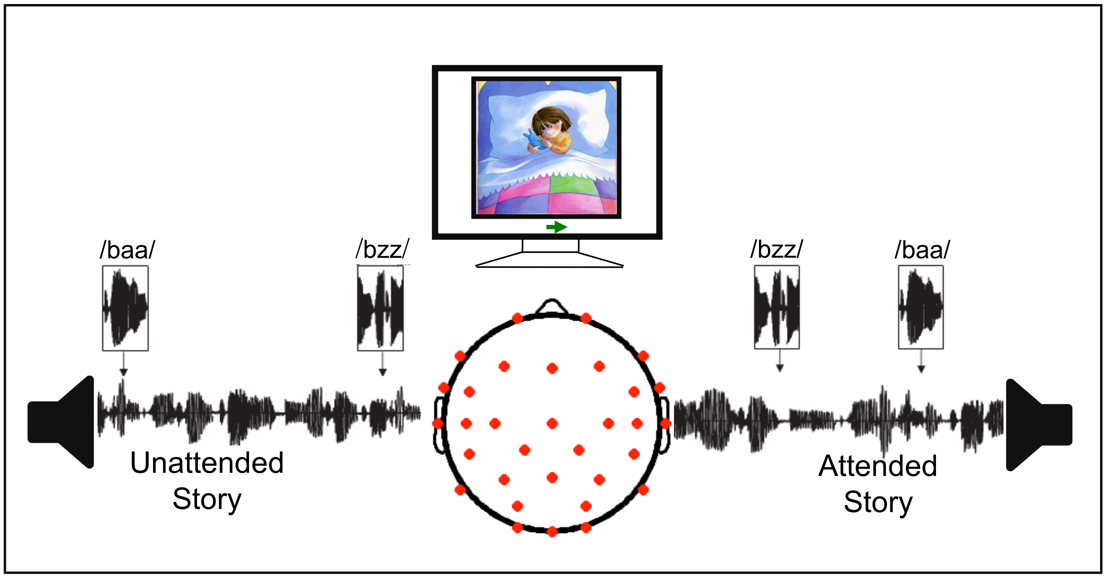

Figure 2.1. Schematic representation of the dichotic listening task to assess auditory selective attention. ERPs were recorded to identical sound probes when embedded in simultaneously presented attended and unattended stories.

Stimuli. Four sets of narratives in English were presented at 60 dB SPL, each set containing a story narrated by a male speaker and a story narrated by a female speaker. Stories were 2.5-3.5 minutes in duration and were digitally recorded (16 bit, 22 kHz) while being read by the narrator at a normal speaking rate in a child-directed manner. The location (left/right) and voice (male/female) of the attended story were counterbalanced. ERPs were recorded to identical probes when superimposed on the attended and unattended narratives. Two kinds of probes were presented. Linguistic probes consisted of the syllable /ba/ spoken in a female voice different from that of the narrators. Non-linguistic probes consisted of a scrambled version of the /ba/ syllable used for the linguistic probes, created by temporally and spectrally rotating 4-6 ms segments of the /ba/. This resulted in a /bzz/ sound with the same acoustic properties of the linguistic /ba/. Both probes were 100 ms in duration and were presented with equal frequency in the attended and unattended channel (~400 probes per channel). Probes were presented at 70 dB SPL at randomly jittered short (175-225 ms), medium (475-525 ms), or long (975-1025 ms) inter-stimulus intervals, and they were never presented simultaneously in both channels.

EEG Recording and Processing. EEG data were recorded at a sampling rate of 512 Hz during completion of the auditory selective attention task from 32 Ag/Ag-Cl electrodes positioned along the scalp according to the 10-20 system. The online recording was referenced to the Common Mode Sense active electrode (BioSemi Active2, Amsterdam, Netherlands), and the data were re-referenced off-line relative to the average of the left and right mastoids. Eye movements were monitored by placing additional electrodes at the outer canthi of both eyes and below the right eye. The left and right eye electrodes were re-referenced to one-another to detect horizontal eye movements, and the vertical eye electrode was re-referenced to Fp1 to detect blinks and vertical eye movements. A band-pass filter from 0.1 to 40 Hz was applied to the raw EEG data using EEGLAB (Delorme & Makeig, 2004).

Following this process, 600 ms epochs time-locked to probe onset were extracted using a 100 ms baseline (100 ms pre-onset to 500 ms post-onset). Epochs that exceeded established peak-to-peak thresholds (±100μV for eye channels and ±200μV for all other channels) were identified by an automatic artifact rejection algorithm using a 200 ms window moving in 50 ms increments. Subsequently, trained research assistants visually inspected the data to identify and reject additional epochs with ocular, muscular, or paroxysmal artifacts. A total of 5 participants had a channel that was identified as faulty by visual inspection during data cleaning by multiple expert raters. Faulty channels were replaced with the mean of the other three neighboring channels located in the same quadrant (anterior, central, or posterior rows by hemisphere). No participant had more than one replaced channel.

Supportive Parenting Behaviors. Observed parenting behaviors were coded from videotaped mother-child interactions during a free-play task, which was collected identically at pre- and post-assessment. The Parenting Interactions with Children: Checklist of Observations Linked to Outcomes (PICCOLO) coding system (Roggman et al., 2013a, 2013b) was employed to code for supportive parenting behaviors displayed during these interactions. The PICCOLO focuses on supportive parenting behaviors in four domains: Encouragement, Affection, Responsiveness, and Teaching. For each domain, seven to eight concrete behaviors (total of 29 items) were scored on a three-point scale ranging from zero to two, which coded for whether the behavior was clearly present (score of two), barely present (score of one), or absent (score of zero). Both frequency and complexity of the behaviors displayed during the entire length of the interaction were taken into consideration.

The PICCOLO Total score, which collapsed across the four domains, could range from 0-58. Both the PICCOLO Total score and the individual domain scores were used as outcome variables. Furthermore, an a priori defined composite of the PICCOLO items that were considered to be most directly targeted by the parenting component of PCMC-A (hereon referred to as the “A Priori Composite”) was created to test the effect of the intervention on a subset of items expected to be better-suited to capture intervention-related changes. Out of the 29 PICCOLO items, nine items were selected, so the A Priori Composite could range from 0-18. All four domains were represented in the selected items. The guidelines followed to select the items for the A Priori Composite are detailed in the Procedures section, below.

Moderators.

Socioeconomic Status & Maternal Education. The Hollingshead Four Factor Index of Social Status (Hollingshead, 1975) was used to measure SES and maternal education. Information about maternal and paternal occupation and highest educational attainment was collected as part of the parent interview, and then coded by trained coders following the Hollingshead's guidelines. Parental occupation was coded on a nine-point scale, with higher ratings indicating a more prestigious occupation. Parental educational attainment was coded on a seven-point scale, so that 1 = less than 7^{th} grade, 2 = junior high school, 3 = partial high school, 4 = high school graduate, 5 = partial college, 6 = college graduate, and 7 = graduate degree. When calculating the index, occupation was weighted more heavily (weight of five) than educational attainment (weight of three), and whether one or both parents were present and gainfully employed was taken into consideration. The Hollingshead index, which was used as a proxy for the SES of the child's family, could range from a minimum of eight to a maximum of 66. In addition to SES, maternal education was also independently examined as a moderator because the sample focused on mothers. A total of four participants in the Control group and two participants in the PCMC-A group had missing data for the SES index. Two participants in the Control group and one in the PCMC-A group had missing data for maternal education.

Child Sex & Age. Mother reports were used to determine child sex, which was dummy-coded with males set as the reference group. Age was calculated based on the child's date of birth and the date when the pre-assessment took place. There were no missing data for these variables.

Non-Verbal IQ. Non-verbal IQ was measured using a composite of the Stanford-Binet Intelligence Scales – 5th Edition (Roid, 2003), which included the Fluid Reasoning, Quantitative Reasoning, and Working Memory subtests within the non-verbal domain. The composite score was created by averaging the scaled scores for each of the three subtests, following previous studies from our lab (Isbell et al., 2016). Scaled scores for each subtest were age-adjusted, with a mean of 10 and a standard deviation of 3. The non-verbal IQ composite could range from 1 to 19, with higher scores indicating higher non-verbal IQ performance. There were no missing data for this variable.

Behavior Problems & Social Skills. Mother reports of child social skills and behavior problems were measured using the Preschool and Kindergarten Behavior Scales – 2nd Edition (PKBS-2; Merrell, 2002). The Social Skills scale included 34 items that measured social cooperation, social interaction, and social independence behaviors. The Behavior Problems scale included 42 items that measured internalizing and externalizing behaviors. The composite standard scores were used for each scale, which had a mean of 100 and a standard deviation of 15. Higher scores on the Social Skills composite indicated better social skills, while higher scores on the Problem Behaviors composite indicated more behavior problems. One participant in the Control group and four participants in the PCMC-A group had missing data for the Social Skills scale. Three participants in the PCMC-A group had missing data for the Behavior Problems scale.

Interactive Language Use. This variable was operationalized as the mean length of utterance (MLU) produced by the mother while interacting with her child. The mean number of morphemes produced in each maternal utterance during the free-play task was calculated using the Systematic Analysis of Language Transcript (SALT; Chapman & Miller, 1984). Trained coders who met reliability criteria and were blind to experimental condition transcribed the dialogue that occurred during the free-play task and coded it according to the SALT guidelines. There were no missing data for this variable.

Parenting Ability & Confidence. Perceived sense of parenting confidence and ability was measured using the Ability & Confidence Rating Scale (Neville et al., 2013). Mothers rated their ability and their confidence to navigate eight parenting situations. These included encouraging cooperation, enforcing house rules, enhancing child language, setting limits, managing behavior problems, increasing child confidence, changing child behavior, and effectively communicating with the child. Mothers first rated their perceived ability on these eight situations and then rated their feelings of confidence for the same situations. Both were rated on a five-point Likert scale, with one being “never” and five being “always”. The wording of the response options for each scale varied slightly to reflect the dimension being assessed. As an example, the response option for the Ability scale read “I rarely do this well”, while for the Confidence scale it read “I rarely feel confident”. The average response for the eight items was calculated separately for each scale, each of which could range between one and five, with higher scores indicating greater feelings of confidence or ability. One participant in the Control group had missing data for the Ability Rating Scale. Two participants in the Control group and one in the PCMC-A group had missing data for the Confidence Rating Scale.

Parenting Stress. The Parent Daily Report (PDR; Chamberlain & Reid, 1987) was used to measure perceived parenting stress elicited by child behavior problems. Over five consecutive weekdays, parents completed phone interviews, providing information about the occurrence of 48 common child behavior problems from the PDR checklist during the past 24 hrs. For each reported problem behavior, a follow-up question was asked regarding whether the mother had experienced that particular child behavior as stressful. The ratio of perceived stress to reported child problem behaviors was used, with higher scores indicating more perceived stress. All mothers had available data for at least three days. Two participants in the Control group and two participants in the PCMC-A had missing data for this variable.

Procedures

Testing Procedure. Families visited the lab to complete two identical multimethod assessments, which took place before and after the intervention period. Each assessment entailed two lab visits, which occurred within a span of no more than 30 days. During the first visit, the child completed a battery of behavioral tests of cognition with a trained tester, while the mother completed an interview and a series of questionnaires. Together, the mother and the child completed a free-play task, which was used to code for supportive parenting behaviors and for interactive language use. Mothers were provided with a standard set of toys, which included a pirate ship, kitchen and food items, vehicles, and plastic animals, and were instructed to play with their child as they normally would for eight minutes while their interaction was video recorded.

During the second visit, the child completed the ERP task to assess auditory selective attention. An experimenter with behavioral management training and blind to experimental condition placed an electrode cap on the child. Following application of the cap, the child was led into a sound-attenuating and electrically-shielded booth and sat in a comfortable chair facing a monitor. Two speakers were located on either side of the child. Once in place, a recording explained the instructions to the child and demonstrated the experience. The recording specified that two stories would play simultaneously, but the child should only pay attention to one of them and ignore any other sounds presented. Before each set of stories, the to-be-attended narrator instructed the child to pay attention to his or her voice. As additional cues of the direction of attention, the monitor displayed an arrow pointing in the direction of the speaker playing the attended story and showed pictures illustrating that story. Four sets of stories were presented, with each side playing the attended story twice, in counterbalanced order (right-left-left-right or left-right-right-left).

One experimenter accompanied the child for the duration of the task to reinforce instructions and to manage behavior, while a second experimenter outside of the booth operated the ERP equipment and monitored the recording, troubleshooting when necessary. After each set of stories, the experimenter asked the child three forced-choice comprehension questions about the attended story. The purpose of these questions was to motivate the child to attend to one story at a time and to gage the extent to which the child was attending to the correct story. Performance below chance was taken as indication that the child was not following task instructions, so children who met this criterion were excluded from ERP analyses.

At the post-assessment, the same testing procedure was followed and the same tasks were completed by the child and the mother. For every lab visit, mothers provided informed consent and children gave verbal assent. Families were financially compensated for their participation, with a bonus added at the post-assessment as an incentive to complete both rounds of assessment.

PICCOLO Coding Procedure. Video recordings of the free-play task were coded by two trained coders using the PICCOLO coding system. Coders trained for over 12 hours using training videos until they reached inter-rater reliability, following the criteria outlined by the PICCOLO developers, defined as no more than three items with a one-point difference per domain or 75% agreement (Roggman et al., 2013b). Training videos with the same characteristics as the videos included in the dataset were coded by both coders in order to determine inter-rater reliability, which was assessed via percent agreement, as recommended by the PICCOLO developers. These videos were randomly interspersed with the videos that each coder was coding independently to be included in the dataset, so coders were blind to which videos would be used for inter-rater reliability purposes and which would be included in the dataset. The average inter-rater percent agreement for these videos ($n = 23$) was 75.6%, meeting the 75% requirement established by the PICCOLO developers (Roggman et al., 2013b).

Two of the videos included with the PICCOLO training materials featured children close to the age range of our sample. These videos were coded by both coders to assess reliability with the PICCOLO developers. The coders had individual average percent agreements with the PICCOLO developers of 72.4% and 75.9%. Furthermore, the two coders and the coding supervisor met on a weekly basis for the duration of the coding process to avoid drift. During each of these meetings, the coding system and the videos coded for inter-rater reliability purposes during the previous week were reviewed and doubts were discussed. Additionally, a new training video was coded independently by each coder and reviewed as a group to assess inter-rater reliability in an ongoing manner. The average inter-rater percent agreement for the videos coded during these meetings (n = 13) was 79.1%.

The videos included in the dataset were coded independently by one of the two coders. Each coder coded half of the pre-assessment videos and the non-corresponding half of the post-assessment videos. This arrangement avoided having the same dyad coded twice by the same coder. Coders filled out the PICCOLO scoring sheet after watching the full length of the video while taking notes, rewinding when necessary. Videos were coded in a random order and coders were blind to experimental condition and time of assessment, as well as to which videos would be used for inter-rater reliability assessment purposes.

PICCOLO A Priori Composite Selection Procedure. The procedure to select the items that would conform the A Priori Composite took place once the coding process was complete, but before any analyses had been conducted. Two team interventionists who have taught the parent component of PCMC-A and are familiar with the PICCOLO coding system, but did not conduct the coding, were in charge of this process. Both interventionists independently reviewed all of the PICCOLO items and marked the ones they considered were most directly targeted by the curriculum of the PCMC-A parent component. Together, they then discussed each item and came to an agreement on whether it should be included in the composite or not, consulting the parent component materials when relevant. This process resulted in nine items selected to form the A Priori Composite; three items came from the Encouragement domain, one from the Affection domain, three from the Responsiveness domain, and two from the Teaching domain.

One of the targets of PCMC-A was to increase the amount of positive attention the parent gives to the child when he or she engages in “preferred behaviors”, defined as behaviors the parent values and wants to see increase, with the goal of also boosting the child’s self-confidence. One of the strategies suggested to achieve this was to consistently provide specific praise to the child, explicitly pointing out the behaviors for which they are being praised. “Praises child” from the Affection domain and “verbally encourages child’s efforts” from the Encouragement domain were selected for the A Priori Composite because they were considered to capture this aspect of the parent component curriculum.

One of the parenting training sessions focused on optimized play. During this session, parents learned about the importance of letting the child direct the play and following the child’s lead. They were also taught strategies designed to enhance child language and attention during play by introducing new vocabulary and making suggestions to maintain the focus on the activity at hand for longer. For these reasons, this session was considered to target the following PICCOLO items: “pays attention to child” and “follows what child is trying to do” from the Responsiveness domain, and “suggests activities to extend what child is doing” and “talks to child about characteristics of objects” from the Teaching domain.

One of the main strategies taught as part of PCMC-A was to provide the child with choices and allowing them choose, with the goal of facilitating cooperation, providing a sense of control, and creating opportunities to practice thinking skills. “Supports child in making choices” and “supports child in doing things on his or her own” were selected from the Encouragement domain because these items were considered to be closely tied to this PCMC-A strategy. Finally, the rationale for selecting the item "responds to child's emotions" from the Responsiveness domain was that PCMC-A emphasized monitoring the child's emotional saturation and suggested concrete strategies to assist the child with emotional regulation. For these reasons, this item was considered to be explicitly targeted by PCMC-A.

CHAPTER III

EFFECT OF PCMC-A ON SUPPORTIVE PARENTING BEHAVIORS AND MODERATORS OF CHANGE

This work is in preparation to be submitted for publication with co-authors. I designed the studies and wrote the manuscript, with my co-authors, A. Hampton Wray, E. Pakulak, and H. J. Neville providing feedback and editorial assistance.

Current Study

The aim of the present study was to determine the extent to which supportive parenting behaviors are modifiable via the PCMC-A intervention. Previous studies have documented that some aspects of parenting change as a function of PCMC-A, specifically decreases in self-reports of parenting stress and increases in indices of appropriate parent-child language use (Neville et al., 2013). However, whether PCMC-A leads to changes in parenting behaviors has not been investigated. The current study addressed this gap by examining changes in observed supportive parenting behaviors coded from a mother-child interaction employing the PICCOLO coding system (Roggman et al., 2013a). We hypothesized that mothers assigned to PCMC-A would show increases in supportive parenting behaviors from pre- to post-intervention, relative to mothers assigned to a Control group receiving Head Start services as usual, as a result of participating in PCMC-A parenting training.

To further understand the effects of PCMC-A on this outcome, supplementary exploratory analyses examined whether intervention-related changes in supportive parenting behaviors were moderated by child and mother characteristics that have been associated with variability in supportive parenting. The child characteristics examined were age, sex, and non-verbal IQ, as well as mother reports of behavior problems and social skills. The mother characteristics examined were variables related to aspects of parenting, including self-perceptions of parenting ability and confidence, perceived parenting stress in relation to child behavior problems, and mother-child interactive language use, indexed by the length of maternal utterances during the mother-child interaction. An index of family SES composed of parental occupation and education was also tested as a moderator. Additionally, we examined maternal education independently as an index of SES because our sample was restricted to mothers.

We examined child age as a potential moderator based on previous findings suggesting that as children age they begin to assert more autonomy from their parents and exhibit higher levels of non-compliance, which can have negative implications for the level of supportive parenting they receive from their parents (for a review, see Forman, 2007). Based on this evidence, we hypothesized that mothers of older children would show more intervention-related changes in supportive parenting because many on the strategies taught as part of PCMC-A parenting training are designed to address child compliance.

In light of evidence indicating that parents exhibit different parenting behaviors and interactional patterns towards their children depending on their sex (for a review, see Leaper, 2005), we hypothesized that child sex could moderate the effect of PCMC-A on changes in supportive parenting, but we did not have specific predictions regarding the directionality of this moderating effect. Furthermore, given evidence that children with lower IQ receive less supportive parenting (Fenning, Baker, Baker, & Crnic, 2007), we hypothesized that mothers of children with lower IQ scores would show more supportive parenting change as a function of PCMC-A relative to mothers of children with higher IQ scores because they would have more room for growth.

We hypothesized that mother reports of child behavior problems would moderate the effect of PCMC-A on supportive parenting given the established relationship between the two (Campbell, 1995; Deater-Deckard, 2000; Frick, 1994). Given that PCMC-A parenting training was adapted from the curriculum of a preventive intervention for children with conduct problems (Reid et al., 1999), we hypothesized that mothers of children with higher behavior problems would benefit more from PCMC-A because they would find the strategies taught more useful. We also hypothesized that mother reports of child social skills would act as a moderator because supportive parenting has been shown to vary as a function of child temperament (Putnam, Sanson, & Rothbart, 2002), which is associated with social skills in children (for a review, see Sanson, Hemphill, & Smart, 2004). We predicted that mothers of children with higher social skills would benefit more from PCMC-A because they would find it easier to implement PCMC-A parenting strategies with their children. However, an equally plausible alternative hypothesis is that they would benefit less because they would have less room for improvement.

We also hypothesized that parenting stress, perceived sense of parenting ability and confidence, and mother-child interactive language use (indexed by maternal MLU) would moderate the effect of PCMC-A on this outcome because these parenting characteristics have been associated with supportive parenting (e.g. Anthony et al., 2005; Deater-Deckard, 1998; Hoff, 2006; Morawska & Sanders, 2007; Raikes & Thompson, 2005). However, we had competing hypotheses about the directionality of the moderating effects. On the one hand, we expected that mothers reporting higher levels of parenting stress, lower perceived parenting ability and confidence, and lower interactive language use would benefit more from PCMC-A because they would be more in need of parenting training. On the other hand, we predicted that these mothers would benefit less because they would require a higher dosage of parenting training and support than the one provided by PCMC-A. Finally, given the well-documented relationship between SES and supportive parenting (for a review, see Bradley & Corwyn, 2002), we hypothesized that mothers from lower SES backgrounds and with lower levels of educational attainment would benefit more from PCMC-A in terms of increases in supportive parenting because they would have more room for growth.

Sample

The sample for the current study included the full sample described in Chapter II. Of the 86 dyads, 42 were randomly assigned to participate in PCMC-A and 44 were randomly assigned to the Control group, which received Head Start services as usual. As shown in Table 3.1, children in the PCMC-A and the Control group were matched for age, sex, SES, maternal education, and non-verbal IQ.

Effect of PCMC-A on Supportive Parenting Behaviors

Analytical Strategy. To examine the effect of PCMC-A on supportive parenting behaviors, as measured by the PICCOLO, we ran hierarchical multiple regression models to predict the post-assessment PICCOLO score. The pre-assessment PICCOLO score was entered at step one, a dummy variable coding for group (PCMC-A vs. Control, with Control set as the reference group) was entered at step two, and the interaction between group and the pre-assessment PICCOLO score was entered at step three. Continuous variables were grand mean centered for ease of interpretation of the intercepts and in order to reduce multicollinearity with interaction terms (Aiken, West, & Reno, 1991). Results are reported for the model containing all predictors. This model allowed us to test the effect of group assignment on the post-assessment PICCOLO score when controlling for the pre-assessment score, as well as whether the effect of group on the post-assessment score differed as a function of the pre-assessment score. We ran the model with the PICCOLO Total score, which collapses across the four domains, as the outcome variable, as well as with each of the individual domains and with the PICCOLO A Priori Composite.

Table 3.1
Sample Descriptive Statistics by Group

	Group			
	PCMC-A (n = 42)		Control (n = 44)	
	n	Mean (SD)	n	Mean (SD)
% Females	42	64%	44	59%
Age	42	4.61 (.51)	44	4.43 (.54)
SES	40	30.36 (12.18)	40	29.19 (11.34)
Maternal Education	41	4.51 (1.08)	42	4.71 (1.13)
Non-Verbal IQ	42	11.78 (1.90)	44	12.43 (1.94)

Note. Significant group differences are bolded ($p < .05$).

Results. The model examining the effects on the PICCOLO Total score was significant, $F(3,82) = 11.42$, $p < .001$, with an R^2 of .30. As summarized in Table 3.2, controlling for the pre-PICCOLO score and the interaction term, the main effect of group was trending towards significance, $p = .05$, with membership in the PCMC-A group predicting a higher post-PICCOLO score relative to Control. The expected post-

PICCOLO score for the Control group was 44.40, while for the PCMC-A group it was 2.41 points higher. Including group as a predictor in the model explained marginally significantly more variance than the model including only the pre-PICCOLO score, $\Delta R^2 = .03$, $p = .06$. The main effect of the pre-PICCOLO score was also significant, $p < .001$, while the interaction term was not, $p = .08$, indicating that initial levels on the PICCOLO Total score were associated with levels at the post-assessment, but that the effect of PCMC-A on the post-PICCOLO score was not conditional on the pre-PICCOLO score.

Table 3.2

Hierarchical Regression Model Predicting the Post-PICCOLO Total Score

Variable	*B*	*SE*	*β*	*p*	ΔR^2	*F*	*p*
Step 1					.23	25.69	< .001
(Constant)	45.63	.63		< .001			
Pre-PICCOLO Score	.52	.10	.48	< .001			
Step 2					.03	3.71	.06
(Constant)	44.46	.87		< .001			
Pre-PICCOLO Score	.53	.10	.49	< .001			
Group	2.39	1.24	.18	.06			
Step 3					.03	3.21	.08
(Constant)	44.40	.86		< .001			
Pre-PICCOLO Score	.73	.15	.68	< .001			
Group	2.41	1.23	.18	.05			
Pre-PICCOLO x Group	-.36	.20	-.25	.08			

Note. Group: Control coded as 0; PCMC-A coded as 1.

The analyses by domain revealed that the effect of PCMC-A on the PICCOLO Total score was driven by the Encouragement domain. The model examining the effects on the Encouragement domain was significant, $F(3,82) = 4.51$, $p < .01$, with an R^2 of .14. The results for the hierarchical regression analysis for this domain are summarized in

Table 3.3. There was a significant main effect of group, with participation in PCMC-A predicting a higher Encouragement score at post-assessment relative to Control, $p = .01$. The Control group had an expected Encouragement score of 11.10 and the PCMC-A group had an expected score that was 1.05 points higher. The addition of group as a predictor to the model explained significantly more variance, $\Delta R^2 = .07$, $p = .01$. The main effect of the pre-Encouragement score was also significant, $p = .04$, while the interaction term was not, $p = .82$. This pattern indicates that pre-assessment levels on the Encouragement score were associated with levels at the post-assessment, but that the effect of PCMC-A on the post-Encouragement score did not vary as a function of the pre-Encouragement score.

Table 3.3
Hierarchical Regression Model Predicting the Post-Encouragement Score

Variable	*B*	*SE*	*β*	*p*	ΔR^2	*F*	*p*
Step 1					.07	6.41	.01
(Constant)	11.62	.21		< .001			
Pre-Encouragement Score	.28	.11	.27	.01			
Step 2					.07	6.79	.01
(Constant)	11.10	.28		< .001			
Pre-Encouragement Score	.30	.11	.28	.01			
Group	1.05	.40	.27	.01			
Step 3					.001	.05	.82
(Constant)	11.10	.28		< .001			
Pre-Encouragement Score	.32	.16	.31	.04			
Group	1.05	.41	.27	.01			
Pre-Encouragement x Group	-.05	.22	-.03	.82			

Note. Group: Control coded as 0; PCMC-A coded as 1.

The model for the Affection domain was also significant, $F(3,82) = 9.18$, $p < .001$, with an R^2 of .25. The main effect of the pre-Affection score was significant, $b = .64$, $t(82) = 4.29$, $p < .001$, but the main effect of group and the interaction term were not significant, *p*s > .10. The same pattern of results was found for the Responsiveness domain. The model was significant, $F(3,82) = 5.58$, $p < .01$, with an R^2 of .17, and there was a significant main effect of pre-Responsiveness, $b = .35$, $t(82) = 2.86$, $p < .01$, but no significant main effect of group or interaction term, *p*s > .10. These results indicate that participating in PCMC-A did not lead to significant increases in the post-scores for these domains relative to Control, and that this relationship was not conditional on pre-scores.

The model for the Teaching domain was significant, $F(3,82) = 7.23$, $p < .001$, with an R^2 of .21. The main effect of the Teaching score at pre-assessment was also significant, $b = .87$, $t(82) = 4.60$, $p < .001$, while the main effect of group was not, $p = .38$. For this domain, the interaction term was significant, $b = -.77$, $t(82) = -3.11$, $p < .01$. As shown in Figure 3.1, there was a positive relationship between the Teaching score at pre-assessment and at post-assessment for the Control group, $b = .87$, $t(42) = 4.30$, $p < .001$, but not for the PCMC-A group, $b = .10$, $t(40) = .64$, $p = .53$.

To probe this finding further, we examined the same model but looking at change in the Teaching score from pre- to post-assessment as the outcome measure. The interaction term was significant, $b = -.77$, $t(82) = -3.11$, $p < .01$, indicating that the relationship between the pre-assessment Teaching score and change in the Teaching score from pre- to post-assessment differed by group. As can be seen in Figure 3.2, there was a negative relationship between these two variables for the PCMC-A group, $b = -.91$, *t*(40) = -6.10, $p < .001$, while there was no relationship for the Control group, *b* = -.14, *t*(42) = -.67, *p* = .50.

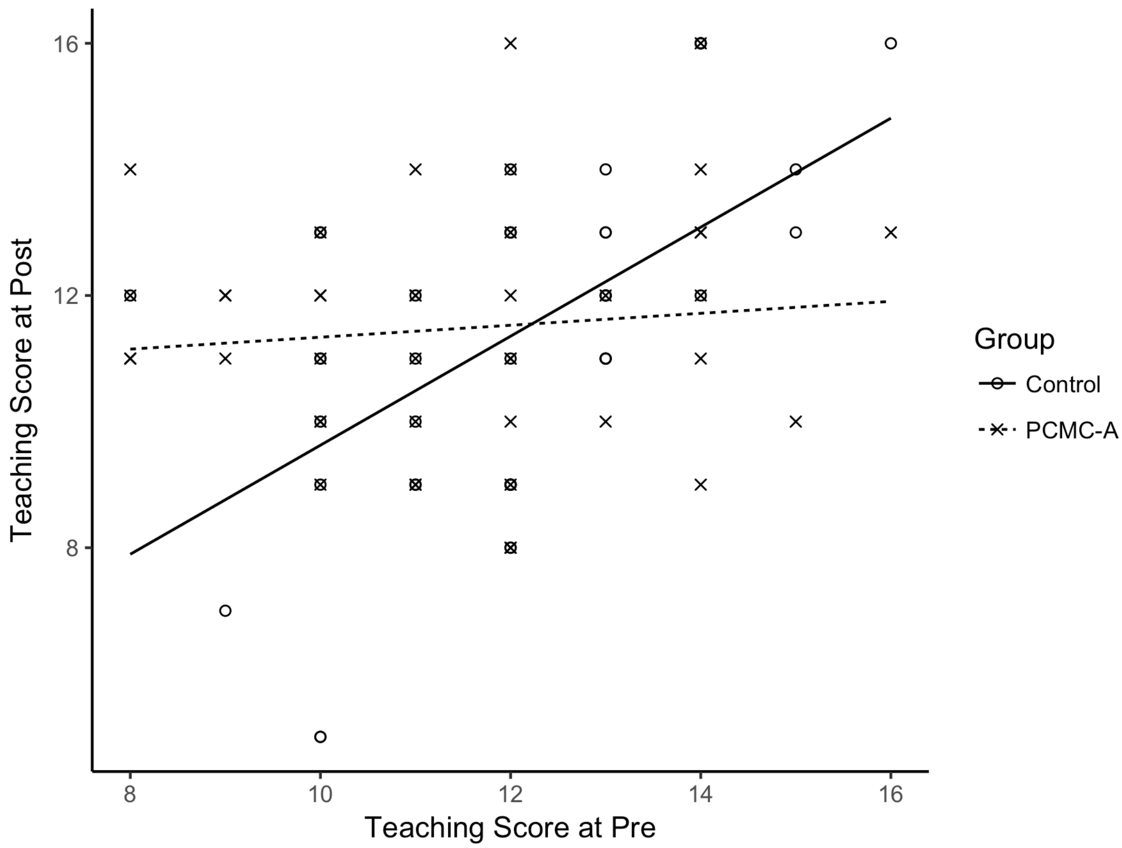

Figure 3.1. Relationship between the Teaching domain score at pre-assessment and the Teaching domain score at post-assessment plotted separately for each group.

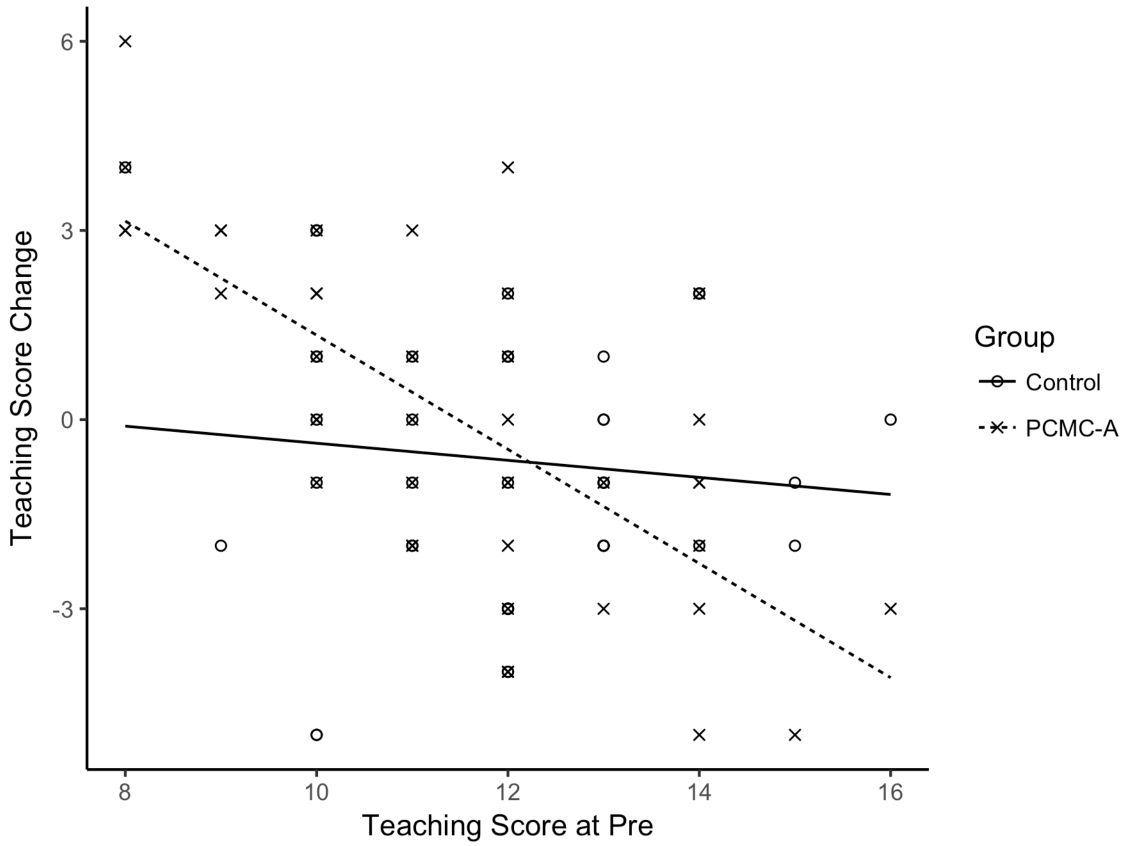

Figure 3.2. Relationship between the Teaching domain score at pre-assessment and change in the Teaching domain score from pre- to post-assessment plotted separately for each group.

The model for the A Priori Composite was also significant, $F(3,82) = 6.64$, $p < .001$, with an R^2 of .20. As summarized in Table 3.4, the main effect of group was significant, with PCMC-A group membership predicting a higher A Priori Composite score at post-assessment relative to Control, $p = .04$. The Control group had an expected post-score on the A Priori Composite of 14.15, while the PCMC-A group had an expected score 1.12 points higher. Adding group as a predictor to the model explained significantly more variance, $\Delta R^2 = .04$, $p = .04$. The main effect of the A Priori Composite score at pre-assessment was also significant, $p < .01$, while the interaction term was not, $p = .22$. As was the case with the PICCOLO Total score and the

Encouragement domain score, the effect of PCMC-A on the post-A Priori Composite score was not moderated by the pre-assessment score.

Table 3.4
Hierarchical Regression Model Predicting the Post-A Priori Composite Score

Variable	*B*	*SE*	*β*	*p*	ΔR^2	*F*	*p*
Step 1					.14	13.29	< .001
(Constant)	14.71	.27		< .001			
Pre-A Priori Composite Score	.37	.10	.37	< .001			
Step 2					.04	4.42	.04
(Constant)	14.16	.37		< .001			
Pre-A Priori Composite Score	.38	.10	.38	< .001			
Group	1.12	.53	.21	.04			
Step 3					.02	1.54	.22
(Constant)	14.15	.37		< .001			
Pre-A Priori Composite Score	.52	.15	.52	< .01			
Group	1.12	.53	.21	.04			
Pre-A Priori Composite x Group	-.25	.20	-.19	.22			

Note. Group: Control coded as 0; PCMC-A coded as 1.

Summary of Findings. Controlling for the PICCOLO Total score at the pre-assessment, hierarchical regression analyses showed a trending effect of PCMC-A on the post-assessment PICCOLO Total score, which collapses across the four parenting domains. The same analyses conducted by parenting domain revealed that this trend was driven by the Encouragement domain. We did not find evidence of a main effect of PCMC-A on post-assessment scores for the Affection domain, the Responsiveness domain, or the Teaching domain. However, having participated in PCMC-A predicted a higher post-assessment score on the Encouragement domain relative to that of the Control group. Notably, the effect of PCMC-A was also significant for the PICCOLO A Priori

Composite, which consists of the PICCOLO items considered to be most directly targeted by PCMC-A.

In every model, the PICCOLO pre-assessment score was a significant predictor of the post-assessment score. However, no evidence of this relationship differing as a function of group was found for the parenting domains examined, with the exception of the Teaching domain. For this domain, there was a significant relationship between the pre-assessment score and the post-assessment score for the Control group, but not for the PCMC-A group. To further understand this pattern, we examined whether the relationship between the Teaching score at the pre-assessment and change on the Teaching score from pre- to post-assessment differed by group. We found no relationship for the Control group, but a significant negative relationship for the PCMC-A group, indicating that the pre-assessment Teaching score moderated the effect of PCMC-A on change in the Teaching score. Mothers with lower initial Teaching scores who participated in PCMC-A showed positive change from pre- to post-assessment, while mothers with higher scores showed no change or negative change over time.

Moderators of Intervention-Related Changes in Supportive Parenting Behaviors

Analytical Strategy. Exploratory analyses were conducted to test for moderators of the effect of PCMC-A on the aspects of the PICCOLO that showed malleability to the intervention. Examining additional moderators of the effect of PCMC-A on the Teaching domain, which was itself moderated by the pre-assessment score, entailed including multiple interactions to the model. Due to concerns about statistical power with this approach, we focused on the aspects of supportive parenting for which we found main effects of PCMC-A on change over time: the PICCOLO Total score, the Encouragement domain, and the A Priori Composite. As summarized in Table 3.5, the two groups did not differ significantly at the pre-assessment on any of the child and mother characteristics examined as potential moderators. A series of hierarchical regression models were conducted to test for moderation. Group and the moderator variable were entered as predictors at step one. The interaction between these two factors was entered at step two to determine whether the effect of PCMC-A on change in the PICCOLO score from pre- to post-assessment differed as a function of the moderator variable. Results are reported for the model including all three predictors.

Table 3.5
Pre-Assessment Descriptive Statistics by Group

	Group			
	PCMC-A (n = 42)		Control (n = 44)	
	n	Mean (SD)	n	Mean (SD)
% Females	42	64%	44	59%
Age	42	4.61 (.51)	44	4.43 (.54)
SES	40	30.36 (12.18)	40	29.19 (11.34)
Maternal Education	41	4.51 (1.08)	42	4.71 (1.13)
Non-Verbal IQ	42	11.78 (1.90)	44	12.43 (1.94)
Behavior Problems	39	108.41 (12.23)	44	107.39 (12.78)
Social Skills	38	103.61 (7.64)	43	102.86 (8.43)
Mean Length Utterance	42	5.03 (.89)	44	4.84 (.64)
Parenting Ability	42	3.93 (.47)	43	3.78 (.57)
Parenting Confidence	41	3.97 (.47)	42	3.92 (.67)
Parenting Stress	40	.44 (.26)	42	.36 (.24)

Note. Significant group differences are bolded ($p < .05$).

Results. Child behavior problems emerged as a moderator of the effect of PCMC-A on the PICCOLO Total score. The model including this moderator variable, group, and the interaction term was significant $F(3,79) = 2.98$, $p = .04$, with an R^2 of .10. As summarized in Table 3.6, there was no main effect of group and no main effect of behavior problems, *p*s > .10, but there was a significant interaction between the two, $p = .01$. Adding the interaction term to the model explained significantly more variance, $\Delta R^2 = .08$, $p = .01$. As shown in Figure 3.3, there was not a significant relationship between child behavior problems and change in the PICCOLO Total score for the Control group, $b = -.11$, $t(42) = -1.36$, $p = .18$. However, for the PCMC-A group child behavior problems was a positive and significant predictor of change in this outcome, $b = .17$, $t(37) = 2.47$, $p = .02$. These results indicate that mothers who reported having children with more behavior problems at the pre-assessment changed more on the PICCOLO Total score as a function of participating in PCMC-A than mothers who reported fewer child behavior problems.

Table 3.6
Hierarchical Regression Model Testing Child Behavior Problems as a Moderator of Change in the PICCOLO Total score

Variable	*B*	*SE*	*β*	*p*	ΔR^2	*F*	*p*
Step 1					.02	.99	.38
(Constant)	-.72	.92		.44			
Group	1.81	1.34	.15	.18			
Behavior Problems	.02	.05	.04	.74			
Step 2					.08	6.82	.01
(Constant)	-.78	.89		.39			
Group	1.79	1.30	.15	.17			
Behavior Problems	-.11	.07	-.21	.14			
Group x Behavior Problems	.28	.11	.38	.01			

Note. Group: Control coded as 0; PCMC-A coded as 1.

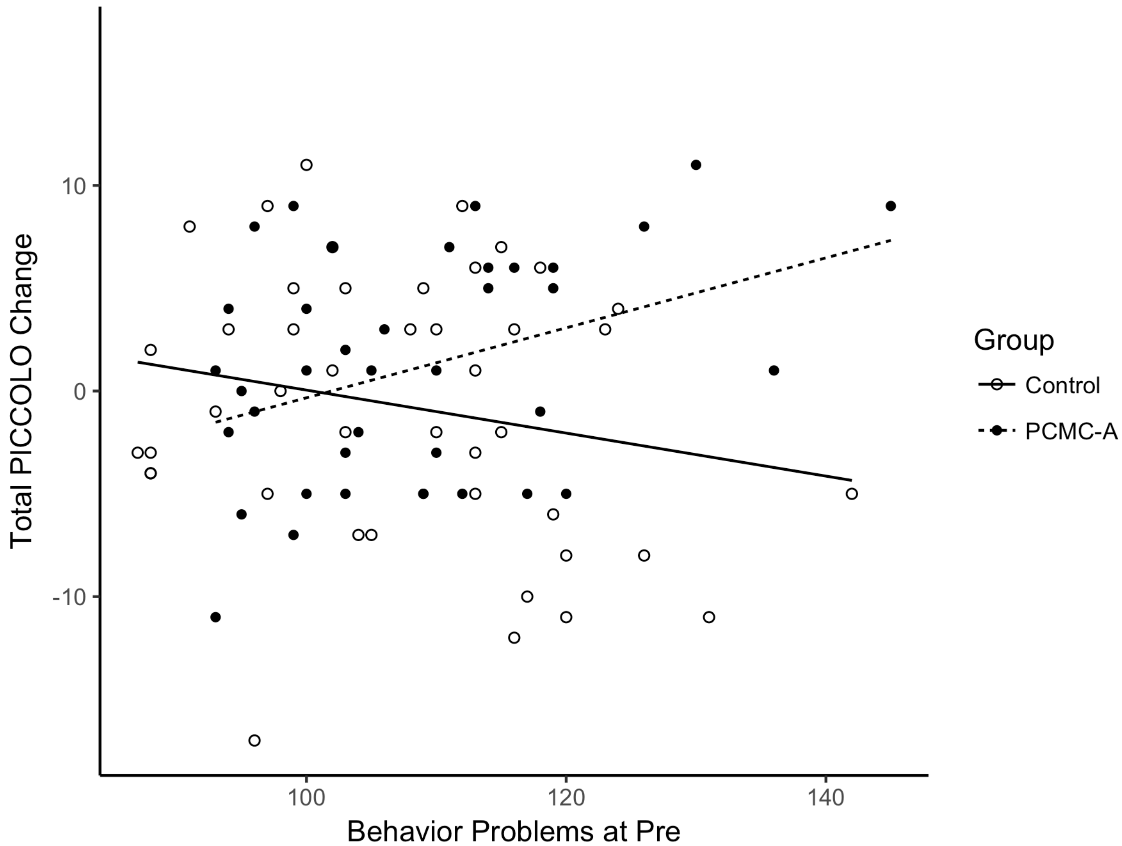

Figure 3.3. Relationship between child behavior problems at pre-assessment and change in the PICCOLO Total score from pre- to post-assessment plotted separately for each group.

Maternal mean length of utterance (MLU) coded during the mother-child interaction also emerged as a moderator of change in the PICCOLO Total score. This model was significant, $F(3,82) = 3.54$, $p = .02$, with an R^2 of .12. As summarized in Table 3.7, there was no main effect of MLU, $p = .16$, and the main effect of group was trending towards significance, $p = .06$. The interaction between group and MLU was significant, $p = .02$, such that including this term contributed significantly to the model, $\Delta R^2 = .06$, $p = .02$. As illustrated in Figure 3.4, there was no relationship between maternal MLU and change in the PICCOLO Total score for the Control group, $b = -2.09$, $t(42) = -1.36$, $p = .18$. However, there was a positive and significant relationship between MLU and change in this outcome for the PCMC-A group, $b = 2.39$, $t(40) = 2.25$, $p = .03$, indicating that a longer maternal MLU at the pre-assessment was associated with more change in the PICCOLO Total score as a function of participating in PCMC-A relative to shorter maternal MLU.

Table 3.7

Hierarchical Regression Model Testing Maternal Mean Length of Utterance as a Moderator of Change in the PICCOLO Total score

Variable	*B*	*SE*	*β*	*p*	ΔR^2	*F*	*p*
Step 1					.05	2.25	.11
(Constant)	-.65	.98		.51			
Group	2.53	1.40	.19	.08			
Mean Length Utterance	.80	.91	.10	.38			
Step 2					.06	5.86	.02
(Constant)	-.92	.95		.34			
Group	2.64	1.36	.20	.06			
Mean Length Utterance	-2.09	1.49	-.25	.16			
Group x Mean Length Utterance	4.48	1.85	.42	.02			

Note. Group: Control coded as 0; PCMC-A coded as 1.

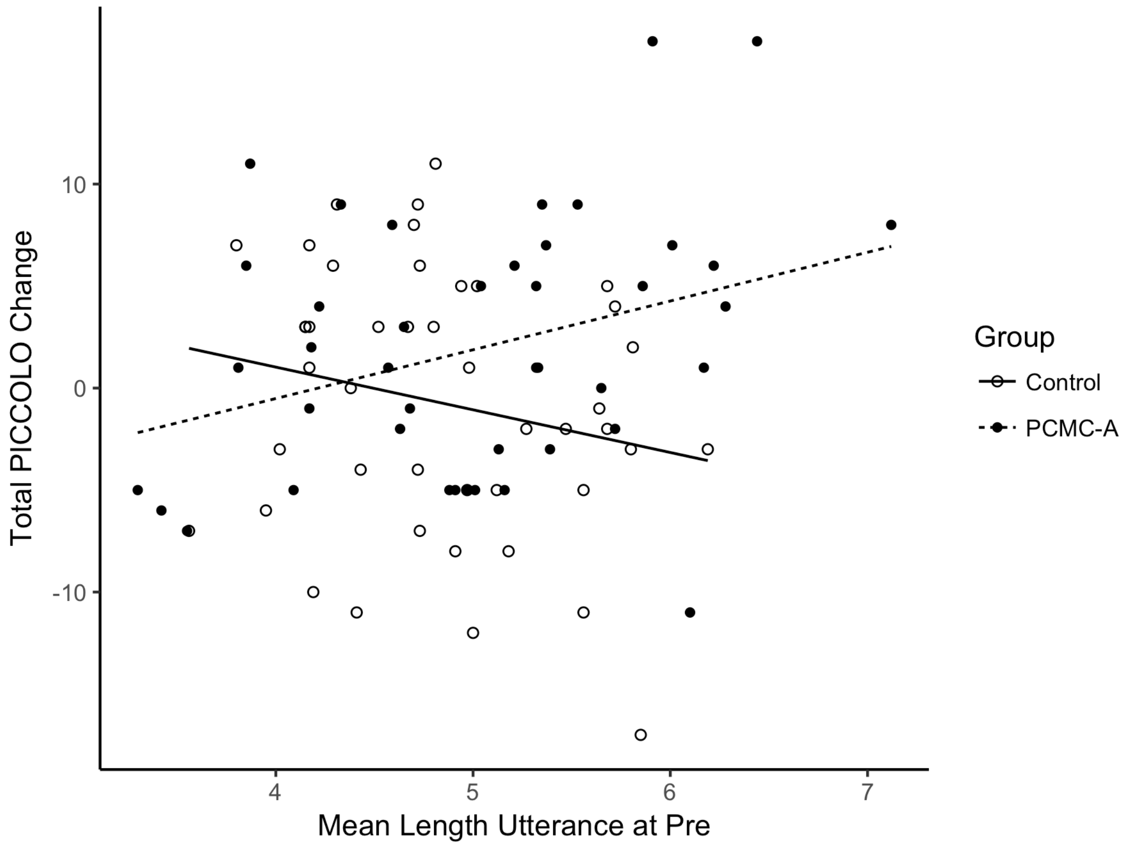

Figure 3.4. Relationship between maternal mean length of utterance (MLU) during the free-play task at pre-assessment and change in the PICCOLO Total score from pre- to post-assessment plotted separately for each group.

Child age also emerged as a moderator of change in the PICCOLO Total score. The model testing age as a moderator was significant, $F(3,82) = 2.96$, $p = .04$, with an R^2 of .10. As summarized in Table 3.8, there was a significant age by group interaction, $p = .03$. Including the interaction term contributed significantly to the model, $\Delta R^2 = .05$, $p = .03$. As shown in Figure 3.5, the relationship between age and change in the PICCOLO Total score differed significantly by group, but this relationship was not significantly different from zero for the Control group, $b = -3.39$, $t(42) = -1.89$, $p = .07$, or for the PCMC-A group, $b = 2.33$, $t(40) = 1.21$, $p = .24$. This pattern of results indicates that there was a significant difference between the PCMC-A and Control groups in the effect of age on change in the PICCOLO Total score, such that having an older child at the pre-assessment tended to be associated with more negative change for the Control group, but not for the PCMC-A group.

Table 3.8
Hierarchical Regression Model Testing Child Age as a Moderator of Change in the PICCOLO Total score

Variable	*B*	*SE*	*β*	*p*	ΔR^2	*F*	*p*
Step 1					.05	2.00	.14
(Constant)	-.80	.98		.42			
Group	2.82	1.42	.22	.05			
Age	-.75	1.34	-.06	.58			
Step 2					.05	4.69	.03
(Constant)	-1.03	.97		.29			
Group	2.77	1.39	.21	.05			
Age	-3.39	1.79	-.27	.06			
Group x Age	5.71	2.64	.31	.03			

Note. Group: Control coded as 0; PCMC-A coded as 1.

These same factors also emerged as significant moderators of change in the Encouragement domain. As summarized in Table 3.9, the interaction between group and behavior problems was a significant predictor of change in Encouragement, $\Delta R^2 = .05$, $p = .04$. As shown in Figure 3.6, the relationship between child behavior problems and change in Encouragement differed significantly by group, even though this relationship was not significantly different from zero for the Control group, $b = -.03$, $t(42) = -1.14$, $p = .26$, or for the PCMC-A group, $b = .05$, $t(37) = 1.75$, $p = .09$. This pattern of results indicates that there was a significant difference between the PCMC-A and Control groups in the effect of child behavior problems on change in the Encouragement domain, such that higher reports of child behavior problems at the pre-assessment tended to be associated with more change for the PCMC-A group, but not for the Control group.

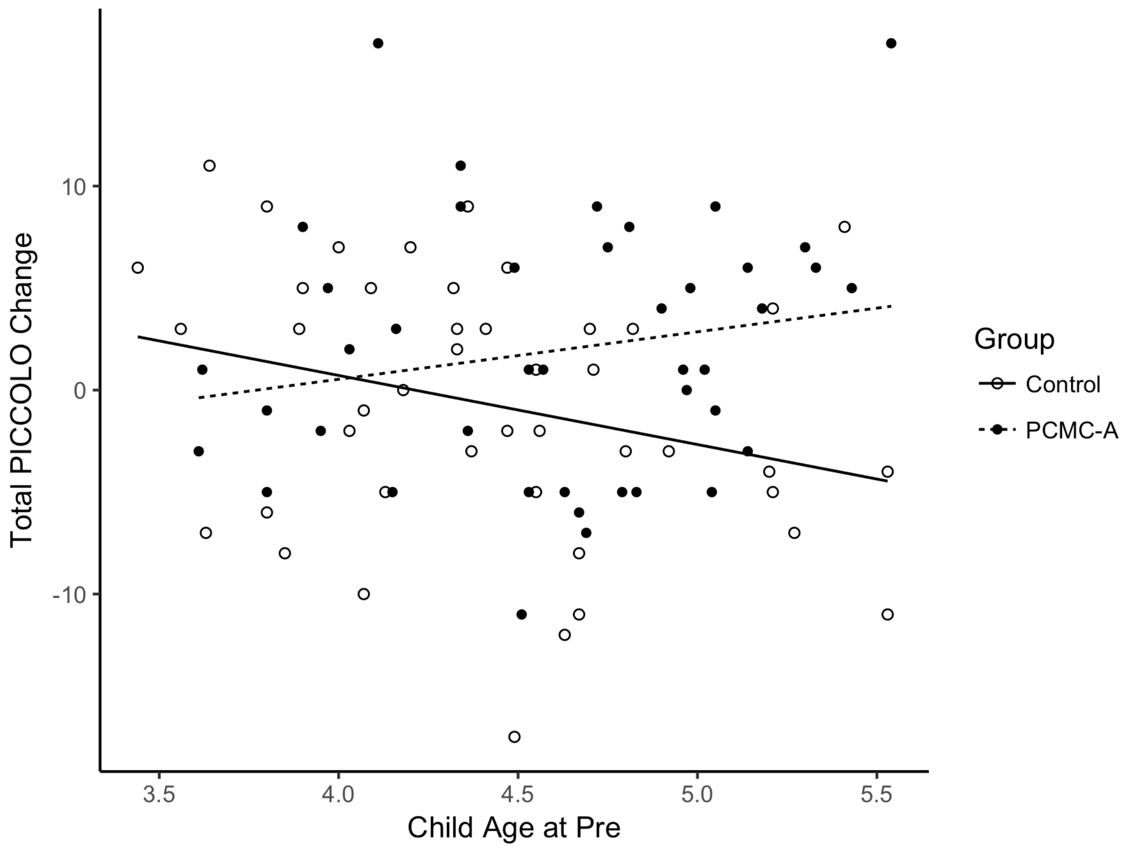

Figure 3.5. Relationship between child age at pre-assessment and change in the PICCOLO Total score from pre- to post-assessment plotted separately for each group.

Table 3.9

Hierarchical Regression Model Testing Behavior Problems as a Moderator of Change in the Encouragement Domain

Variable	*B*	*SE*	*β*	*p*	ΔR^2	*F*	*p*
Step 1					.05	2.22	.12
(Constant)	-.32	.35		.37			
Group	1.06	.51	.23	.04			
Behavior Problems	.01	.02	.03	.78			
Step 2					.05	4.22	.04
(Constant)	-.33	.34		.33			
Group	1.05	.50	.23	.04			
Behavior Problems	-.03	.03	-.17	.25			
Group x Behavior Problems	.08	.04	.30	.04			

Note. Group: Control coded as 0; PCMC-A coded as 1.

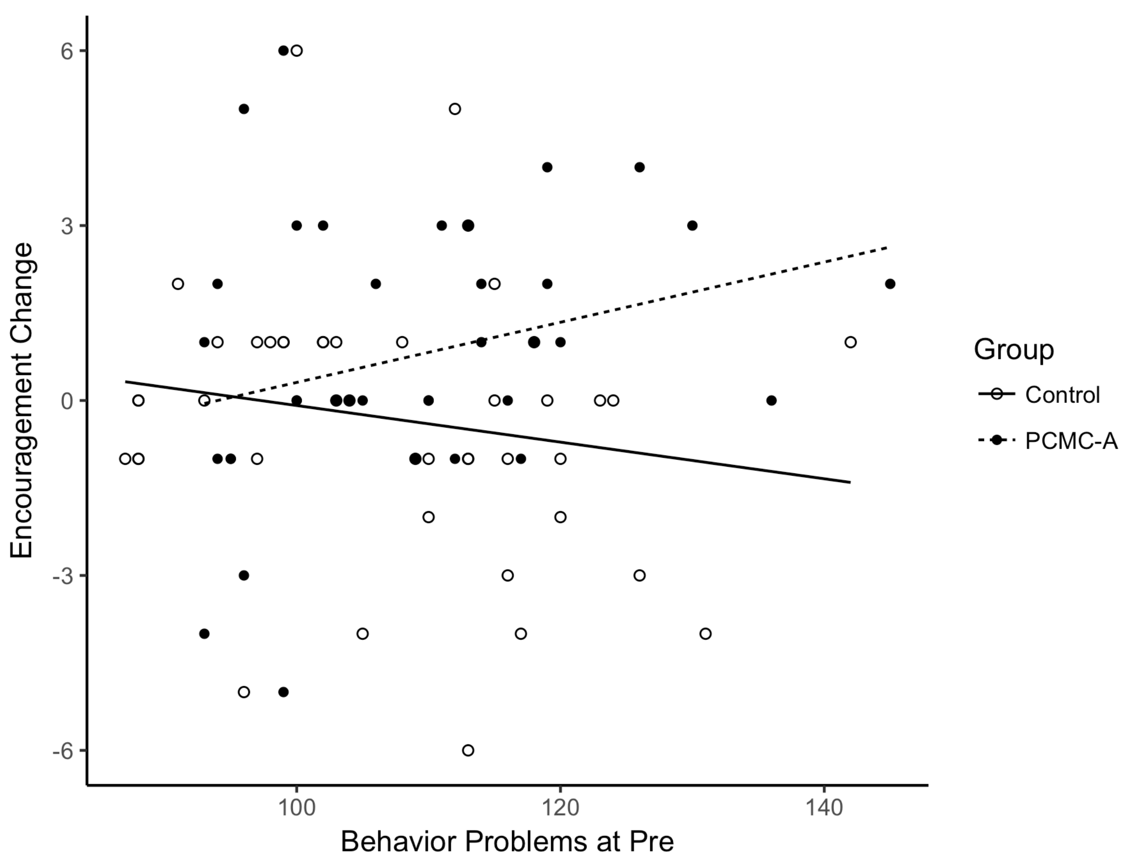

Figure 3.6. Relationship between child behavior problems at pre-assessment and change in the Encouragement domain score from pre- to post-assessment plotted separately for each group.

There was also a significant interaction between group and MLU, $\Delta R^2 = .07$, $p = .01$ (see Table 3.10). As shown in Figure 3.7, there was no relationship between MLU and change in Encouragement for the Control group, $b = -.93$, $t(42) = -1.74$, $p = .09$. However, this relationship was positive and significant for the PCMC-A group, $b = .81$, $t(40) = 2.10$, $p = .04$, indicating that for this group longer maternal MLU at the pre-assessment was associated with more change in Encouragement relative to shorter MLU.

Table 3.10

Hierarchical Regression Model Testing Maternal Mean Length of Utterance as a Moderator of Change in the Encouragement Domain

Variable	*B*	*SE*	*β*	*p*	ΔR^2	*F*	*p*
Step 1					.07	3.20	.05
(Constant)	-.30	.35		.39			
Group	1.19	.50	.25	.02			
Mean Length Utterance	.19	.33	.06	.56			
Step 2					.07	6.99	.01
(Constant)	-.41	.34		.24			
Group	1.23	.49	.26	.01			
Mean Length Utterance	-.93	.53	-.31	.08			
Group x Mean Length Utterance	1.74	.66	.46	.01			

Note. Group: Control coded as 0; PCMC-A coded as 1.

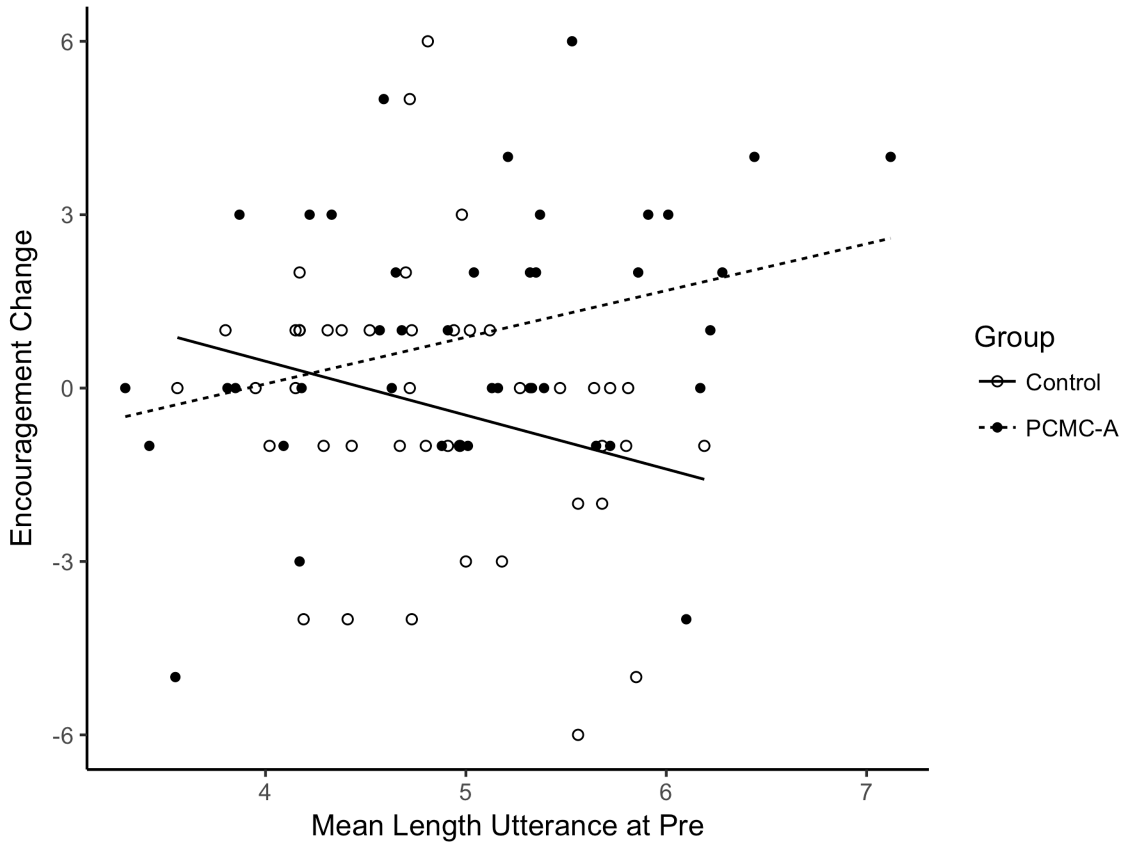

Figure 3.7. Relationship between maternal mean length of utterance (MLU) during the free-play task at pre-assessment and change in the Encouragement domain score from pre- to post-assessment plotted separately for each group.

The interaction between group and age was also a significant predictor of change in Encouragement, $\Delta R^2 = .09$, $p < .01$ (see Table 3.11). As shown in Figure 3.8, there was a significant negative relationship between age and change in Encouragement for the Control group, $b = -1.94$, $t(42) = -3.29$, $p < .01$, which was not significant for the PCMC-A group, $b = .72$, $t(40) = 1.03$, $p = .31$. These findings reveal that mothers in the Control group with older children at the pre-assessment had greater reductions in the Encouragement score from pre- to post-assessment, while age was not significantly related to change in Encouragement for mothers in the PCMC-A group.

Table 3.11

Hierarchical Regression Model Testing Age as a Moderator of Change in the Encouragement Domain

Variable	*B*	*SE*	*β*	*p*	ΔR^2	*F*	*p*
Step 1					.09	4.23	.02
(Constant)	-.38	.35		.27			
Group	1.36	.50	.29	.01			
Age	-.71	.47	-.16	.14			
Step 2					.09	8.57	< .01
(Constant)	-.49	.33		.14			
Group	1.33	.48	.28	.01			
Age	-1.94	.62	-.44	< .01			
Group x Age	2.66	.91	.40	< .01			

Note. Group: Control coded as 0; PCMC-A coded as 1.

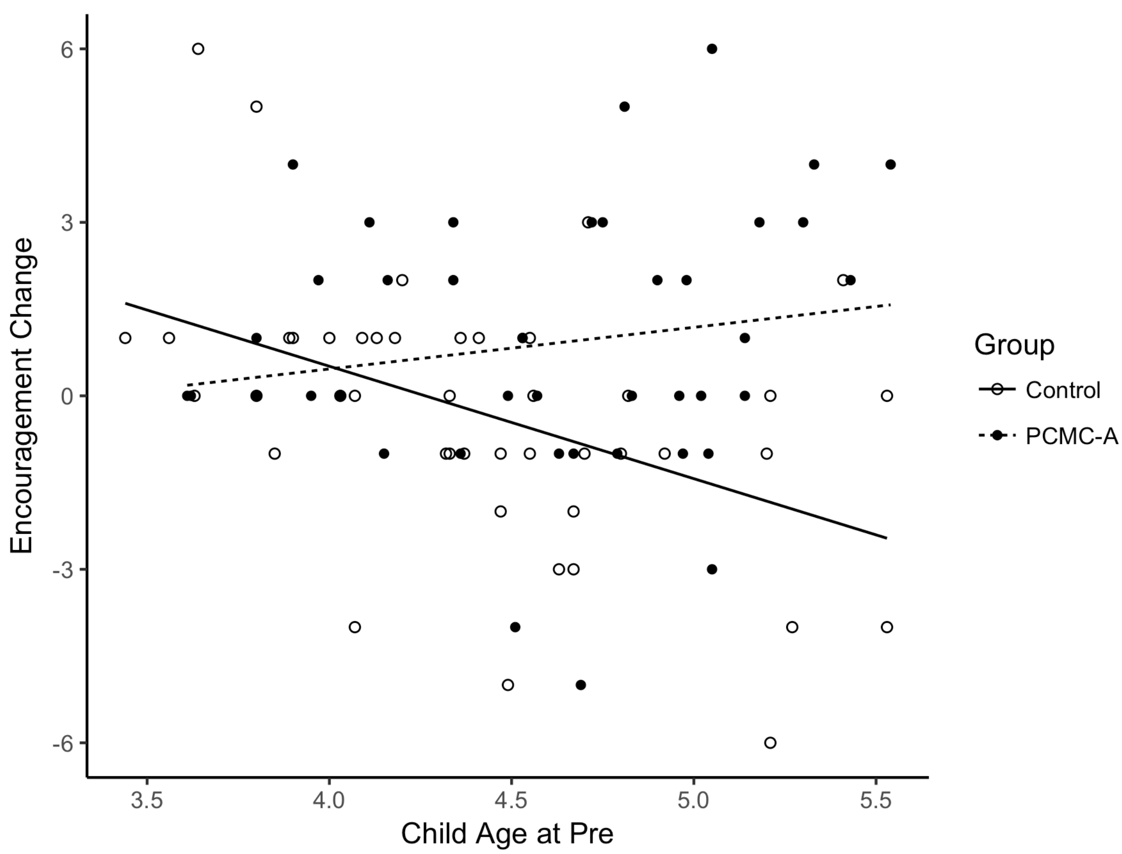

Figure 3.8. Relationship between child age at pre-assessment and change in the Encouragement domain score from pre- to post-assessment plotted separately for each group.

When examining change in the A Priori Composite, child behavior problems and MLU also emerged as significant moderators. The interaction between group and behavior problems was significant, $\Delta R^2 = .08$, $p < .01$ (see Table 3.12). Follow-up analyses revealed that the relationship between behavior problems and change in the A Priori Composite was not significant for the Control group, $b = -.03$, $t(42) = -.77$, $p = .45$, but it was significant for the PCMC-A group, $b = .10$, $t(37) = 3.34$, $p < .01$. These relationships are illustrated in Figure 3.9, which shows that mothers reporting higher levels of child behavior problems at the pre-assessment also showed more change in the A Priori Composite as a function of PCMC-A than mothers reporting lower baseline levels.

Table 3.12
Summary of Hierarchical Regression Testing Behavior Problems as a Moderator of Change in the A Priori Composite

Variable	*B*	*SE*	*β*	*p*	ΔR^2	*F*	*p*
Step 1					.04	1.83	.17
(Constant)	-.19	.42		.66			
Group	.87	.62	.15	.17			
Behavior Problems	.03	.03	.14	.22			
Step 2					.08	7.34	< .01
(Constant)	-.22	.41		.60			
Group	.85	.60	.15	.16			
Behavior Problems	-.03	.03	-.12	.40			
Group x Behavior Problems	.13	.05	.38	< .01			

Note. Group: Control coded as 0; PCMC-A coded as 1.

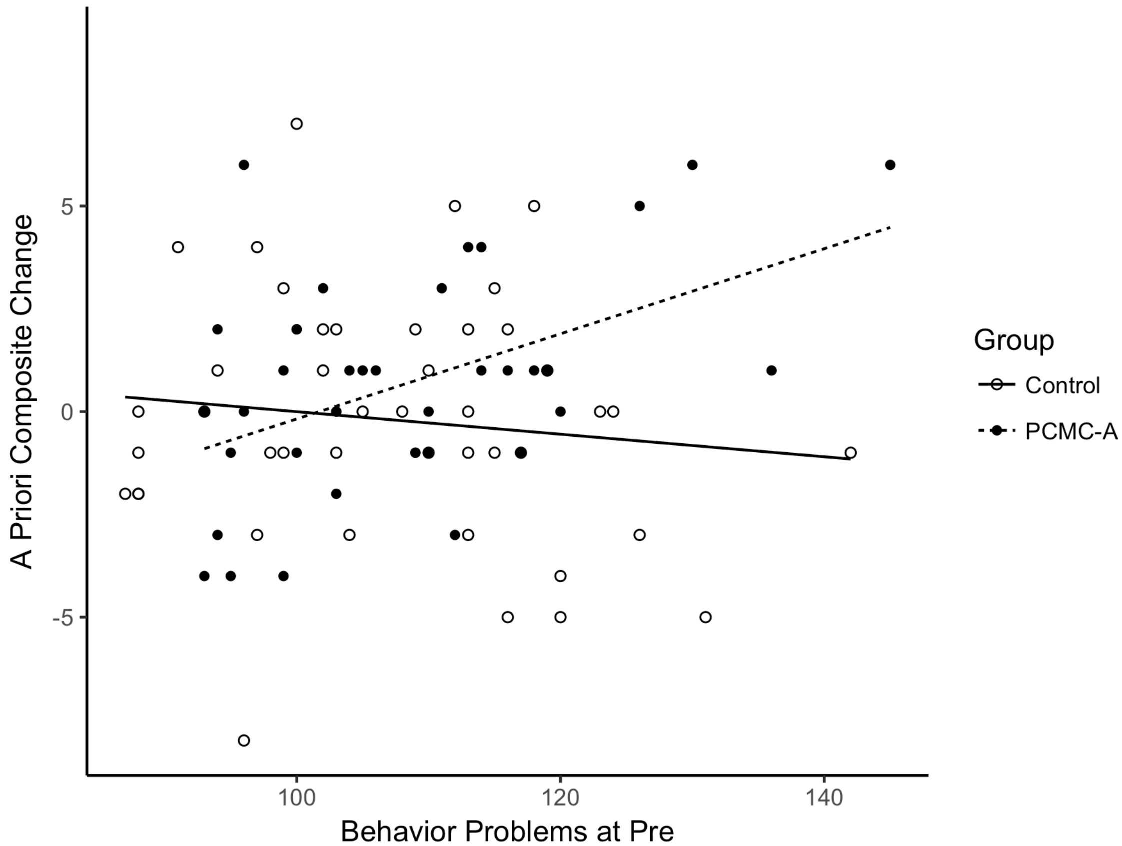

Figure 3.9. Relationship between child behavior problems at pre-assessment and change in the A Priori Composite score from pre- to post-assessment plotted separately for each group.

The interaction between group and maternal MLU was also a significant predictor of change in the A Priori Composite, $\Delta R^2 = .07$, $p = .02$ (see Table 3.13). As shown in Figure 3.10, the relationship between maternal MLU and change in the A Priori Composite was not significant for the Control group, $b = -1.08$, $t(42) = -1.54$, $p = .13$, but it was positive and significant for the PCMC-A group, $b = 1.03$, $t(40) = 2.07$, $p = .045$. As was documented for the PICCOLO Total score and the Encouragement domain, mothers with longer MLU at baseline showed more change on the A Priori Composite as a function of PCMC-A than mothers with shorter MLU.

Table 3.13

Hierarchical Regression Model Testing Maternal Mean Length of Utterance as a Moderator of Change in the A Priori Composite

Variable	*B*	*SE*	*β*	*p*	ΔR^2	*F*	*p*
Step 1					.05	2.14	.13
(Constant)	-.18	.45		.69			
Group	1.20	.65	.20	.07			
Mean Length Utterance	.29	.42	.07	.50			
Step 2					.07	6.11	.02
(Constant)	-.31	.44		.50			
Group	1.25	.63	.21	.05			
Mean Length Utterance	-1.08	.69	-.28	.12			
Group x Mean Length Utterance	2.11	.85	.43	.02			

Note. Group: Control coded as 0; PCMC-A coded as 1.

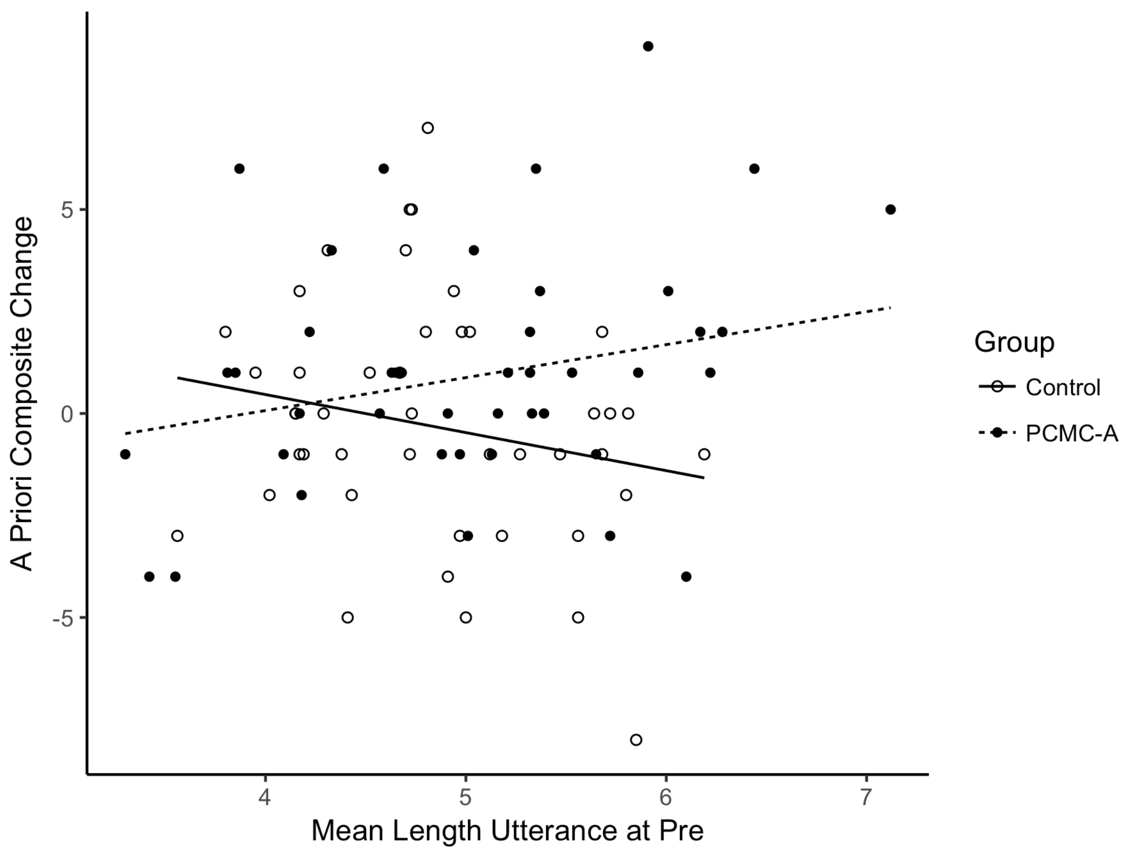

Figure 3.10. Relationship between maternal mean length of utterance (MLU) at pre-assessment and change in the A Priori Composite score from pre- to post-assessment plotted separately for each group.

As summarized in Table 3.14, the model testing age as a moderator of change in the A Priori Composite was significant, $F(3,82) = 3.22$, $p = .03$, with a significant effect of group, $p = .03$, and a significant main effect of age, $p = .02$. However, in this case the age by group interaction was not significant, $b = 2.10$, $p = .09$, indicating that age did not moderate the effect of PCMC-A on change in this composite (see Figure 3.11).

Table 3.14
Hierarchical Regression Mode Testing Child Age as a Moderator of Change in the A Priori Composite

Variable	*B*	*SE*	*β*	*p*	ΔR^2	*F*	*p*
Step 1					.07	3.24	.04
(Constant)	-.29	.45		.51			
Group	1.43	.64	.24	.03			
Age	-.98	.61	-.17	.11			
Step 2					.03	3.02	.09
(Constant)	-.38	.44		.39			
Group	1.41	.64	.24	.03			
Age	-1.95	.82	-.34	.02			
Group x Age	2.10	1.21	.25	.09			

Note. Group: Control coded as 0; PCMC-A coded as 1.

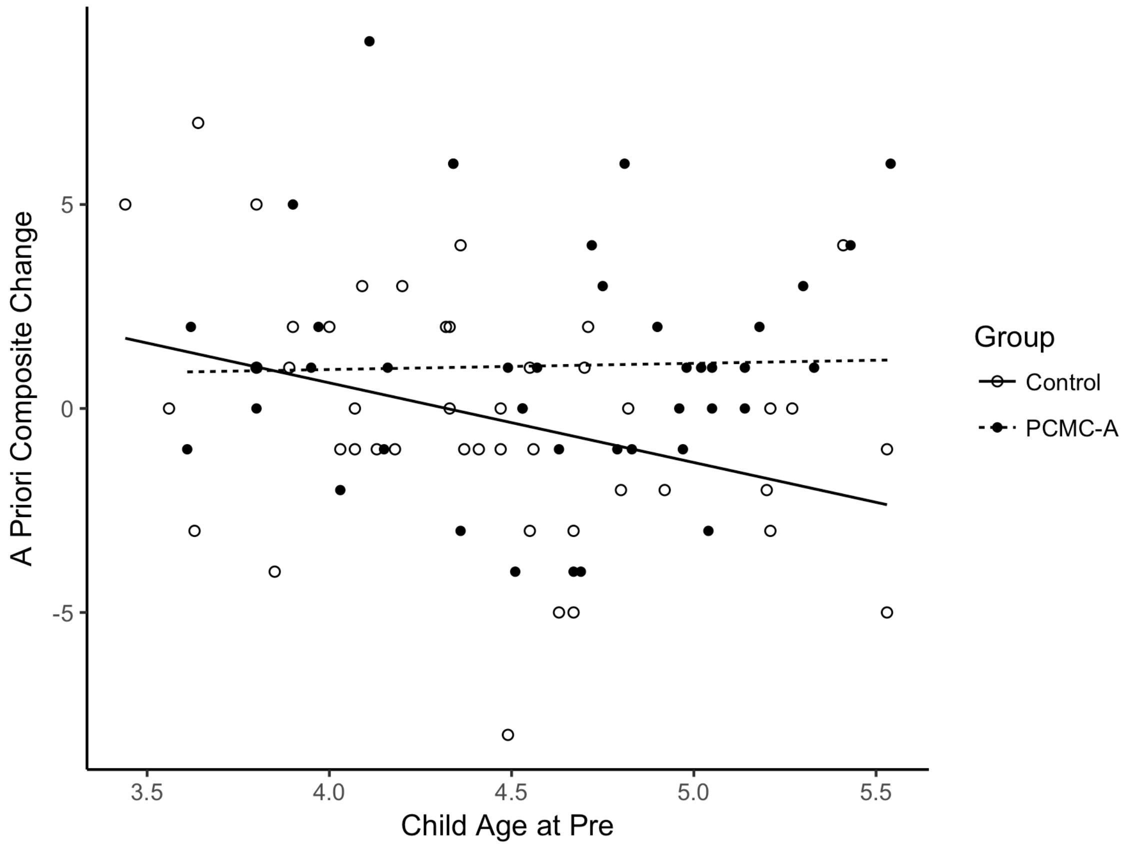

Figure 3.11. Relationship between child age at pre-assessment and change in the A Priori Composite score from pre- to post-assessment plotted separately for each group.

The other child and mother characteristics examined as moderators of change in the PICCOLO Total score, the Encouragement domain, and the A Priori Composite were family SES and maternal education, child sex, non-verbal IQ, and social skills, maternal sense of parenting ability and confidence, and parenting stress. The R-squared change test for the interaction between group and all of these other moderator variables was not significant (all *p*s > .10), indicating that these factors did not significantly moderate the effect of PCMC-A on change from pre- to post-assessment in these PICCOLO outcomes.

Summary of Findings. Of the child and mother characteristics examined, three emerged as moderators of change of the effect of PCMC-A on the PICCOLO outcomes that showed malleability to the intervention. Mother reports of child behavior problems and maternal mean length of utterance during the mother-child interaction at the pre-assessment moderated intervention-related changes in the PICCOLO Total score, the Encouragement domain score, and the A Priori Composite score. For each PICCOLO outcome, higher reports of child behavior problems and longer maternal MLU observed at the pre-assessment for the PCMC-A group were associated with more change from pre- to post-assessment relative to lower baseline levels. Child age was identified as a moderator of change in the PICCOLO Total score and the Encouragement domain score. In this case, having an older child at the pre-assessment was associated with more negative change relative to having a younger child for the Control group, but not for the PCMC-A group, and there was a significant difference between the groups in the effect of age on change. Child age did not moderate the effect of PCMC-A on change in the A Priori Composite. Evidence of moderation was not found for the other child and mother characteristics tested as potential moderators for any of the PICCOLO outcomes examined.

CHAPTER IV

CHANGES IN SUPPORTIVE PARENTING AS PREDICTORS OF THE EFFECT OF PCMC-A ON CHILD BRAIN FUNCTION FOR SELECTIVE ATTENTION

This work is in preparation to be submitted for publication with co-authors. I designed the studies and wrote the manuscript, with my co-authors, A. Hampton Wray, E. Pakulak, and H. J. Neville providing feedback and editorial assistance.

Current Study

The main aim of the present study was to determine whether changes in supportive parenting behaviors were associated with intervention-related changes in a neural index of auditory selective attention in children. PCMC-A, which includes parenting training and child attention training components, has been shown to lead to gains in this neural index of selective attention. Importantly, these improvements were not observed in an active control group with a focus on child training nor in a control group receiving services as usual (Neville et al., 2013). This evidence indicates that parenting training contributed to gains in selective attention over and above child training, suggesting that changes in parents elicited by the parenting training might help explain these gains.

To address this aim, we first tested the hypothesis that participation in PCMC-A would lead to improvements in child brain function for selective attention relative to children assigned to a Control group receiving services as usual, as was previously documented with a smaller sample (Neville et al., 2013). As described in detail in Chapter II, we assessed brain function for selective attention by recording ERPs during a child-friendly dichotic listening task, which has been previously validated with preschoolers from lower SES backgrounds (Hampton Wray et al., in press; Isbell et al., 2016; Neville at al., 2013). In line with pervious findings on the effect of PCMC-A on this neural index (Neville et al., 2013), we hypothesized that the effect of PCMC-A would be specific to the signal enhancement component of selective attention, indexed by increases in amplitude of the neural response to attended information over the intervention period. Next, we evaluated whether changes in supportive parenting as a function of PCMC-A were associated with intervention-related changes in this neural index of selective attention. Based on the prior evidence from the RCT of PCMC-A discussed above (Neville et al., 2013), we hypothesized that increases in supportive parenting behaviors in the PCMC-A group would predict intervention-related improvements in child brain function for selective attention.

Sample

The sample for the studies presented in Chapter IV and Chapter V was restricted to dyads from the full sample (described in Chapter II) for which the child had acceptable ERP data quality for the auditory selective attention task at both pre- and post-assessment, as this was the main outcome of interest for both studies. Acceptable ERP data quality was operationalized as low EEG artifacts and no fewer than 75 trials per condition. At the post-assessment, 11 of the 86 child participants did not have acceptable ERP data quality, so they were not included in this sample. One participant only completed three out of four stories for the selective attention task. As a result, this participant had fewer trials overall and an imbalanced number of presentations to each ear, therefore this participant was also excluded. Furthermore, four participants had accuracy below 50% for the comprehension questions during the selective attention task at post-assessment, so they were also excluded from the sample for meeting this exclusion criterion. This resulted in a sample of 70 dyads, of which 35 had been randomly assigned to the Control group receiving Head Start services as usual and 35 to the PCMC-A group. As shown in Table 4.1, this subsample was also matched across groups for age, sex distribution, SES, maternal education, and non-verbal IQ. Furthermore, there were no significant differences on any of these variables between children who were included in the sample and those who were excluded for the reasons detailed above (all *p*s > .10).

Table 4.1
Descriptive Statistics by Group for Subsample

	Group			
	PCMC-A (n = 35)		Control (n = 35)	
	n	Mean (SD)	n	Mean (SD)
% Females	35	69%	35	57%
Age	35	4.59 (.55)	35	4.46 (.52)
SES	33	31.12 (12.38)	33	30.38 (11.32)
Maternal Education	34	4.50 (1.11)	34	4.88 (1.01)
Non-Verbal IQ	35	11.82 (1.93)	35	12.50 (1.74)

Note. Significant group differences are bolded ($p < .05$).

Effect of PCMC-A on Child Brain Function for Selective Attention

Analytical Strategy. Following previous studies employing this paradigm with preschoolers from lower SES backgrounds (e.g. Hampton Wray et al., in press; Isbell et al., 2016; Neville et al., 2013), ERP analyses focused on the mean amplitude relative to baseline between 100 and 200 ms post-stimulus onset, collapsing across linguistic and non-linguistic probes. As shown in figure 4.1, three electrode aggregates were created to assess distributional differences in the modulation of attention across the scalp for anterior (F7/8, F3/4, FT7/8, FC5/6), central (T7/8, C5/6, C3/4, CP5/6), and posterior (P3/4, P7/8, PO3/4, O1/2) electrode sites.

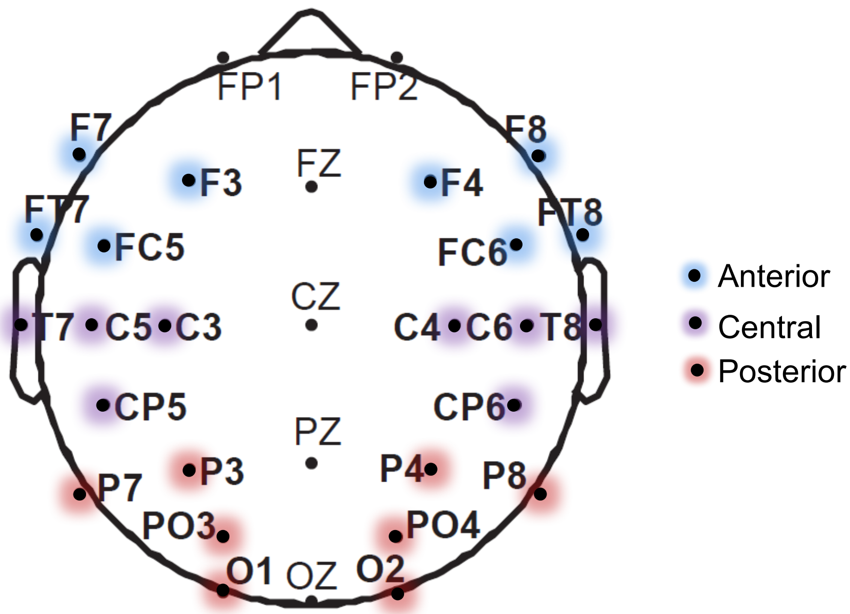

Figure 4.1. Electrode configuration for ERP recordings. Electrode sites included in analyses are highlighted, with color denoting the channels included in each electrode aggregate: anterior, central, and posterior.

To examine the effect of PCMC-A on brain function for selective attention, we performed a repeated-measures ANOVA with time of assessment (pre/post), condition (attended/unattended), and anteriority (anterior/central/posterior) as within-subject factors, and group (PCMC-A/Control) as the between-subjects factor. This omnibus ANOVA was followed up with step-down analyses to isolate significant interactions, collapsing across factors for which interactions were not observed. To test our hypothesis that the effect of PCMC-A would be driven by improvements in the signal enhancement component of selective attention, we performed separate a priori repeated-measures ANOVAs for the attended and unattended conditions, including time of assessment (pre/post) as the within-subjects factor and group (PCMC-A/Control) as the between-subjects factor. Alpha was set at $p < .05$. Greenhouse-Geisser corrected p-values, but uncorrected degrees of freedom, are reported for factors with more than two levels. For all ANOVA effects, partial-eta squared (η_p^2) is reported as a measure of effect size.

Results. Analyses of the change in ERP responses elicited by the selective attention task from pre- to post-assessment as a function of group revealed a significant three-way interaction of Time X Condition X Group, $F(1,68) = 4.75$, $p = .03$, $\eta_p^2 = .07$, with no differences in distribution across the scalp (Time X Condition X Anteriority X Group: $F(2,67) = .23$, $p = .70$, $\eta_p^2 = .003$). To unpack this interaction, step-down analyses were conducted for each group separately, collapsing across the anteriority factor indexing scalp distribution. These analyses revealed that the PCMC-A group showed a significant amplitude difference between the ERPs elicited by attended vs. unattended stimuli as a function of time of assessment (Time X Condition: $F(1,34) = 8.85$, $p < .01$, $\eta_p^2 = .21$). This interaction was not significant for the Control group, (Time X Condition: $F(1,34) = .02$, $p = .89$, $\eta_p^2 = .001$), and neither were the main effects of Time, $F(1,34) = 1.48$, $p = .23$, $\eta_p^2 = .04$, or Condition, $F(1,34) = 1.00$, $p = .33$, $\eta_p^2 = .03$.

Follow up step-down analyses were conducted for each group to determine if there was an attention effect, indexed by a significant amplitude difference between the EPRs elicited by the attended vs. unattended conditions, at each time of assessment. At the pre-assessment, there was no significant attention effect for the Control group,

$F(1,34) = .60$, $p = .45$, $\eta_p^2 = .02$, or the PCMC-A group, $F(1,34) = .22$, $p = .64$, $\eta_p^2 = .01$. A between-group comparison at pre-assessment confirmed that both groups exhibited comparable neural responses at baseline (Group: $F(1,68) = 1.09$, $p = .30$, $\eta_p^2 = .02$; Group X Condition: $F(1,68) = .78$, $p = .38$, $\eta_p^2 = .01$). However, by the post-assessment the PCMC-A group exhibited a significant attention effect, with more positive responses elicited by the attended condition compared to the unattended condition, (Condition: $F(1,34) = 16.69$, $p < .001$, $\eta_p^2 = .33$). Such an attention effect was not observed at the post-assessment for the Control group (Condition: $F(1,34) = .42$, $p = .52$, $\eta_p^2 = .01$). This difference between groups was confirmed by a significant Group X Condition interaction at post-assessment, $F(1,68) = 5.23$, $p = .03$, $\eta_p^2 = .07$.

This pattern of results can be seen in Figure 4.2, which shows the ERPs for each time of assessment plotted by group for a representative frontocentral electrode site (FC5). Additionally, Figure 4.3 shows topographical maps illustrating the distribution of the attention effect across the scalp by time of assessment and group. Plots of the grand averaged ERP waveforms showing all electrodes included in the analyses for each time of assessment by group can be found in Appendix A.

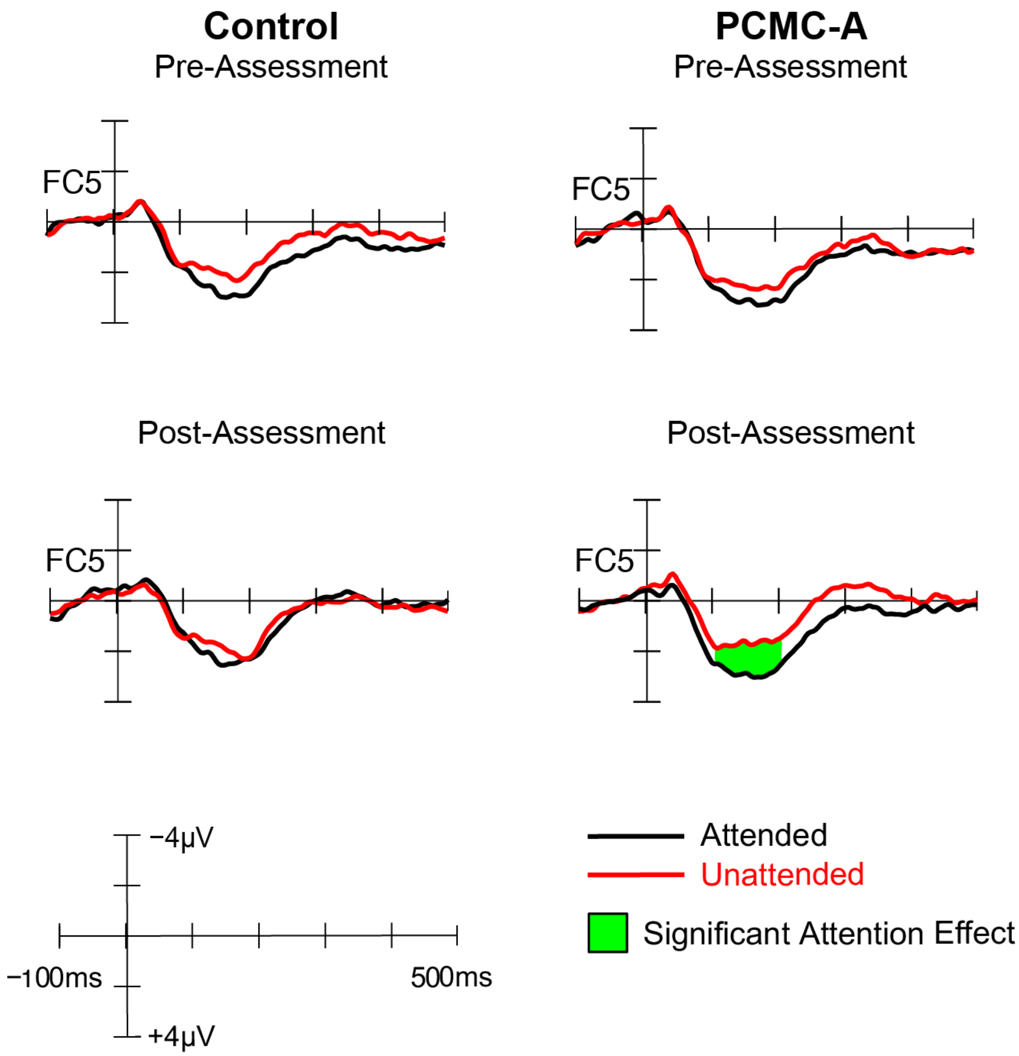

Figure 4.2. Grand averaged waveforms showing the ERP response elicited by the attended (black) and the unattended (red) conditions for a representative frontocentral electrode site at each time of assessment by group. At the pre-assessment, neither group showed an attention effect. By the post-assessment, the PCMC group showed a significant attention effect (illustrated in green), which was not observed for the Control group. Negative is plotted upwards.

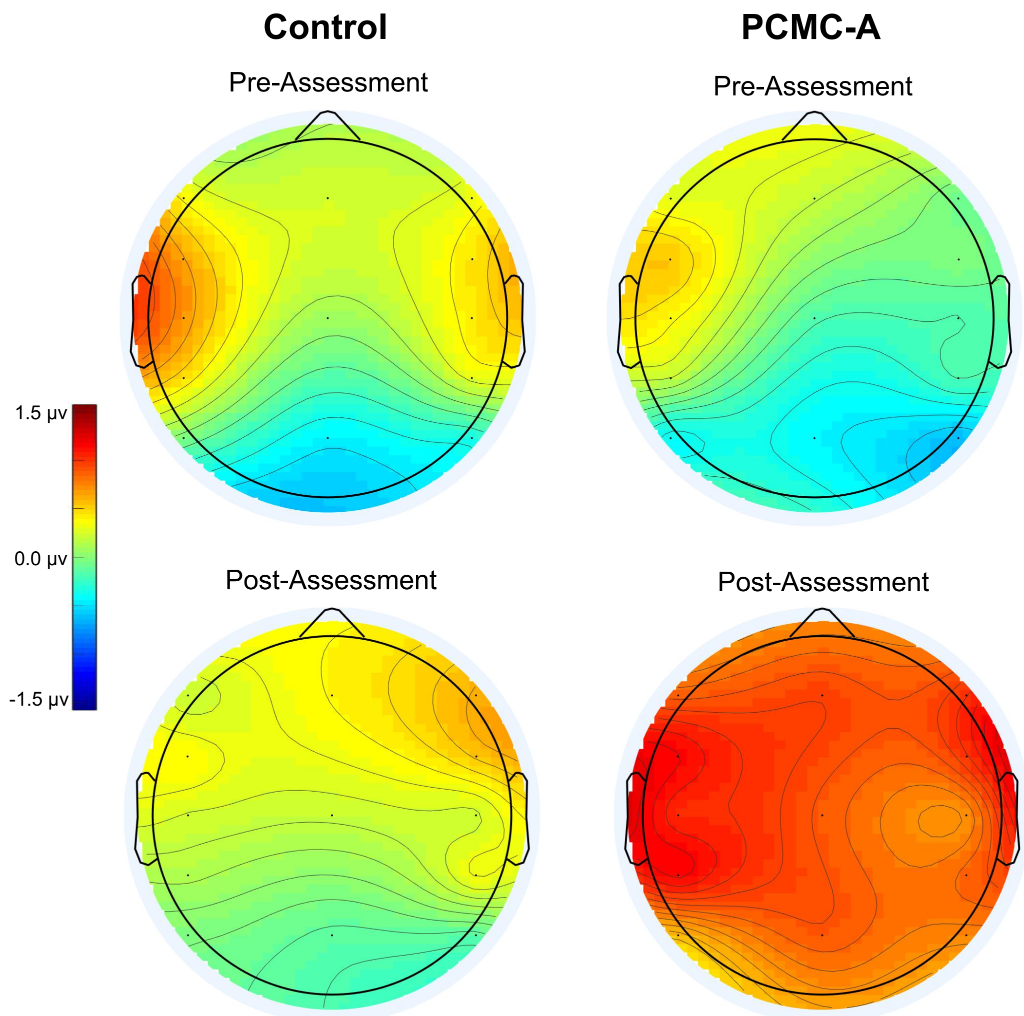

Figure 4.3. Topographical maps showing the distribution of the attention effect (attended minus unattended) across the scalp during the 100-200 ms time window at each time of assessment by group. Color scale ranges from -1.5 to 1.5 microvolts, with warmer colors indicating a more positive attention effect. Neither group showed a significant attention effect at the pre-assessment. At the post-assessment, a significant attention effect distributed across the scalp was observed for the PCMC-A group, but not for the Control group.

Next, we tested our hypothesis that changes in the attention effect over time would be driven by improvements in the signal enhancement component of selective attention. These analyses revealed significant differences in amplitude from pre- to post-assessment as a function of group for ERPs elicited by the attended condition (Time X Group: $F(1,68) = 5.27$, $p = .03$, $\eta_p^2 = .07$), but not for ERPs elicited by the unattended condition, (Time X Group: $F(1,68) = .18$, $p = .67$, $\eta_p^2 = .003$). These interactions were followed up by step-down analyses to test whether change over time differed between the attended and unattended conditions for each group. For the PCMC-A group, ERPs elicited by the attended condition showed a significant increase from pre- to post-assessment (Time: $F(1,34) = 6.50$, $p = .02$, $\eta_p^2 = .16$), but no change over time was observed for the unattended condition (Time: $F(1,34) = 2.47$, $p = .13$, $\eta_p^2 = .07$). No differences were observed for the Control group from pre- to post-assessment for the attended condition (Time: $F(1,34) = 1.08$, $p = .31$, $\eta_p^2 = .03$) or the unattended condition (Time: $F(1,34) = .92$, $p = .34$, $\eta_p^2 = .03$). As can be seen in Figure 4.4, these findings indicate that the development of the attention effect observed for the PCMC-A group was specific to increases in amplitude for ERPs elicited by the attended condition over the intervention period.

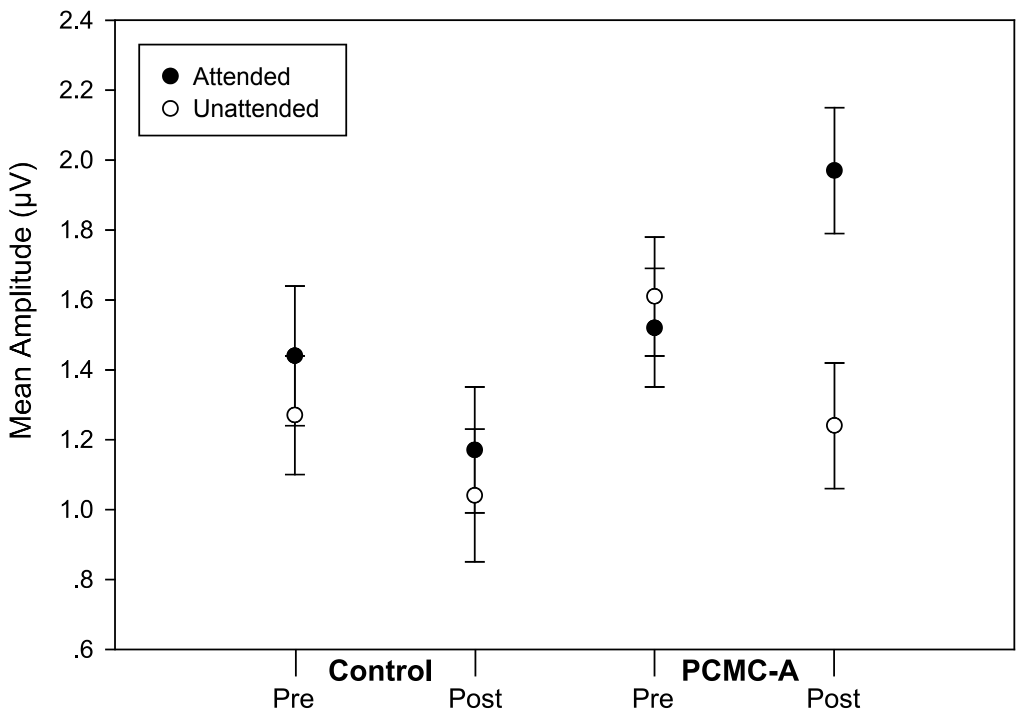

Figure 4.4. ERP mean amplitudes in microvolts for each condition (attended vs. unattended) at both times of assessment, plotted separately by group. Error bars represent +/– 1 SE. The only significant difference between the attended and the unattended conditions was observed at the post-assessment for the PCMC-A group. For this group, the amplitude of ERPs to the attended condition increased significantly from pre- to post-assessment. No changes were observed for the unattended condition.

Effect of Intervention-Related Changes in Supportive Parenting Behaviors on Changes in Child Brain Function for Selective Attention

Analytical Strategy. Analyses examining changes in supportive parenting as a predictor of changes in selective attention from pre- to post-assessment collapsed across the three levels of anteriority, given that we did not find interactions with scalp distribution in the omnibus ANOVA described above. The dependent variable for these analyses was the change in the attention effect from pre- to post-assessment, which was calculated as the difference between the ERP elicited by the attended condition and the ERP elicited by the unattended condition (attended – unattended) across the 24 channels comprising the anterior, central, and posterior electrode aggregates. The electrodes included in these analyses are illustrated in Figure 4.1, above.

Two participants, one in the PCMC-A group and one in the Control group, had attention effects that were more than 3.5 standard deviations below the grand mean for the posterior aggregate at pre-assessment and at post-assessment, respectively. These were considered outlier values, so they were winsorized by replacing the outlier value with the next most extreme value that was not considered an outlier (Hawkins, 1980). A 24-channel aggregate consisting of the average of the anterior aggregate, the central aggregate, and the winsorized posterior aggregate was created for each condition (attended and unattended) at each time of assessment (pre and post). The change in the attention effect was calculated by subtracting the attention effect at pre-assessment from the attention effect at post-assessment (post-assessment – pre-assessment), resulting in a 24-channel aggregate representing change in the attention effect from pre- to post-assessment. This aggregate contained no outlier values, operationalized as values more than 3.5 standard deviations away from the mean in either direction, and was used as the dependent measure for all subsequent analyses.

We conducted hierarchical regression analyses to examine whether changes in the PICCOLO Total score, the individual domain scores, and the A Priori Composite score predicted change in the attention effect. Group and change in the PICCOLO score from pre- to post-assessment (grand mean centered) were entered at the first step, and the interaction between these two factors was entered at the second step. We hypothesized that change in the PICCOLO scores would be associated with change in the attention effect for the PCMC-A group, indicated by a significant R-squared change for the step including the interaction term.

Results. As summarized in Table 4.2, the R-squared change test was not significant for any of the interaction terms between group and change in the PICCOLO scores. Furthermore, a main effect of change in the PICCOLO score was not observed in any of the models tested, with all *p*s > .10. These results indicate that change in the PICCOLO scores was not a significant predictor of change in the attention effect, and that this relationship did not differ by group.

Table 4.2
Summary of R-Squared Change Tests for Interaction Terms Predicting Change in the Attention Effect

Interaction Term	*B*	*SE*	ΔR^2	*F*	*p*
Group x Δ PICCOLO Total	-.04	.06	.01	.33	.57
Group x Δ Encouragement	.02	.18	.00	.01	.94
Group x Δ Affection	.28	.20	.03	1.96	.17
Group x Δ Responsiveness	-.16	.17	.01	.90	.35
Group x Δ Teaching	-.24	.16	.03	2.12	.15
Group x Δ A Priori Composite	-.13	.14	.01	.97	.33

Note. Group: Control coded as 0; PCMC-A coded as 1.

Summary of Findings

As has been previously documented with a smaller sample (Neville et al., 2013), we found a significant effect of PCMC-A on child brain function for selective attention. Neither group showed an attention effect at the pre-assessment, characterized as a larger ERP response elicited by the probes embedded in the attended story relative to the one elicited by the probes embedded in the unattended story. However, by the post-assessment, the PCMC-A group showed a significant attention effect that could be detected across the scalp, which was not observed for the Control group. This effect was driven by increases in ERPs to the attended condition from pre- to post-assessment, suggesting intervention-related improvements in the signal enhancement component of selective attention. However, we did not find support for the hypothesis that changes in the PICCOLO scores as a function of PCMC-A would predict intervention-related changes in the attention effect.

CHAPTER V

CHANGE IN SUPPORTIVE PARENTING AS A MEDIATOR OF INTERVENTION-RELATED CHANGES IN CHILD BRAIN FUNCTION FOR SELECTIVE ATTENTION AND MODERATORS OF CHANGE

This work is in preparation to be submitted for publication with co-authors. I designed the studies and wrote the manuscript, with my co-authors, A. Hampton Wray, E. Pakulak, and H. J. Neville providing feedback and editorial assistance.

Current Study

In Chapter III, we found an effect of PCMC-A on a subset of supportive parenting behaviors, and identified child and mother characteristics that moderated those intervention-related changes. In Chapter IV, we found an effect of PCMC-A on child brain function for selective attention, but did not find evidence indicating that those gains were explained by changes in supportive parenting. The original aim of the present study was to examine whether changes in supportive parenting mediate the effect of PCMC-A on child brain function for selective attention. One of the necessary steps to test for mediation is to first establish that a relationship exists between the mediator and the dependent variable (Baron & Kenny, 1986). Given that we did not find a relationship between changes in supportive parenting behaviors and changes in brain function for selective attention, we did not have evidence for this prerequisite. For this reason, we were not able to test the mediation model proposed.

Instead, we conducted supplementary exploratory analyses to determine whether the level of supportive parenting mothers exhibited at the pre-assessment moderated the impact of PCMC-A on the attention effect. We predicted that supportive parenting at the pre-assessment would moderate intervention-related changes in child brain function for selective attention, but had competing hypotheses regarding the directionality of the moderating effect. Given the positive relationship between supportive parenting and the development of cognitive abilities related to selective attention (for a review, see Fay-Stammbach et al., 2014), we hypothesized that children of mothers exhibiting higher baseline levels of supportive parenting would benefit less from PCMC-A because they would start the program with better selective attention, leaving less room for growth. On the other hand, we hypothesized that such children would benefit more from PCMC-A because the effect of the intervention would be enhanced in the presence of supportive parenting.

Additionally, with the goal of further understanding the profile of children who showed intervention-related changes in the attention effect, we tested the child and mother characteristics examined in Chapter III as moderators of change in child brain function for selective attention. The characteristics examined were family SES, maternal education, child non-verbal IQ, child age, mother reports of child behavior problems and social skills, parenting stress, mother's perceived sense of parenting ability and confidence, and mother-child interactive language use as indexed by maternal MLU. We did not examine child sex as a moderator of intervention-related changes in brain function for selective attention because we did not have a clear rationale for doing so given the lack of studies directly examining variations in this neural index of selective attention as a function of child sex.

Prior studies have documented deficits in the same neural index of selective attention in children from lower SES backgrounds as determined by the Hollingshead

Index (Hampton Wray et al., in press), children of mothers with lower educational attainment (Stevens et al., 2009), and children with lower non-verbal IQ scores (Isbell et al., 2016), as well as in Head Start preschoolers when they are younger relative to when they are older (Hampton Wray et al., in press). Based on this evidence, we hypothesized that child non-verbal IQ scores, maternal education, family SES, and child age would moderate the effect of PCMC-A on selective attention, such that children lower on the continuum of these characteristics would show greater intervention-related gains because they would have more room for growth.

Given that child behavior problems have been negatively associated with aspects of selective attention and self-regulation (Calkins & Fox, 2002), we hypothesized that variations in mother reports of child behavior problems would moderate intervention-related changes in selective attention, with competing hypotheses regarding the directionality of the moderating effect. On the one hand, we hypothesized that children with higher levels of behavior problems at baseline would show greater gains in selective attention because they would have more room for improvement. On the other hand, we predicted that these children would show lower gains because they might require additional services to address their behavior problems in order to be able to benefit from PCMC-A. We also anticipated that mother reports of child social skills would moderate the effect of PCMC-A on this outcome because higher levels of social skills have been positively associated with aspects of school readiness related to selective attention (McClelland, Morrison, & Holmes, 2000; for a review, see Raver, 2003). We predicted that children with higher social skills at baseline would benefit less from PCMC-A because they would have less room for improvement. Alternatively, we hypothesized that these children might benefit more because they would be better equipped to be receptive to the child attention training, which is delivered in group format and entails interaction with peers.

We also hypothesized that parenting stress, perceived sense of parenting ability and confidence, and mother-child interactive language use (indexed by maternal MLU) would moderate the effect of PCMC-A on selective attention because these parenting characteristics have been associated with supportive parenting (e.g. Anthony et al., 2005; Deater-Deckard, 1998; Hoff, 2006; Morawska & Sanders, 2007; Raikes & Thompson, 2005), which in turn has been associated with selective attention development (Fay-Stammbach et al., 2014). Consistent with our hypotheses for the moderating effects of baseline levels of supportive parenting, we anticipated that children of mothers showing levels on these characteristics that promote supportive parenting (i.e. lower parenting stress, higher sense of parenting ability and confidence, and higher interactive language use) would either benefit less from PCMC-A because they would have less room for growth, or would benefit more because their mothers would be better equipped to implement the intervention strategies, thus boosting their selective attention development.

Supportive Parenting as a Moderator of Intervention-Related Changes in Child Brain Function for Selective Attention

Analytical Strategy. The sample used in the present study was identical to the sample used in Chapter IV. To determine whether supportive parenting at the pre-assessment moderated intervention-related changes in brain function for selective attention, we conducted hierarchical regression models predicting change in the attention effect from pre- to post-assessment. Group and the moderator were entered as predictors at step one, and the interaction between the two was entered at step two. The pre-assessment scores for the PICCOLO Total score, the four individual domains, and the PICCOLO A Priori Composite were tested as moderators of change in the attention effect from pre- to post-assessment. Results are reported for the model including all predictors. As shown in Table 5.1, there were no significant differences between groups on any of the PICCOLO scores at the pre-assessment.

Table 5.1
Pre-Assessment PICCOLO Scores by Group

	Group	
	PCMC-A (n = 35)	Control (n = 35)
	Mean (SD)	Mean (SD)
PICCOLO Total score	44.23 (6.83)	45.80 (5.53)
Encouragement Domain	11.06 (2.06)	11.66 (1.76)
Affection Domain	10.40 (2.08)	10.63 (1.93)
Responsiveness Domain	11.37 (2.30)	11.57 (2.16)
Teaching Domain	11.40 (2.12)	11.94 (1.47)
A Priori Composite	14.03 (2.97)	14.57 (2.43)

Note. Significant group differences are bolded ($p < .05$).

Results. The interaction between group and the PICCOLO Total pre-score was not significant, $\Delta R^2 = .00$, $b = -.01$, $t(66) = -.13$, $p = .90$. However, controlling for group, there was a significant main effect of the PICCOLO Total pre-score on change in the attention effect, $\Delta R^2 = .06$, $b = .06$, $t(67) = 2.04$, $p = .045$. Results for the model testing the Encouragement domain as a moderator showed the same pattern; there was no significant interaction with group, $\Delta R^2 = .002$, $b = -.07$, $t(66) = -.34$, $p = .73$, but, controlling for group, there was a positive and significant main effect of Encouragement pre-score, $\Delta R^2 = .07$, $b = .23$, $t(67) = 2.31$, $p = .02$. These main effects indicate that, across groups, children of parents with higher scores on the PICCOLO Total score and the Encouragement domain at the pre-assessment showed a larger increase in the attention effect from pre- to post-assessment.

The interaction between group and the Affection domain pre-score was not significant, $\Delta R^2 = .007$, $b = -.14$, $t(66) = -.72$, $p = .48$. This was also the case for the interaction between group and the Responsiveness domain pre-score, $\Delta R^2 = .003$, $b = .08$, $t(66) = .43$, $p = .67$, and the Teaching domain pre-score, $\Delta R^2 = .004$, $b = .13$, $t(66) = .57$, $p = .57$. The interaction between group and the pre-score for the A Priori Composite was also not significant, $\Delta R^2 = .01$, $b = .14$, $t(66) = .96$, $p = .34$. Furthermore, there were no main effects of pre-score for any of these three domains or for the A Priori Composite (all *p*s > .05). These findings indicate that baseline scores on these variables did not moderate the effect of PCMC-A on changes in the attention effect and did not predict change in the attention effect from pre- to post-assessment across groups.

Child and Mother Characteristics as Moderators of Intervention-Related Changes in Child Brain Function for Selective Attention

Analytical Strategy. We used the same hierarchical regression approach described above in the additional exploratory analyses conducted to test child and mother characteristics as moderators of the documented intervention-related gains in brain function for selective attention. Like for the full sample reported in Chapter III, there were no significant group differences at the pre-assessment on any of the moderators examined for the subsample used in this study (see Table 5.2).

Table 5.2

Pre-Assessment Descriptive Statistics by Group for Moderator Variables

	Group			
	PCMC-A (n = 35)		Control (n = 35)	
	n	Mean (SD)	n	Mean (SD)
Age	35	4.59 (.55)	35	4.46 (.52)
SES	33	31.12 (12.38)	33	30.38 (11.32)
Maternal Education	34	4.50 (1.11)	34	4.88 (1.01)
Non-Verbal IQ	35	11.82 (1.93)	35	12.50 (1.74)
Behavior Problems	32	106.53 (9.55)	35	106.71 (13.05)
Social Skills	31	104.61 (6.79)	34	103.68 (8.12)
Mean Length Utterance	35	5.02 (.91)	35	4.83 (.66)
Parenting Ability	35	3.96 (.48)	34	3.80 (.56)
Parenting Confidence	35	4.01(.48)	33	3.94 (.66)
Parenting Stress	34	0.44 (.25)	33	0.33 (.24)

Note. Significant group differences are bolded ($p < .05$).

Results. Out of the potential moderators evaluated, mother report of child social skills was the only moderator to emerge as significant (all other moderator models, ps > .10). The model including group, child social skills, and the interaction between the two as predictors of change in the attention effect was significant, $F(3,61) = 3.05$, $p = .04$. As summarized in Table 5.3, there were no significant main effects (ps > .05), but there was a significant interaction between group and child social skills, $\Delta R^2 = .06$, $p = .05$. As shown in Figure 5.1, child social skills was a significant predictor of change in the attention effect for the PCMC-A group, $b = .10$, $t(29) = 2.53$, $p = .02$, but not for the Control group, $b = -.01$, $t(32) = -.25$, $p = .81$.

Table 5.3

Hierarchical Regression Model Testing Child Social Skills as a Moderator of Change in the Attention Effect

Variable	*B*	*SE*	*β*	*p*	ΔR^2	*F*	*p*
Step 1					.07	2.45	.10
(Constant)	.05	.28		.85			
Group	.70	.40	.22	.08			
Social Skills	.03	.03	.15	.22			
Step 2					.06	4.01	.05
(Constant)	.03	.27		.90			
Group	.69	.39	.21	.08			
Social Skills	-.01	.03	-.04	.79			
Group x Social Skills	.11	.05	.31	.05			

Note. Group: Control coded as 0; PCMC-A coded as 1.

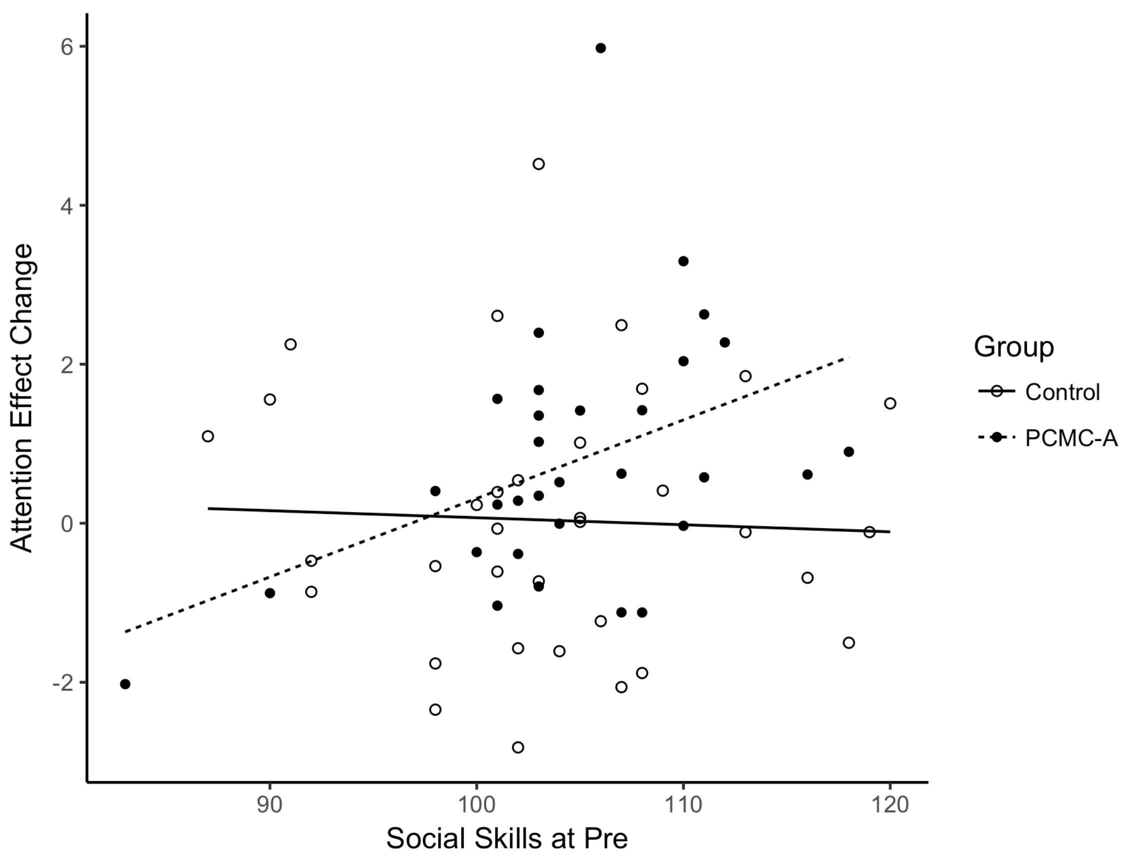

Figure 5.1. Relationship between child social skills at pre-assessment and change in the attention effect in microvolts from pre- to post-assessment plotted separately for each group.

These findings indicate that children with higher social skills who participated in PCMC-A showed greater gains in the attention effect from pre- to post-assessment relative to children with lower social skills. This pattern of results can be seen in the ERP plots and topographical maps shown in Figure 5.2 and Figure 5.3. These figures illustrate the change in the attention effect from pre- to post-assessment for children with higher and lower social skills (as determined by a median split) for each group. Plots showing difference waves for all electrode sites included in analyses can be found in Appendix B.

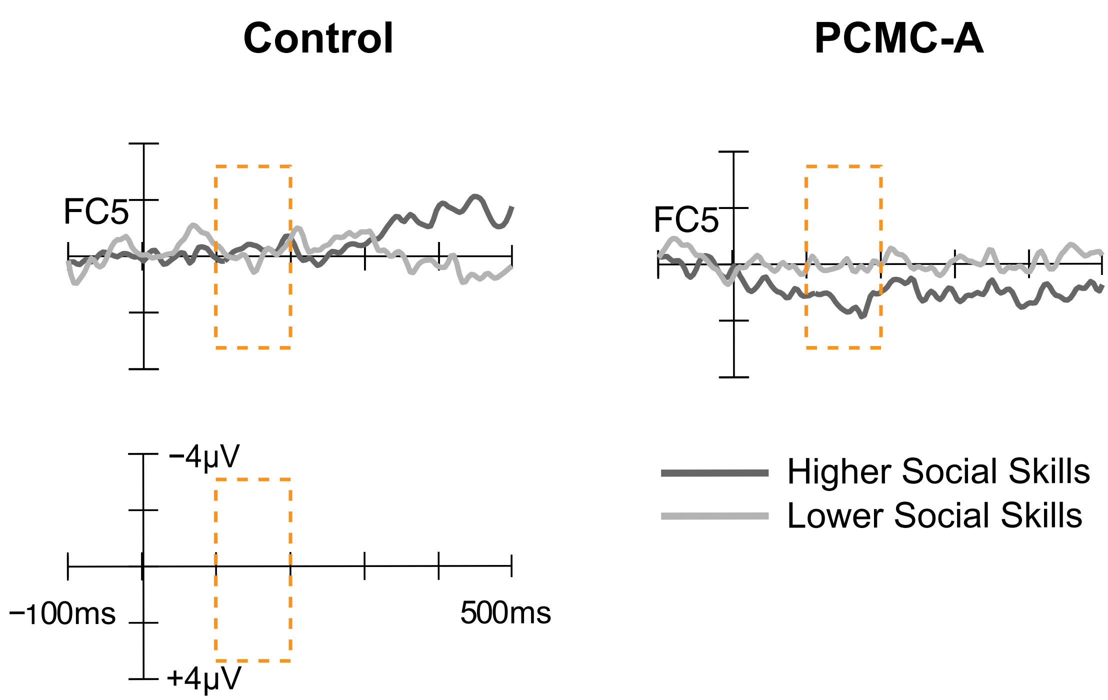

Figure 5.2. ERP difference waves at a representative frontocentral electrode site showing change in the attention effect (attended – unattended) from pre- to post-assessment for children with high (dark gray) and low (light gray) pre-assessment social skills plotted separately by group. Higher pre-assessment social skills predicted more change in the attention effect during the 100-200 ms time window (illustrated in orange) for the PCMC-A group, but not for the Control group.

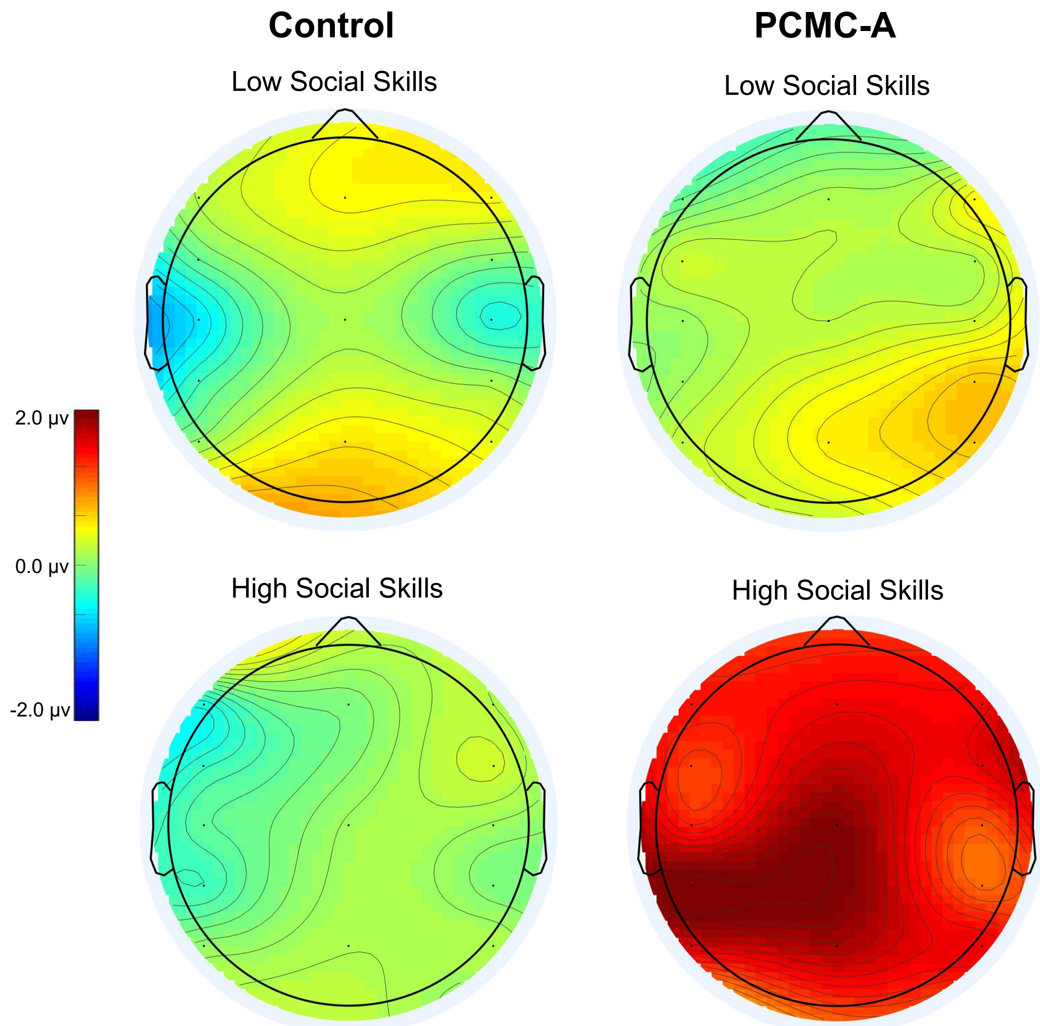

Figure 5.3. Topographical maps showing the distribution of change in the attention effect from pre- to post-assessment across the scalp during the 100-200 ms time window for children with high and low pre-assessment social skills by group. Color scale ranges from -2 to 2 microvolts, with warmer colors indicating more positive change in the attention effect.

As summarized in Table 5.4, the interaction with group was not significant for any of the other child and mother characteristics examined as potential moderators of change in the attention effect, indicating that they did not moderate the effect of PCMC-A on child brain function for selective attention.

Table 5.4
Summary of R-Squared Change Tests for Interaction Terms Predicting Change in the Attention Effect

Interaction Term	*B*	*SE*	ΔR^2	*F*	*p*
Group x Age	-.18	.74	.00	.06	.81
Group x Maternal Education	.29	.38	.01	.57	.45
Group x SES	.02	.04	.00	.24	.63
Group x Non-Verbal IQ	-.09	.22	.00	.16	.69
Group x Behavior Problems	-.06	.04	.03	2.40	.13
Group x Mean Length Utterance	-.09	.53	.00	.03	.86
Group x Parenting Ability	.29	.77	.00	.15	.70
Group x Parenting Confidence	-.62	.73	.01	.72	.40
Group x Parenting Stress	.12	1.64	.00	.01	.94

Note. Group: Control coded as 0; PCMC-A coded as 1.

Summary of Findings

Given that we did not find evidence of a relationship between intervention-related changes in supportive parenting and changes in child brain function for selective attention, we were not able to test the proposed mediation model. Instead, we tested for moderators of the effect of PCMC-A on the attention effect found in Chapter IV. PICCOLO scores at the pre-assessment, indexing the levels of supportive parenting behaviors mothers exhibited before the intervention period, were not associated with intervention-related changes in the attention effect. However, controlling for group, the pre-assessment scores for the PICCOLO Total score and for the Encouragement domain were significant predictors of change in the attention effect over the intervention period.

These findings indicate that, across groups, children of mothers who displayed higher scores on the PICCOLO Total score and on the Encouragement domain at the pre-assessment showed greater increases in brain function for selective attention during this period that were not intervention-related.

Furthermore, mother reports of child social skills at the pre-assessment emerged as a significant moderator of change in the attention effect. The direction of the observed moderating effect indicated that children who were reported to have higher social skills at baseline showed greater improvements in the attention effect as a function of PCMC-A relative to children with lower social skills. None of the other child and mother characteristics examined showed evidence of moderation of the effect of PCMC-A on child brain function for selective attention.

CHAPTER VI

DISCUSSION

The present dissertation examined whether Parents and Children Making Connections – Highlighting Attention (PCMC-A), a dual-generation intervention program for families from lower SES backgrounds that includes parenting training for parents and attention training for children, leads to increases in observed supportive parenting behaviors and in child brain function for selective attention. In response to the call to move beyond examining intervention main effects (Shonkoff & Fisher, 2013), moderators of these effects were also examined to identify characteristics of mothers and children who benefited from PCMC-A to different extents. With the goal of increasing our understanding of how this intervention program operates to promote gains in child brain function for selective attention, the neurocognitive system targeted by PCMC-A, the main objective of this dissertation was to test intervention-related changes in supportive parenting behaviors as an explanatory mechanism for the effect of PCMC-A on neural indices of selective attention.

These questions were examined as part of the RCT to evaluate the impact of PCMC-A on Head Start preschoolers and their parents, employing a multi-method approach. We found that participation in PCMC-A led to increases in specific aspects of supportive parenting behaviors coded from an observed parent-child interaction. The documented intervention-related increases in supportive parenting were moderated by characteristics of the child and the mother at the pre-assessment, including mother reports of child behavior problems, child age, and maternal interactive language use. We also found an effect of PCMC-A on child brain function for selective attention measured using the event-related potential (ERP) technique, which was moderated by mother reports of child social skills at the pre-assessment. Even though we documented changes in both of these outcomes as a function of PCMC-A, we did not find evidence that changes in supportive parenting explained gains in child brain function for selective attention, suggesting that other explanatory mechanisms may be at play. Together, the findings of the present dissertation characterize the effect of PCMC-A on these specific outcomes, begin to paint a picture of the families who benefit most and least from this intervention, and contribute to our understanding of the mechanisms through which PCMC-A impacts child brain function for selective attention.

Effect of PCMC-A on Supportive Parenting

Changes in supportive parenting were evaluated using the Parenting Interactions with Children: Checklist of Observations Linked to Outcomes (PICCOLO) coding system, which focuses on positive parenting behaviors along four domains: Encouragement, Affection, Responsiveness, and Teaching. We examined the effect of PCMC-A on the PICCOLO Total score, which collapses across the four domains. We also looked at each domain separately to examine whether the effect of PCMC-A differed by domain of parenting. Furthermore, under the hypothesis that PCMC-A would be most likely to impact those parenting behaviors that it targets most directly, we created the PICCOLO A Priori Composite. This composite was comprised of the PICCOLO items from across the four PICCOLO domains considered to be most directly targeted by the parenting curriculum of PCMC-A.

We found an effect of PCMC-A on the PICCOLO Total score, such that mothers who participated in PCMC-A showed a higher PICCOLO Total score at the post-assessment relative to mothers in the Control group. The analyses by domain revealed that this effect was driven by changes in the Encouragement domain, as no main effect of PCMC-A was documented for the Affection, Responsiveness, and Teaching domains. Furthermore, we also found an effect of PCMC-A on the A Priori Composite showing the same pattern. Together, these findings indicate that supportive parenting behaviors are malleable to PCMC-A, but that this effect is specific to the behaviors that are most directly targeted by the curriculum of the parent component.

Although the PICCOLO Total score changed as a function of intervention, an effect of PCMC-A was not documented for every domain of the PICCOLO. Out of the four domains measured by the PICCOLO, only Encouragement showed intervention-related effects. The items that comprise the Encouragement domain include behaviors related to supporting the child's autonomy by encouraging and scaffolding the child's efforts (Roggman et al., 2013a). These specific parenting behaviors have been associated with the development of EF (Bibok et al., 2009; Bernier et al., 2010; Hammond et al., 2012; Hughes & Ensor, 2009) and have been shown to be malleable to intervention with parents of young children from lower SES backgrounds (Knoche et al., 2012). These behaviors are also closely tied to strategies that parents learn as part of PCMC-A parenting training. For example, parents learn to support the child's autonomy by providing choices and allowing the child to choose how certain activities are carried out. Giving specific praise is another strategy that parents learn to encourage their child's efforts by clearly and directly communicating what they like about their behavior, with the goal of promoting those preferred behaviors. Thus, strategies from PCMC-A parent component were directly related to multiple specific parenting behaviors captured by the

Encouragement domain. The current findings indicate that the parenting behaviors directly targeted by PCMC-A strategies were the behaviors that changed from pre- to post-assessment. This conclusion is further supported by the finding that an effect of PCMC-A was found for the A Priori Composite. Importantly, this composite was comprised of items from all four of the PICCOLO domains, including the domains for which we did not observe changes as a function of PCMC-A. However, when taken together, the items across domains considered to be most directly targeted by PCMC-A parenting training showed intervention-related change. This finding suggests that PCMC-A was effective in bringing about change in the specific parenting behaviors it sought to address. This evidence highlights the importance of having a focused intervention curriculum that directly targets the specific outcomes that the program intends to impact.

Interestingly, we also found that the level of supportive parenting mothers showed before the intervention period was associated with the extent to which they showed intervention-related changes for the Teaching domain, but not for any of the other domains or PICCOLO outcomes examined. There was no relationship between the Teaching score at the pre-assessment and change on the Teaching score from the pre- to post-assessment for the Control group, but there was a significant negative relationship for the PCMC-A group. Mothers with lower initial Teaching scores who participated in PCMC-A showed positive change in the Teaching domain from pre- to post-assessment, while mothers with higher scores showed no change or negative change. This finding suggests that mothers who had more room for improvement benefitted more from PCMC-A on this specific aspect of supportive parenting, while those who started with higher levels benefitted less, in some cases showing negative change over time. Such a finding indicates that there was an effect of PCMC-A on supportive parenting behaviors captured by the Teaching domain, but that it was not homogeneous across mothers who participated in PCMC-A. It is worth noting that mothers who showed negative change on this outcome had pre-assessment scores that would be considered above average as per the PICCOLO scoring grids, which correspond to the highest 16% of scores in the PICCOLO validation sample (Roggman et al., 2013b). This suggests that the negative change over time observed in these mothers could be an indication of regression to the mean from pre- to post-assessment, which is a common phenomenon in intervention studies when extreme values are observed at the pre-assessment (Morton & Torgerson, 2005).

Moderators of Change in Supportive Parenting

To better understand the profiles of mothers who benefitted from PCMC-A to different extents, we examined child and mother characteristics that have been associated with supportive parenting as potential moderators of the observed intervention-related changes in this outcome. Examining additional moderators of the effect of PCMC-A on the Teaching domain, which was itself moderated by the pre-assessment score, entailed including multiple interactions to the model. Due to concerns about statistical power with this approach, these analyses focused on the aspects of supportive parenting for which we found main effects of PCMC-A on change over time: the PICCOLO Total score, the Encouragement domain score, and the A Priori Composite. Of the child and mother characteristics examined, three emerged as moderators of intervention-related changes in supportive parenting: child behavior problems, maternal mean length of utterance (MLU) during the mother-child interaction, and child age. Child behavior problems and maternal

MLU moderated all three of the PICCOLO outcomes examined, while child age moderated changes in the PICCOLO Total score and the Encouragement score, but not the A Priori Composite score.

Mothers in PCMC-A who reported having children with higher levels of behavior problems before the intervention period showed more change in supportive parenting behaviors from pre- to post-assessment, suggesting that these mothers benefited more from PCMC-A. One explanation for this finding is the fact that the parenting component of PCMC-A was based on the parenting training curriculum of the Linking the Interests of Families and Teachers program (LIFT; Reid et al., 1999). LIFT was developed as a preventive intervention for children with conduct problems, so the strategies that are part of its parenting training curriculum were specifically designed to be effective for parents of children displaying behavior problems. As such, it might have been the case that mothers of children with behavior problems who participated in PCMC-A found these strategies more useful and/or were more motivated to implement them in the home. In turn, this might have increased their engagement in the program, thus heightening the impact that the program had on their supportive parenting behaviors. It is also possible that mothers who were more willing to recognize and acknowledge their child's behavior problems were also more open to learning and implementing the strategies suggested. Future studies should empirically test this and other possibilities to further understand the mechanisms through which level of child behavior problems moderates the effect of PCMC-A on changes in supportive parenting. Given that preschoolers from lower SES backgrounds are at increased risk for displaying behavior problems (Huaqing Qi & Kaiser, 2003), understanding which intervention strategies are effective for families with these characteristics and how they operate to elicit positive change should be a priority of intervention and prevention research.

It must be noted that the measure used to assess child behavior problems in the present study had two main limitations that should be taken into consideration when interpreting this finding. First, the measure used collapses across externalizing and internalizing behavior problems. This prevented us from being able to examine whether these different types of behavior problems interact in different ways to moderate the effect of PCMC-A on supportive parenting. The etiology, symptomatology, and consequences for child outcomes have been shown to differ between internalizing and externalizing behavior problems (for a review, see Cicchetti & Toth, 1991), highlighting the importance of teasing apart their potentially different contributions in future studies. Second, the measure used was a parent report, which is subject to the parent's bias. For this reason, it was not possible to disentangle the mother's own perception of her child's behavior from the child's actual behavior. Studies using more objective measures of child behavior problems, such as observations by blind coders or clinical evaluations, or compiling reports from multiple informants, including teacher and other caregiver reports, will be necessary to better characterize this moderating effect.

Maternal MLU, which was used as a proxy for mothers' interactive language use coded from the same mother-child interaction from which supportive parenting behaviors were coded, also moderated the effect of PCMC-A on changes in supportive parenting. Mothers in the PCMC-A group who showed a longer MLU at baseline tended to show more growth in supportive parenting over the intervention period. To interpret this finding, it is worth noting that a previous study examining the impact of PCMC-A documented reductions in MLU for parents who participated in PCMC-A relative to parents assigned to the Head Start-alone control group receiving services as usual (Neville et al., 2013). This finding was interpreted as indication of intervention-related increases in parents' efforts to approximate more closely their language level to that of their child (Neville et al., 2013), proposing that a shorter maternal MLU is more developmentally supportive. This interpretation is in line with one of the targets of the parent component of PCMC-A, which centers around modifying the way parents use language with their children.

PCMC-A explicitly emphasizes the importance of following the child's lead and not dominating the conversation during parent-child interactions, particularly in the context of shared play, as a way to promote the child's language and cognitive development. This is illustrated with the metaphor of a piggy bank, in which the parent should not be "withdrawing" more words than the child "deposits" as a strategy for the conversation to remain balanced and child-led. Thus, the curriculum of PCMC-A is designed to help parents become more self-aware of the way in which they use language around their children and suggests concrete strategies to use language in ways that are more developmentally supportive. As such, one possible interpretation for the present finding is that mothers who initially talked in longer statements when interacting with their children, indexed by a longer MLU at the pre-assessment, became more self-aware of their behavior towards their child. In turn, this increased self-awareness might have made them more receptive to PCMC-A strategies, leading to greater improvements in their supportive parenting.

It must also be considered that longer parental MLU has been associated with vocabulary growth during toddlerhood, a period of rapid expressive language development (for a review, see Zauche, Thul, Mahoney, & Stapel-Wax, 2016). Furthermore, mothers from lower SES backgrounds tend to produce shorter utterances when interacting with their children compared to their counterparts from higher SES backgrounds (Hoff, 2003; Hoff & Naigles, 2002; Szagun & Stumper, 2012), and maternal MLU has been shown to account for the relationship between SES and child vocabulary (Hoff, 2003). Based on this evidence, a longer MLU at baseline in our sample of mothers from lower SES backgrounds could be taken as indication of more maternal speech during the play interaction, which has been associated with positive child outcomes (Hoff, 2006; Zauche et al., 2016). Thus, another possible interpretation for the present finding is that mothers with a longer MLU at the pre-assessment were already more linguistically engaged with their children, which may have predisposed them to larger increases in their supportive parenting behaviors as a function of the parenting training they received through PCMC-A. However, this interpretation assumes that longer MLU indexes interactive language use in a way that seeks to engage the child.

In light of evidence indicating that the utterances mothers from lower SES backgrounds produce when interacting with their children are more likely to be directives than bids for conversation (for a review, see Hoff, Laursen, & Tardif, 2002), it is important to take into consideration information about the content and purpose of mothers' utterances during this interaction. Characterizing these aspects of the utterances would help inform the interpretation of the current finding. However, MLU on its own only provides information about the average length of the statements uttered by the mother. This makes MLU a coarse measure of the interactive nature of language, as it does not provide information about important aspects of language use that have been positively associated with the development of child language and other cognitive outcomes (for a review, see Hoff, 2006). For example, it does not indicate whether the utterance was child-directed, how related it was to the child's focus of attention, if it occurred in response to a child utterance, or the extent to which it matched the child's own MLU. Thus, future studies employing measures that provide richer information about the characteristics of the language used in this interactive context will be necessary to tease apart the reasons why MLU moderated the effect of PCMC-A on supportive parenting.

Another moderator of change in supportive parenting as a function of PCMC-A was child age at the pre-assessment, with this moderation effect being specific to changes in the PICCOLO Total score and the Encouragement domain score. There was a significant difference between the PCMC-A and the Control groups in the effect of child age on change in supportive parenting. For the Control group, having an older child at pre-assessment was associated with more negative change in supportive parenting. This relationship was not observed for the PCMC-A group, for which change in supportive parenting did not differ by child age. This finding suggests that PCMC-A might be buffering mothers with older children from what would otherwise be a decline in these aspects of supportive parenting as their children grow older. This interpretation is in line with findings from the validation of the PICCOLO coding system with different age groups. The PICCOLO has been validated with a large sample of 10-47 month-old children and with a smaller sample of older preschoolers aged 52-73 months. The

PICCOLO developers report that parents of Head Start children in this older age range tend to show lower levels of supportive parenting in the Encouragement domain relative to parents of children in the younger age range (Roggman et al., 2013b). The decline in the Encouragement domain score observed for parents in the Control group is consistent with this report. The fact that we did not observe this decline for the PCMC-A group lends support to the hypothesis that PCMC-A may contribute to buffering against a decline in supportive parenting.

A decline in supportive parenting associated with child age could be explained by previous findings showing that as children grow older they begin to assert more autonomy from their parents, which may take the form of non-compliance (for a review, see Forman, 2007). Furthermore, older preschoolers tend to assert their autonomy to a greater extent than younger preschoolers (e.g. Killen & Smetana, 1999). Thus, it might be the case that this developmental process requires that what served as supportive parenting during younger ages adapts to accommodate the child's growing need for autonomy. This hypothesis is supported by evidence showing that consistently supportive parenting from infancy to the preschool years is associated with greater cognitive growth over this period, compared to high supportive parenting that is only present during infancy (Landry et al., 2001). Thus, a decline in supportive parenting as children age that is explained by developmental increases in assertions of autonomy would be aligned with the existing literature.

When interpreted through the lens of this evidence, our findings suggest that mothers of older children in the Control group who did not receive parenting training may have had more difficulty adapting their supportive parenting behaviors as their children aged, leading to declines in this aspect of supportive parenting over the intervention period. In contrast, mothers of older children who did receive parenting training through PCMC-A did not show evidence of this decline. Together, these findings suggest that PCMC-A may help buffer mothers from lower SES backgrounds from declines in supportive parenting by providing strategies that help them better adapt their supportive parenting behaviors to their child's changing developmental needs during the preschool years.

Interestingly, other parenting-related variables did not moderate the effect of PCMC-A on changes in supportive parenting, such as perceived parenting stress, and sense of parenting confidence and ability. These findings are in contrast with our hypotheses that these variables would be associated with changes in supportive parenting. We expected that mothers who perceived more parenting stress and reported lower levels of parenting confidence and ability might have benefitted more from PCMC-A because they were more in need of parenting training. Alternatively, they might have benefitted less because they required more parenting training than that which is provided by PCMC-A. However, we found no evidence of differences in supportive parenting changes as a function of these parenting characteristics, indicating that PCMC-A was equally effective for parents with differing levels of parental stress and sense of parenting confidence and ability.

Furthermore, given the well-documented relationship between SES and supportive parenting (for a review, see Bradley & Corwyn, 2002), we also hypothesized that SES would act as a moderator of the effect of PCMC-A on supportive parenting. In addition to an index of SES that takes into consideration maternal and paternal occupation and level of educational attainment, we also examined maternal education independently as a moderator. We made this decision because our sample focused exclusively on mothers, and also in response to the call to examine components of SES independently, given that they might have different influences on outcomes (Duncan & Magnuson, 2012). We predicted that mothers from lower SES backgrounds and with lower educational attainment would benefit more from PCMC-A because they would be more likely to show lower levels of supportive parenting at the pre-assessment, thus having more room for growth. However, we did not find evidence of moderation by either of these proxies for SES. One explanation for this finding is that our whole sample consisted of families who qualified for Head Start based on their SES, so we might not have had sufficient variability to detect moderation.

Given the evidence for reciprocal, bidirectional influences of parent and child characteristics on parenting (Collins, Maccoby, Steinberg, Hetherington, & Bornstein, 2000), we also examined other child characteristics as moderators of intervention-related changes in supportive parenting: child sex, non-verbal IQ, and social skills. Some evidence indicates that parents show different parenting behaviors and interactional patterns towards their children depending on their sex (for a review, see Leaper, 2005), which has also been documented specifically in the context of shared play (Leaper, 2000). This motivated the examination of whether the extent to which supportive parenting behaviors changed as a function of PCMC-A differed for mothers of females vs. mothers of males. Furthermore, supportive parenting has been shown to vary as a function of child IQ (Fenning et al., 2007) and as a function of temperament (Putnam et al., 2002), which is associated with social skills in children (for a review, see Sanson et al., 2004). Based on these findings, we also examined child IQ and social skills as moderators of this effect. However, we found no evidence of moderation for any of these variables, suggesting that the effect of PCMC-A on changes in supportive parenting did not differ as a function of child sex, non-verbal IQ, or social skills.

Together, these findings begin to paint a picture of the mothers who benefited from PCMC-A to different extents in terms of changes in their supportive parenting behaviors. Our evidence indicates that mothers who reported having children with more behavior problems, mothers who used longer statements when interacting with their children before the intervention period, and mothers of older children seem to benefit most. Given that the moderator analyses reported were exploratory in nature, they should be interpreted with caution. However, if these findings are replicated in future studies, they could be used to make recommendations regarding who might benefit most and least from PCMC-A. Such evidence-based recommendations would be instructive in directing limited resources to those parents for whom the program is expected to have a greater positive impact.

Effect of PCMC-A on Child Brain Function for Selective Attention

Consistent with previous studies employing the same ERP paradigm to assess auditory selective attention in children from lower SES backgrounds of the same age (Hampton Wray et al., in press; Neville et al., 2013), we found that at the pre-assessment this sample of Head Start preschoolers did not show an attention effect. Notably, children who participated in PCMC-A exhibited gains in this neural index of selective attention over the intervention period. By the post-assessment, the PCMC-A group showed a reliable attention effect indexed by a heightened neural response to attended stimuli relative to unattended stimuli, which was not observed for the Control group. This intervention-related increase in the attention effect was driven by increases in the neural response to attended stimuli from pre- to post-assessment, with no differences observed over the intervention period for the neural response to unattended stimuli, consistent with previous findings (Neville et al., 2013). This evidence indicates that the effect of PCMC-A on brain function for selective attention was specific to the signal enhancement component of selective attention, with no evidence of improvements in the distractor suppression component.

These findings replicate previous findings from the RCT of PCMC-A examining this question with a smaller sample (Neville et al., 2013). In this previous study, gains in the attention effect for the PCMC-A group were also driven by increases in signal enhancement, which were observed exclusively over posterior electrode sites. In the present study, which included a larger sample, increases in the attention effect as a function of PCMC-A were also observed across anterior and central electrode sites. This suggests that, with this larger sample, intervention-related increases in the attention effect were more robust, so they could be detected across the scalp. Previous studies examining individual differences in this neural index of selective attention in children have localized them to anterior and central electrode sites, including differences as a function of SES (Stevens et al., 2009), non-verbal IQ (Isbell et al., 2016), and development over time (Hampton Wray et al., in press). Thus, our finding that increases in the attention effect as a function of PCMC-A extended to anterior and central electrode sites is consistent with these previous findings.

Previous studies using this paradigm to compare brain function for selective attention between children from higher and lower SES backgrounds have documented deficits specific to distractor suppression (Hampton Wray et al., in press; Stevens et al., 2009). A longitudinal study that followed a group of preschoolers from lower SES backgrounds over a one-year period found no evidence of an attention effect when they were 4-year-olds, but a significant attention effect was present by the time they were 5 years of age. In contrast, 4-year-olds from higher SES backgrounds showed an attention effect at that age. The development of an attention effect for preschoolers from lower SES backgrounds over this time period was explained by improvements in signal enhancement, with no evidence of developmental change in distractor suppression. In fact, 5-year-olds from lower SES backgrounds showed reduced distractor suppression relative to 4-year-olds from higher SES backgrounds (Hampton Wray et al., in press). This evidence indicates that preschoolers from lower SES backgrounds show delays in the development of brain function for selective attention relative to their counterparts from higher SES backgrounds. These delays are characterized by slower development of signal enhancement over the preschool period that is accompanied by continued differences in distractor suppression. In light of this longitudinal evidence, the present finding that increases in signal enhancement over the intervention period were observed for the PCMC-A group but not for the Control group can be interpreted as indication that PCMC-A is contributing to accelerating the maturational trajectory of this component of selective attention in preschoolers from lower SES backgrounds.

By post-assessment, no evidence of an effect of PCMC-A on the distractor suppression component of selective attention was found. It is possible that an effect of

PCMC-A on distractor suppression is not present immediately after the intervention period, but can be detected later on. A longitudinal study following the development of brain function for selective attention for the PCMC-A and the Control groups would be necessary to test this hypothesis. It might also be the case that the effects of PCMC-A on brain function for selective attention are exclusive to signal enhancement and do not extend to the distractor suppression component. Given that neural mechanisms supporting the distractor suppression component have been shown to be more vulnerable in children from lower SES backgrounds than mechanisms supporting signal enhancement (Hampton Wray et al., in press; Stevens et al., 2009), it is possible that a higher intervention dosage or more targeted strategies are necessary to elicit change in this component. Previous studies have documented that older children from lower SES backgrounds continue to show deficits in this component of selective attention relative to their higher SES peers beyond the preschool years (D'Angiulli et al., 2008; Stevens et al., 2009). Together with the present findings, this evidence suggests that interventions that also impact the neural system supporting the distractor suppression component of selective attention might be necessary to close the SES gap in this cognitive ability.

Moderators of Change in Child Brain Function for Selective Attention

The report by Neville and colleagues (2013) on the RCT of PCMC-A focused on examining the main effect of this dual-generation program on brain function for selective attention. One of the novel contributions of this dissertation is that it moves beyond main effects analyses by also examining differential effects on this outcome. To this end, child and mother characteristics were tested as moderators of the effect of PCMC-A on child brain function for selective attention. Of the characteristics examined, maternal reports of child social skills were found to moderate this effect. Children for whom their mothers reported higher social skills at baseline showed larger increases in the attention effect from pre- to post-assessment as a function of PCMC-A. Brain Train, the child component of PCMC-A that focuses on attention and self-regulation training, was delivered in small-group format of four to six children at a time. Thus, it is possible that children who came into Brain Train with higher social skills were better equipped from the onset to interact with their peers, follow directions, wait for their turn, and more generally act prosocially in this group context. This may have enabled them to be more receptive to the Brain Train activities designed to train self-regulation of attention, leading to greater improvements in their brain function for selective attention over the intervention period. This interpretation is in line with the literature on the relationship between social skills and academic outcomes, which documents that children with higher social skills tend to show better self-regulation in the classroom, which in turn leads to higher school readiness (McClelland et al., 2000; for a review, see Raver, 2003). This finding, provided that it is supported by further evidence, can inform recommendations for how to adapt PCMC-A for children with different profiles. For example, children who show lower social skills might benefit more from PCMC-A if they receive social skills training prior to participating in Brain Train, or if they receive Brain Train in one-on-one sessions as opposed to in group format.

Interestingly, other child and mother characteristics that were hypothesized to be potential moderators of the effect of PCMC-A on brain function for selective attention did not show evidence of differential effects. Previous studies have documented deficits in the same neural index of selective attention examined in the present dissertation in children with lower non-verbal IQ scores (Isbell et al., 2016), children of mothers with lower educational attainment (Stevens et al., 2009), and children from lower SES backgrounds (determined using the same index used here; Hampton Wray et al., in press). Furthermore, as reviewed above, children from lower SES backgrounds show maturational delays in the development of this neural index of selective attention, such that their attention effect becomes reliable over time but is not observed during early preschool years (Hampton Wray et al., in press). Based on this evidence, we hypothesized that child non-verbal IQ scores, maternal education, family SES, and child age would moderate the effect of PCMC-A on the neural index of selective attention, such that children lower on the continuum of these characteristics would show greater intervention-related gains in selective attention because they would have more room to grow. This hypothesis is informed by previous evidence that homozygous carriers of the long allele of the 5-HTTLPR serotonin transporter gene, who show deficits in this neural index of selective attention compared to carriers of the short allele (Isbell, Stevens, Hampton Wray, Bell, & Neville, 2016), also show greater gains in selective attention as a function of PCMC-A (Isbell et al., in press).

We also examined mother reports of child behavior problems as a moderator of this effect. Even though the relationship between child behavior problems and our neural index of selective attention has not been directly examined, child behavior problems have been associated with aspects of selective attention and self-regulation (Calkins & Fox, 2002; Campbell, 1995), particularly in the context of attention deficit/hyperactivity disorder (ADHD; DuPaul, McGoey, Eckert, & VanBrakle, 2001; for a review, see Barkley, 2003). Given that our sample was restricted to typically developing children with no clinical diagnosis of ADHD or conduct problems, we predicted that variations within the normal range of behavior problems could be associated with intervention-related gains in selective attention in two ways. On the one hand, children with higher levels of behavior problems at baseline could show greater gains in selective attention if they had more room for improvement. On the other hand, these children could show lower gains if they needed additional services to address their behavior problems in order to be able to benefit from PCMC-A.

Stemming from our central hypothesis that changes in supportive parenting would explain intervention-related increases in child brain function for selective attention, we predicted that parent characteristics that are associated with supportive parenting would moderate the effect of PCMC-A on selective attention. Based on this logic, we examined perceived sense of parenting ability and confidence, parenting stress, and parent-child interactive language use (indexed by maternal MLU) as moderators of this effect, as these parent characteristics have been shown to interact to promote supportive parenting (e.g. Anthony et al., 2005; Deater-Deckard, 1998; Hoff, 2006; Morawska & Sanders, 2007; Raikes & Thompson, 2005). We predicted that children of mothers showing levels on these characteristics that promote supportive parenting (i.e. lower parenting stress, higher sense of parenting ability and confidence, and higher interactive language use) would be more responsive to PCMC-A. Our rationale was that these mothers would be better equipped to implement the PCMC-A strategies in the home to boost the home environment and promote selective attention. Alternatively, we predicted that these children would be less responsive to PCMC-A because they would start with higher selective attention, thus having less room for growth.

Contrary to these predictions, we did not find evidence indicating that the effect of PCMC-A on brain function for selective attention varied depending on SES or maternal education, on child age, non-verbal IQ, or behavior problems, or on parenting characteristics associated with supportive parenting. The fact that we did not find evidence of moderation as a function of these child and mother characteristics suggests that children who participated in PCMC-A benefitted equally from the program, regardless of where they fell on the continuum for each measure. It must be noted that the present study did not meet sample size recommendations to detect small moderation effects (Shieh, 2009). The sample was also relatively homogeneous, as it was intentionally restricted to children enrolled in Head Start with no diagnosed behavioral or neurological syndromes, who were not receiving special education services, and who were English monolingual speakers. Furthermore, consistent with the demographics of the local population, the sample was primarily White. Therefore, a plausible alternative explanation is that we did not find evidence of moderation for these child and mother characteristics due to statistical reasons, such as lack of sufficient statistical power or enough variability in the moderator variables examined (McClelland & Judd, 1993).

We found that this subset of child and mother characteristics at baseline were not associated specifically with intervention-related changes in brain function for selective attention. However, it is possible that they do moderate changes in other outcomes as a function of PCMC-A. This possibility is supported by our finding that some of these characteristics moderated the effect of PCMC-A on supportive parenting. Neville and colleagues (2013) documented main effects of PCMC-A on other child outcomes, including improvements in standardized measures of language and non-verbal IQ, as well as other parent outcomes, including reductions in self-reports of parenting stress. Thus, it is important that future studies examine differential effects of PCMC-A on other outcome measures that were beyond the scope of the present dissertation so we can gain a better understanding of who benefits from PCMC-A.

In addition to these parent and child characteristics, we also examined supportive parenting behaviors at baseline as moderators of the effect of PCMC-A on brain function for selective attention. Higher supportive parenting is associated with better performance on cognitive abilities related to selective attention (for a review, see Fay-Stammbach et al., 2014). Thus, we predicted that children of mothers who exhibited higher levels of supportive parenting behaviors prior to intervention would be either, less responsive to PCMC-A because they would have less room for improvement in selective attention, or would be more responsive because the effect of PCMC-A would be enhanced in the presence of supportive parenting. However, we did not find evidence for this moderation effect, indicating that the effect of PCMC-A on this outcome was not related to variations in supportive parenting at the pre-assessment. Yet, when controlling for group membership we found that, across groups, higher baseline scores on the PICCOLO Total score and on the Encouragement domain were associated with growth in brain function for selective attention over the intervention period. Thus, we did not find support for the hypothesis that baseline levels of supportive parenting would moderate the effect of PCMC-A on child brain function for selective attention. However, we found evidence indicating that for the PCMC-A group *and* for the Control group higher PICCOLO Total and Encouragement domain scores at baseline predicted greater change in brain function for selective attention. The fact that this effect was not specific to the PCMC-A group, but was observed across groups, indicates that higher baseline levels on these aspects of supportive parenting were associated with more accelerated development of brain function for selective attention over the intervention period that was not intervention-related.

The finding that these aspects of supportive parenting are associated with growth in brain function for selective attention is intriguing given that these were also the aspects of supportive parenting for which we found effects of PCMC-A. Hence, this finding raises the hypothesis that intervention-related increases in these aspects of supportive parenting could be related to gains in selective attention for the PCMC-A group that are not evident at the post-assessment, but that emerge over time. In other words, if the effect of PCMC-A on the aspects of supportive parenting that showed evidence of being related to selective attention development becomes stronger with time, it might lead to later impacts on brain function for selective attention. Such a hypothesis is consistent with longitudinal evidence documenting an association between supportive parenting behaviors captured by the Encouragement domain and the development of EF over time (Bibok et al., 2009; Bernier et al., 2010; Hammond et al., 2012; Hughes & Ensor, 2009). This possibility is discussed further in the following section, which delves into explanatory mechanisms.

Explanatory Mechanisms for the Effect of PCMC-A on Child Brain Function for Selective Attention

The central hypothesis of the present dissertation was that, if supportive parenting behaviors were malleable to PCMC-A, intervention-related changes in supportive parenting would explain accompanying changes in child brain function for selective attention. However, we did not find evidence to support this hypothesis, as we found that documented changes in supportive parenting did not explain observed changes in child brain function for selective attention. One possible interpretation of this finding is that the proposed explanatory mechanism is indeed the one at play, but characteristics of the design of the study prevented us from detecting its effect at this time. Alternatively, it is also possible that other explanatory mechanisms are operating to explain the observed effects of PCMC-A on supportive parenting and on child brain function for selective attention.

The present dissertation operationalized supportive parenting using a specific coding system that focuses exclusively on positive domains of parenting behaviors in the context of a free-play interaction. It is possible that changes in supportive parenting in fact do explain changes in child selective attention, but not when they are measured the way we measured them using the PICCOLO coding system. One possibility is that reductions in negative dimensions of parenting as a function of the intervention, rather than increases in positive parenting behaviors, predict changes in child selective attention. However, given that negative parenting behaviors are not captured by the PICCOLO, we were not able to test this possibility. The Incredible Years intervention with Head Start families documented intervention-related reductions in negative aspects of parenting, specifically critical statements, which were associated with decreases in preschoolers' conduct problems (Reid, Webster-Stratton, & Baydar, 2004). Together with evidence of an inverse relationship between negative aspects of parenting and EF (Cuevas et al., 2014; Hopkins et al., 2013; Rhoades et al., 2011), this evidence provides support for the possibility that intervention-related reductions in negative parenting behaviors could mediate the effect of PCMC-A on child selective attention. Future studies employing measures of supportive parenting that capture negative dimensions of parenting behaviors will be necessary to test this hypothesis.

Other characteristics of the PICCOLO coding system that may have limited its sensitivity to detect correlated change are that it takes a global rating approach to coding and focuses exclusively on the parent's behavior, without taking into consideration the child's behavior. It is possible that the changes in supportive parenting that account for changes in child selective attention are subtle and need to be considered in relation to the child's behavior. Thus, a measure that codes at the micro-social level and considers the dyadic interaction, rather than the parent's behavior alone, might be necessary to detect the proposed mediational relationship. Examples of coding systems with these characteristics that have been used in the investigation of intervention effects on parenting behaviors include the Structural Analysis of Social Behavior (SASB; Benjamin, 1974) and the Relationship Affect Coding System (RACS; Dishion et al., 2017). Coding systems such as these ones, which are designed to be more sensitive to subtle changes in a dyadic context, could be employed in future studies to test the hypothesized mediation model.

Another possibility is that changes in supportive parenting in the context of a free-play interaction are not associated with changes in selective attention, but that these associations might be observed with intervention-related increases in supportive parenting in other contexts. Contexts that place more demands on the parent than a shared play interaction might make it more challenging to consistently show supportive parenting, such as when requesting cooperation from the child or during joint problem-solving tasks. Supportive parenting behaviors have been shown to vary as a function of the demands of the parent-child interaction task employed, with lower levels of supportive parenting observed during a challenging cooperation task compared to a free-play task (Ginsburg, Grover, Cord, & Ialongo, 2006). In light of this prior evidence, future studies should test whether the effect of PCMC-A on supportive parenting extends to more challenging contexts, and whether these changes explain changes in child brain function for selective attention.

Additional explanations for the present findings could be related to the timing of the assessments examined to evaluate the impact of PCMC-A. One alternative explanation is that intervention-related increases in supportive parenting might not explain immediate gains in selective attention after the eight-week intervention period, but they could be related to the extent to which this effect is maintained or increases over time. Given that in the present dissertation we did not compare the groups at a longer-term follow-up, we were not able to examine this alternative. However, we found that, of the domains of supportive parenting coded by the PICCOLO, the effect of PCMC-A was specific to the domain that captures encouragement in the form of autonomy support. Previous studies have documented that this aspect of supportive parenting is most predictive of EF development over time (Bernier et al., 2010). Given the relationship between EF and selective attention (Garon et al. 2008), it is promising that increases in encouraging parenting as a function of PCMC-A could be related to the continued development of brain function for selective attention longitudinally. We also found that, across groups, higher levels of encouraging parenting at baseline were associated with greater gains in brain function for selective attention over the intervention period. This finding suggests that intervention-related changes in encouraging parenting could boost selective attention if the effect of PCMC-A on this aspect of parenting increases with time, once parents have had a longer period to put into practice what they learned through PCMC-A. Examining the effects of PCMC-A on supportive parenting and on brain function for selective attention, as well as the relationship between the two, at a longer-term follow-up would allow for investigation of these questions.

It is also possible that intervention-related changes in supportive parenting as measured by the PICCOLO do mediate the effect of PCMC-A on child brain function for selective attention at the post-assessment, but that this is only the case for dyads with specific characteristics. We found evidence that dyads who benefit most from the parent component in terms of supportive parenting have a different profile from those who benefit most from the child component in terms of brain function for selective attention, which provides support for this hypothesis. The available sample size in the present study prevented us from testing questions of moderated mediation (Preacher, Rucker, & Hayes, 2007), thus this is an avenue that should be pursued by future studies.

Alternatively, one may speculate that changes in other targets of PCMC-A that were not examined in the present dissertation account for the intervention-related gains observed in supportive parenting and in brain function for selective attention. The PCMC-A parent component takes a multifocal approach, targeting multiple aspects of the parent-child relationship and the home environment. Thus, it is possible that, rather than changes in supportive parenting as measured in the present dissertation, changes in other aspects of parenting targeted by PCMC-A account for the observed gains in child selective attention. One of the core components of PCMC-A, which is based on a core component of the PMTO model (Forgatch & Patterson, 2010), is to encourage parents to use contingent discipline and consistent limit setting. The importance of these parenting practices is discussed as part of the parent group and parents have opportunities to practice concrete strategies that they are encouraged to implement in the home. If PCMC-A is successful in increasing parent's use of contingent discipline and consistent limit setting, it is possible that changes in these parenting practices explain observed gains in child brain function for selective attention. Other intervention programs based on the PMTO model and adapted for parents or foster parents of preschoolers have documented intervention effects on positive discipline practices (Fisher et al., 2000; Webster-Stratton, 1998), providing supportive evidence that these parenting practices are malleable to interventions that include strategies that target them explicitly.

As part of the curriculum of the PCMC-A parent component, parents are also encouraged to provide scaffolded opportunities for their children to practice their thinking skills by allowing them to make choices and solve problems. Suggestions of opportunities for parents to engage in this form of cognitive stimulation with their children are embedded throughout the curriculum and reiterated each session. It is possible that, as a result, parents participating in PCMC-A show increases in the extent to which they afford opportunities for their children to choose, think, and problem solve. These opportunities are, in turn, hypothesized to promote the development of their selective attention by engaging attentional skills in the representation and evaluation of the choice or problem at hand (Zelazo, Carter, Reznick, & Frye, 1997).

Thus, strategies employed as part of PCMC-A are specifically designed to target different parenting practices, including contingent discipline and cognitive stimulation.

However, to date, no studies have evaluated whether PCMC-A is having an impact on these intervention targets. Until this is directly investigated, it will not be possible to test whether anticipated intervention-related increases in these other parenting practices targeted by PCMC-A lead to changes in child outcomes, specifically selective attention. Future studies examining the impact of PCMC-A should make it a priority to evaluate such changes in order to gain precision in the understanding of the impacts of PCMC-A and to enable testing of these hypotheses.

Another core component of the PCMC-A parenting curriculum is to reduce stress in the home by employing strategies to target stress in the parent and in the child. The strategies parents learn to foster consistent and predictable routines in the home (e.g. using a bedtime routine chart and a weekly calendar) are expected to reduce stress in the child by allowing him or her to be able to know what to expect when, and by breaking down big tasks into manageable steps. The rationale for these strategies is that when children know what is expected of them and the steps they have to take to accomplish it, they are more likely to cooperate, which is expected to reduce stress in the parent as well as the child. Parents also learn ways to improve parent-child clear communication with the goal of promoting child cooperation and avoiding power struggles, as well as emotion regulation techniques for themselves and for their child. The effect that stress has on the brain and the ways in which preschool-aged children manifest stress are also explicitly discussed, and parents learn how to monitor their child's emotional regulation and how to respond accordingly and in developmentally appropriate ways. Thus, several of the strategies PCMC-A employs target reducing stress in the home, which raises the hypothesis that reductions in stress might act as an explanatory mechanism for the observed gains in child brain function for selective attention.

Stress has been shown to be negatively associated with the development of cognitive abilities throughout the lifespan, including during childhood (for a review, see Lupien, McEwen, Gunnar, & Heim, 2009). It has also been shown to mediate the relationship between SES and cognitive outcomes, including self-regulation and executive functions (e.g. Blair et al., 2011; for a review, see Blair, 2010), cognitive abilities related to selective attention (Garon et al., 2008). Previous interventions have documented impacts on biological markers of stress in children (for a review, see Slopen, McLaughlin, & Shonkoff, 2014), indicating that physiological stress regulation is malleable to intervention. Furthermore, exposure to stressors associated with SES disadvantage (for a review, see Bradley & Corwyn, 2002) and parenting stress (for a review, see Deater-Deckard, 1998) are negatively associated with supportive parenting. Together, this evidence supports the hypothesis that reductions in stress in the home as a function of PCMC-A could explain intervention-related increases in both child brain function for selective attention and supportive parenting behaviors.

Neville and colleagues (2013) documented that the gains in brain function for selective attention seen in children participating in PCMC-A were accompanied by reductions in self-reports of parenting stress in PCMC-A parents. However, the relationship between intervention-related changes in these two outcomes has not been directly investigated. To further investigate the potential effect of PCMC-A on stress, we are now collecting measures of heart rate variability as a physiological index of stress regulation in both parents and children (Pakulak et al., 2015). Notably, specific aspects of this physiological index of stress regulation in preschoolers from lower SES backgrounds are associated with their brain function for selective attention, as measured by the same neural index examined in the present dissertation (Giuliano et al., under review). This evidence positions intervention-related reductions in stress as a promising alternative mechanism to explain the effect of PCMC-A on child brain function for selective attention. An ongoing study of a modified delivery model of PCMC-A will test this explanatory mechanism, taking a multimethod approach that allows for assessment of different aspects of stress, including changes in perceived stress and physiological stress indices.

An alternative possibility to those already discussed is that the parent and child components of PCMC-A act in parallel. This would mean that the parent component has an effect on supportive parenting and the child component has an effect on brain function for selective attention, but the effect on the former is not related to the effect on the latter. It is possible that improvements in brain function for selective attention are explained by changes in the child resulting from Brain Train, the child component of PCMC-A, rather than by changes in the parent. The activities and strategies that make up Brain Train were explicitly designed to target self-regulation of attention. They provide an opportunity for children to recognize what focusing attention and getting distracted feel like, accompanied by opportunities to practice concrete strategies to sustain their attention and deal with distractions in a controlled and supportive environment. Thus, it is possible that the improvements observed in brain function for selective attention immediately after the intervention period are explained by changes elicited by the strategies employed as part of Brain Train's attention training.

A related additional possibility is that changes in the home leverage Brain Train's attention training. As part of the parent component, parents learn about what their children are doing during Brain Train, including the rationale behind the activities and strategies used to train self-regulation of attention. They also receive the necessary coaching and materials so they can extend the Brain Train activities and strategies to the home. Thus, it is possible that the children of parents who implement the Brain Train activities and strategies in the home to a greater extent show larger gains in selective attention, as these children would have opportunities to practice their attention skills in the home environment in addition to in the context of Brain Train. Thus, if the parent component of PCMC-A succeeds in leveraging the home environment to promote selective attention in this way, it could compound the direct effect of Brain Train, explaining observed gains in child brain function for this ability.

This mechanism could also explain why Neville and colleagues (2013) documented improvements in brain function for selective attention in the PCMC-A group, but not in the ABC child-focused comparison group, in which children received child attention training but contact with the parents was limited. Even though children in the ABC group received a higher dosage of attention training than children in PCMC-A (four weekly 40-min sessions vs. one weekly 50-min session), they did not show the same improvements in selective attention over the intervention period. This could be because their parents did not receive the same level of coaching to extend the attention training activities and strategies to the home environment. Such an interpretation would suggest that the combined effect of child-focused attention training and parent-focused support to extend this training to the home is necessary to impact child brain function for selective attention. Given that the ABC comparison group was not designed as a parametric manipulation of PCMC-A, a study that directly compares the effect of both components of PCMC-A on child brain function for selective attention to the effect of the child component alone would be necessary to examine this question further.

Conclusions and Implications

The present dissertation documented that PCMC-A, a dual-generation intervention, has impacts on both children and parents. We replicated with a larger sample previous findings documenting an effect of PCMC-A on child brain function for selective attention, and extended previously documented changes in parents as a function of the PCMC-A parenting training to observed supportive parenting behaviors during a parent-child interaction. By also investigating differential effects of PCMC-A on these outcomes, we obtained evidence indicating that the impact of PCMC-A was not homogeneous, as dyads with certain characteristics benefitted differentially. Being able to identify the profile of those who benefit from PCMC-A to different extents will inform how to target the program to those who will likely be most responsive to it, following an evidence-based approach to do so. It will also allow for the identification of those children and families who might require adaptations to the program, additional services, or a different approach altogether. As such, this information has the potential to increase the program's efficacy and resource effectiveness, while at the same time help improve the way children and families are matched with existing resources, including assessing whether PCMC-A would be a good fit.

The present dissertation sought to gain precision in our understanding of the way in which PCMC-A, a multifocal intervention program, operates to bring about change in the neurocognitive system it targets: selective attention. To this end, we tested an explanatory mechanism that was informed by theory and prior evidence on the relationship between supportive parenting and cognitive development, as well as by previous findings showing an effect of PCMC-A on brain function for selective attention only when child attention training was coupled with focused parenting training. Even though we documented for the first time that supportive parenting was malleable to PCMC-A, we did not find evidence of a relationship between changes in supportive parenting and changes in child brain function for selective attention when assessed immediately after the intervention period. Having not found support for the proposed explanatory mechanism provides valuable information, as it motivates investigation of other potential explanatory mechanisms, such as the ones previously discussed.

A precise understanding of how PCMC-A operates will enable the identification of the active ingredients that result in its impact. In turn, this information will be instructive in the distillation of PCMC-A to its most impactful elements, which will also increase its feasibility of implementation and its resource effectiveness. Thus, identifying *who* benefits from PCMC-A and understanding *why* this is the case will inform evidence-based, targeted enhancements to refine the program with the goal of reaching more families and maximizing its impact. Having contributed evidence to begin to answer these key questions, the present dissertation project represents a step in that direction.

APPENDIX A

SUPPLEMENTARY FIGURES FOR CHAPTER IV

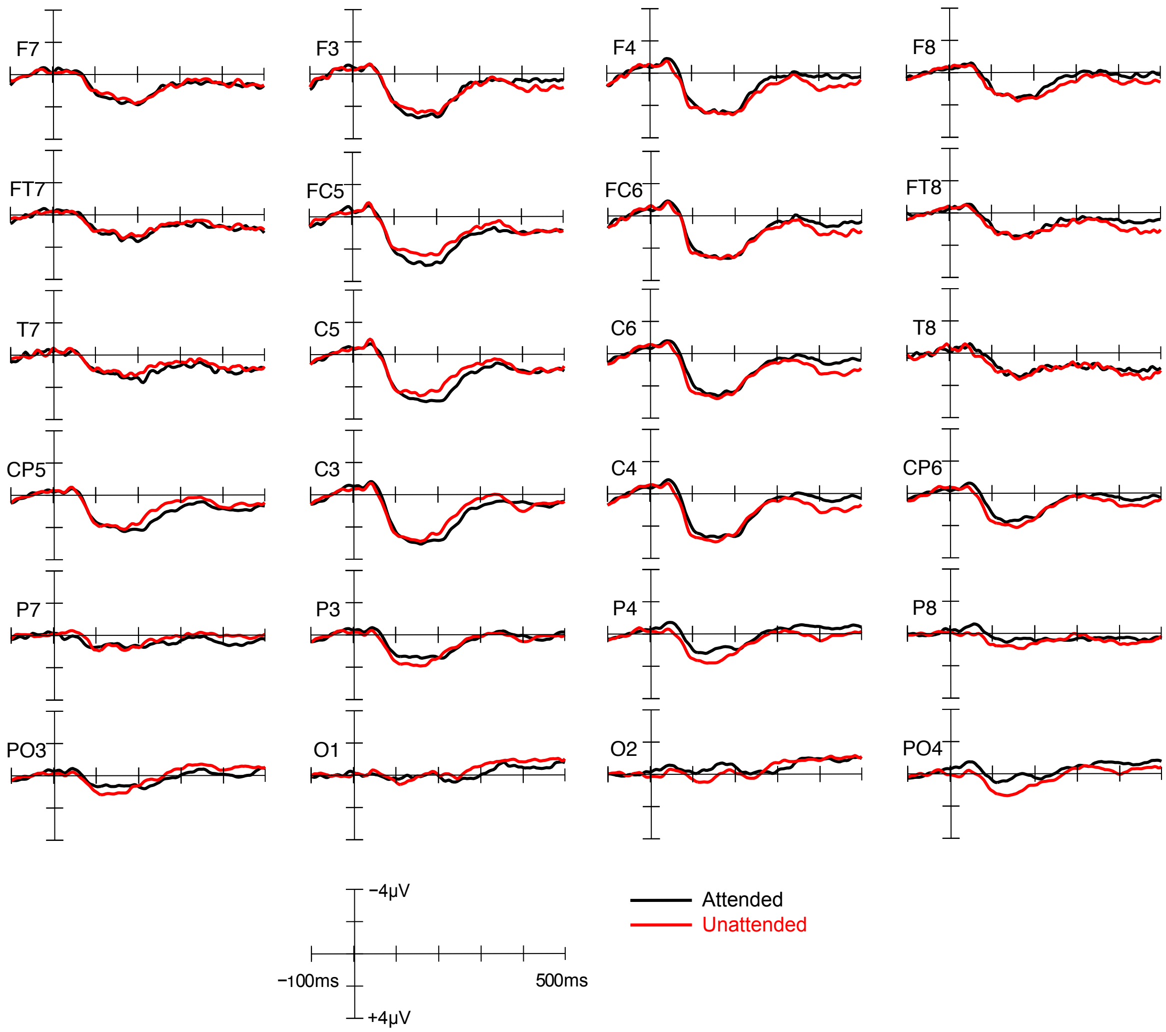

Figure A.1. Grand averaged waveforms showing the ERP response elicited by the attended (black) and the unattended (red) conditions for all electrode sites included in analyses at the pre-assessment for the PCMC-A group. For this and all subsequent ERP figures, negative is plotted upwards.

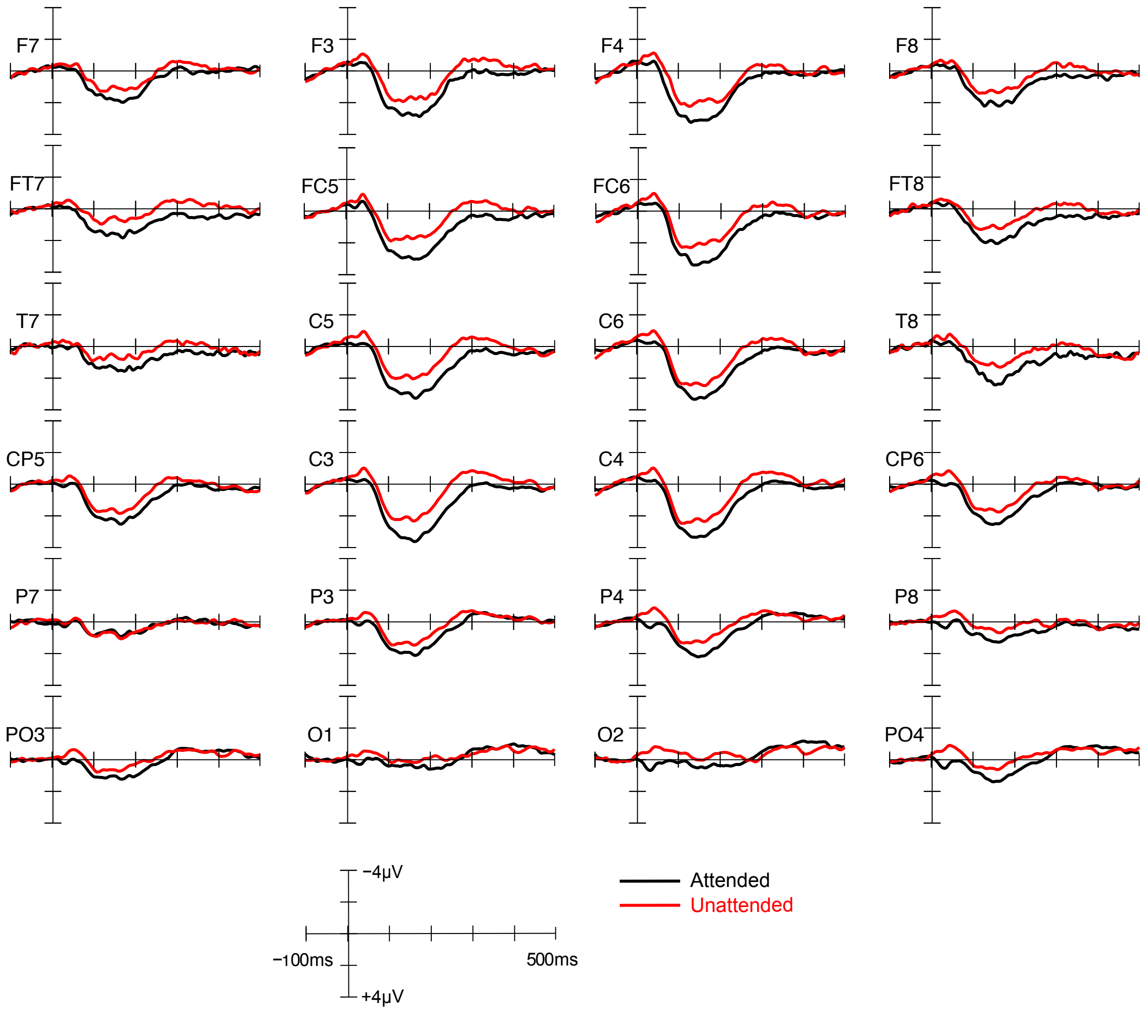

Figure A.2. Grand averaged waveforms showing the ERP response elicited by the attended (black) and the unattended (red) conditions for all electrode sites included in analyses at the post-assessment for the PCMC-A group.

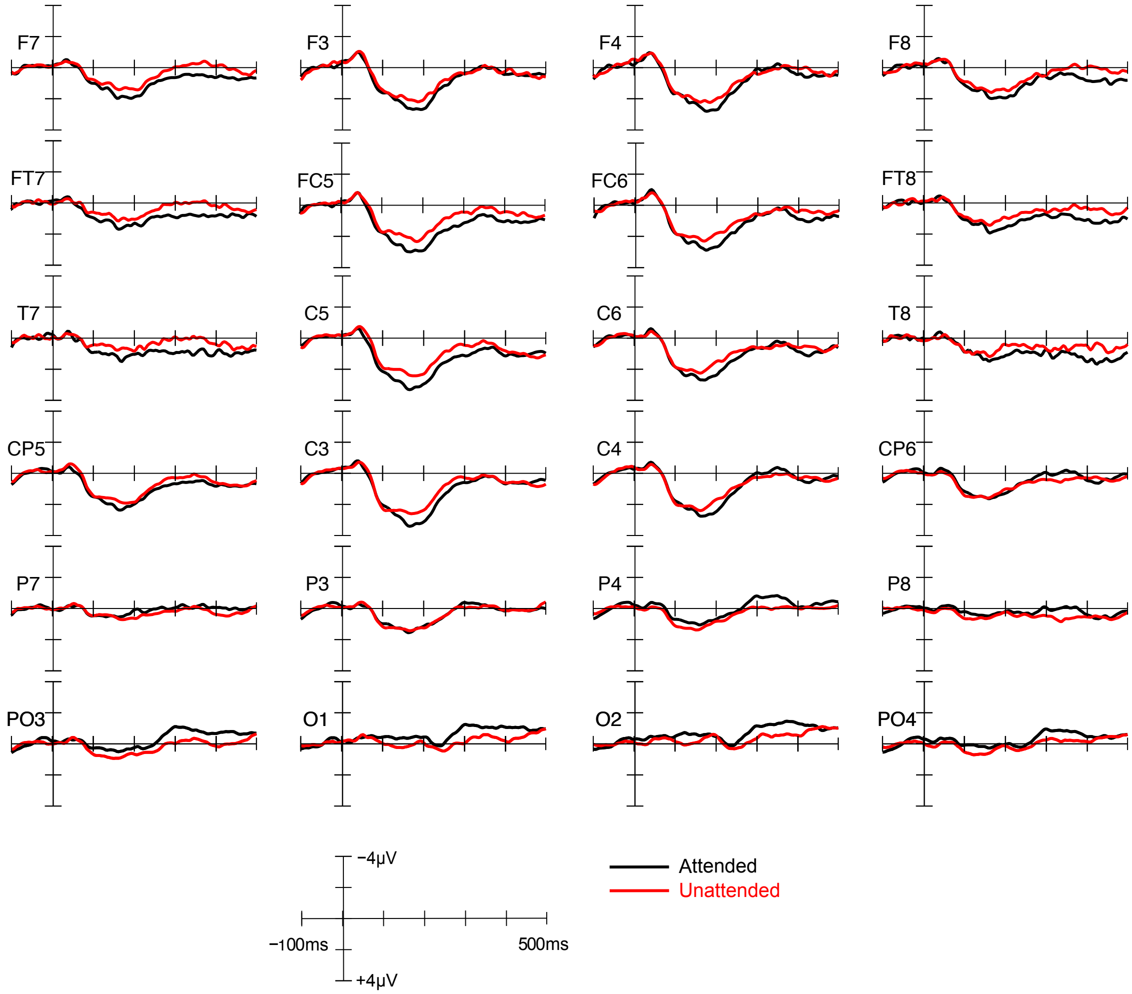

Figure A.3. Grand averaged waveforms showing the ERP response elicited by the attended (black) and the unattended (red) conditions for all electrode sites included in analyses at the pre-assessment for the Control group.

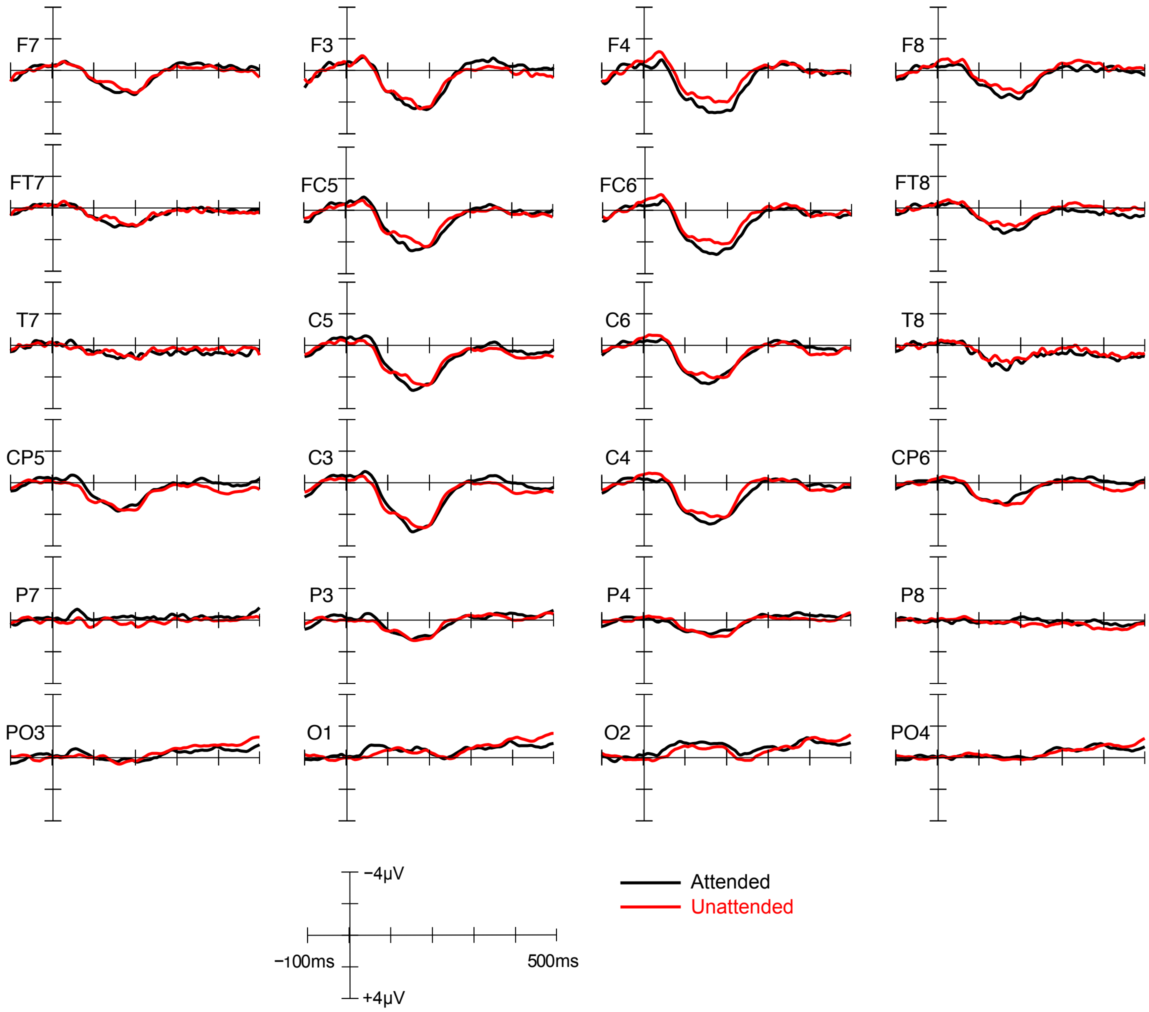

Figure A.4. Grand averaged waveforms showing the ERP response elicited by the attended (black) and the unattended (red) conditions for all electrode sites included in analyses at the post-assessment for the Control group.

APPENDIX B

SUPPLEMENTARY FIGURES FOR CHAPTER V

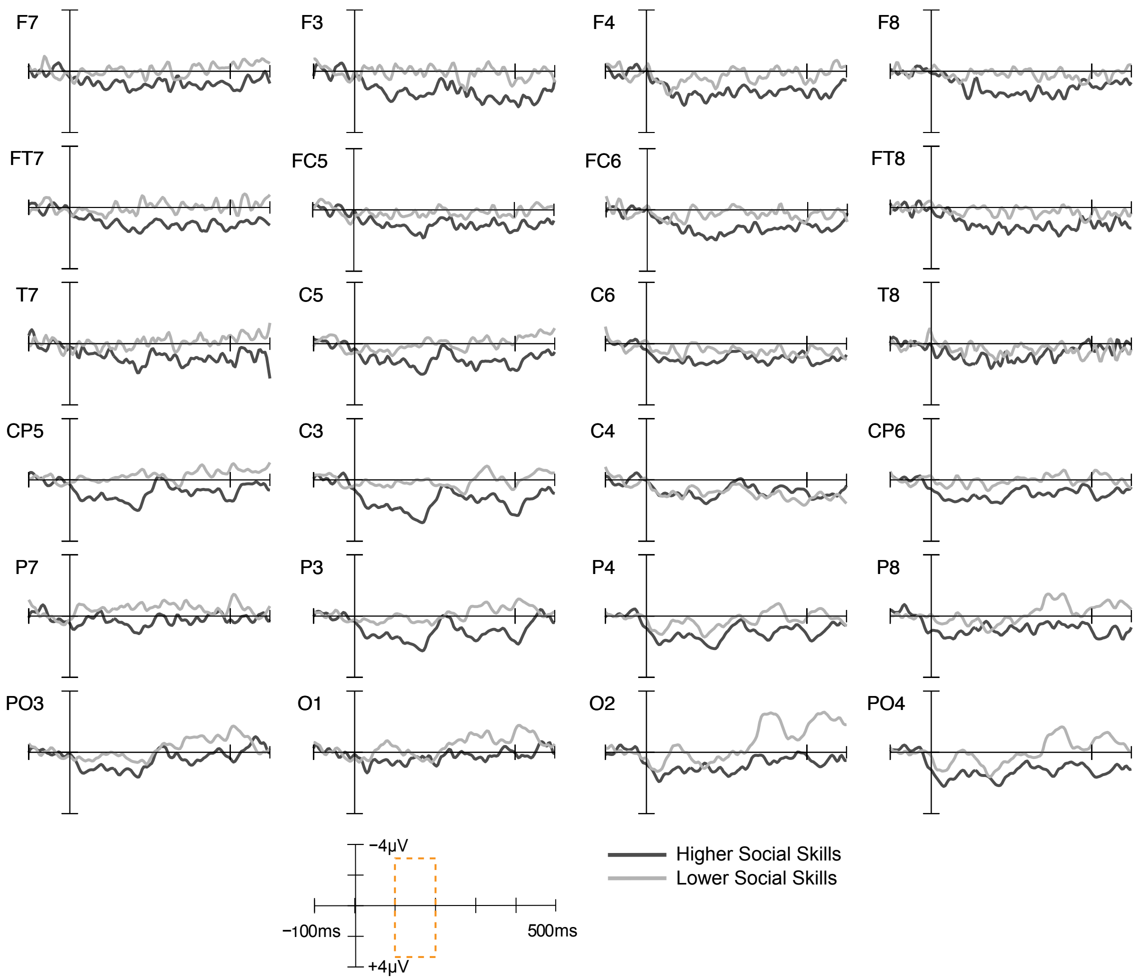

Figure B.1. ERP difference waves for all electrode sites included in analyses showing change in the attention effect (attended – unattended) from pre- to post-assessment for children with high (dark gray) and low (light gray) pre-assessment social skills in the PCMC-A group. The 100-200 ms time window is illustrated in orange.

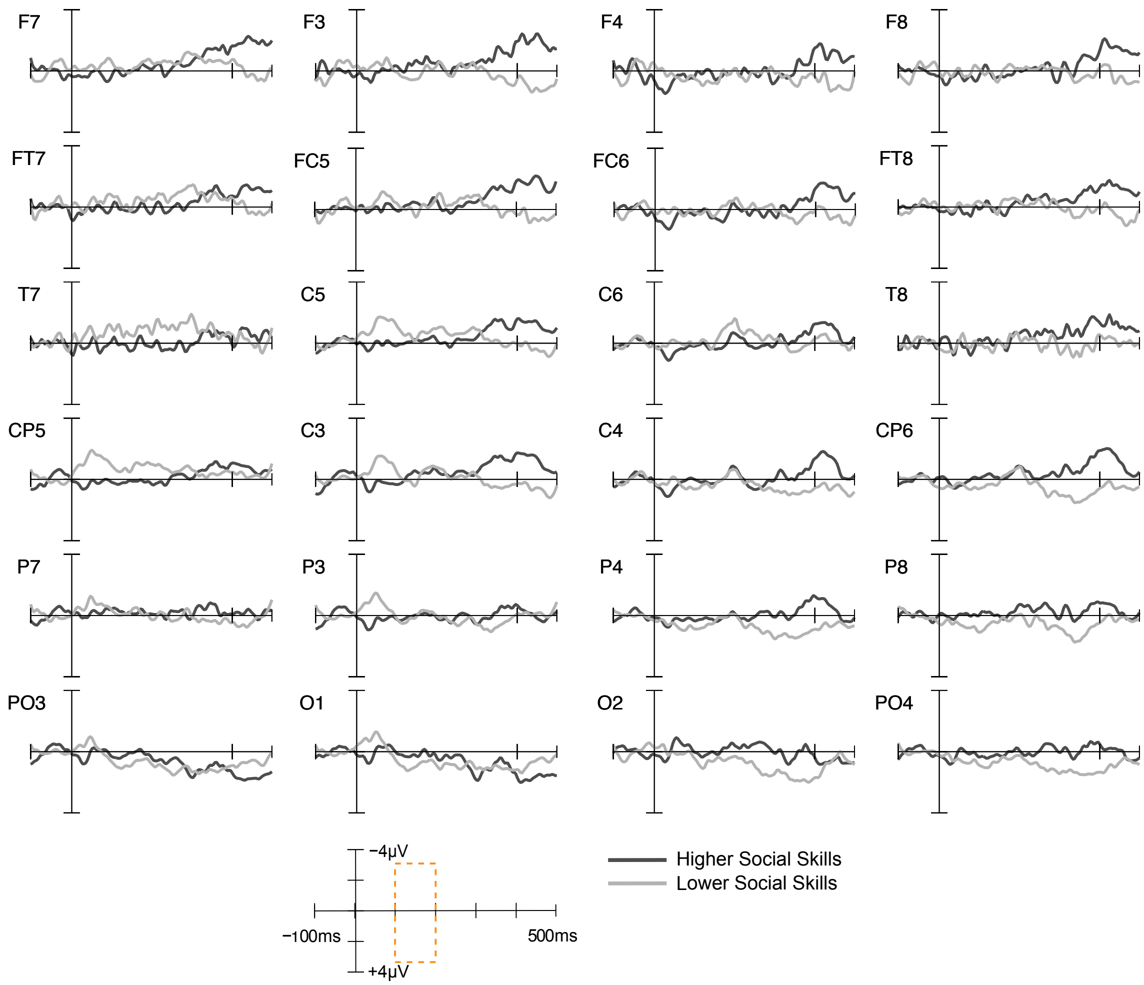

Figure B.2. ERP difference waves for all electrode sites included in analyses showing change in the attention effect (attended – unattended) from pre- to post-assessment for children with high (dark gray) and low (light gray) pre-assessment social skills in the Control group. The 100-200 ms time window is illustrated in orange.

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