Published in final edited form as:

Early Child Res Q. 2016 ; 34: 128–139. doi:10.1016/j.ecresq.2015.10.003.

Effects of a Responsiveness-Focused Intervention in Family Child Care Homes on Children's Executive Function

Emily C. Merz¹, Susan H. Landry², Ursula Y. Johnson², Jeffrey M. Williams², and Kwanghee Jung²

¹Department of Epidemiology, Columbia University, Mailman School of Public Health, 722 West 168th Street, 7th floor, New York, NY 10032, USA

²Children's Learning Institute, University of Texas Health Science Center, 7000 Fannin Street, 23rd floor, Houston, TX 77030, USA

Abstract

Caregiver responsiveness has been theorized and found to support children's early executive function (EF) development. This study examined the effects of an intervention that targeted family child care provider responsiveness on children's EF. Family child care providers were randomly assigned to one of two intervention groups or a control group. An intervention group that received a responsiveness-focused online professional development course and another intervention group that received this online course plus weekly mentoring were collapsed into one group because they did not differ on any of the outcome variables. Children ($N = 141$) ranged in age from 2.5 to 5 years (mean age = 3.58 years; 52% female). At pretest and posttest, children completed delay inhibition tasks (gift delay-wrap, gift delay-bow) and conflict EF tasks (bear/dragon, dimensional change card sort), and parents reported on the children's level of attention problems. Although there were no main effects of the intervention on children's EF, there were significant interactions between intervention status and child age for delay inhibition and attention problems. The youngest children improved in delay inhibition and attention problems if they were in the intervention rather than the control group, whereas older children did not. These results suggest that improving family child care provider responsive behaviors may facilitate the development of certain EF skills in young preschool-age children.

Keywords

caregiver responsiveness; early childhood; inhibitory control; attention control

Executive function (EF) refers to a set of cognitive processes that are linked with the prefrontal cortex and support flexible, goal-directed behavior (Jones, Rothbart, & Posner, 2003; Kane & Engle, 2002; Osaka et al., 2003; Peake, Hebl, & Mischel, 2002). EF skills,

Corresponding Author: Emily Merz, Department of Epidemiology, Columbia University, Mailman School of Public Health, 722 West 168th Street, 7th floor, New York, NY 10032, USA Phone: (412) 526-9379, emilymerz@gmail.com.

Publisher's Disclaimer: This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

such as inhibiting an automatic response, updating information in working memory, and shifting between rules or behaviors, are robust predictors of school readiness, academic achievement, and social-emotional competence (Duncan et al., 2007; Espy, Sheffield, Wiebe, Clark, & Moehr, 2011; Welsh, Nix, Blair, Bierman, & Nelson, 2010). Given that early childhood is a period of rapid growth and considerable plasticity in EF processes (Garon, Bryson, & Smith, 2008; Rueda, Posner, & Rothbart, 2005), early experience may play an important role in shaping children's EF development.

Supporting the development of EF skills early in life increases children's chances of positive academic and social-emotional outcomes. Interventions in prekindergarten and Head Start settings have been shown to improve children's EF development (Bierman, Nix, Greenberg, Blair, & Domitrovich, 2008; Diamond, Barnett, Thomas, & Munro, 2007; Raver et al., 2011; Weiland & Yoshikawa, 2013). However, little is known about the effects of interventions conducted in child care settings on EF. Furthermore, caregiver responsiveness, a broad construct emphasizing sensitive and contingent responding to children's cues, has been identified as a robust predictor of children's EF development (Bernier, Carlson, & Whipple, 2010; Conway & Stifter, 2012; Hamre, Hatfield, Pianta, & Jamil, 2014), suggesting that improving responsiveness may be a crucial component of an effective child care intervention.

As such, the purpose of the current study was to investigate the effects of an intervention that targeted family child care provider responsiveness on children's EF skills. Child care providers in the intervention group received training that emphasized responsiveness primarily via an online professional development course, and children completed EF assessments at pretest and posttest. The results of this study were expected to shed light on the ways in which family child care might be improved to enhance children's early EF skills.

Executive Function Processes

Two EF processes that have been highlighted in the developmental literature are *delay inhibition* and *conflict EF* (Bernier, Carlson, & Whipple, 2010; Bernier, Carlson, Deschênes, & Matte-Gagné, 2012; Carlson, Mandell, & Williams, 2004; Conway & Stifter, 2012). Delay inhibition tasks (e.g., delay of gratification tasks) require children to control impulses or inhibit an automatic response in the context of a reward. Conflict EF tasks require children to suppress a dominant response while executing a novel, conflicting response and holding information in working memory (Carlson & Moses, 2001; Carlson, White, & Davis-Unger, 2014). Conflict EF tasks include Stroop-like inhibition tasks (e.g., day/night, bear/dragon) and attention shifting tasks (e.g., dimensional change card sort [DCCS]; Bernier et al., 2010; Carlson & Moses, 2001; Carlson et al., 2004; Matte-Gagné & Bernier, 2011). Factor analytic studies of preschool-age children have yielded empirical support for separate delay inhibition and conflict EF dimensions (Bernier et al., 2010; Bernier et al., 2012; Carlson & Moses, 2001; Carlson et al., 2004; Conway & Stifter, 2012; Matte-Gagné & Bernier, 2011) and, similarly, separate "hot" (affectively salient) and "cool" (affectively neutral) EF dimensions (Brock, Rimm-Kaufman, Nathanson, & Grimm, 2009; Kim, Nordling, Yoon, Boldt, & Kochanska, 2013; Willoughby, Kupersmidt, Voegler-Lee, &

Bryant, 2011; Zelazo & Carlson, 2012), although not all findings are consistent (Allan & Lonigan, 2011; Sulik et al., 2010).

There is also evidence that delay inhibition and conflict EF differ in their developmental course, predictors, and associations with social-emotional and academic outcomes (Allan, Hume, Allan, Farrington, & Lonigan, 2014; Carlson, 2005; Lengua et al., 2014; Li-Grining, 2007). For instance, preschoolers' delay inhibition but not conflict EF accounted for unique variance in later internalizing and externalizing problems (Kim et al., 2013; Smith-Donald, Raver, Hayes, & Richardson, 2007), whereas conflict EF but not delay inhibition made unique contributions to growth in emergent literacy and mathematics (Brock et al., 2009; Bull, Espy, & Wiebe, 2008; Clark, Pritchard, & Woodward, 2010; McClelland et al., 2007; Welsh et al., 2010; Willoughby et al., 2011).

The construct of executive attention, which refers to attention processes under cognitive control, overlaps considerably with the construct of EF (Rueda et al., 2005; Zhou, Chen, & Main, 2012). For instance, some EF skills and tasks, such as inhibitory control skills measured using Stroop-like tasks, have also been studied as executive attention skills and tasks (Zelazo et al., 2013), illustrating the close association between attention regulation and EF (Cuevas & Bell, 2014). Although these skills are typically measured using performance-based tasks, rating scales have been used to understand children's EF and attention regulatory behavior in everyday contexts (Bierman et al., 2008; Clark et al., 2010; Raver et al., 2011). Measures of EF using rating scales have also been found to predict later academic achievement (Clark et al., 2010).

Early Experience and Executive Function Development

Children's early experiences are linked with variability in their EF skills. Although the home environment is a central context for early development, many children spend a significant amount of time in child care and preschool settings during their early years (Laughlin, 2013). The quality of child care and preschool contexts has been associated with children's EF and attention skills (NICHD ECCRN, 2005; Rimm-Kaufman, Curby, Grimm, Nathanson, & Brock, 2009). For example, teacher responsiveness and positive classroom management and routines are associated with growth in EF skills across the preschool year (Hamre et al., 2014).

Interventions improving prekindergarten or Head Start quality have been found to enhance children's EF outcomes (Diamond, Barnett, Thomas, & Munro, 2007; Weiland & Yoshikawa, 2013). For instance, the Head Start REDI intervention improved 3- to 5-year-old children's attention shifting (DCCS task) and interviewer-rated attention and self-regulatory skills (Bierman et al., 2008). Also, Head Start children in the Chicago School Readiness Project (CSRP) intervention outperformed control children in terms of their conflict EF and interviewer-rated attention and impulsivity but not their delay of gratification skills (Raver et al., 2011). However, few studies have examined the effects of interventions conducted in child care settings on EF.

Family or home-based child care, defined as care that takes place in the provider's home, is one of the most common non-parental child care arrangements for young children in the

United States (Laughlin, 2013). In particular, low-income families frequently use family child care (Burchinal, Howes, & Kontos, 2002; Dowsett, Huston, Imes, & Gennetian, 2008; NICHD ECCRN, 2004). Some evidence suggests that family child care homes are often lower in quality than center-based care, although both types of care vary widely in their quality (NICHD ECCRN, 2004; Votruba-Drzal, Coley, & Chase-Lansdale, 2004; Fuller, Kagan, Loeb, & Chang, 2004; Loeb, Fuller, Kagan, & Carrol, 2004; Ruzek, Burchinal, Farkas, & Duncan, 2014). In addition, children in family child care settings show lower school readiness skills compared to children in center-based child care (Ansari & Winsler, 2013; Burchinal et al., 2000; Gordon, Colaner, Usdansky, & Melgar, 2013; Loeb et al., 2004; NICHD ECCRN, 2006; NICHD ECCRN & Duncan, 2003).

Some previous studies have examined the effects of interventions conducted in family child care homes, with several targeting the linguistic stimulation caregivers provided to the children (Koh & Neuman, 2009). For example, family child care providers who received a 10-hour in-service training focused on supporting children's early language development provided greater language stimulation to children compared to providers in the control group (Ota & Austin, 2013). Other interventions have targeted family child care provider sensitivity and support for children's social development (Howes, Galinsky, & Kontos, 1998). For example, a 6-session video-feedback intervention targeting child care provider sensitivity and behavior management improved global child care quality, but not provider sensitivity, in the Netherlands (Groeneveld, Vermeer, van IJzendoorn, & Linting, 2011). Also, family child care providers who completed a 9-hour video-based training program on promoting children's social development increased their use of effective behavior management practices compared to the control group, and more effective behavior management was associated with decreased externalizing behavior across children in care (Rusby, Smolkowski, Marquez, & Taylor, 2008). Given the lack of studies examining children's EF outcomes, studies are needed that investigate the effects of interventions conducted in family child care homes on children's EF development.

Caregiver Responsiveness and Executive Function Development

Caregiver responsiveness is thought to be crucial to early EF development. As conceptualized across theoretical frameworks including attachment theory and socio-cultural theory, responsiveness encompasses a broad set of behaviors emphasizing warm acceptance of the child's needs and interests, sensitive and contingent responses to child signals (Ainsworth, Blehar, Waters, & Wall, 1978), scaffolding the child's ability to maintain attention (Vygotsky, 1978), and rich language input attuned to the child's developmental needs (Landry, Smith, & Swank, 2006; Landry, Smith, Swank, Assel, & Vellet, 2001). Caregiver responsiveness is theorized to foster a secure attachment, which in turn encourages the child to explore the environment and engage in problem-solving activities (Bernier et al., 2012). From a neurobiological perspective, caregiver responsiveness is also thought to facilitate regulation of the child's emotions and stress-response systems (Gunnar & Quevedo, 2007), enabling development of the prefrontal networks underlying EF (Blair, 2010; Blair et al., 2011; Loman & Gunnar, 2010; McEwen & Gianaros, 2010). In addition, caregiver responsiveness may ensure that the child gets to take the lead and make choices during social interactions and learning activities, which supports the child's autonomy

(Grolnick & Ryan, 1989). Although these theories focus on parental responsiveness, caregiver responsiveness in child care and preschool settings may influence child EF via some of the same mechanisms.

Empirical research has revealed robust longitudinal associations between parental responsiveness and early EF development (Bernier et al., 2010; Conway & Stifter, 2012; Lengua, Honorado, & Bush, 2007). Some research has also focused on responsiveness in early care and education settings. For instance, child care provider sensitivity was found to benefit children's cognitive development, even after taking parental sensitivity into account (Hirsh-Pasek & Burchinal, 2006). In addition, higher responsiveness in early care and education settings has been found to promote children's EF development (Hamre et al., 2014). Therefore, enhancing child care provider responsiveness may be a key feature of an intervention that is effective at improving children's early EF.

Moderating Role of Child Age and Initial EF Skill Level

Examining moderators of intervention effects can yield information used to match children with effective interventions and increase our understanding of the mechanisms underlying intervention effects. Interventions may differentially influence children's development based on child age or initial skill level. Previous research with preschool-age children has found that younger children and those with lower initial skill levels benefited the most from interventions. For instance, younger preschoolers were found to benefit in terms of their level of conduct problems from the Incredible Years parenting intervention to a greater degree than older preschoolers (Gardner, Hutchings, Bywater, & Whitaker, 2010). Similarly, children with lower initial EF skills levels have demonstrated greater developmental gains than those with higher initial EF skills (Razza, Bergen-Cico, & Raymond, 2013; Tominey & McClelland, 2011). For example, children with lower initial EF skills demonstrated greater gains in social competence and cognitive skills from the Head Start REDI intervention compared to those with higher initial EF skills (Bierman et al., 2008). Children who start interventions with low levels of EF skills may have the opportunity for more growth and variability in gain scores. In the case of caregiving or teaching interventions, it is also possible that children with lower initial EF skills depend more on the support that high caregiving quality provides in order to develop self-regulatory skills (Karreman, van Tuijl, Van Aken, & Dekovic, 2006; Kopp, 1982).

Furthermore, the intervention in the current study targeted caregiver responsiveness, which may be especially important to EF development in younger preschool-age children (Bernier et al., 2010). At older preschool ages, when children are more socially advanced and interested in testing limits, other caregiving practices such as the caregiver's ability to employ positive behavior management strategies may have a stronger impact on EF development (Raver et al., 2011). Thus, based on these prior studies, we investigated whether effects of the current intervention on children's EF were moderated by child age and initial EF skill level.

Current Study

The primary goal of this study was to examine the effects of an intervention targeting family child care provider responsiveness on EF in 2.5- to 5-year-old children. Participants were a sub-sample from a larger study examining the effects of this intervention on a range of cognitive and social-emotional skills in infants through preschoolers (Johnson, Landry, & Jung, 2015). Child care providers in the intervention group received training in responsiveness primarily via an online professional development course. At pretest and posttest, children completed delay inhibition and conflict EF assessments and parents reported on the children's attention problems. Including delay inhibition, conflict EF, and parent-reported attention problems as outcomes allowed us to examine the effectiveness of the intervention with regard to different EF processes and from the perspective of both direct measurement and observations of behavior in everyday contexts.

First, we investigated intervention effects on child care provider responsive behavior to ensure that the intervention produced changes in the caregiving environment that would be expected to improve children's EF. These analyses relied on data from observations of the child care providers interacting with the children in their care at pretest and posttest. Second, we examined main effects of the intervention on children's EF as well as whether intervention effects on EF were moderated by child age or initial EF skill level.

Method

Participants

Recruitment—Participants were a sub-sample from a larger study conducted in Houston, Texas that evaluated the effects of an online professional development course, called Beginning Education: Early Childcare at Home (BEECH; see Johnson, Landry, & Jung, 2015 for details). The MASKED Department of Family and Protective Services online database was used to identify licensed and registered child care homes. Home-based child care providers were then contacted by email and/or phone to determine eligibility and interest. Eligibility criteria included operation of a full-day licensed or registered child care, a minimum enrollment of three children age 5 years or younger, and access to a computer with high-speed internet. Family child care providers who were eligible and interested were then consented into the study and randomly assigned to one of three conditions: 1) online professional development course plus mentoring (BEECH+Mentor group), 2) online professional development course only (BEECH group), or 3) business-as-usual control. Parents provided informed consent for their children to participate in the study. Eligible children attended child care for a minimum of four hours per day on a regular basis and did not attend another child care or early education program.

Children between 2.5 and 5 years of age who were consented into the larger study were eligible to participate in the EF tasks. Child care home visits were conducted to administer EF tasks to the children. We attempted to test all of the eligible children in family child care homes assigned to the BEECH+Mentor and control groups. For the BEECH group, we only visited child care homes that had two or more eligible children and thus only tested eligible children in these child care homes. This approach resulted in 80% of the total number of 2.5-

to 5-year-old children participating in EF testing (92% of those in the BEECH+Mentor group, 99% of those in the control group, and 52% of those in the BEECH group). There were no significant differences in age, gender, race/ethnicity, or parental education between eligible children who participated in EF testing and those who did not.

Child and family characteristics—Participants were 2.5- to 5-year-old children (52% female; see Table 1). Of the 141 total children, there were 61 in the control group, 33 in the BEECH group, and 47 in the BEECH+Mentor group. As described in the Statistical Analyses section, the BEECH and BEECH+Mentor groups were collapsed into one intervention group because they did not differ significantly on any of the outcome measures. The intervention and control groups did not differ in child age, gender, parental marital status, parental education, number of parents in the household, or hours in child care per week, but they differed in racial/ethnic composition with the control group having a higher percentage of Caucasian/White children and lower percentage of Hispanic/Latino children, $\chi^2(2) = 8.29, p < .05$ (see Table 1). Children of child care providers ($n = 8$) were excluded from analyses (children being cared for by their parents, who were family child care providers).

Of the 166 children who participated in EF testing at pretest, 141 children participated in EF testing at posttest, representing a relatively low overall attrition rate of 15%, with no differential attrition between the intervention and control groups. One main reason that children did not complete the posttest EF assessment was that two child care providers dropped out of the study (see below) and thus the children in their care ($n = 6$) did not participate at posttest. The second main reason was that children left the child care home or were not available for testing after several visits to the child care home ($n = 19$). Children who left the study did not differ significantly from those who remained in the study in terms of child age, gender, race/ethnicity, parental marital status, parental education, number of parents in the household, hours in child care per week, or pretest EF and attention problems scores.

Family child care provider characteristics—Of the 64 family child care providers at pretest, 62 participated at posttest (two child care providers dropped out of the study due to time constraints or closing the child care home). Twenty-eight providers were in the control group, 13 were in the BEECH group, and 21 were in the BEECH+Mentor group. All of the providers were licensed, female, and spoke English with the children in their care; 74% were racial/ethnic minorities (see Table 1). They had an average of 10 years childcare experience. They all had at least a high school education, and 47% had higher levels of education. There was an average of five total children (ranging from infancy to preschool-age) per child care home. Child care provider race/ethnicity, years of teaching experience, and education did not differ significantly between the intervention and control groups (see Table 1).

Intervention Procedure

The intervention was adapted from an empirically-supported responsive parenting intervention model, NAME MASKED (ACRONYM MASKED; REF MASKED), which is grounded in the attachment and socio-cultural theories (Ainsworth et al., 1978; Vygotsky,

1978) and teaches the use of a range of responsive behaviors to promote children's early social-emotional and cognitive development. Child care providers in both the BEECH and BEECH+Mentor groups completed the BEECH online professional development course and attended three in-person training sessions. Child care providers in the BEECH+Mentor group also had a mentor visit weekly. All child care providers received three sets of learning materials (e.g., paper, crayons, scissors, paint, toys, and books).

Online professional development course—The online professional development course consisted of 20 weekly sessions and took about five months to complete. Each session took approximately one hour and included review of the previous session's content, introduction of a new concept, testing knowledge through questions about video clips, case studies, and multiple-choice quizzes, discussing experiences applying new concepts with other child care providers online, and choosing additional materials to put concepts into practice (e.g., video clips, handouts, and online resources). The course used documentary video of caregivers and children interacting along with voice-overs as a way of introducing new concepts.

Child care providers were taught how to use responsive strategies including exhibiting warmth and acceptance, responding in a sensitive and contingent manner to children's cues (e.g., staying attuned and expanding on children's interests, providing opportunities for children to take the lead during activities, understanding when to step in and help), maintaining rather than redirecting children's attention, and providing rich language input and interactive conversations matched to children's needs (e.g., labeling and connecting objects and actions). Child care providers learned to incorporate these practices into playtime, everyday routines (e.g., meal time, dressing, transitions, and clean-up), and learning activities focused on early literacy and math skills (e.g., shared book reading, nursery rhyme activities, counting and shape recognition activities). Additional sessions covered developmentally-appropriate behavior management strategies and progress monitoring.

In-person training sessions—In addition to the online course, child care providers in the BEECH and BEECH+Mentor groups attended three, 4-hour in-person training sessions on Saturdays. The training sessions were held at the beginning, middle, and end of the online course and consisted of resolving any technical issues and covering content that corresponded to what was being covered in the online course. In each of these sessions, new concepts were introduced and demonstrated and then the child care providers practiced applying them.

Mentoring—Trained and certified mentors made weekly visits to the child care providers in the BEECH+Mentor group and worked with them on concepts they were learning in the online course. Mentoring sessions were guided by a script, which included time to reinforce session content and coach practice of newly learned skills. Ten mentoring sessions were held during active time to practice strategies, and 10 sessions were held during nap time to review video and discuss challenges and successes in implementing strategies.

During the certification process, the trainer observed the mentor facilitating a session with a child care provider, took notes using a certification checklist (e.g., ability to build rapport, content knowledge, and use of mentoring/coaching strategies), and then provided written and verbal feedback to the mentor. The mentor was then observed a second time using the same certification checklist to ensure that she had addressed any issues from the first observation. Mentors received certification if all criteria on the checklist were met at an acceptable level, and all mentors were certified after two observations. Once mentors started working with child care providers, mentoring quality was monitored through weekly supervision meetings in which mentors showed video of themselves mentoring in the child care homes. Also, trainers observed a mentoring session in-person a minimum of once a month for each mentor and used the certification checklist to monitor fidelity and improve mentoring skills.

Dosage and fidelity—Dosage was adequate for the online professional development course in both the BEECH and BEECH+Mentor groups, as the child care providers in both groups completed nearly all of the online course sessions. Specifically, BEECH group child care providers completed 97% of the video-related questions in sessions 1–20, 98% of the quizzes, and 98% of the case studies. An average of 2.98 posts were posted in the discussion forum for each session. Similarly, BEECH+Mentor group child care providers completed 96% of the video-related questions, 96% of the quizzes, and 96% of the case studies; they had average of 3.01 posts in each discussion forum. On average, child care providers in the BEECH+Mentor group received 18.95 out of 20 mentoring sessions ($SD = 1.07$; range = 16–20; see also Johnson, Landry, & Jung, 2015 for fidelity information).

Assessment Procedure

At pretest and posttest, child care providers were rated by trained observers during a one hour visit to the child care home, children completed an EF task battery, and parents completed the Child Behavior Checklist (CBCL; Achenbach & Rescorla, 2000). Pretest child EF assessments were conducted in October through the beginning of December, with the majority (76%) occurring in October and November, and pretest Teacher Behavior Rating Scale (TBRS; Landry, Crawford, Gunnewig, & Swank, 2000) assessments were conducted in October and November. Posttest TBRS and child EF assessments were conducted in April and May. There were no significant differences in the timing of the pretest or posttest TBRS or child EF assessments across groups.

The first author and two, trained research assistants administered the EF tasks; the research assistants were blind to condition but the first author was not. All children completed the gift delay-wrap, gift delay-bow, and bear/dragon tasks. Three- to 5-year-old children also completed the DCCS task. The EF tasks were administered in the same order to all children: bear/dragon, DCCS (only 3- to 5-year-olds), gift delay-wrap, and gift delay-bow. Children's performance on the gift delay-wrap, gift delay-bow, and bear/dragon tasks was videotaped and then coded in the lab; the DCCS was scored by the examiner who administered the task. Coding of the EF tasks was completed by one individual who was trained to reliability by a master coder (80% agreement with the master coder). To assess inter-rater reliability,

another trained coder coded 10% of the EF task batteries; intra-class correlations (ICCs) are reported below for each task.

Measures

Child care provider responsive behaviors—The TBRS (Landry et al., 2000) was used to evaluate child care provider responsive behaviors at pretest and posttest. The TBRS consists of eight subscales which include items that capture both quality and quantity of specific responsive behaviors: Sensitivity (12 items; e.g., *Uses sensitivity behaviors when responding to children's signals and needs*), Classroom Community (6 items; e.g., *Orients children to the expectations of the classroom through established rules and routines*), Oral Language (7 items; e.g., *Uses "thinking" questions or comments to support children's thinking or activity of interest*), Book Reading Behaviors (7 items; e.g., *Teacher paces the reading to fit the type of book being read and to allow for children to be involved through comments and questions*), Phonological Awareness (1 item; e.g., *Provides phonological awareness activities from the developmental continuum, for example, listening, sentence segmenting, and syllable blending*), Print and Letter Knowledge (7 items; e.g., *Provides opportunities for children to compare and discuss same/different in letters, names, and words*), Written Expression (1 item; e.g., *Provides children with a variety of opportunities and materials to engage in writing*), and Math Concepts (5 items; e.g., *Involves children in organized hands-on activities that support one or more conceptual areas in math, for example, number, arithmetic, space and geometry, patterns, and measurement*).

Quantity ratings are made on a 4-point scale with 1 = *never* and 4 = *often*. Quality ratings are made on a 4-point scale with 1 = *low* and 4 = *high*. For each subscale, quality and quantity scores, which were strongly correlated, were averaged to compute the subscale score used in analyses. The subscale scores were averaged to compute a TBRS total score. Interrater reliability for the TBRS ranged from .71 to 1.00 in a previous study with a child care sample (Landry et al., 2014). In this study, interrater reliability, which was conducted for 13% of the TBRS observations, was acceptable for most subscales, ranging from .71 to .92. However, it was .61 for Oral Language and .64 for Book Reading Behaviors. Internal consistency was in the acceptable range for all TBRS scores (Cronbach's $\alpha = .68 - .78$ at pretest and $.69 - .84$ at posttest).

Delay inhibition—In the gift delay-wrap task (Kochanska, Murray, & Harlan, 2000; Li-Grining, 2007), children were told that they would be receiving a present but that they could not peek while the present was being wrapped. Children were then instructed to turn their backs to the examiner as the examiner noisily wrapped the present for 60 seconds. A score for strategy (0 = does not peek, 1 = peeks over shoulder, 2 = turns body in seat to peek; 3 = leaves seat to peek) was given for every 15 seconds of the task. Scores for strategy (summed across four segments of the task and reverse-scored) and latency to peek (in seconds) were correlated ($r = .73$ at pretest; $r = .79$ at posttest). These scores were standardized and averaged to create the gift delay-wrap score used in analyses (interrater reliability: ICC = .86-.95).

In the gift delay-bow task (Kochanska et al., 2000), the wrapped gift was placed on the table in front of the child and the child was told to wait in his/her chair and not to touch or open the gift until the examiner returned with a bow. The delay lasted two minutes. A strategy score (0 = does not touch the box, 1 = touches the box but does not open it, 2 = lifts the lid of the box 2 inches, 3 = lifts the lid of the box 3 inches or takes lid off, 4 = removes toy from box or touches toy in box) was given for every 15 seconds of the task. Scores for strategy (summed across eight segments of the task and reverse-scored) and latency to touch (in seconds) were correlated ($r = .63$ at pretest; $r = .57$ at posttest). These scores were standardized and averaged (interrater reliability: ICC = .94–.99).

Conflict EF—In the bear/dragon task (Carlson, 2005; Garon et al., 2008; Jones et al., 2003), children were told to follow the “nice” bear puppet’s commands (e.g., touch your nose) but not the “mean” dragon puppet’s commands. After practicing, there were 12 test trials (two sets of 6 trials, with a reminder of the rules in the middle) with the bear and dragon commands alternating in pseudo-random order. Trial scores ranging from 0–2 (0 = no movement, 1 = partial movement, 2 = full movement) were summed for the bear and the dragon separately. Performance on dragon trials (reverse-scored so higher is better) served as an index of conflict EF (ICC = .98–.99). Internal consistency reliability for this task was high at pretest (Cronbach’s $\alpha = .97$) and posttest (Cronbach’s $\alpha = .96$).

In the Dimensional Change Card Sort task (DCCS; Frye, Zelazo, & Palfai, 1995; Zelazo et al., 2003), children were seated facing a box with a picture of a red rabbit on it and another box with a picture of a blue boat on it. Children were then presented with a series of sorting cards (red and blue rabbits and boats) and instructed to sort the cards by shape. After five consecutively correct trials, children were instructed to sort the cards by color. The examiner reminded the child of the sorting rule before each trial. The five post-switch trials consisted of two trials that were compatible with sorting by shape and three trials that were incompatible with sorting by shape. The total number of correct post-switch trials served as the outcome measure. The DCCS task is reported to have high interrater reliability, to be sensitive to age, and to be moderately correlated with other established EF measures (Carlson, 2005).

The correlations between the two delay inhibition tasks (pretest: $r = .42$; posttest: $r = .40$) and between the two conflict EF tasks (pretest: $r = .67$; posttest: $r = .63$) tended to be stronger than those across delay inhibition and conflict EF tasks (pretest: $r = .16$ to $.43$; posttest: $r = .13$ to $.36$). Based on prior findings that yielded two EF dimensions (Bernier et al., 2010; Bernier et al., 2012; Carlson et al., 2004), a principal components analysis was conducted on the gift delay-wrap, gift delay-bow, bear/dragon, and DCCS measures at both pretest and posttest. As expected, at pretest, two components (eigenvalues > 1) emerged after rotation reflecting delay inhibition and conflict EF and accounting for 79% of the total variance. Gift delay-wrap (.70) and gift delay-bow (.93) loaded on the delay inhibition component, whereas bear/dragon (.91) and DCCS (.90) loaded on the conflict EF component. No cross-loadings ($> .35$) were observed, and the correlation between the two factors was .28.

Similarly, at posttest, two components (eigenvalues > 1) emerged after rotation reflecting delay inhibition and conflict EF and accounting for 75% of the total variance. Gift delay-wrap (.78) and gift delay-bow (.86) loaded on the delay inhibition component, whereas bear/dragon (.89) and DCCS (.91) loaded on the conflict EF component. No cross-loadings ($>.35$) were observed, and the correlation between the two factors was .28. A delay inhibition composite score was calculated by averaging the z scores of the gift delay-wrap and gift delay-bow tasks. A conflict EF composite was created by averaging the z scores of the bear/dragon and DCCS tasks.

Attention problems—Parents completed the Child Behavior Checklist 1.5–5 (CBCL; Achenbach & Rescorla, 2000) based on observations of the child’s behavior in the previous two months (0 = not true, 1 = somewhat or sometimes true, 2 = very true or often true). The Attention Problems subscale (5 items) measures difficulty focusing and controlling impulsive behavior (e.g., *Can’t concentrate, can’t pay attention for long; Can’t sit still, restless, or hyperactive; and Quickly shifts from one activity to another*). Items were summed to calculate an attention problems subscale raw score. The CBCL has good test–retest and inter-rater reliability for all scales and subscales and evidence of discriminative, convergent, and predictive validities (Achenbach & Rescorla, 2000). In the current sample, internal consistency for the Attention Problems subscale was minimally acceptable at both pretest (Cronbach’s $\alpha = .66$) and posttest (Cronbach’s $\alpha = .67$).

Statistical Analyses

Although the children in our sample were nested within child care homes, there was only an average of 2.5 children (age 2.5 to 5 years) per child care home ($SD = 1.43$; range = 1–8). At posttest, intra-class correlations ranged from .04–.09, all *ns*, indicating that very little of the variance in children’s posttest EF was attributable to the child care home level, rather than the individual level. In addition, the design effects for the EF outcomes ranged from 1.08 to 1.14, and design effect estimates > 2 indicate a need for multilevel modeling (Muthén & Satorra, 1995). Thus, there was no need for analyses (conducted using the mixed procedure in SAS [SAS Institute, 2010]) to account for the clustering of children in child care homes (Peugh, 2010). Nonetheless, we also ran our main analyses accounting for nesting by using multilevel modeling and found no differences in results. Given that there were no significant differences between the BEECH and BEECH+Mentor groups in child care provider responsive behaviors or children’s EF at posttest, these groups were collapsed into one intervention group, creating a dichotomous intervention status variable (0 = control, 1 = intervention).

To examine intervention effects on child care provider responsive behaviors, posttest TBRS scores were regressed on intervention status and pretest TBRS scores. In addition, although most child care provider characteristics (e.g., education level, teaching experience; see Table 1) were not significantly associated with the TBRS scores, the number of children in the child care home was significantly positively associated with the total score, $r = .33, p < .05$, and Sensitivity subscale score, $r = .29, p < .05$. Thus, the number of children in the child care home was included as a covariate in analyses of intervention effects on TBRS scores.

To examine intervention effects on children's EF, posttest EF scores were regressed on intervention status and pretest EF scores. Testing whether potential covariates (i.e., child age, gender, race/ethnicity, parental education, and child care provider characteristics) were associated with intervention status and posttest EF outcomes revealed significant associations for child age and gender (see Table 4). Thus, age and gender were included as covariates in these analyses. Interactions between intervention status and child age were also tested, followed by interactions between intervention status and initial skill level (pretest score). Only significant interactions were retained in the final models.

Results

Descriptive Statistics

Descriptive statistics for child care provider responsive behaviors are presented in Table 2. Descriptive statistics and bivariate correlations for children's EF are presented in Tables 3 and 4, respectively. Children's performance on the delay inhibition and conflict EF tasks improved from pretest to posttest, and they had low levels of parent-reported attention problems at both pretest and posttest. There was considerable stability in EF and attention problem scores from pretest to posttest. Delay inhibition and conflict EF were moderately correlated at pretest and posttest. Pretest attention problem scores were not associated with pretest or posttest delay inhibition or conflict EF; however, posttest attention problem scores were significantly negatively associated with pretest delay inhibition, posttest delay inhibition, and posttest conflict EF.

Intervention Effects on Child Care Provider Responsive Behaviors

Table 2 provides the descriptive statistics and results, including effect sizes, for analyses of intervention effects on the TBRS. There were no significant differences between the intervention and control groups at pretest. At posttest, child care providers in the intervention group had a higher TBRS total score than child care providers in the control group, even after accounting for their pretest scores and the number of children in the child care home. In terms of the TBRS subscales, child care providers in the intervention group had significantly higher scores on the Sensitivity, Oral Language, Print and Letter Knowledge, Book Reading Behaviors, and Math Concepts subscales than child care providers in the control group. Child care providers in the intervention group did not differ significantly from those in the control group on the Classroom Community, Phonological Awareness, and Written Expression subscales.

Intervention Effects on Children's Executive Function

There were no significant differences between the intervention and control groups in delay inhibition, conflict EF, or attention problems at pretest (see Table 3 for descriptive statistics).

Delay inhibition—Although there was not a main effect of intervention status on delay inhibition, there was a significant interaction between intervention status and child age (see Table 5). The main effects and interaction models accounted for 53 and 55% of the variance in delay inhibition, respectively. We examined this significant interaction effect by plotting

the simple regression slopes of delay inhibition on intervention status at 1 *SD* lower than the mean, the mean, and 1 *SD* higher than the mean of child age (see Figure 1), and testing whether these simple slopes differed significantly from zero (Cohen, Cohen, West, & Aiken, 2003). Intervention status (0 = control, 1 = intervention) was significantly positively associated with children's posttest delay inhibition in the youngest children, $t(135) = 2.35$, $p < .05$, but not in older children, $t(135) = .90$, *ns*, or the oldest children, $t(135) = -1.11$, *ns*. The youngest children showed higher levels of posttest delay inhibition if they were in the intervention group rather than the control group. In contrast, older children did equally well on delay inhibition tasks whether they were in the intervention or control group.

We then ran a model in which initial (pretest) delay inhibition was examined as the moderator rather than age. This analysis yielded a significant interaction between intervention status and pretest delay inhibition, $b = -.28$, $SE = .12$, $p < .05$. Examination of the simple slopes revealed a similar pattern to the model with age as the moderator. Among children with the lowest initial level of delay inhibition skills, those in the intervention group had significantly higher delay inhibition at posttest compared to those in the control group, $t(135) = 2.22$, $p < .05$; however, there were no group differences in children with moderate, $t(135) = 1.01$, *ns*, and high initial delay inhibition skills, $t(135) = -1.00$, *ns*.

Conflict EF—There was not a main effect of intervention status and there were no significant interactions (with either age or initial conflict EF as the moderating variable) for conflict EF (see Table 5). Because the DCCS was only administered to 3- to 5-year-old children in the sample, we re-ran these analyses examining intervention effects on the bear/dragon task (rather than the conflict EF composite, which was composed of the bear/dragon and DCCS tasks). Results of this alternative approach to these analyses were the same.

Attention problems—There was not a significant main effect of intervention status on attention problems, but there was a significant interaction between intervention status and child age (see Table 5). The main effects and interaction models accounted for 29 and 31% of the variance in attention problems, respectively. The interaction indicated that the youngest children exhibited lower levels of attention problems if they were in the intervention group rather than the control group, $t(128) = -2.08$, $p < .05$. The older, $t(128) = -1.03$, *ns*, and oldest, $t(128) = .71$, *ns*, children did not differ significantly in their attention problems as a function of intervention status (see Figure 1). In a separate model, the interaction between intervention status and initial attention problems was not significant, $b = .23$, $SE = .15$, $p = .13$.

As a further exploration, we examined whether TBRS scores potentially mediated the effects of the intervention on children's delay inhibition and attention problems for both the full sample and the youngest children in the sample. However, we did not find any significant associations between posttest TBRS scores and children's posttest delay inhibition or attention problems, possibly due to the small sample size.

Discussion

The purpose of this study was to examine the effects of an intervention targeting family child care provider responsiveness on children's EF skills. The early development of EF skills, such as delay inhibition and conflict EF, supports children's academic success once they enter school and serves as a foundation for positive emotional and behavioral functioning (Welsh et al., 2010). Based on theory and prior research linking caregiver responsiveness and EF development (Bernier et al., 2010; Hamre et al., 2014), we predicted that an intervention emphasizing child care provider responsiveness would enhance EF development.

While a number of studies have tested the effects of interventions conducted in prekindergarten or Head Start settings on EF (Raver et al., 2011), to our knowledge, this is the first study examining the effects of an intervention conducted in family child care homes on children's EF. Home-based child care is often lower in overall quality than center-based child care, and children in home-based child care have lower school readiness skills compared to those in center-based child care (Ansari & Winsler, 2013; NICHD ECCRN, 2004). Thus, family child care may be a context in need of intervention to support the early development of the many children who experience this type of early care.

The intervention tested in this study consisted primarily of an online professional development course based on a responsive parenting intervention model which in previous random assignment studies has been shown to increase parental responsiveness and in turn improve children's cognitive and social-emotional skills (Landry, Smith, Swank, & Guttentag, 2008). Family child care providers in the intervention group learned how to use a range of responsive behaviors, such as responding sensitively and contingently to children's signals, maintaining children's attention and expanding on their interests, and providing rich language input and interactive conversations. Child care providers were taught how to incorporate these responsive strategies into playtime, everyday routines, and learning activities.

Intervention Effects on Child Care Provider Responsive Behaviors

This intervention was found to significantly improve a range of child care provider responsive behaviors including sensitivity, responsive language and literacy stimulation attuned to children's needs, and the use of responsive strategies to promote children's early math skills. These results are consistent with prior findings indicating positive effects of this responsiveness-focused early intervention when implemented with parents (Landry et al., 2008) and in child care centers (Landry et al., 2014). Given that the intervention improved a range of responsive behaviors, many aspects of caregiving in the child care home environment were enhanced for children.

Intervention Effects on Children's Executive Function

Although there were no significant main effects of the intervention on children's EF skills, there were significant interactions between intervention status and age for delay inhibition and parent-reported attention problems. The youngest children had greater delay inhibition

and lower attention problems if they were in the intervention group rather than the control group. Older children in the intervention and control groups did not differ significantly in terms of these EF outcomes. Initial delay inhibition skill level also significantly moderated intervention effects on delay inhibition; children who started the intervention with the lowest level of skills demonstrated significant gains in delay inhibition.

Improvements in child care provider responsive behaviors may explain intervention effects on EF for the youngest children. Caregiver responsiveness is thought to foster a secure attachment and promote children's stress regulation, allowing them to explore the environment and engage in problem-solving activities (Ainsworth et al., 1978; Bernier et al., 2012). In addition, caregiver responsiveness may ensure that children have opportunities to make choices and take the lead, which promote their autonomy and sense of volition (Grolnick & Ryan, 1989). Furthermore, child care provider responsiveness may have facilitated children's use of attention strategies (e.g., direct attention away from the reward) to withhold impulsive behavior during the delay inhibition tasks (Conway & Stifter, 2012; Peake et al., 2002). It is possible that improvements in child care provider responsiveness were a particularly good match for EF development in the late toddler/early preschool period. The caregiving factors that support EF development may differ depending on children's age, with responsiveness being crucial during the earliest years and practices such as limit-setting and behavior management gaining in importance during the older preschool years (Lengua et al., 2007; Raver et al., 2011). However, it is important to emphasize that we cannot make any conclusions about which specific component of the intervention may have improved delay inhibition and attention problems in the youngest children. As shown above, the intervention targeted and improved various child care provider responsive behaviors, all of which may have contributed to gains in these EF skills (but see Limitations section below for comments about the mediation analyses).

There are also other possible explanations for why the youngest children improved in EF as a function of intervention group but the older children did not. The youngest children and those with low levels of baseline skills may have had the possibility of more growth and variability in their EF skills. Or, younger children with lower levels of baseline skills may have been more dependent on the child care provider to shape their growth in these EF skills compared to older children with higher initial skill levels (Kopp, 1982).

In contrast to results for delay inhibition and attention problems, there were no group differences or significant interactions for children's conflict EF skills. Given that the conflict EF tasks placed greater demands on working memory capacity than the delay inhibition tasks (Garon et al., 2008), children may have needed specific instruction or additional practice in working memory. Conflict EF tasks also differed from the delay inhibition tasks in terms of requiring EF in a motivationally- or emotionally-neutral context (the absence of an extrinsic reward). Thus, perhaps integrating support for EF into more abstract or decontextualized learning activities may have led to improvement in conflict EF. Given that this study had a younger preschool-age sample, it is possible that conflict EF skills would have improved had the intervention been delivered at an older age, when conflict EF skills are more rapidly developing and possibly more malleable (Carlson, 2005). At older

preschool ages, children begin to succeed on tasks that place higher demands on working memory or require the integration of multiple EF processes (Garon et al., 2008).

Findings indicating that the intervention enhanced the EF skills of the youngest children may have practical relevance in light of the fact that family child care is more often used for infants and toddlers than for older preschoolers (Burchinal et al., 2002; NICHD ECCRN, 2004). Moreover, although this study did not focus recruitment on children from low-SES families, family child care is often used by low-SES families (Dowsett et al., 2008; NICHD ECCRN, 2004). Thus, this intervention may be an effective means of improving delay inhibition and attention control in low-SES children in order to better equip them to be successful when they enter school. An advantage of an intervention conducted in child care homes is that it would reach low-SES children in their earliest years, which has the greatest payoff in terms of improving their long-term trajectories (Heckman, 2006).

The BEECH group, which only received the online professional development course, and the BEECH+Mentor group, which received the online course plus weekly mentoring, were combined into one intervention group for this study. This approach was consistent with the goals of the study and was also supported by the lack of significant differences between the BEECH and BEECH+Mentor groups in child care provider responsive behaviors and children's EF at posttest. Prior research has shown that the combination of professional development coursework with mentoring or coaching can be more effective at improving child care provider behavior than professional development coursework alone (Koh & Neuman, 2009; Ota & Austin, 2013), although some research has not found a supplemental benefit of coaching (Jackson et al., 2006). Our finding may suggest that the professional development course that was tested in this study was sufficient for family child care providers to understand how to apply responsive strategies in their child care homes. It is possible that these home-based child care providers learned to be independent in the course of building their child care businesses and thus took the initiative to apply new strategies on their own without relying on a mentor. However, comparison of the BEECH and BEECH +Mentor groups was not the focus of our study, which relied on a fairly small subsample from a larger study; the reader is referred to this larger study for a more in-depth comparison of these two groups (see Johnson, Landry, & Jung, 2015).

Limitations and Conclusions

This study had several limitations that must be kept in mind when interpreting the results. Some of the EF tasks were not well-matched to the younger children in the sample ($M = 3.58$ years; range: 2.5 to 5 years). As noted in the method section, the DCCS task was not administered to children younger than age 3. Given that the average scores for the DCCS and bear/dragon tasks were low, it is possible that floor effects could have affected the conflict EF results. However, moderation analyses did not reveal intervention effects on conflict EF by age even though there was more variability in conflict EF task performance among older children. Nonetheless, future studies examining the effects of this responsiveness-focused family child care intervention should use tasks that are sensitive measures of conflict EF during toddlerhood and the early preschool period.

At pretest, some children (those assessed later in November or in December) completed EF testing after their child care providers had already had up to four sessions of the online professional development course. It is unlikely that the intervention would have improved provider behavior to the point of enhancing child EF skills by this time. Also, there were no differences in the timing of the pretest EF assessment between the intervention and control groups.

Also, it should be noted that the CBCL Attention Problems subscale was designed as a measure of attention problems rather than EF-related skills. However, there is considerable overlap in item/scale content between the CBCL Attention Problems subscale and parent-report measures of EF, such as the Behavior Rating Inventory of Executive Function-Preschool Version (BRIEF-P; Gioia, Espy, & Isquith, 2003) or the Children's Behavior Questionnaire (CBQ) Attention Focusing and Inhibitory Control scales (Rothbart, Ahadi, Hershey, & Fisher, 2001; see Espy et al., 2011). For example, items on the CBCL Attention Problems scale include, "Can't concentrate, can't pay attention for long," which is similar to "Has trouble concentrating when listening to a story" on the CBQ Attention Focusing scale. In addition, the CBCL Attention Problems scale includes "Can't sit still, restless or hyperactive", the CBQ Inhibitory Control scale includes, "Has trouble sitting still when s/he is told to (at movies, church, etc.)" and the BRIEF-P includes, "Is fidgety, restless or squirmy." Items on the CBCL Attention Problems scale include "Quickly shifts from one activity to another," which is similar to "Often shifts rapidly from one activity to another" on the CBQ Attention Focusing scale. Also, the fact that results for attention problems paralleled those for delay inhibition suggests that the attention problems scale may have captured children's EF-related behavior adequately.

Given that this study had a smaller sample size, a larger scale study is needed to further investigate the utility of this intervention with regard to promoting EF. A study with a larger sample size would also provide sufficient power to detect mediation effects. Although in the current study changes in child care provider responsive behaviors were not found to mediate intervention effects on children's delay inhibition or attention problems, a more ideal test of this mediation model would require three time points and a larger sample size. Finally, future research should examine whether the gains made by child care providers and children in the intervention group are maintained over time by following participants for a longer period of time after conclusion of the intervention. Children may also show further improvement in EF after they have experienced higher child care provider responsiveness for a longer period of time.

In summary, this study examined the effects of an intervention targeting family child care provider responsiveness on 2.5- to 5-year-old children's EF skills. Results indicated significant interactions between intervention status and age for delay inhibition and parent-reported attention problems. The youngest children in the sample benefited from the intervention in terms of their delay inhibition and attention skills but older children did not. Thus, improving responsiveness in family child care settings may facilitate growth in certain EF processes for young children.

Acknowledgments

This research was supported by grants from the United States (U.S.) Department of Health and Human Services, Administration for Children and Families (90SC0041) and the U.S. Institute of Education Sciences (R32B110007) to the Children's Learning Institute, University of Texas Health Science Center. In addition, a U.S. National Institute of Mental Health training grant (T32MH13043) supported Emily Merz. The authors are grateful to the child care providers, parents, and children who participated in this study.

References

- Achenbach, TM.; Rescorla, L. Child Behavior Checklist for Ages 1½–5. Burlington VT: University of Vermont; 2000.
- Ainsworth, MDS.; Blehar, M.; Waters, E.; Wall, S. Patterns of attachment: Observations in the strange situation and at home. Hillsdale, NJ: Erlbaum; 1978.
- Allan NP, Hume LE, Allan DM, Farrington AL, Lonigan CJ. Relations between inhibitory control and the development of academic skills in preschool and kindergarten: A meta-analysis. *Developmental Psychology*. 2014; 50(10):2368–2379. [PubMed: 25069051]
- Allan NP, Lonigan CJ. Examining the dimensionality of effortful control in preschool children and its relation to academic and socioemotional indicators. *Developmental Psychology*. 2011; 47(4):905–915. [PubMed: 21553957]
- Ansari A, Winsler A. Stability and sequence of center-based and family childcare: Links with low-income children's school readiness. *Children and Youth Services Review*. 2013; 35(2):358–366.
- Bernier A, Carlson SM, Whipple N. From external regulation to self-regulation: Early parenting precursors of young children's executive functioning. *Child Development*. 2010; 81(1):326–339. [PubMed: 20331670]
- Bernier A, Carlson SM, Deschênes M, Matte-Gagné C. Social factors in the development of early executive functioning: A closer look at the caregiving environment. *Developmental Science*. 2012; 15(1):12–24. [PubMed: 22251288]
- Bierman KL, Nix RL, Greenberg MT, Blair C, Domitrovich CE. Executive functions and school readiness intervention: Impact, moderation, and mediation in the Head Start REDI program. *Development and Psychopathology*. 2008; 20(03):821–843. [PubMed: 18606033]
- Blair C. Stress and the development of self-regulation in context. *Child Development Perspectives*. 2010; 4(3):181–188. [PubMed: 21779305]
- Blair C, Granger DA, Willoughby M, Mills-Koonce R, Cox M, Greenberg MT, ... Fortunato CK. Salivary cortisol mediates effects of poverty and parenting on executive functions in early childhood. *Child Development*. 2011; 82(6):1970–1984. [PubMed: 22026915]
- Brock LL, Rimm-Kaufman SE, Nathanson L, Grimm KJ. The contributions of 'hot' and 'cool' executive function to children's academic achievement, learning-related behaviors, and engagement in kindergarten. *Early Childhood Research Quarterly*. 2009; 24(3):337–349.
- Bull R, Espy KA, Wiebe SA. Short-term memory, working memory, and executive functioning in preschoolers: Longitudinal predictors of mathematical achievement at age 7 years. *Developmental Neuropsychology*. 2008; 33(3):205–228. [PubMed: 18473197]
- Burchinal MR, Roberts JE, Riggins R Jr, Zeisel SA, Neebe E, Bryant D. Relating quality of center-based child care to early cognitive and language development longitudinally. *Child Development*. 2000; 71(2):339–357. [PubMed: 10834469]
- Burchinal M, Howes C, Kontos S. Structural predictors of child care quality in child care homes. *Early Childhood Research Quarterly*. 2002; 17(1):87–105.
- Carlson SM. Developmentally sensitive measures of executive function in preschool children. *Developmental Neuropsychology*. 2005; 28(2):595–616. [PubMed: 16144429]
- Carlson SM, Mandell DJ, Williams L. Executive function and theory of mind: Stability and prediction from ages 2 to 3. *Developmental Psychology*. 2004; 40(6):1105–1122. [PubMed: 15535760]
- Carlson SM, Moses LJ. Individual differences in inhibitory control and children's theory of mind. *Child Development*. 2001; 72(4):1032–1053. [PubMed: 11480933]

- Carlson SM, White RE, Davis-Unger AC. Evidence for a relation between executive function and pretense representation in preschool children. *Cognitive Development*. 2014; 29:1–16.
- Clark CA, Pritchard VE, Woodward LJ. Preschool executive functioning abilities predict early mathematics achievement. *Developmental Psychology*. 2010; 46(5):1176–1191. [PubMed: 20822231]
- Cohen, J.; Cohen, P.; West, SG.; Aiken, LS. *Applied multiple regression/correlation analysis for the behavioral sciences*. Mahwah, NJ: Lawrence Erlbaum; 2003.
- Conway A, Stifter CA. Longitudinal antecedents of executive function in preschoolers. *Child Development*. 2012; 83(3):1022–1036. [PubMed: 22469209]
- Cuevas K, Bell MA. Infant attention and early childhood executive function. *Child Development*. 2014; 85(2):397–404. [PubMed: 23711103]
- Diamond A, Barnett WS, Thomas J, Munro S. Preschool program improves cognitive control. *Science*. 2007; 318(5855):1387–1388. [PubMed: 18048670]
- Dowsett CJ, Huston AC, Imes AE, Gennetian L. Structural and process features in three types of child care for children from high and low income families. *Early Childhood Research Quarterly*. 2008; 23(1):69–93. [PubMed: 19609366]
- Duncan GJ, Dowsett CJ, Claessens A, Magnuson K, Huston AC, Klebanov P, ... Japel C. School readiness and later achievement. *Developmental Psychology*. 2007; 43(6):1428–1446. [PubMed: 18020822]
- Espy KA, Sheffield TD, Wiebe SA, Clark CA, Moehr MJ. Executive control and dimensions of problem behaviors in preschool children. *Journal of Child Psychology and Psychiatry*. 2011; 52(1):33–46. [PubMed: 20500238]
- Frye D, Zelazo PD, Palfai T. Theory of mind and rule-based reasoning. *Cognitive Development*. 1995; 10(4):483–527.
- Fuller B, Kagan SL, Loeb S, Chang YW. Child care quality: Centers and home settings that serve poor families. *Early Childhood Research Quarterly*. 2004; 19:505–527.
- Gardner F, Hutchings J, Bywater T, Whitaker C. Who benefits and how does it work? Moderators and mediators of outcome in an effectiveness trial of a parenting intervention. *Journal of Clinical Child & Adolescent Psychology*. 2010; 39(4):568–580. [PubMed: 20589567]
- Garon N, Bryson SE, Smith IM. Executive function in preschoolers: A review using an integrative framework. *Psychological Bulletin*. 2008; 134(1):31–60. [PubMed: 18193994]
- Gioia, G.; Espy, KA.; Isquith, P. *Behavior Rating Inventory of Executive Function – Preschool Version (BRIEF-P)*. Lutz, FL: Psychological Assessment Resources; 2003.
- Gordon RA, Colaner A, Usdansky ML, Melgar C. Beyond an “Either-Or” approach to home-based and center-based care: Characteristics of families who combine types or use just one. *Early Childhood Research Quarterly*. 2013; 28(4):918–935.
- Groeneveld MG, Vermeer HJ, van IJendoorn MH, Linting M. Enhancing home-based child care quality through video-feedback intervention: A randomized controlled trial. *Journal of Family Psychology*. 2011; 25(1):86–96. [PubMed: 21355649]
- Grolnick WS, Ryan RM. Parent styles associated with children’s self-regulation and competence in school. *Journal of Educational Psychology*. 1989; 81(2):143–154.
- Gunnar M, Quevedo K. The neurobiology of stress and development. *Annual Review of Psychology*. 2007; 58:145–173.
- Hamre B, Hatfield B, Pianta R, Jamil F. Evidence for general and domain-specific elements of teacher–child interactions: Associations with preschool children’s development. *Child Development*. 2014; 85:1257–1274. [PubMed: 24255933]
- Heckman JJ. Skill formation and the economics of investing in disadvantaged children. *Science*. 2006; 312(5782):1900–1902. [PubMed: 16809525]
- Hirsh-Pasek K, Burchinal M. Mother and caregiver sensitivity over time: Predicting language and academic outcomes with variable-and person-centered approaches. *Merrill-Palmer Quarterly*. 2006; 52(3):449–485.
- Howes C, Galinsky E, Kontos S. Child care caregiver sensitivity and attachment. *Social Development*. 1998; 7(1):25–36.

- Jackson B, Larzelere R, Clair LS, Corr M, Fichter C, Egertson H. The impact of Heads Up! Reading on early childhood educators' literacy practices and preschool children's literacy skills. *Early Childhood Research Quarterly*. 2006; 21(2):213–226.
- Johnson UY, Landry SH, Jung KH. Examining caregiver and child outcomes of a professional development program for home-based child care providers. 2015 Manuscript in preparation.
- Jones LB, Rothbart MK, Posner MI. Development of executive attention in preschool children. *Developmental Science*. 2003; 6:498–504.
- Kane MJ, Engle RW. The role of prefrontal cortex in working-memory capacity, executive attention, and general fluid intelligence: An individual-differences perspective. *Psychonomic Bulletin & Review*. 2002; 9(4):637–671. [PubMed: 12613671]
- Karremans A, van Tuijl C, Van Aken MA, Dekovic M. Parenting and self-regulation in preschoolers: A meta-analysis. *Infant and Child Development*. 2006; 15(6):561–579.
- Kim S, Nordling JK, Yoon JE, Boldt LJ, Kochanska G. Effortful control in “hot” and “cool” tasks differentially predicts children's behavior problems and academic performance. *Journal of Abnormal Child Psychology*. 2013; 41(1):43–56. [PubMed: 22798038]
- Kochanska G, Murray KT, Harlan ET. Effortful control in early childhood: continuity and change, antecedents, and implications for social development. *Developmental Psychology*. 2000; 36(2):220–232. [PubMed: 10749079]
- Koh S, Neuman SB. The impact of professional development in family child care: A practice-based approach. *Early Education and Development*. 2009; 20(3):537–562.
- Kopp C. Antecedents of self-regulation: A developmental perspective. *Developmental Psychology*. 1982; 18:199–214.
- Landry SH, Smith KE, Swank PR, Guttentag C. A responsive parenting intervention: The optimal timing across early childhood for impacting maternal behaviors and child outcomes. *Developmental Psychology*. 2008; 44(5):1335–1353. [PubMed: 18793067]
- Landry SH, Smith KE, Swank PR. Responsive parenting: Establishing early foundations for social, communication, and independent problem-solving skills. *Developmental Psychology*. 2006; 42(4):627–642. [PubMed: 16802896]
- Landry, SH.; Crawford, A.; Gunnewig, S.; Swank, PR. Unpublished research instrument. Center for Improving the Readiness for Children for Learning and Education, University of Texas Health Science Center; Houston, TX: 2000. The CIRCLE–Teacher Behavior Rating Scale.
- Landry SH, Smith KE, Swank PR, Assel MA, Vellet S. Does early responsive parenting have a special importance for children's development or is consistency across early childhood necessary? *Developmental Psychology*. 2001; 37(3):387–403. [PubMed: 11370914]
- Landry SH, Zucker TA, Taylor HB, Swank PR, Williams JM, Assel M, ... Klein A. Enhancing early child care quality and learning for toddlers at risk: The responsive early childhood program. *Developmental Psychology*. 2014; 50(2):526–541. [PubMed: 23772822]
- Laughlin, L. Who's minding the kids? Child care arrangements: Spring 2011. *Current Population Reports*. Washington, DC: U.S. Census Bureau; 2013.
- Lengua LJ, Honorado E, Bush NR. Contextual risk and parenting as predictors of effortful control and social competence in preschool children. *Journal of Applied Developmental Psychology*. 2007; 28(1):40–55. [PubMed: 21687825]
- Lengua LJ, Kiff C, Moran L, Zalewski M, Thompson S, Cortes R, Ruberry E. Parenting mediates the effects of income and cumulative risk on the development of effortful control. *Social Development*. 2014; 23:631–649.
- Li-Grining CP. Effortful control among low-income preschoolers in three cities: Stability, change, and individual differences. *Developmental Psychology*. 2007; 43(1):208–221. [PubMed: 17201520]
- Loeb S, Fuller B, Kagan SL, Carrol B. Child care in poor communities: Early learning effects of type, quality, and stability. *Child Development*. 2004; 75(1):47–65. [PubMed: 15015674]
- Loman MM, Gunnar MR. Early experience and the development of stress reactivity and regulation in children. *Neuroscience & Biobehavioral Reviews*. 2010; 34(6):867–876. [PubMed: 19481109]
- Matte-Gagné C, Bernier A. Prospective relations between maternal autonomy support and child executive functioning: Investigating the mediating role of child language ability. *Journal of Experimental Child Psychology*. 2011; 110(4):611–625. [PubMed: 21798554]

- McClelland MM, Cameron CE, Connor CM, Farris CL, Jewkes AM, Morrison FJ. Links between behavioral regulation and preschoolers' literacy, vocabulary, and math skills. *Developmental Psychology*. 2007; 43(4):947–959. [PubMed: 17605527]
- McEwen BS, Gianaros PJ. Central role of the brain in stress and adaptation: Links to socioeconomic status, health, and disease. *Annals of the New York Academy of Sciences*. 2010; 1186(1):190–222. [PubMed: 20201874]
- Muthén BO, Satorra A. Complex sample data in structural equation modeling. *Sociological Methodology*. 1995; 25:267–316.
- NICHD Early Child Care Research Network. Type of child care and children's development at 54 months. *Early Childhood Research Quarterly*. 2004; 19(2):203–230.
- Duncan GJ. NICHD Early Child Care Research Network. Modeling the impacts of child care quality on children's preschool cognitive development. *Child Development*. 2003; 74:1454–1475. [PubMed: 14552408]
- NICHD Early Child Care Research Network. Predicting individual differences in attention, memory, and planning in first graders from experiences at home, child care, and school. *Developmental Psychology*. 2005; 41(1):99–114. [PubMed: 15656741]
- NICHD Early Child Care Research Network. Child-care effect sizes for the NICHD Study of Early Child Care and Youth Development. *American Psychologist*. 2006; 61(2):99–116. [PubMed: 16478355]
- Osaka M, Osaka N, Kondo H, Morishita M, Fukuyama H, Aso T, Shibasaki H. The neural basis of individual differences in working memory capacity: An fMRI study. *NeuroImage*. 2003; 18(3):789–797. [PubMed: 12667855]
- Ota CL, Austin AMB. Training and mentoring: Family child care providers' use of linguistic inputs in conversations with children. *Early Childhood Research Quarterly*. 2013; 28(4):972–983.
- Peake PK, Hebl M, Mischel W. Strategic attention deployment for delay of gratification in working and waiting situations. *Developmental Psychology*. 2002; 38(2):313–326. [PubMed: 11881765]
- Peugh JL. A practical guide to multilevel modeling. *Journal of School Psychology*. 2010; 48(1):85–112. [PubMed: 20006989]
- Raver CC, Jones SM, Li-Grining C, Zhai F, Bub K, Pressler E. CSRP's impact on low-income preschoolers' preacademic skills: Self-regulation as a mediating mechanism. *Child Development*. 2011; 82(1):362–378. [PubMed: 21291447]
- Razza RA, Bergen-Cico D, Raymond K. Enhancing preschoolers' self-regulation via mindful yoga. *Journal of Child and Family Studies*. 2013; 24(2):372–385.
- Rimm-Kaufman SE, Curby TW, Grimm KJ, Nathanson L, Brock LL. The contribution of children's self-regulation and classroom quality to children's adaptive behaviors in the kindergarten classroom. *Developmental Psychology*. 2009; 45(4):958–972. [PubMed: 19586173]
- Rothbart M, Ahadi S, Hershey K, Fisher P. Investigations of temperament at three to seven years: The Children's Behavior Questionnaire. *Child Development*. 2001; 72:1394–1408. [PubMed: 11699677]
- Rueda MR, Posner MI, Rothbart MK. The development of executive attention: Contributions to the emergence of self-regulation. *Developmental Neuropsychology*. 2005; 28(2):573–594. [PubMed: 16144428]
- Rusby JC, Smolkowski K, Marquez B, Taylor TK. A small-scale randomized efficacy trial of Carescapes: Enhancing children's social development in child care homes. *Early Childhood Research Quarterly*. 2008; 23(4):527–546. [PubMed: 19802343]
- Ruzek E, Burchinal M, Farkas G, Duncan GJ. The quality of toddler child care and cognitive skills at 24 months: Propensity score analysis results from the ECLS-B. *Early Childhood Research Quarterly*. 2014; 29(1):12–21.
- SAS Institute. SAS Version 9.2 [Computer software]. Cary, NC: Author; 2010.
- Smith-Donald R, Raver CC, Hayes T, Richardson B. Preliminary construct and concurrent validity of the Preschool Self-regulation Assessment (PSRA) for field-based research. *Early Childhood Research Quarterly*. 2007; 22(2):173–187.
- Sulik MJ, Huerta S, Zerr AA, Eisenberg N, Spinrad TL, Valiente C, ... Taylor HB. The factor structure of effortful control and measurement invariance across ethnicity and sex in a high-risk

- sample. *Journal of Psychopathology and Behavioral Assessment*. 2010; 32(1):8–22. [PubMed: 20593008]
- Tominey SL, McClelland MM. Red light, purple light: Findings from a randomized trial using circle time games to improve behavioral self-regulation in preschool. *Early Education & Development*. 2011; 22(3):489–519.
- Votruba-Drzal E, Coley RL, Chase-Lansdale PL. Child care and low-income children's development: Direct and moderated effects. *Child Development*. 2004; 75(1):296–312. [PubMed: 15015691]
- Vygotsky, LS. *Mind in society*. Cambridge, MA: Harvard University Press; 1978.
- Weiland C, Yoshikawa H. Impacts of a prekindergarten program on children's mathematics, language, literacy, executive function, and emotional skills. *Child Development*. 2013; 84(6):2112–2130. [PubMed: 23534487]
- Welsh JA, Nix RL, Blair C, Bierman KL, Nelson KE. The development of cognitive skills and gains in academic school readiness for children from low-income families. *Journal of Educational Psychology*. 2010; 102(1):43–53. [PubMed: 20411025]
- Willoughby M, Kupersmidt J, Voegler-Lee M, Bryant D. Contributions of hot and cool self-regulation to preschool disruptive behavior and academic achievement. *Developmental Neuropsychology*. 2011; 36(2):162–180. [PubMed: 21347919]
- Zelazo PD, Carlson SM. Hot and cool executive function in childhood and adolescence: Development and plasticity. *Child Development Perspectives*. 2012; 6(4):354–360.
- Zelazo PD, Müller U, Frye D, Marcovitch S, Argitis G, Boseovski J, ... Carlson SM. The development of executive function in early childhood. *Monographs of the Society for Research in Child Development*. 2003; 68(3):vii–151. [PubMed: 14723273]
- Zelazo PD, Anderson JE, Richler J, Wallner-Allen K, Beaumont JL, Weintraub S. II. NIH Toolbox Cognition Battery (CB): Measuring executive function and attention. *Monographs of the Society for Research in Child Development*. 2013; 78:16–33. [PubMed: 23952200]
- Zhou Q, Chen SH, Main A. Commonalities and differences in the research on children's effortful control and executive function: A call for an integrated model of self-regulation. *Child Development Perspectives*. 2012; 6(2):112–121.

Highlights

- We tested effects of a family child care intervention on executive function
- Family child care providers learned responsive behaviors to use with children
- We found interactions between intervention status and age for two outcomes
- The intervention improved the youngest children's delay inhibition and attention skills
- The intervention also improved provider interactions with the children

Figure 1.

Figure 1a. Simple slopes of the association between intervention status and posttest delay inhibition at 1 *SD* lower than the mean, the mean, and 1 *SD* higher than the mean of age.

Figure 1b. Simple slopes of the association between intervention status and posttest attention problems at 1 *SD* lower than the mean, the mean, and high 1 *SD* higher than the mean of age.

Table 1
Descriptive statistics for child/parent (N = 141) and family child care provider (N = 62) characteristics

	Child/parent		Family child care provider	
	Intervention	Control	Intervention	Control
Mean age in years at pretest (<i>SD</i>)	3.57 (.69)	3.60 (.78)	--	--
Gender (% female)	51	55	100	100
Race/ethnicity (%)				
African American	59	49	68	63
Hispanic/Latino	18	7	9	11
Caucasian/White	24	44	24	26
Parent marital status (% married)	55	60	--	--
Single-parent household (%)	35	29	--	--
Education level (%)				
High school diploma or GED	53	58	59	46
Associate's degree	15	6	22	8
Bachelor's degree	23	27	19	42
Master's degree or higher education	9	9	0	4
Mean hours in child care per week (<i>SD</i>)	39.92 (12.64)	36.95 (12.08)	--	--
Teaching credential ^a (%)	--	--	47	33
Mean years of home child care provider experience (<i>SD</i>)	--	--	8.24 (7.24)	11.00 (8.96)
Mean years of teaching experience (<i>SD</i>)	--	--	8.70 (8.36)	11.61 (11.80)
Mean number of children in child care home ^b (<i>SD</i>)	--	--	5.21 (1.87)	5.11 (2.22)

Note. The intervention group consists of the BEECH and BEECH+Mentor groups.

^a Associate's degree in teaching, elementary teaching credential, early childhood education teaching credential, special education credential, or Child Development Associate credential

^b All children younger than 5 years of age (i.e., not just 2.5- to 5-year-olds)

Table 2

Intervention effects on child care provider responsive behaviors

	Pretest				Posttest				<i>F</i> (1,57)	<i>p</i>	Effect size
	Intervention		Control		Intervention		Control				
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>			
TBRS total score	1.83	.35	1.79	.32	1.96	.33	1.77	.28	7.81	<.01	.55
Sensitivity	2.38	.40	2.31	.43	2.50	.29	2.34	.29	5.39	<.05	.37
Classroom Community	1.66	.42	1.45	.42	1.95	.46	1.70	.38	1.86	<i>ns</i>	.29
Oral Language	2.24	.35	2.22	.39	2.32	.33	2.14	.33	5.74	<.05	.52
Book Reading Behaviors	1.69	.41	1.77	.39	1.81	.46	1.66	.39	4.03	<.05	.52
Phonological Awareness	.57	.93	.50	.85	.16	.53	.13	.46	.07	<i>ns</i>	.02
Print and Letter Knowledge	1.67	.65	1.53	.63	1.73	.55	1.38	.70	4.99	<.05	.50
Written Expression	.89	.90	.93	.88	.85	1.05	.61	.93	.93	<i>ns</i>	.27
Math Concepts	1.26	.78	1.33	.66	1.58	.77	1.05	.92	8.18	<.01	.78

Note. TBRS, Teacher Behavior Rating Scale. Total score is an average of all the subscale scores. Each subscale score is an average of the quality and quantity scores for that subscale. Analyses controlled for the number of children in the child care home.

Table 3

Descriptive statistics for EF tasks and parent-reported attention problems

	Pretest				Posttest			
	Intervention		Control		Intervention		Control	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Gift delay-wrap								
Latency	27.42	26.08	31.94	25.79	42.67	24.00	40.28	24.82
Strategy	10.38	2.85	10.87	2.74	11.51	2.59	11.68	1.95
Gift delay-bow								
Latency	72.87	50.33	79.25	46.10	69.60	49.94	71.70	50.41
Strategy	29.84	5.56	30.58	4.65	30.24	5.16	30.14	5.83
Bear/dragon	3.39	4.31	4.05	4.99	4.28	5.11	5.57	5.52
DCCS	2.75	1.24	2.88	1.32	2.83	1.27	2.83	1.32
Attention problems	2.00	1.76	1.81	1.45	1.76	1.61	1.69	1.42

Note. DCCS, Dimensional Change Card Sort. Raw scores are presented. Bear/dragon, gift delay-wrap strategy, and gift delay-wrap strategy scores are reverse scored. Higher scores are better for the EF tasks and worse for attention problems.

Table 4
Bivariate correlations for delay inhibition, conflict EF, and parent-reported attention problems

	1	2	3	4	5	6	7	8
1. Age	--							
2. Gender	.12	--						
3. Pretest delay inhibition	.42*	.26*	--					
4. Pretest conflict EF	.59*	.18*	.37*	--				
5. Pretest attention problems	.04	-.02	-.10	.02	--			
6. Posttest delay inhibition	.48*	.26*	.49*	.26*	-.01	--		
7. Posttest conflict EF	.62*	.11	.41*	.70*	-.06	.34*	--	
8. Posttest attention problems	-.03	-.02	-.27*	-.08	.51*	-.18*	-.18*	--

Note. Gender coded 0 = male, 1 = female.

* $p < .05$ to .001

Table 5
Intervention effects on delay inhibition, conflict EF, and parent-reported attention problems

	Posttest delay inhibition		Posttest conflict EF		Posttest attention problems	
	<i>b</i>	<i>SE</i>	<i>b</i>	<i>SE</i>	<i>b</i>	<i>SE</i>
Age	.32 [*]	.09	.25 [*]	.12	-.46 ⁺	.23
Gender	.21 [*]	.10	-.08	.11	-.25	.24
Intervention status	.09	.10	-.07	.11	-.24	.24
Pretest score	.32 [*]	.06	.58 [*]	.08	.45 [*]	.07
Intervention status x age	-.32 [*]	.13	.07	.15	.65 [*]	.32

Note. Age and pretest score were centered. For gender, 0 = male, 1 = female, and for intervention status, 0 = control group, 1 = intervention group.

⁺ $p < .10$;

^{*} $p < .05$