



HHS Public Access

Author manuscript

Child Dev. Author manuscript; available in PMC 2016 September 01.

Published in final edited form as:

Child Dev. 2015 September ; 86(5): 1588–1603. doi:10.1111/cdev.12386.

Early Parenting and the Development of Externalizing Behavior Problems: Longitudinal Mediation through Children's Executive Function

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Abstract

Path analysis was used to investigate the longitudinal associations among parenting and children's executive function and externalizing behavior problems from 36 to 90 months of age in the Family Life Project ($N = 1,115$), a study of child development in the context of rural poverty. While controlling for stability in the constructs, semi-structured observations of parenting prospectively predicted performance on a battery of executive function tasks and primary caregivers' reports of externalizing behavior. Furthermore, the association between early parenting and later externalizing behavior was longitudinally mediated by executive function, providing support for a process model in which sensitive parenting promotes children's self-regulation, which in turn reduces children's externalizing behavior.

Keywords

Executive Function; Parenting; Externalizing behavior problems; Longitudinal; Mediation

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Externalizing behavior problems such as aggression are relatively frequent in young children and, when persistent, are associated with elevated risk for psychopathology in adulthood (Conduct Problems Prevention Research Group, 1992). Executive function, an aspect of self-regulation encompassing the “attention shifting, working memory, and inhibitory control cognitive processes utilized in planning, problem solving, and goal-directed activity” (Blair & Razza, 2007, p. 648), has been identified as a robust correlate of child externalizing behavior problems in cross-sectional studies (Ogilvie, Stewart, Chan, & Shum, 2011). Nonetheless, there are few longitudinal studies relating these two constructs, so the direction of the association between executive function and externalizing behavior is somewhat unclear. Strong executive function could be used to support the regulation of externalizing behavior or negative emotions associated with externalizing behavior such as anger. It seems plausible, however, that these behavioral patterns and emotions could also interfere with children’s ability to effectively deploy executive function, perhaps slowing its development over time (Bridgett et al., 2009; Leve et al., 2013). Indeed, such associations may well be bidirectional (Blair & Raver, 2012). Furthermore, parenting has been identified as an important predictor of both executive function and externalizing behavior, and could potentially influence the development of both of these constructs.

In this paper, we investigate the longitudinal associations among parenting, child executive function, and child externalizing behavior from 36 to 90 months of age using data from the Family Life Project, a prospective longitudinal study of child development in the context of rural poverty. We use mediation analysis to test a process model of development in which sensitive parenting promotes children’s capacity for self-regulation, which in turn reduces children’s externalizing behavior. In addition, we investigate the possibility of bidirectional associations between parenting and children’s executive function and externalizing behavior.

Parenting: Associations with Externalizing Symptoms

In young children, there is already substantial rank-order stability in externalizing behavior over a period of several years (Calkins, Blandon, Williford, & Keane, 2007). Despite this high stability (which limits researchers’ ability to predict change), parenting consistently predicts children’s externalizing behavior in prospective longitudinal studies that control for earlier externalizing behavior (Combs-Ronto, Olson, Lunkenheimer, & Sameroff, 2009; Eisenberg et al., 2005; Lengua, 2006; Spinrad et al., 2007). However, few studies have tested reciprocal associations between externalizing behavior and parenting (with the exception of disciplinary practices; e.g., Lansford et al., 2011). Although children’s externalizing behavior has been shown to predict parents’ immediate responses (Patterson, 1982), longitudinal studies testing longer-term associations between children’s externalizing behavior and parenting in early childhood have produced inconsistent results: some investigators have reported null findings (Eisenberg, Spinrad, Eggum, et al., 2010), whereas others have reported effects of child externalizing behavior on parenting while controlling for rank-order stability in the constructs (Combs-Ronto et al., 2009).

Parenting: Associations with Self-Regulation

There appears to be a bidirectional pattern of associations between parenting and children's self-regulation. Research has indicated that parenting predicts change in both executive function (Hammond, Müller, Carpendale, Bibok, & Liebermann-Finestone, 2012) and effortful control (Kochanska, Murray, & Harlan, 2000; Lengua, Honorado, & Bush, 2007), which is an aspect of temperamental self-regulation that overlaps with executive function (Zhou, Chen, & Main, 2012). The reverse direction of effect, from self-regulation to subsequent parenting, has also been documented in preschool- and early school-age children. For example, in an analysis using data from the Family Life Project, Blair and colleagues (2014) reported that executive function at 36 months predicted change in parenting from 36 to 60 months. Similarly, using data from the National Institute of Child Health and Human Development (NICHD) Study of Early Child Care and Youth Development, Belsky, Fearon, and Bell (2007) reported that executive attention predicted change in parenting from 54 months to first grade and from fourth grade to fifth grade (but not from first grade to third grade). However, null associations were found in community samples when effortful control was tested as a predictor of parenting from 18 to 30 months of age and from 30 to 42 months of age (Eisenberg, Spinrad, Eggum, et al., 2010) and in older samples (Eisenberg et al., 2005; Valiente et al., 2006).

Self-Regulation: Associations with Externalizing Symptoms

Meta-analysis (Ogilvie et al., 2011) has indicated that there is a moderate association between executive function and externalizing behavior, and that controlling for ADHD symptoms reduces—but does not eliminate—this association. There have been few longitudinal, prospective studies, however, that have examined the associations between executive function and externalizing behavior. Riggs, Blair, and Greenberg (2004) reported that executive function prospectively predicted externalizing behavior two years later while controlling for stability. Similarly, Nigg, Quamma, Greenberg, and Kusche (1999) reported that one aspect of executive function (inhibitory control; i.e., Color Word Stroop), but not a second (visual attention and task switching; i.e., Trails B), was prospectively related to teachers' reports of externalizing behavior two years later while controlling for stability in externalizing behavior. Comparable longitudinal studies relating effortful control to externalizing behavior have been more common, and generally indicate that effortful control is negatively related to change in externalizing behavior after 54 months of age but that the evidence for longitudinal associations in younger children is equivocal (for a review of these studies, see Eisenberg, Spinrad, & Eggum, 2010). Little is known about the alternative direction of effect (externalizing behavior → executive function) in younger children, but externalizing behavior has been found to inconsistently predict effortful control across a one-year lag in early childhood (Eisenberg, Spinrad, Eggum, et al., 2010), and null associations between externalizing behavior and later executive attention have been reported in middle childhood (Belsky et al., 2007). Eisenberg, Spinrad, Eggum, and colleagues (2010) speculated that children with externalizing behavior problems may have fewer opportunities to practice and improve self-regulatory skills. Although there is limited theory and empirical evidence that externalizing behavior longitudinally predicts self-regulation, we did not want to prematurely foreclose on the alternative direction of prediction from

externalizing behavior to executive function and the possibility of bidirectional or transactional pathways.

Mediation

Although no studies have examined children's executive function as a longitudinal mediator between parenting and externalizing behavior, several longitudinal studies have tested effortful control as a mediator of this association. Support for this mediational model in early childhood has been mixed. For example, Eisenberg, Sprinad, Eggum, and colleagues (2010) reported that effortful control (measured using questionnaires and laboratory tasks) at 30 months failed to mediate the association between 18-month parenting and 42-month externalizing behavior. In a somewhat comparable study of children of alcoholic parents, the longitudinal association between parenting at age 2 and externalizing behavior at age 5 was mediated by self-regulation at age 3, a construct that included (but was not limited to) a battery of effortful control tasks (Eiden, Edwards, & Leonard, 2007). Findings are more consistent at older ages, with results from several studies of older children (Belsky et al., 2007; Valiente et al., 2006) and adolescents (Eisenberg et al., 2005) indicating that the association between parenting and externalizing behavior is longitudinally mediated by effortful control.

The Present Investigation

Our goal was to examine the longitudinal relations among parenting, executive function, and externalizing behavior during a developmental period of rapid growth in children's self-regulation in a sample at risk for poor self-regulation and high externalizing behavior. Based on prior empirical findings from the effortful control literature, we hypothesized a longitudinal mediation model in which early parenting would show a negative indirect association with children's development of externalizing behavior, such that parenting would predict executive function, which in turn would predict externalizing behavior (parenting → executive function → externalizing behavior). A strength of our longitudinal panel design is that it allows us to specify and test alternative models, such as a bidirectional model in which child characteristics predict later parenting and an alternative mediation model in which parenting predicts child externalizing behavior, which in turn predicts child executive function (parenting → externalizing behavior → executive function).

Previous studies investigating similar mediation hypotheses have been limited by the use of questionnaire methods to assess multiple constructs (or have relied on a single, specific measure of self-regulation; see Belsky et al., 2007). When the same informant (e.g., parent, teacher) reports on multiple constructs, the presence of method effects can bias the associations among the constructs. In this study, questionnaires were used to assess children's externalizing behavior, whereas laboratory measures were used to assess parenting behavior and children's executive function. Furthermore, executive function was assessed using a battery of tasks to obtain a broad measure that included working memory, inhibitory control, and set shifting.

Method

Participants

We use data from the Family Life Project, a prospective longitudinal study of 1,292 children born between fall 2003 and fall 2004 in six rural counties in Pennsylvania and North Carolina. Low-income families were oversampled in both states and African American families were oversampled in North Carolina. Extensive details about recruitment procedures and sample characteristics have been published elsewhere (Vernon-Feagans, Cox, & The Family Life Project Key Investigators, 2013). Children were assessed at home at approximately 2, 6, 15, 24, 36, 48, 60, and 90 months of age (summer following first grade). At each of these time points, families were visited by two highly-trained data collectors and parents completed questionnaires on family demographics, household characteristics, and children's behavior. At the 6-, 15-, 24-, 36- and 60-month assessments, parents engaged in a semi-structured interaction with their child. Children were administered a battery of executive function tasks at the 36-, 48- and 60-month assessments.

Measures

Executive function—The executive function battery consisted of five tasks at the 36-month assessment and six tasks at the 48- and 60-month assessments. At the 48- and 60-month assessments, the executive function battery included three inhibitory control tasks, two working memory tasks, and one attention shifting task. The inhibitory control tasks included a Simon-like spatial conflict task, a Stroop-like silly sounds task, and a farm animal go no-go task. The working memory tasks included a span-like task and a self-ordered pointing task. The attention shifting task was an item selection task modeled on the Dimensional Change Card Sort task (Willoughby, Wirth, & Blair, 2011). At the 36-month assessment, a similar (but not identical) spatial conflict task was used and the self-ordered pointing task was not administered.

Each task was presented in an open spiral bound flipbook with pages that measured 8" × 14". For each task, research assistants established that the child knew colors and numbers and administered training trials and up to three practice trials if needed. If children failed to demonstrate an understanding of the goals of the task following the practice trials, the examiner discontinued that task. Full details regarding the administration rules, psychometric properties, and scoring approach for each of these tasks have been presented elsewhere (Willoughby, Wirth, et al., 2011).

Item response theory was used to generate expected a posteriori (EAP) scores for each task and these scores were equated over time using a calibration sample. For details about the generation of the EAP scores and information about the longitudinal measurement invariance of these scores, see Willoughby, Wirth, Blair, & The Family Life Project Investigators (2012). Within each assessment, a one-factor model fit the data well and a two-factor model did not provide better fit to the data (Willoughby, Blair, Wirth, Greenberg, & The Family Life Project Investigators, 2010; Willoughby et al., 2012). Within each assessment, EAP scores were averaged to form a composite measure of executive function ability. As is typical of executive function measures (Willoughby, Holochwost, Blanton, &

Blair, 2014), reliability coefficients for the composites at each time point were relatively low, α s = .37 at 36 months ($n = 973$), .55 at 48 months ($n = 1,008$) and .50 at 60 months ($n = 1,038$).

Externalizing behavior—Primary caregivers (typically biological mothers) completed the five-item conduct problems (e.g., “Often fights with other children or bullies them”) scale from the Strengths and Difficulties Questionnaire (SDQ; Goodman, 1997) at the 36 ($n = 1,093$), 48 ($n = 1,062$), 60 ($n = 1,084$), and 90 ($n = 1,088$) month assessments. The conduct problems scale is broadly representative of externalizing behavior problems. The SDQ items have three response categories (0 = “Not true”; 1 = “Somewhat true”; 2 = “Certainly true”). Because Cronbach’s α underestimates reliability for ordinal scales (especially for ordinal scales with few response categories), we report ordinal α reliability coefficients for these scales (Zumbo, Gaderman, & Zeisser, 2007). Ordinal α s were .76, .78, .81, and .87 at the 36-, 48-, 60-, and 90-month assessments, respectively.

Parenting—Children and their primary caregiver completed a 10 minute semi-structured free-play task at the 6- and 15-month assessments and a 10 minute puzzle task at the 24- and 36-months assessments. The free-play interaction involved asking each caregiver to use a standardized set of toys and to play with the infant as he or she normally would. The puzzle task presented the child with a series of three increasingly difficult jig-saw puzzles to complete and asking the primary caregiver to assist the child in any way that he or she chose. At the 60-month assessment, primary caregivers and children participated in two consecutive tasks for a combined 12 minute period. The first task was a tower construction task in which they were asked to recreate a tower structure using smaller wooden blocks of different shapes. The second task was a “slap jack” card game during which each player took turns putting down card and slapped the pile whenever a jack card was played (in order to win the cards in the pile). These parent-child interactions were video recorded, and the following seven aspects of parenting were later coded for each of the 6- through 36-month assessments: sensitivity, detachment, intrusiveness, stimulation, positive regard, negative regard, and animation in interacting with the child (Cox & Crnic, 2002; NICHD Early Child Care Research Network, 1999). At the 60-month assessment, the same parenting scales were coded as at previous assessments except that respect for child autonomy replaced the intrusiveness code and the animation code was dropped. Ratings were made on a scale ranging from 1 (“not at all characteristic”) to 5 (“highly characteristic”) at the 6- and 15-month assessments and on a scale ranging from 1 (“not at all characteristic”) to 7 (“highly characteristic”) at the 24-, 36- and 60-month assessments; to maintain consistency across time, scores at the latter visits were rescaled to range from 1 to 5.

Each scale was coded by a team of 4–5 coders, which included 1–2 master coders. Each coder was trained to be reliable with the master coder(s) and each coder completed approximately 30% of the tapes with the master coder(s). Although the composition of the coding teams changed over time, at least one of the master coders was consistent from one assessment to the next (e.g., a master coder who participated at the 6-month assessment also participated at the 15-month assessment). Intraclass correlations for independent ratings

were used to assess reliability. For each of the parenting scales, the intraclass correlation exceeded .80 at each assessment.

Factor analysis of the parenting variables yielded two dimensions of parenting behavior from 6 to 36 months (Mills-Koonce et al., 2011; Vernon-Feagans et al., 2013). Based on those results, we utilize a composite measure of parenting which includes the sensitivity, detachment (reversed), stimulation, positive regard, and animation codes. Intrusiveness and negative regard loaded on the second parenting factor. To simplify the presentation of results, we only include the first parenting factor in our analyses; substituting the second parenting factor did not substantively change the results. Cronbach's α for the 5-item parenting composite was .89, .90, .87, and .80 at the 6-, 15-, 24-, and 36-month assessments. We averaged the parenting scores across these four assessments to create a measure of early parenting quality, $\alpha = .86$, which for simplicity we subsequently refer to as "36-month parenting." At the 60-month assessment, we averaged the sensitivity, detachment (reversed), stimulation, positive regard variables to create a similar measure of parenting quality, $\alpha = .83$

Demographic covariates—State of residence (PA = 0; NC = 1) was included as a covariate to control for site differences in study variables. At the 2-month assessment, primary caregivers reported on their number of years of education and the sex (0 = Male; 1 = Female) and race (0 = not African American; 1 = African American) of their child. In addition, primary caregivers and, when applicable, secondary caregivers provided information about household income and the number of individuals in the household at the 6-, 15-, 24-, and 36-month assessments. The household income-to-needs ratio was calculated as household income divided by the concurrent US federal poverty threshold for a household of that size (U.S. Department of Health and Human Services, 2014), such that a value of 1.0 corresponds to household income equal to the poverty threshold (e.g., \$18,850 for a family of four in 2004). These scores were highly correlated across time, with r s ranging from .73 to .85. Household income-to-needs was therefore averaged across 6- through 36-month assessments, $\alpha = .94$, $M = 1.86$, $SD = 1.53$. This variable was natural log transformed to normalize its distribution, which exhibited high skewness and kurtosis prior to transformation.

Results

Missing Data

The full sample of the Family Life Project was composed of 1,292 participants at the 2 month assessment. Complete data were available for state of residence, sex and race of the child, and primary caregiver years of education. The percentage of missing data for other study variables was as follows: 36-month income-to-needs = 5.5%; 36-month executive function = 24.7%, 48-month executive function = 22.0%; 60-month executive function = 19.7%; 36-month externalizing behavior = 15.4%; 48-month externalizing behavior = 17.8%; 60-month externalizing behavior = 17.8%; 90-month externalizing behavior = 16.1%; 36-month parenting = 5.5%; and 60-month parenting = 25.5%.

We used SAS 9.3 and a macro obtained from <http://www.appliedmissingdata.com/macro-programs.html> to compute Little's (1988) test for data missing completely at random (MCAR), $\chi^2(df = 605) = 888.354, p < .001$. This result indicates that the pattern is missing data is systematic (i.e., associated with measured or unmeasured variables). To assess potential bias due to differential attrition, we correlated missing data indicators (0 = not missing; 1 = missing) for each study variable with the demographic covariates and early parenting. Although there were a number of modest but significant correlations between these two sets of variables, none of these correlations exceeded .13.

Participants were included in the analytic sample ($N = 1,115$), which was used for all subsequent analyses, if they had non-missing data at one or more assessments for executive function, externalizing behavior, and parenting. All models were specified and fitted in Mplus 7.11 (Muthén & Muthén, 2012) using the full information maximum likelihood (FIML) estimator.

Descriptive Statistics and Correlations

Descriptive statistics and correlations for all study variables are presented in Table 1. On average, primary caregivers reported 14.45 years of education, $SD = 2.80$ years; 19.8% of primary caregivers reported less than 12 years of education. Prior to transformation, the average household income-to-needs ratio was 1.86, $SD = 1.53$; and 67.8% of participating households' average income from 6–36 months was below 200% of the poverty threshold. To characterize the severity of externalizing behavior in the Family Life Project sample, we compared the means on the conduct problems scale from the 48-, 60-, and 90-month assessments to gender-matched national norms for the United States from the National Health Interview Survey for children aged 4–7 (Youthinmind Ltd., 2004). As expected based on the high-risk nature of the sample, Family Life Project participants scored higher than the age 4–7 norms at all three assessments, average Cohen's $d = 0.43$ for girls and 0.32 for boys.

There was considerable rank-order stability in parenting from 36 to 60 months, $r = .70$. There was also rank-order stability for all child constructs that were assessed multiple times, with cross-time correlations ranging from .33 to .60 for executive function and from .49 to .55 for externalizing behavior. Executive function was negatively related to concurrently measured externalizing behavior at the 36-, 48-, and 60-month assessments, $r_s = .14, .21,$ and $.25$. Parenting at 36 and 60 months was positively related to executive function and negatively related to externalizing behavior across all time points, with r_s ranging from .28 to .39 for executive function and from .17 to .33 for externalizing behavior.

Longitudinal Panel Model

In a preliminary analysis step, we estimated autoregressive models for executive function and externalizing behavior separately. Using likelihood ratio tests, models in which each score was predicted by the scores at all previous time points fit significantly better than simpler models in which all longitudinal paths were not included. Because the more complex, completely saturated autoregressive models showed better fit to the data and because controlling for all prior scores provides a more conservative test of cross-lagged

paths in a panel model with multiple constructs, we retained the more complex autoregressive models for use in subsequent analyses.

We combined the autoregressive models for executive function and externalizing behavior described above and added demographic variables (i.e., state, sex, race, primary caregiver education, and family income-to-needs) at the initial assessment and parenting at 36 and 60 months. All within-time correlations among exogenous variables were estimated at the 36-month assessment, and standardized residual covariances among concurrently measured exogenous variables were estimated at subsequent assessments. To maintain a parsimonious model, we only included longitudinal paths for demographic covariates when indicated by substantial changes in model fit: (1) executive function at 48 months was regressed on sex; (2) executive function at 48 months was regressed on African American race; and (3) parenting at 60 months was regressed on the family income-to-needs ratio. Furthermore, the inclusion of these paths did not substantively change the results. This model—which is depicted (without covariates) in Figure 1—fit the data well, $\chi^2(DF = 37) = 189.064, p < .001$, Root mean square error of approximation (RMSEA) = 0.061 (90% CI [0.052, 0.069]), comparative fit index (CFI) = 0.969, standardized root mean square residual (SRMR) = 0.038.

The standardized and unstandardized coefficients for all directional paths among the executive function, externalizing behavior, and parenting variables in this model (with *SEs*) are presented in Table 2 and the statistically significant directional paths in the model are also depicted (with standardized β s) in Figure 2. As expected, we found evidence for an association between early parenting and later executive function and externalizing behavior: parenting at 36 months predicted executive function at both 48 months and at 60 months, β s = 0.248 and 0.130, and was also predictive of externalizing behavior at 48 months (but not of externalizing behavior at 60 months), $\beta = 0.093$. Contrary to expectations, parenting at 60 months was unrelated to externalizing behavior at 90 months. There was evidence for modest prediction of parenting from child characteristics, with executive function (but not externalizing behavior) at 48 months predicting parenting at 60 months, $\beta = 0.052$. There was a small but significant standardized residual covariance between parenting and externalizing behavior at 60 months, $\phi = .08, p < .01$.

The cross-lagged paths between executive function and externalizing behavior allow us to address questions about the direction of influence between these two constructs. As expected based on prior research, there was consistent prediction from executive function to externalizing behavior at the subsequent assessment: executive function at 36 months predicted externalizing behavior at 48 months, executive function at 48 months predicted externalizing behavior at 60 months, and executive function at 60 months predicted externalizing behavior at 90 months, β s = 0.065, 0.065, and 0.078. The opposite direction of prediction—from externalizing behavior to executive function at the subsequent assessment—was significant at 48 to 60 months, $\beta = 0.073$, but not from 36 to 48 months. There were modest standardized residual covariances between executive function and externalizing behavior at 48 and at 60 months, ϕ s = .07 and .09, $p < .05$ and $p < .01$.

The R^2 for the endogenous variables in this model were as follows: 48-month executive function = 26.6%, 60-month executive function = 39.1%, 48-month externalizing behavior = 30.7%, 60-month externalizing behavior = 37.6%, 90-month externalizing behavior = 40.9%, and 60-month parenting = 51.4%. To quantify the effect size of the direct effects of executive function, externalizing behavior, and parenting we fixed these paths to zero for each of these variables and computed the difference in R^2 between the constrained and unconstrained models. The direct effect of early parenting uniquely explained 3.5% of the variance in executive function at 48 months, 1.1% of the variance in executive function at 60 months, and 0.5% of the variance in externalizing behavior at 48 months, whereas executive function at 48 months explained only 0.1% of the variance in parenting at 60 months. Executive function at 36 months explained 0.4% of the variance in externalizing behavior at 48 months, executive function at 48 months explained 0.3% of the variance in externalizing behavior at 60 months, and executive function at 60 months explained 0.5% of the variance in externalizing behavior at 90 months. With respect to the opposite direction of prediction, externalizing behavior at 48 months explained 0.4% of the variance in executive function at 60 months.

To examine whether there were sex differences in the paths, we estimated a multigroup path model for boys and girls in which all covariances and directional paths were free to vary across groups. We then compared this model to a nested model in which all covariances and directional paths were constrained to be equal for boys and girls. The unconstrained model fit well, $\chi^2(df = 58) = 126.258, p < .001$, RMSEA = .046 (90% CI [.035, .057]), CFI = .983, SRMR = .029, as did the constrained model, $\chi^2(df = 108) = 180.488, p < .001$, RMSEA = .035 (90% CI [.026, .043]), CFI = .982, SRMR = .039. To compare models, we used a likelihood ratio test, which indicated that the constrained model did not fit worse relative to the unconstrained model, $\chi^2(df = 50) = 54.230, p = .316$. As a result, we did not consider this multigroup model further.

Mediation

Our primary hypothesis was that the association between parenting and later externalizing behavior would be mediated by executive function. We therefore tested the indirect effect of 36-month parenting on 60-month externalizing behavior through 48-month executive function (see Figure 3, panel a), and the indirect effect of 36-month parenting on 90-month externalizing behavior through 60-month executive function (see Figure 3, panel b). In addition, we tested mediational pathways involving executive function that involved more than a single mediator (see Figure 3, panel c). There were two such pathways of interest: (1) from 36-month parenting to 48-month executive function to 60-month executive function to 90-month externalizing behavior; and (2) from 36-month parenting to 48-month executive function to 60-month externalizing behavior to 90-month externalizing behavior. We were also interested in the effects of parenting on later externalizing behavior that were mediated by stability in externalizing behavior (e.g., from 36-month parenting to 48-month externalizing behavior to 60-month externalizing behavior).

In addition to testing the hypothesized model in which the effect of parenting on later externalizing behavior was mediated by executive function, we also evaluated an alternative

model in which the effect of parenting on executive function would be mediated by externalizing behavior. Therefore, we also tested the indirect effect of 36-month parenting on 60-month executive function through 48-month externalizing (see Figure 3, panel d).

All indirect effects were all evaluated using the panel model that we previously presented, with one minor change: we added the (nonsignificant) direct path between 36-month parenting and 90-month externalizing behavior so that the total effect of 36-month parenting could be decomposed into direct and indirect effects. All indirect effects were tested using the percentile bootstrap with 5,000 bootstrap sample draws (Taylor, MacKinnon, & Tein, 2008). To quantify effect size, we report the completely standardized indirect effects (Preacher & Kelley, 2011) with bootstrapped 95% confidence intervals. The β coefficients for the indirect effects indicate how much the dependent variable would be expected to change (expressed on the metric of standard deviations) for a 1 *SD* change in the predictor.

First we tested the hypothesized (Figure 3, Panel a) and alternative mediation models (Figure 3, Panel d) using dependent variables at the 60-month assessment (see Table 3). As hypothesized, the association between 36-month parenting and 60-month externalizing behavior was mediated by 48-month executive function, $\beta = 0.015$. However, there was also support for the alternative model in which the association between 36-month parenting and 60-month executive function was mediated by 48-month externalizing behavior, $\beta = .007$. Next, we tested the hypothesized model using the dependent variable at 90 months (see Table 3). Unfortunately, the alternative model could not be tested in this analysis because executive function data were not collected at the 90-month assessment. The effect of 36-month parenting on 90-month externalizing behavior was mediated by executive function at 60 months (see Figure 3, panel b), $\beta = 0.010$, and by two more complex pathways involving executive function at 48 months: one pathway from parenting to executive function at 48 months to executive function at 60 months (see Figure 3, panel c) and one pathway from parenting to executive function at 48 months to externalizing behavior at 60 months (not depicted), β s = 0.009 and 0.005. The sum of these three indirect effects was negatively related to 90-month externalizing behavior, $\beta = 0.023$. The effects of parenting were also carried forward through stability in executive function and in externalizing behavior. For example, 36-month parenting predicted 48-month executive function, which in turn predicted 60-month executive function. These indirect effects are also listed in Table 3.

Discussion

Our primary goal was to test a hypothesized longitudinal mediation model in which early parenting predicts child executive function, which in turn predicts child externalizing behavior problems (parenting \rightarrow executive function \rightarrow externalizing behavior). Because externalizing behavior was assessed four times, we were able to test the hypothesized mediation effect twice, and the hypothesized mediation model was supported in both of these instances: we found a significant, indirect effect of 36-month parenting on 60-month and 90-month externalizing behavior that operated through children's executive function at intermediate assessments. Although modest, the effect sizes should be interpreted in light of the high stability in all constructs, which limited our ability to predict across constructs. This is especially an issue for the effect size of the mediated effect, which is calculated as the

product of two other coefficients. We calculated that the standardized β s for the indirect effects reported by Belsky and colleagues (2007) were 0.044 and 0.017. These values are comparable to the indirect effects for executive function that we reported in this study, β s = 0.015 and 0.023.

These mediation results provide evidence consistent with a causal model in which sensitive parenting reduces children's externalizing behavior primarily by promoting children's executive function, and parallels findings from a school-based intervention study in which executive function mediated the effect of intervention status on externalizing behavior (Riggs, Greenberg, Kusché, & Pentz, 2006). Critically, these results help inform our understanding of a potential, albeit weak mechanism through which parenting might influence children's externalizing behavior problems. Executive function is believed to be a resource that children can use to flexibly regulate their behaviors and emotions and to plan. This volitional capacity for self-regulation could potentially be applied in a variety of ways to reduce externalizing behavior.

However, we are currently unable to rule out the possibility of the alternative mediation model (parenting \rightarrow externalizing behavior \rightarrow executive function), which also received some support. A transactional pattern of associations, in which executive function and externalizing behavior are mutually influential over time, remains a possibility.

Testing Bidirectional Relations

We were also able to investigate the associations between parenting and child executive function and externalizing behavior over time to test for bidirectional or transactional associations between parenting and child characteristics. While controlling for rank-order stability in the constructs, early parenting had a direct effect on executive function assessed one and two years later, and on externalizing behavior problems one year later. This pattern of associations mirrors prior work in which parenting has been reported to predict the subsequent development of children's self-regulation (Hammond et al., 2012). The effect size (for the direct effect) of early parenting on 48 month externalizing behavior was modest ($R^2 = 0.5\%$), but was more substantial for executive function at 48 months, $R^2 = 1.1\%$, and early parenting continued to independently predict executive function (but not externalizing behavior) at 60 months, $R^2 = 0.5\%$. Although relatively small, these R^2 values should be interpreted with respect to the high stability in the constructs, which limit the variability that can be explained by other predictors.

In contrast to the paths from parenting to child characteristics, there was only limited evidence of child characteristics predicting parenting: child executive function at 48 months predicted parenting at 60 months, but this effect uniquely explained only 0.1% of the variance in 60-month parenting. For comparison, Blair and colleagues (2014) reported somewhat larger standardized regression coefficients using 36-month executive function as a predictor of 60-month parenting in the Family Life Project; however, their models did not include child externalizing behavior, which could potentially reduce the unique effect of executive function on parenting. The small effect size for the association between child executive function and parenting is in line with other studies finding weak or inconsistent evidence in support of child effects on parent behavior (Bates, Schermerhorn, & Petersen,

2012). It is possible, however, that so-called “coercive” child effects on parenting behavior (Patterson, 1982) are moderated by severity of externalizing behavior symptomatology; that these patterns have already been established early in life and therefore do not have additional effects later on parenting; or that the amount of time between assessments in this study was too long to detect such effects. Unfortunately, the absence of parenting data at the 48-month assessment also limited our ability to draw conclusions regarding child effects on parenting.

The longitudinal design also made it possible to examine the temporal ordering of the associations between executive function and externalizing behavior. Whereas executive function consistently predicted externalizing behavior at every subsequent assessment, the evidence for the alternative direction of prediction was more limited, with externalizing behavior predicting executive function at the subsequent assessment only one of two times. All effect sizes for the prediction across these constructs were modest. Consistent with Eisenberg, Spinrad, Eggum, and colleagues’ (2010) findings, externalizing behavior at 48 months was prospectively related to executive function at 60 months. At present, this evidence is somewhat inconclusive and, as previously stated, we cannot rule out a transactional developmental process in which executive function and externalizing behavior exert mutual influence on one another over time—or that an unmeasured confounding variable influences change in both executive function and externalizing behavior.

Effects for Early but not Later Parenting

In contrast to the association between early parenting and subsequent externalizing behavior, parenting assessed at 60 months failed to predict externalizing behavior at 90 months while controlling for stability in externalizing behavior. This does not imply that parenting at 60 months and externalizing behavior at 90 months were unrelated. Rather, it means that we did not find additional prediction of children’s externalizing behavior at 90 months from parenting at 60 months over and above prior externalizing behavior. Although the amount of time between assessments can affect the magnitude of the associations observed in longitudinal panel models (Selig & Little, 2012), the longer amount of time between the last two assessments (i.e., 30 months) than between the previous assessments (i.e., 12 months), cannot explain why early parenting predicts 90-month externalizing behavior, but 60-month parenting does not. It might be the case that parents regulate their children’s behavior problems externally in early childhood, when children’s self-regulatory abilities are weak, and that effective external regulation promotes effective self-regulation in their children that can then be used to manage externalizing behavior even in the absence of external regulation from caregivers (Eisenberg & Spinrad, 2004; Kopp, 1982). The stronger effect of early parenting relative to later parenting on 90 month externalizing behavior is consistent with theories of experiential canalization and developmental plasticity (Blair & Raver, 2012; Del Giudice, Ellis, & Shirtcliff, 2011) and suggests that parenting interventions targeting externalizing behavior would likely be most effective earlier, rather than later, in children’s development.

Distinguishing Executive Function from Effortful Control

Although we focus on executive function in this study, prior research on effortful control has also indicated that the development of self-regulation is influenced by the early family environment. However, those studies have used questionnaires or relatively narrow assessments of self-regulation rather than a comprehensive battery of executive function tasks assessing working memory, shifting, and inhibition. Our study provides evidence that early parenting behavior is a robust predictor of subsequent executive function while controlling for stability (see also Blair et al., 2014), and a particular strength of our findings is that each of the three constructs (parenting, executive function, and externalizing behavior) was assessed using independent methods. Although externalizing behavior was assessed using only a single informant, the high mean levels are consistent with the high-risk nature of the Family Life Project sample and parent reports on the SDQ have been shown to be a valid screening measure for clinical levels of externalizing behavior problems (Goodman, 2001).

Batteries of laboratory tasks are frequently used in developmental studies to assess both executive function (Garon, Smith, & Bryson, 2014; Wiebe, Espy, & Charak, 2008) and effortful control (Kochanska & Knaack, 2003), and there is some overlap between the tasks that are used as measures of executive function and effortful control, with “day-night” (Gerstadt, Hong, & Diamond, 1994) and similar inhibition tasks being used as measures of both constructs. However, there is one major difference in the measurement of these two constructs: effortful control batteries have not used tasks that assess primarily working memory or set shifting (Kochanska & Knaack, 2003), whereas these tasks are considered an important component of batteries assessing executive function (Garon et al., 2014; Miyake et al., 2000; Wiebe et al., 2008). In addition, effortful control batteries more commonly include delay tasks, which might differ from cognitive executive function tasks that lack a strong motivational component (Kim, Nordling, Yoon, Boldt, & Kochanska, 2012; Willoughby, Kupersmidt, Voegler-Lee, & Bryant, 2011). Furthermore, the use of questionnaire measures appears to be more common in the effortful control literature. At present, it is still unclear how much these differences in measurement contribute differences in the associations between effortful control, executive function, and other constructs (Blair & Razza, 2007).

One small meta-analytic study has suggested that the effect size of the association between inhibitory control and externalizing behavior is greater than the association between other aspects of executive function (i.e., working memory; set shifting) and externalizing behavior (Schoemaker, Mulder, Dekovi, & Matthys, 2013). An important direction for future research will be to examine how the three foundational executive function abilities are differentially related to externalizing behavior in longitudinal studies.

Limitations, Conclusions, and Implications

The degree of rank-order stability in the constructs is negatively related to statistical power to detect prediction of change over time across constructs. When power is low, is not clear whether the absence of an association is due to the failure to detect a true effect or the absence of a true association among the variables. Given high levels of stability for

parenting and moderate levels of stability for externalizing behavior and executive function, a large sample size is therefore needed to adequately address questions of longitudinal mediation among these constructs. Our sample was ideally suited to address this research question because the large sample size affords much greater statistical power than most previous investigations (for an exception, refer to Belsky et al., 2007).

One limitation of our study was the relatively low reliability of the battery of executive function tasks, which was particularly acute at the initial assessment. In longitudinal mediation analyses, unreliability can have two undesirable and opposing effects. First, unreliability attenuates the estimates of the associations among the constructs and the degree of rank-order stability in each construct over time. This can potentially result in biased longitudinal prediction across constructs because variance in the variables at later assessments that *should* be accounted for by rank-order stability in the constructs and covariance among the constructs at an earlier assessment can potentially be predicted longitudinally. Second, unreliability in the mediating variable is known to negatively bias the indirect effect and positively bias the direct effect (Kenny, 2014), potentially leading to an underestimate of the true effect size of the mediated effect. However, the low reliability of the executive function measures is a limitation that is by no means unique to the Family Life Project, in which executive function was measured using a battery of 5–6 diverse executive function tasks with the goal of obtaining a comprehensive assessment of executive function ability.

Our model provides evidence that one way in which parents might influence the development of children's subsequent externalizing behavior is by scaffolding and nurturing their executive function skills (for a discussion of the mechanisms through which parenting might affect executive function, see Bernier, Carlson, & Whipple, 2010; Hughes & Ensor, 2009). However, we have limited knowledge about the specificity of parenting behavior and the development of children's executive function or externalizing behavior. In part, this is because different aspects of parenting tend to be interrelated, which makes it difficult to disentangle the effects of specific aspects of parenting. Our measure of parenting was reliable, longitudinally stable, and a conceptually broad measure, but it is unclear whether more specific aspects of parenting would provide better prediction than our broad measure of parenting quality.

Acknowledgments

We would like to thank the many families and research assistants who made this study possible. Support for this research was provided by the National Institute of Child Health and Human Development Grants R01 HD51502 and P01 HD39667 with co-funding from the National Institute on Drug Abuse.

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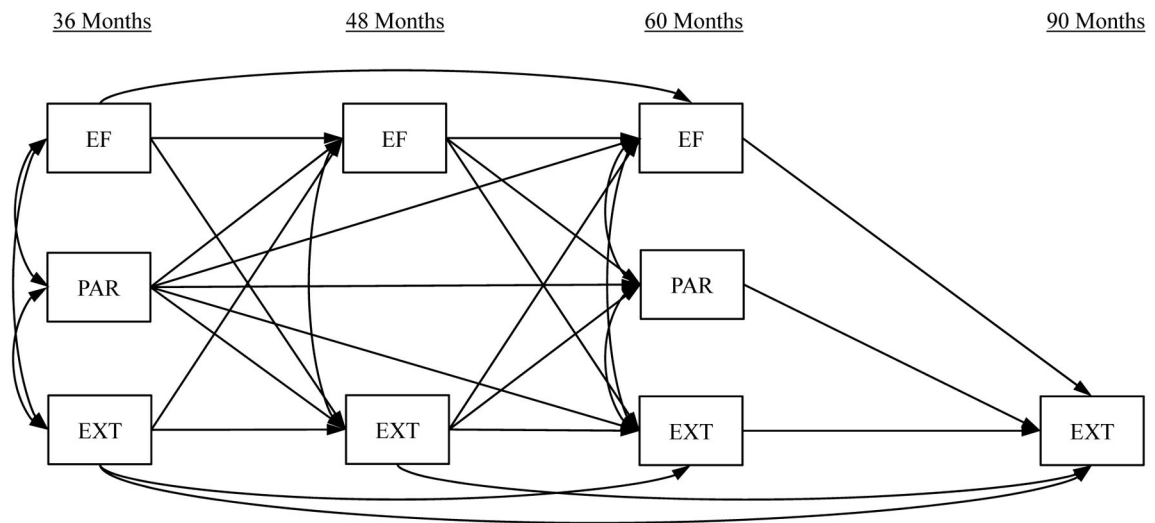


Figure 1.
Hypothesized Autoregressive Model with Cross-lagged Paths
EF = Executive function; EXT = Externalizing behavior; PAR = Parenting. Our statistical model included covariates that are not depicted in this figure.

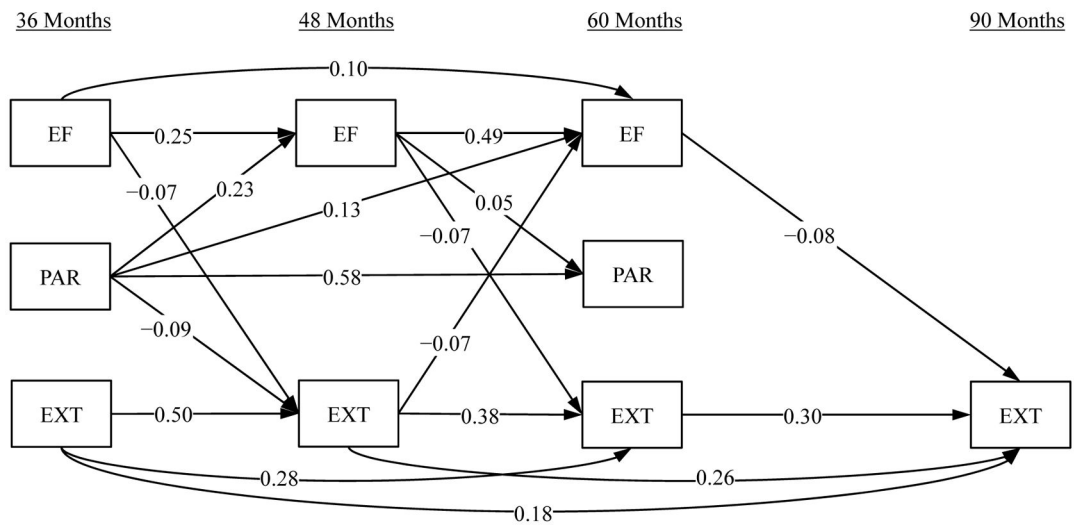
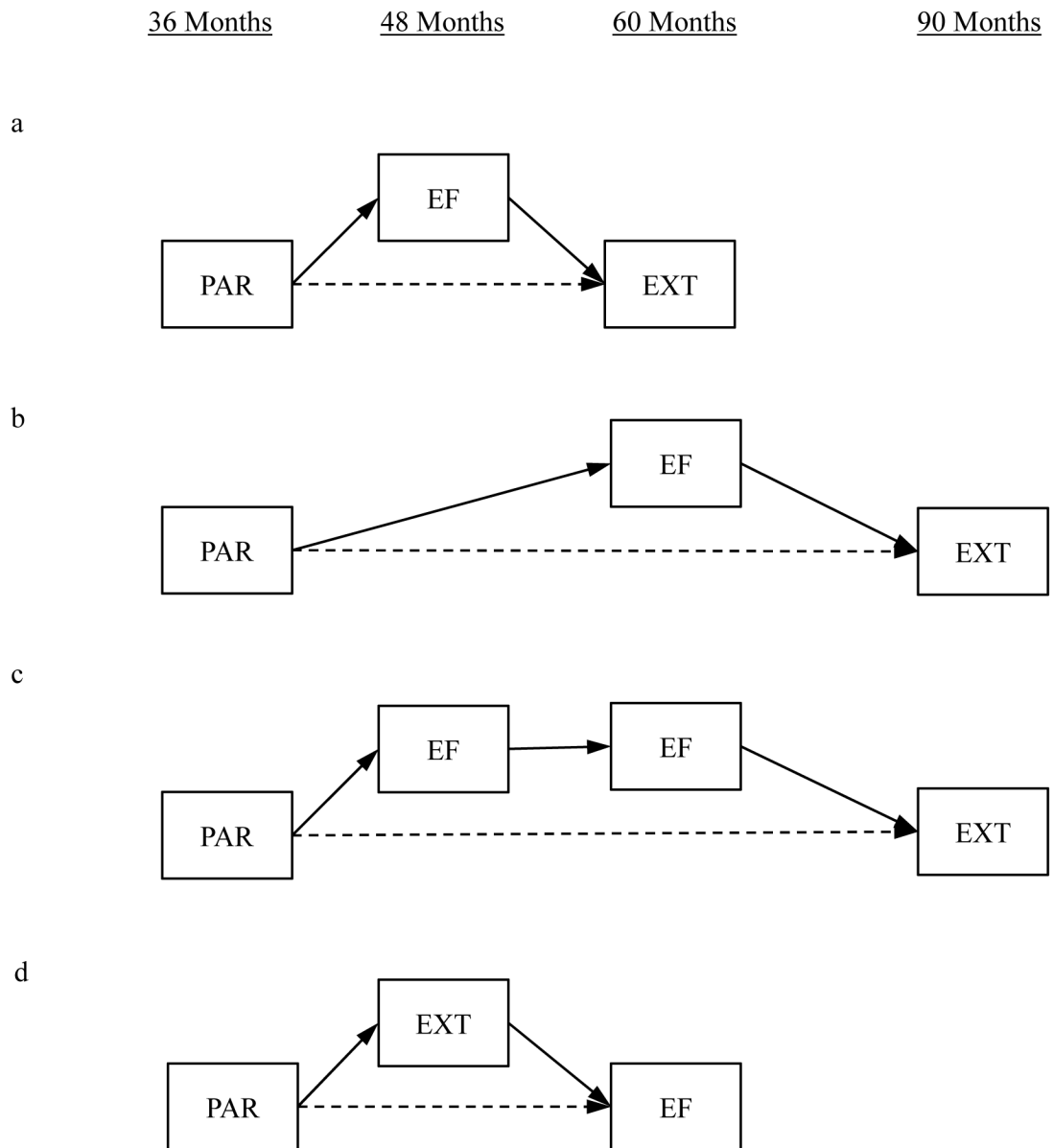


Figure 2. Significant Directional Paths in Autoregressive Model with Cross-lagged Paths
 EF = Executive function; EXT = Externalizing behavior; PAR = Parenting. Only significant directional paths (with standardized β s) are shown. Our statistical model included nonsignificant directional paths, covariates, correlations among all exogenous variables at the first assessment, and correlations among residuals within each subsequent assessment that are not depicted in this figure.

**Figure 3.****Mediation Model Examples**

EF = Executive function; EXT = Externalizing behavior; PAR = Parenting. Solid lines indicate the paths between the predictor and a mediator, between two mediators, or between a mediator and the criterion, whereas dashed lines indicate the direct effect of the predictor on the criterion while accounting for the indirect effects.

Table 1

Correlations and Descriptive Statistics

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1 North Carolina	–													
2 Female	0.07	–												
3 African American	0.63	–0.01	–											
4 Caregiver Education	–0.17	–0.01	–0.22	–										
5 Ln(Income-to-Needs)	–0.29	–0.04	–0.44	0.60	–									
6 36-month Parenting	–0.30	0.02	–0.42	0.51	0.53	–								
7 60-month Parenting	–0.27	0.01	–0.39	0.47	0.51	0.70	–							
8 36-month EF	–0.29	0.10	–0.29	0.20	0.26	0.30	0.28	–						
9 48-month EF	–0.31	0.14	–0.34	0.31	0.32	0.39	0.34	0.38	–					
10 60-month EF	–0.22	0.13	–0.28	0.26	0.29	0.37	0.30	0.33	0.60	–				
11 36-month EXT	0.09	–0.06	0.14	–0.27	–0.30	–0.33	–0.26	–0.14	–0.19	–0.23	–			
12 48-month EXT	0.07	–0.07	0.13	–0.26	–0.25	–0.28	–0.22	–0.16	–0.21	–0.22	0.54	–		
13 60-month EXT	0.03	–0.05	0.12	–0.27	–0.26	–0.26	–0.26	–0.09	–0.21	–0.25	0.51	0.55	–	
14 90-month EXT	–0.03	–0.09	0.05	–0.22	–0.21	–0.23	–0.17	–0.10	–0.15	–0.25	0.49	0.54	0.55	–
Mean	0.59	0.43	0.50	14.45	0.94	2.86	2.88	–0.56	–0.13	0.29	0.63	0.44	0.39	0.38
SD	–	–	–	2.80	0.44	0.66	0.76	0.55	0.51	0.48	0.41	0.34	0.36	0.39

Note. EF = Executive function; EXT = Externalizing behavior. Bold = $p < .05$.

Table 2

Directional Paths in the Longitudinal Panel Model

		Dependent Variable							
		Executive Function			Parenting				
		Externalizing			Parenting				
48 Months									
Predictor	<i>b</i>	<i>SE</i>	β	<i>b</i>	<i>SE</i>	β	<i>b</i>	<i>SE</i>	β
Parenting 36	0.182	0.025 ***	0.232	-0.048	0.015 **	-0.093			
EF 36	0.233	0.029 ***	0.248	-0.040	0.018 *	-0.065			
EXT 36	-0.058	0.036	-0.047	0.408	0.023 ***	0.502			
60 Months									
Predictor	<i>b</i>	<i>SE</i>	β	<i>b</i>	<i>SE</i>	β	<i>b</i>	<i>SE</i>	β
Parenting 36	0.095	0.020 ***	0.130	-0.023	0.015	-0.042	0.669	0.032 ***	0.579
EF 36	0.085	0.027 **	0.096						
EF 48	0.464	0.027 ***	0.493	-0.045	0.019 *	-0.065	0.077	0.038 *	0.052
EXT 36				0.239	0.026 ***	0.276			
EXT 48	-0.104	0.037 **	-0.073	0.405	0.032 ***	0.381	-0.006	0.054	-0.002
90 Months									
Predictor	<i>b</i>	<i>SE</i>	β	<i>b</i>	<i>SE</i>	β	<i>b</i>	<i>SE</i>	β
Parenting 60				0.017	0.014	0.034			
EF 60				-0.063	0.021 **	-0.078			
EXT 36				0.173	0.029 ***	0.186			
EXT 48				0.299	0.036 ***	0.261			
EXT 60				0.325	0.033	0.302			

Note. EF = Executive function; EXT = Externalizing behavior.

* $p < .05$,

Empty cells indicate that no directional path was estimated.

*** $p < .001$.

** $p < .01$.

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Table 3

Mediation Analysis: Direct and Indirect Effects of Early Parenting

Predictor	Dependent Variable					
	Executive Function			Externalizing Behavior		
	60 Months					
PAR (Direct Effect)	<i>b</i>	<i>SE</i>	β	<i>b</i>	<i>SE</i>	β
	0.095	0.020 ***	0.130	-0.023	0.016	-0.042
Specific Indirect Effects						
PAR → EF 48	0.084	0.013 ***	0.115	-0.008	0.004 *	-0.015
PAR → EXT 48	0.005	0.003 *	0.007	-0.019	0.006 **	-0.035
	90 Months					
PAR (Direct Effect)				-0.012	0.020	-0.020
Specific Indirect Effects through EF						
PAR → EF 48 → EF 60				-0.005	0.002 *	-0.009
PAR → EF 48 → EXT 60				-0.003	0.001 *	-0.005
PAR → EF 60				-0.006	0.002 *	-0.010
Sum of Specific Indirect Effects through EF				-0.013	0.004 **	-0.023
Specific Indirect Effects through EXT						
PAR → EXT 48				-0.014	0.005 **	-0.024
PAR → EXT 48 → EXT 60				-0.006	0.002 **	-0.011
PAR → EXT 60				-0.007	0.005	-0.013
Sum of Specific Indirect Effects through EXT				-0.028	0.008 **	-0.047

Note. PAR = Parenting; EF = Executive function; EXT = Externalizing behavior. Specific indirect effects are the sum of the specific indirect effects listed in this table. There are additional, nonsignificant indirect effects in the model.

 $p < .001$,

**
 $p < .01$,

$d < .50^*$

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