Abstract

According to prominent models of child development, parental factors may contribute to individual differences in children's executive functioning (EF). Here we examine the relative importance of parents' socioeconomic status (SES), mental health, and parenting as predictors of EF development, drawing on a large (n = 1,070) community sample of Norwegian children who received biennial EF assessments from 6 to 10 years of age. We measure EF by means of the Behavior Rating Inventory of Executive Function. We assess parenting through observer ratings of parent–child interactions and parental mental health via the Beck Anxiety Inventory, Beck Depression Inventory, and Hopkins Symptom Checklist. When we adjust for all time-invariant unmeasured confounders, higher parental education predicts superior EF development, whereas harsh parenting forecasts poorer EF development. However, parenting does not mediate the effect of parental education. These results indicate that harsh parenting should be targeted in interventions aimed at improving EF.

Keywords: BRIEF, education, executive functions, occupation, parenting, parental mental health, self-regulation, SES.

Parental Predictors of Children' Executive Functioning from Ages 6 to 10

Introduction

Executive functioning (EF) refers to a collection of discrete but interrelated cognitive abilities that are involved in flexible, goal-directed behavior (Goldstein, Naglieri, Princiotta, & Otero, 2014), often divided into the three core components: working memory, attention shifting, and inhibitory control (Miyake & Friedman, 2012). In everyday life, children rely on EF to adapt to the demands of school and social interactions (Diamond, 2013). EF emerges during the first years of life and continues to develop through childhood and adolescence (Best & Miller, 2010). Children's daily environment changes quite radically when they start school. For instance, school-aged children are required to participate in more structured activities than previously, which likely places greater demands on their EF. Considering these environmental changes, in combination with the fact that the early school years constitute a critical period of development in EF, it becomes pertinent to identify predictors of differential development of EF at this age.

A vast amount of research suggests wide-ranging effects of EF, with positive implications for academic achievement (Blair & Razza, 2007), mental health (Vinberg, Miskowiak, & Kessing, 2013), and social adjustment (Razza & Blair, 2009). Such findings imply that understanding the developmental antecedents of individual differences in the development of EF could inform preventative and treatment efforts designed to foster EF and, thereby, multiple aspects of development. Although there are substantial maturational and genetic influences on EF and its development (Engelhardt, Briley, Mann, Harden, & Tucker-Drob, 2015), there is also reason to believe that environmental factors contribute (see Müller, Baker, & Yeung, 2013). In line with prominent theories of parental influence on cognitive development (Conger & Donnellan, 2007; Haveman & Wolfe, 1994; Huston & Bentley, 2010), prospective studies indicate that family SES (Hackman, Gallop, Evans, & Farah, 2015;

Hughes, Ensor, Wilson, & Graham, 2010), parental mental health (Hughes, Roman, Hart, & Ensor, 2013), and parenting (Blair, Raver, & Berry, 2014) predict EF.

A major challenge to this body of work concerns potential confounding due to unmeasured factors. This problem plagues inquiries that rely on multiple covariates (e.g. Hackman et al., 2015) because one can never be certain that all possible third-variable effects have been taken into account. Perhaps most notably, unless a study is genetically informed, there is always the possibility that any parental “effects” on child development, for example, family SES, parental mental health, and parenting, are genetically mediated. These may thus be a function of genes shared by parents and children rather than caused by parental (i.e., environmental) factors. This would seem especially so in light of the now-abundant evidence that many would-be environmental predictors are substantially heritable (Plomin, 2013). Although no EF-related investigations have yet addressed this issue, evidence consistent with it can be found in research on candidate genes that has linked them to both self-regulation and parenting (Bridgett, Burt, Edwards, & Deater-Deckard, 2015). Such evidence raises the related possibility that genes that play a role in children’s EF may also be systematically related to family SES and the mental health of parents. To take into account possible confounding resulting from all unmeasured, time-invariant third variables–such as neighborhood and family size–as well as genetics, we employ a fixed-effects approach (Allison, 2009; Firebaugh, Warner, & Massoglia, 2013) in the current inquiry. We model family SES, parental mental health, and parenting effects on the development of EF by measuring teacher ratings of children’s everyday EF from age 6 to 10 in a large community sample of Norwegian children and their parents, following them biennially from the age of 4 to 10 years.

Measurement of EF

The EF phenotype is complex, including many sub-phenotypes, such as working memory, inhibition, cognitive flexibility, etc. (Goldstein et al., 2014), that interchangeably work together or separately. Because of the multi-faceted nature of EF, there exists no gold-standard test or questionnaire to measure EF; they are commonly measured either by rating measures of everyday behavior related to EF, or by laboratory tests. Whereas tests assess the optimal efficiency of different facets of EF, rating measures of EF capture how well the person makes use of these resources in everyday goal-pursuit (Toplak, West, & Stanovich, 2013). Notably, there is little overlap between formal tests of EF and rating-based measures of EF (McAuley, Chen, Goos, Schachar, & Crosbie, 2010). Hence, every study of the development of EF must choose which aspect of EF to focus on and thus which measurement to adopt. Because EF is so important in children's everyday activities, as it is used to initiate actions in school, change from one assignment to another, inhibit impulses, focus on specific tasks, etc., we chose to employ a measure of children's everyday EF. Therefore, this is a study of how parental factors affect children's EF, measured by how it manifests in everyday life.

Parents' Influence on Child EF

Parental influence on child EF can be understood in the framework of social-causation theories. These stipulate that social class influences parental emotional well-being, (e.g. their mental health), which in turn affects parenting and therefore children's development (e.g. EF-development; see Conger & Donnellan, 2007; Huston & Bentley, 2010). This chain of effects leads to the expectation that low family SES predicts poor parental mental health, which in turn predicts less-supportive parenting and therefore less-competent child functioning. Although emerging evidence suggests a relation between EF and SES, as well as between EF and parenting practices (Müller et al., 2013), and parents' mental health (Hughes et al., 2013), it remains to be determined whether these correlates of EF operate mediationally, as stipulated by social-causation theories. Therefore, a primary goal of the research reported herein is to address this issue.

Socioeconomic status. It has repeatedly been found that low SES is related to weaker EF performance in children (Raver, Blair, & Willoughby, 2013). Three studies document this association prospectively (Hackman et al., 2014; Hackman et al., 2015; Hughes et al., 2010). Hackman et al. (2015) reported that infants living in households characterized by limited income and less maternal education evinced poorer EF at preschool/school entry and that positive changes in income-to-needs from 1st to 5th grade were correlated with improvement in EF. It is notable, however, that Hackman et al. (2014) and Hughes et al. (2010) both failed to document any associations between family SES and change in EF over time. Should the present investigation also fail to predict change, it would make yet another replication of a null result. In any event, it remains unclear in all the work cited whether SES-EF associations are a function of unmeasured, time-invariant factors, perhaps especially genes shared by parents and children that could affect both SES and EF.

Parental mental health. Parental mental disorder is associated with less developmentally supportive parenting (Lovejoy, Graczyk, O'Hare, & Neuman, 2000). In particular, parental depression undermines parental sensitivity, warmth, and responsiveness (Jaffee, Belsky, Harrington, Caspi, & Moffitt, 2006). Because maternal responsiveness is known to enhance cognitive development (Landry, Smith, & Swank, 2006), there is reason to presume that maternal depression adversely affects children's cognitive development, including the development of EF. Consistent with this inference, Hughes et al. (2013) observed that maternal depression when the child was 2 years old predicted compromised EF 4 years later. However, these results contrast with those emerging from cross-sectional investigations of older children, which have found no relation between parental mental disorder and EF in children aged 6–17 years (Micco et al., 2009) and 13–15 years (Klimes-

Dougan, Ronsaville, Wiggs, & Martinez, 2006). Thus, further investigations across longer intervals are needed.

Furthermore, the majority of studies on the relationship between EF and parental mental disorder have investigated how depression effects EF development. In this examination, we elaborate by exploring the unique influence of both parental depression and anxiety.

Parenting. Extensive evidence indicates that supportive parenting (e.g., sensitivity, positive reinforcement, and emotional comfort) is positively associated with children's EF (see Müller et al., 2013). It is hypothesized that by being sensitive the parent induces in the child a sense of trust that makes the child more active in social interactions, where he can learn and internalize ways to self-regulate, promoting the development of EF (Fay-Stammbach, Hawes, & Meredith, 2014). In contrast, it is expected that harsh parenting undermine feelings of security, thereby adversely affecting the child's ability to freely engage in social interaction and explore the environment in ways that would be expected to promote EF development. As it turns out, there is only limited evidence addressing effects of negative or harsh parenting on EF; even when such is the focus of inquiry, it is rare that supportive parenting is investigated simultaneously (see Fay-Stammbach et al., 2014). When only supportive or unsupportive parenting is the focus of inquiry, it remains uncertain whether effects detected are due to the presence of positive parenting or merely the absence of negative parenting. For instance, a sensitive and supportive parent might be less likely to be harsh and intrusive. Thus, results showing an effect of positive parental practice on child EF could in truth be a result of the absence of harsh parenting behavior, or vice versa. This is important for designing tailored interventions to reduce disparities in EF; should one opt for reducing harsh parenting, promoting positive parenting, or both?

Furthermore, one must consider that children are not just passive recipients of parental influences; characteristics of the child might just as well influence parenting (Bell, 1968; Belsky, 1984). Thus, it is conceivable that well-regulated children might elicit more positive and less negative parenting behaviors, as shown by studies on behaviorally disordered children (Lytton, 1990). Therefore, in the current study, we control for the child's disruptive behavior when investigating the predictive effect of parenting on EF, including measures of both positive and harsh parenting.

Present Study

The three primary goals of the present study are to determine (i) whether parental SES, parental mental health, and parenting uniquely predict the development of EF during middle childhood; (ii) whether positive and/or harsh parenting predicts EF development; and (iii) whether parental mental health and/or parenting mediate the effect of SES on the development of EF. Critically, we address all these issues while taking into account all unmeasured, time-invariant covariates.

Methods

Participants

Two birth cohorts (2003 and 2004) in Trondheim, Norway and their parents were invited to participate in a longitudinal study on children's psychosocial development and mental health. A letter of invitation along with the Strengths and Difficulties Questionnaire (SDQ) 4-16 version (Goodman, 1997) was sent to their homes in addition to their scheduled appointment for the routine health checkup for 4-year-olds at the local well-child clinic (N=3,456). Of the invited, 3,358 (97%) attended the clinic. The health nurse at the well-child clinic informed the parent about the study using a procedure approved by the Regional Committee for Medical and Health Research Ethics Mid-Norway (approval number 4.2008.2632, project name "Tidlig trygg i Trondheim") and obtained written consent to participate. The well-child clinic staff failed to ask 166 parents. Parents without sufficient proficiency in Norwegian to complete the SDQ were excluded (n=167). Of the 3,016 eligible parents, 2,475 consented (82.1%).

To increase statistical power, we oversampled children with mental health problems. We divided the SDQ scores into four strata (cut offs: 0–4, 5–8, 9–11, 12–40). Using a random number generator, we drew defined proportions of parents to participate in the further study. The drawing probabilities increased with increasing SDQ scores of .37, .48, .70, and .89 in the four strata, respectively.

Of the 1,250 parents who were invited to participate, we were able to interview 997 (79.6%) at the first wave. The dropout rate after consenting at the well-child clinic did not differ across the four SDQ strata (77.6, 83.2, 77.8, and 80.2%, respectively; χ^2=5.70, df=3, p=.13). Retesting took place when the children were 6, 8, and 10 years old. Because measures of EF were included only from the second wave of the data collection, n=795, M_{age}=6.7 years, SD=.17, the present study used data from this testing (T1), the follow-up in third grade (T2), n=699, M_{age}=8.8 years, SD=.24, and in fifth grade (T3) n=702, M_{age}=10.5 years, SD=.17. In all, 1,070 children had usable data for at least one of these measurement points and they form the analytical sample. Descriptive information is presented in Table 1.

The invited families were free to choose whether the mother or the father were to participate together with their child. Mothers escorted a majority of the children, 84.4%.

Attrition at T1 and T2 from initial testing when the children were 4 years old was higher among children with high scores on SDQ at age 4 (OR=1.03, (95% CI, 1.01, 1.06), p=.02). Attrition at T2 was lower with higher parental education (OR=.89, (95% CI, .82, .96), p=.003), higher among those with parents who had higher scores on anxiety (OR=1.02, (95% CI, 1.00, 1.04), p=.05), and greater for those with higher scores on problems with EF (OR=1.01, (95% CI, 1.00, 1.02), p=.002). Although several of the study variables predicted attrition, the combined effect was small (Nagelkerke proxy R^2=.025, Cox & Snell=.038). Attrition at T3 was lower with higher education (OR=.88, (95% CI, .78, .99), *p*=.033) and parental occupational status at initial testing (OR=.73, (95% CI, .57, .94), *p*=.013). Attrition at T3 was greater among those with parents scoring higher on anxiety at age 6 (OR=1.04, (95%CI, 1.00, 1.07), *p*=.033), with more harsh parenting at age 6 (OR=1.15, (95%CI, 1.04, 1.28), *p*=.007), and with higher scores on problems with EF (OR=1.02, (95%CI, 1.00, 1.03), *p*=.027). At T3, the combined effect of predictors of attrition was also small (Nagelkerke proxy R^2=.072, Cox & Snell=.033).

Design and Procedures

Face-to-face data collections were performed by skilled personnel (*n* = 7) who had at least a bachelor's degree in a relevant field and extensive prior experience working with children and families. With written informed consent from the parents, the child's primary teacher completed a questionnaire concerning the child's EF in grades 1, 3, and 5. Children in Norway start school when they are 6 years old.

Measures

Executive function. As mentioned in the introduction, we sought to measure EF as manifested in everyday behavior. We therefore selected the teacher version of the Behaviour Rating Inventory of Executive Functions (BRIEF; Gioia, Isquith, Guy, & Kenworthy, 2000). The BRIEF-T contains 63 items rated using a 3-point ordered scale ("Never," "Sometimes," and "Very often"). Examples of items are "When given three things to do, remembers only the first or last" and "Does not plan ahead for school assignments." BRIEF-T assesses eight interrelated aspects of EF (Inhibit, Flexibility, Emotional Control, Initiate, Working Memory, Plan/Organize, Organization of Materials, and Monitor) and provides a score of general executive functioning which we applied (α = .98). A high score reflects that the child has more problems in activities and situations where EF is required, representing ineffective EF performance.

Socioeconomic status. Because parental occupation and education are recognized as important components of SES (McLoyd, 1998) and both variables seem to be related to EF, we measured both. We scored parental education on a 10-point scale ranging from did not complete junior high school to working toward or already completed PhD. We assessed occupational status by coding the prestige or status of each parent's occupation using the ISCO-88 (International Labour Association, 1990) and collapsing ratings into five categories: leader, professional higher level, professional lower level, formally skilled worker, farmer/fisherman, unskilled worker. In the case of both education and occupation, when children were living with two parents, we averaged each of these variables across the two.

Parental mental health. The psychological well-being of the participating parent was assessed by means of three widely used and well-validated self-reporting measures. At ages 4 and 6, we evaluated parental anxiety using the Beck Anxiety Inventory (BAI; Beck, Epstein, Brown, & Steer, 1988) ($\alpha = .87$), whereas parental depression was measured using the Beck Depression Inventory (BDI; Beck, Ward, Mendelson, Mock, & Erbaugh, 1961) ($\alpha = .87$). When the children were age 8, we measured symptoms of depression and anxiety with the Hopkins Symptom Checklist (HSCL-25). The HSCL has good test–retest reliability (Derogatis, Lipman, Rickels, Uhlenhuth, & Covi, 1974). In this study, $\alpha = .89$ for the total HSCL 25 score. The original version of the HSCL-25 (Derogatis et al., 1974) consists of 3 scales; depression (13 items), anxiety (10 items) and somatic complaints (2 items). We used the scales for depression and anxiety separately in our analysis.

Parenting. To assess parenting when the children were aged 4 and 6, we videotaped three 5-minute episodes of standardized play and clean-up sessions. First, in child-led play, the parent was instructed to let the child lead the interaction. Second, in parent-led play, the child followed the adult's lead. Third, in clean-up, the parent made the child pick up the toys by herself. Videotapes were coded using the Dyadic Parent–Child Interaction Coding System (DPICS; Eyberg, Nelson, Duke, & Boggs, 2004) by scorers blind to all other information on the children and families as well as to the core issues under investigation. Before initiating formal coding, coders underwent extensive training. Upon meeting coding criteria (80% agreement), reliability checks were conducted after every 25th video to prevent coder drift. Blinded raters recorded a random 10% of the tapes for interrater reliability estimation (Intraclass correlation; ICC). Standard situations coded by the DPICS have demonstrated strong evidence of convergent, divergent, discriminative, and predictive validity in many studies (see Eyberg et al., 2004).

In the DPICS III coding system, it is required that each discrete behavior of the parent be assigned to one of 18 categories, some of which are considered negative, some positive, and some neutral. *Harsh parenting* comprised the categories (a) Negative talk (verbal expressions of disapproval or aggression, e.g., "you're being naughty") and (b) Negative touch (any physical touch intended to be restrictive or hurtful, such as shaking or hitting the child) (ICC=.67). *Positive parenting* comprised the coding categories (c) Behavioral descriptions (non-evaluative comments about the child's behavior, e.g., "you are building a tall tower"), (d) Reflective statements (paraphrases and elaborations of child utterances), (e) Labeled praise (positive evaluation of specific behavior, e.g., "your picture is pretty"), and (e) Unlabeled praise (positive evaluation of the child, e.g., "I love you") (ICC=.85).

As the actions of the child partly shape parental behavior, we included a category from DPICS called child noncompliance. This category comprises instances where the child does not perform, attempts to perform, or stops attempting to perform the requested behavior within a 5-second interval following a command (e.g., child continues running around the room for 6 seconds after the parent has asked her to sit down) (ICC=.79).

Because the number of utterances affects the DPICS measures, such that parents who speak more may have higher scores on both positive and negative parenting, we used a ratio score where the numbers of positive and negative parent utterances as well as child non-compliance were each divided by the total number of utterances. The scores are presented in table 2 in percentage.

Results

All analyses were conducted using Mplus Version 7.31 (Muthén & Muthén, 1998-2011). A robust maximum likelihood estimator was applied, which is based not on a multivariate normality but on corrected statistics using the maximum likelihood method and which provide robust error terms (Raykov & Marcoulides, 2006). As attrition was selective according to initial values of the EF outcome, we suspected that data were not missing at random. A full information maximum likelihood procedure was therefore implemented to handle missing data, which in the present situation yields less-biased results than complete-case analysis (Schafer & Graham, 2002; Sterne et al., 2009). Because we oversampled for children with high SDQ scores, data were weighted back to provide correct population estimates by employing weights proportional to the number of participating children in a specific stratum divided by the number of children in that stratum in the population.

Bivariate Associations

Results of bivariate correlational analyses linking predictor and outcome variables are presented in Table 2. As can be viewed from the table, harsh parenting predicts worse EF, whereas the reverse is true for both parental education and parental occupational status. Parental anxiety and depression are not correlated with EF and neither is positive parenting. After applying a correction for the false discovery rate due to multiple testing (Benjamini & Hochberg, 1995) all correlations with $p>.20$ disappeared (5 in total).

Predicting EF Development

We constructed a fixed-effects regression model with a structural equation modeling framework (Allison, 2009; Wichstrom, Penelo, Viddal, de la Osa, & Ezpeleta, 2018) to evaluate prospective relations of parental occupation, education, depression, anxiety, and parenting on children's everyday EF, while discounting all unmeasured, time-invariant factors. In this model, EF was regressed at ages 6, 8, and 10 on parental occupation, education, depression, and anxiety 2 years earlier. Because we only had parenting data available for the first two ages, age 8 and 10 EF were regressed on parenting at age 6, whereas EF at age 6 was regressed on parenting at age 4. We included measures of child non-compliance at both ages 4 and 6 to control for the effect such behavior might have on parenting.

We added fixed effects to the above cross-lagged model by including a latent factor loading on children's everyday EF at age 8 and 10 (i.e., a time-invariant factor). Importantly, this latent time-invariant factor was allowed to correlate with all predictors at ages 6 and 8, including EF at age 6. Age 4 variables had to be considered exogenous, thus setting their correlations with the time-invariant factor to 0. The fixed effects model fitted data well: χ^2=52.57, *df*=29, *p*=.01, CFI=.963, TLI=.927, RMSEA=.030 [90%CI:.017-.043].

Because of the number of *df*s available, to identify the model some paths needed to be fixed. We started by fixing all paths, and then compared this model to less-restrictive models. To compare the models, we used the Satorra–Bentler's scaled chi-square test (Satorra & Bentler, 2001), which is a functional equivalent to the Hausman test (Hausman, 1978). None of the less-constrained models proved to be significantly better than the fully fixed model. Therefore, we chose this model for parsimonious reasons, and present the results derived from it in Table 3.

Recall that higher scores on the BRIEF reflect poorer everyday EF. As can be seen in Table 3, higher parental education predicted better everyday EF. Higher parental occupational status did not predict everyday EF. Harsh parenting predicted more problems with everyday EF, whereas positive parenting did not predict the development of EF. Finally, neither parental depression nor anxiety did not predict everyday EF. No evaluation of potential mediational pathways was undertaken because (a) harsh parenting was not predicted by parental occupation (β=-.10, p=.13), education (β=.02, p=.74), depression (β=.01, p=.81), or anxiety (β=-.06, p=.20), and (b) supportive parenting failed to predict everyday EF.

Discussion

The present study investigated the effects of SES, parental mental health, and parenting on the development of everyday EF from preschool to middle childhood, including whether positive and harsh parenting prove equally influential and whether parenting, as a proximal process, mediates effects of the more distal factors of SES and parental mental health. Results revealed that higher parental education predicted comparatively superior EF development, whereas harsh parent behavior predicted poorer EF development. Parental mental health was not predictive of EF. Parent behavior did not mediate the effect of parent education, and positive parenting was not predictive of EF.

In accordance with previous research, we found SES and particularly parental education to predict EF development. We hypothesized, according to theories of social causation, that parenting mediates the effects of SES. However, our analysis revealed no mediation by parenting on the relationship between parental education and EF, indicating that processes other than harsh and positive parenting explain the SES-EF relationship. Consequently, the mechanisms responsible for the impact of parental education on EF in this study are unknown.

Importantly, the current study involves a strong statistical approach, namely, a fixed-effects model. This model rules out the influence of all unmeasured time-invariant factors (Allison, 2009; Firebaugh et al., 2013). One such factor involves the genes shared by child and parent that could possibly affect both parent SES and child EF. Although other longitudinal studies of the SES-EF relationship have not been positioned to discount such genetic mediation, our analytic approach insured that this was the case. Hence, the present findings suggest that social influence, and not genetic inheritance, is responsible for the parental SES and child EF association.

Turning attention to the effect of parental mental health, we found that neither parental anxiety nor depression predicted EF development. This is in conflict with some earlier studies indicating that parental depression has a negative effect on child EF (Hughes et al., 2013) but in accordance with others that also failed to document links between parental mental health and children's EF (Hackman et al., 2015).

In finding that parenting predicted development of everyday EF, our results accord, at least in general, with previous studies of preschoolers (Blair et al., 2014) and school-aged children (Hackman et al., 2015). The present study extends this prior work by distinguishing harsh and supportive parenting, while investigating effects of both simultaneously. In addition, we controlled for child noncompliance in our analysis, to adjust for the possible effect of child behavior on parenting. Notably, although harsh parenting predicted poorer EF development, positive parenting proved unrelated to EF development. The negative effect of harsh parenting detected in this longitudinal study, which was designed to discount all unmeasured, time-invariant factors, including genetics, thus extends similar results of prior cross-sectional studies that could not discount the genetic mediation of the result in question (Lucassen et al., 2015; Meuwissen & Carlson, 2015). We suspect the reason we failed to discern what other investigations have, namely, that supportive parenting positively relates to EF, is because those prior studies did not examine unique effects of supportive and harsh parenting by including both factors in the same prediction model (Blair et al., 2014; Hammond, Mueller, Carpendale, Bibok, & Liebermann-Finestone, 2012). It will be interesting to see if future work that does so also reveals that effects are more pronounced—or only evident—in the case of harsh parenting and not supportive parenting.

The chosen method for investigating parental behavior may influence the current findings. We used the DPICS, which taps into a broad range of parenting behaviors such as touch, praise, and reflective statements. It is, however, possible that our coding system missed important aspects of parenting. Most notably, perhaps DPICS might not cover all aspects related to the process of scaffolding, which is shown to be related to child EF (Fay-Stammbach et al., 2014).

There are several plausible explanations for why we found that harsh parenting impedes EF development. One possibility is that harsh parental behavior might lead the child to become preoccupied with thoughts and feeling related to fear, anger, or sadness. Emotional activation is known to hamper the function of the prefrontal cortex (Arnsten, 2009). Coupled with the fact that EF can be enhanced by engaging in EF-demanding activities (Diamond, 2013), it seems possible that a child's EF development is undermined when harsh parenting leads to experiencing negative emotions. At the same time, harsh parenting might undermine the child's feelings of self-efficacy. This is important because a perceived lack of control is also related to less activation of the prefrontal cortex (Arnsten, 2009), and hence the child might lose opportunities to practice and thereby enhance EF. Our findings are in line with findings showing that abuse (Spann et al., 2012) and deprivation (Kumsta et al., 2015) seem to undermine EF development.

As already implied, our findings have consequences for prevention efforts. Parents who frequently engage their children in a negative manner could be aided by interventional programs to reduce such behavior. Fortunately, a variety of programs have proven effective in this regard, including The Incredible Years (Webster-Stratton, 2006) and Parent–Child Interaction Therapy (Funderburk & Eyberg, 2011). Such programs have proven beneficial to children at risk for ADHD (Trillingsgaard, Trillingsgaard, & Webster-Stratton, 2014) and children with behavioral problems (Bjorseth & Wichstrom, 2016). As improved EF reduces disruptive problems (Volckaert & Noel, 2015), some of the positive effect of improved parenting on child psychopathology might be mediated through improvements in child EF. Future studies should investigate this prospect.

Limitations

Some limitations should be noted. In this study, we used teacher reporting to measure EF. It can be argued that using laboratory measures of EF would provide more valid data than report forms, because laboratory tests directly measures children's EF. However, Duckworth et al. (2011) investigated the convergence of different measures of self-control, among them EF tasks. EF tasks showed substantial heterogeneity in convergent validity, including the most commonly used EF tasks (such as the Stroop and the go/no-go tasks). In contrast, informant-reported questionnaires demonstrated strong evidence of convergent validity. Further, BRIEF is an ecologically valid measure (McAuley et al., 2010), and hence could be preferred over laboratory measures. Notably, there is little overlap between BRIEF and laboratory tests (McAuley et al., 2010; Toplak et al., 2013): whereas BRIEF measures problems with EF, laboratory tests can separate poor, normal, and high EF. Thus, future studies should compare predictors of EF measured by questionnaires and EF measured by tests to determine whether they are predicted by the same factors.

There are also some limitations concerning the ethnicity of our sample. Approximately 93% of the parents are of Norwegian ethnicity. Thus, we cannot automatically generalize our findings to populations of other ethnicities or cultures. In addition, the ICC for harsh parenting was somewhat low, so we cannot rule out our results possibly being deflated. Finally, although our statistical model can account for the effects of all unmeasured time-invariant factors, we cannot rule out that we have failed to measure time-variant factors that are important for the development of EF (e.g., negative life events).

In summary, our results suggest that low parental education and harsh parenting might promote problems in EF as shown in school during middle childhood. Because we adjusted for all unmeasured potential time-invariant confounders, these results are in accordance with theories that maintain social factors can affect child EF development. If replicated, and given the negative effects of poor EF, the current findings should be considered when designing intervention and treatment programs.

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Table 1
Sample descriptives (n=1070)

	%
Gender	
Boys	49.2
Girls	50.1
Gender of parent informant	
Male	15.2
Female	84.8
Ethnic origin of biological mother	
Norwegian	93.0
Western countries	6.8
Other countries	0.3
Ethnic origin of biological father	
Norwegian	93.0
Western countries	6.5
Other countries	0.5
Biological parents cohabitating status	
Cohabitating	84.6
Not cohabitating	15.4
Inform. parent's highest completed education	
Not completed junior high school	.0
Junior high school (10th grade)	.3
Some education after junior high school	3.9
Senior high school (13th grade)	9.4
Some education after senior high school	2.1
Some college or university education	3.8
Bachelor degree	4.1
College degree (3-4 years study)	21.4
Master degree or similar	13.7
PhD completed or ongoing	3.2
Inform. Parent's occupational status	
Leader	7.8
Professional, higher level	26.3
Professional, lower level	40.5
Formally skilled worker	22.2
Farmer/fisherman	0.1
Unskilled worker	3.0

Table 2

Population means, standard deviations and correlations

	M	SD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1 Executive dysfunction 6 years	99.14	21.81																				
2 Executive dysfunction 8 years	97.71	21.08	.70***																			
3 Executive dysfunction 10 years	98.29	21.02	.58***	.74***																		
4 Parental education 4 years	6.99	1.96	-.15***	-.19***	-.13**																	
5 Parental education 6 years	7.11	1.93	-.14***	-.19***	-.13**	.90***																
6 Parental education 8 years	7.24	1.88	-.13**	-.16***	-.12**	.89***	.91***															
7 Parental occupation 4 years	4.08	0.92	-.10*	-.19***	-.14**	.63***	.64***	.59***														
8 Parental occupation 6 years	4.13	0.89	-.10*	-.14**	-.11*	.62***	.60***	.61***	.69***													
9 Parental occupation 8 years	4.27	0,87	-.06	-.14**	-.13**	.59***	.53***	.56***	.61***	.67***												
10 Parent depression 4 years	4.01	4.87	-.03	.03	.01	-.04	-.01	-.04	-.04	-.08	-.04											
11 Parent depression 6 years	4.61	5.53	.06	-.02	-.01	-.12**	-.05	-.10*	-.10*	-.12**	-.10*	.52***										
12 Parent depression 8 years	14.89	3.67	.02	.06	.02	-.07	-.01	-.06	-.08*	-.13***	-.09*	.43***	.45***									
13 Parent anxiety 4 years	1.83	2.83	-.04	-.01	.02	-.10**	-.08	-.14***	-.10*	-.13**	-.11*	.55***	.33***	.31***								
14 Parent anxiety 6 years	2.25	3.59	.10*	.02	.03	-.09**	-.06	-.10*	-.07	-.13**	-.10*	.37***	.54***	.35***	.46***							
15 Parent anxiety 8 years	9.07	1.82	.02	.04	-.01	-.10**	-.06	-.14**	-.11**	-.12**	-.16***	.33***	39***	.63***	.33***	.46***						
16 Parenting positive 4 years	5.94	4.15	-.01	.02	-.01	.02	.01	.03	-.01	.01	.01	.02	.02	.07	-.01	.04	.05					
17 Parenting positive 6 years	5.47	4.07	-.06	-.04	-.02	.05	.04	.04	.03	.09	.08	-.02	-.06	-.05	-.01	.02	-.04	.28***				
18 Parenting harsh 4 years	2.92	4.07	.16***	.12**	.10*	-.17***	-.16***	-.17***	-.11*	-.12**	-.17***	.01	.13*	.02	.09	.14**	.04	.01	-.10			
19 Parenting harsh 6 years	2.05	2.85	.16***	.09	.13**	-.12*	-.09	-.05	-.10*	-.04	-.04	.02	.02	.04	.-.01	.08	.05	-.02	-.04	.15**		
20 Child noncompliance 4 years	2.20	2.16	.07	.09	.08	-.05	-.05	-.05	-.02	-.09	-.12*	.06	.15	.07	.03	.08	.03	-.08	-.05	.19**	.14	
21 Child noncompliance 6 years	1.19	1.57	.04	.11	.11	-.08	-.05	-.09	-.09	-.07	-.05	.06	-.03	-.07	.04	.05	-.02	-.12*	-.05	.13	.15*	.12*

Note. *p<.05, **p<.01, ***p<.001

Table 3

Parental predictors of executive dysfunction from 4 to 10 years. Fixed effects regression

Predictors	B	95% CI	β	p-value
Occupation	-.49	-1.71; .073	-.02	.433
Education	-1.06	-1.80; -.32	-.11	.004
Depression	-.03	-.22; .16	-.01	.767
Anxiety	-.23	-.57; .11	-.03	.187
Harsh parenting	1.02	.39; 1.67	.14	.001
Positive parenting	-.03	-.28; .21	-.01	.489

Note: Parental factors predict executive dysfunction two years later, and are adjusted for all time invariant unmeasured factors predicting executive dysfunction, as well as child non-compliance and executive dysfunction at age 6. Regression coefficients set to be equal across all lags.