Original Papers

Polish Psychological Bulletin
2016, vol. 47(2) 236–246
DOI - 10.1515/ppb-2016-0028

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Maternal Parenting Attitudes and Preschoolers' Hot and Cool Executive Functions

Abstract*: The relationships between maternal parenting attitudes and preschoolers' hot and cool executive functions (EF) were examined. Forty-eight children aged 3 to 4 years and their mothers took part in the study. Self-report questionnaire concerning parenting attitudes was obtained from the mothers of children who performed a set of EF tasks. Additionally, both maternal and child verbal ability were controlled. It was found that maternal parenting attitudes were related only to child cool EF. Protecting attitude was positively related to child inhibitory control and autonomy support was negatively related to child set-shifting ability. Further analyses revealed that maternal autonomy support accounted for unique variance in child set-shifting, above and beyond the child's age. On the other hand, protecting attitude accounted for unique variance in child inhibitory control, above and beyond child verbal ability. The findings provide further evidence for the importance of mother-child relationships in children's EF development.*

Key words*: parent-child relationship, maternal attitudes, cool and hot executive functions, verbal ability*

Research regarding family antecedents of cognitive development has demonstrated some relationships between child executive functions (EF) and maternal sensitivity (i.e. the mother's ability to perceive and accurately interpret her child's signals), maternal mind-mindedness (i.e. using mental terms when speaking to children), parental scaffolding (i.e. support of child's problem solving), parental monitoring, discipline, attachment quality and negative caregiving behaviors (Bernier, Carlson, Deschênes, & Matte-Gagné, 2012; Bernier, Carlson, & Whipple, 2010; Bibok, Carpendale, & Müller, 2009; Cuevas, Deater-Deckard, Kim-Spoon, Watson, Morasch, & Bell, 2014; Hughes & Ensor, 2009; Landry, Smith, & Swank, 2006; Roskam, Stievenart, Meunier, & Noël, 2014). What is more, correlations between parenting measures and self-regulation capacity of preschoolers were confirmed by a meta-analysis by Karreman, Tuijl, Aken, and Deković (2006). The aforementioned associations are presumed to develop through repeated responsive interactions with parents, during which children internalize and then generalize the acquired behaviors to new situation. That in turn, gives them the feeling of competence, trust in their own choices, and ability to cope with new situations, thus encouraging active exploration (Salonen, Leopla, & Vauras, 2007). Some researchers claim that these effects can be accounted for by children's language capacities (Matte-Gagne & Bernier, 2011) or biological sensitivity (Blair et al., 2011; for the review, see Fay-Stammbach, Hawes, & Meredith, 2014). These claims are consistent with the Vygotskian approach (1978), stating that children who experience more competent parenting develop more elaborate language skills, which in turn provide them with verbal tools supporting their ability to inhibit impulsive responses and develop self-control.

However, most of the research on social origins of executive functions in children is focused entirely on the cool aspect of EF. Their hot aspect and the potential role of maternal parenting attitudes in the development of children's EF had so far been neglected. It is also unclear whether the relationships between particular types of maternal parenting attitudes and their children's EF may be mediated by child verbal ability and whether maternal parenting attitudes are a kind of 'vehicle' in maternal verbal ability effect on children's executive functioning. Therefore, the main goal of the present study was to examine the potential relationships between maternal attitudes and hot and cool EF in preschool children. We were also interested in the role of verbal ability of both children and their mothers in these associations. In the

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next section of the paper we present the results of previous studies on links between children's cognition and parenting attitudes of their mothers, as well as the results of our study.

Hot and Cool Executive Functions

The term *executive functions* refers to a set of higher order cognitive processes involved in the conscious control of thought and action (e.g., Zelazo, Qu, & Müller, 2005). Neuropsychologically, EF are associated with the prefrontal and cingulate cortex, thalamus, and striatum, which play an important role in emotion regulation and cognitive control (e.g., Bush, Luu, & Posner, 2000). Despite the fact that EF mature fully only late in development, they develop most rapidly and attain moderate stability in terms of individual differences during the preschool years (Zelazo & Carlson, 2012). As indicated by extensive evidence, performance on EF tasks clusters in factors. In both children and adults, a three-factor structure is predominantly reported (cf. Hughes & Ensor, 2009). These factors are inhibitory control, working memory, and set-shifting, which are the key components of more complex metacognitive processes which encompass abilities needed for goal-directed behavior such as planning, strategy development, persistence, and flexibility of thought and action. A great many findings indicate that performance on EF tasks is a good predictor of academic achievement (Booth & Boyle, 2009), communication and social competence (Campbell, 1995), as well as self-control and self-regulation (Blair, 2003).

It has been noted that EF vary as a function of affective and motivational significance, which resulted in the distinction between "cool" and "hot" aspects of EF (Kerr & Zelazo, 2004). Hot EF are more likely to be elicited by problems which involve regulation of affect and motivation (e.g., a strategic game with the prospect of reward or delay discounting), whereas cool EF are more likely to be elicited by abstract, decontextualized problems (e.g., sorting cards by color). According to Hongwanishkul, Happaney, Lee, and Zelazo (2005), the evidence for distinct mechanisms involved in these two aspects of EF are their different neural correlates; cool EF aspects are associated with dorsolateral prefrontal cortex (DL-PFC), while the hot aspects are associated with ventromedial regions of prefrontal cortex (VM-PFC). Some additional evidence comes from experimental data – cool and hot EF are only weakly correlated and differences in association patterns between measures of these two components of EF and both intelligence and temperament have been observed (Hongwanishkul et al., 2005). Finally, Zelazo and Carlson (2012) have pointed to the possible existence of relatively distinct and independent developmental trajectories of these two aspects of EF.

Parenting Attitudes and Cognitive Development

As we mentioned earlier, despite a growing body of research on associations between parenting practices and development of child cognitive control, the relationships between maternal attitudes and the hot and cool EF in preschool children have not yet been investigated. Parental attitude towards the child is defined as a way of perceiving and evaluating the child by the parents, and their consequent tendency to behave in a specific way in relation to the child (Benasich & Brooks-Gunn, 1996). Parenting attitudes influence the manner of relating to the child and thinking about him/her. In other words, those attitudes reflect the way in which a family fulfills the function of bringing up the child, the kind of their emotional and cognitive approach, as well as the quality of parent–child interaction. According to many authors (e.g., Holden & Buck, 2002), parenting attitudes are powerful predictors of parenting styles, and thus can be seen as indications of the emotional climate in which children grow up.

There is no single typology of parenting attitudes in the literature. Different authors distinguish many distinct types and adopt different criteria. However, almost all of them agree that "a key domain of parents' attitudes is the extent to which they hold progressive versus authoritarian childrearing views" (Bornstein, Putnick, Lansford, 2011, p. 216). Parents who hold progressive attitudes (e.g. autonomy support, consistency and acceptance) tend to grant children more agency than do parents who hold authoritarian attitudes (e.g., inconsistency, or extensive demands). There is also general agreement that these types of attitudes influence the way in which parents interpret and respond to their child's behavior and emotions, thus informing their parenting practices.

Many studies concerning developmental outcomes other than EF have revealed that support provided by the parents, the optimal level of demands that they make towards their children, and the quality of intrafamilial communication have a positive impact on children's cognitive development (Schroeder & Kelley, 2010). For example, Baldwin, Kalhorn, and Breese (1945) have found significant differences in the intellectual development of preschool children according to the types of their parents' attitudes. Democratic parental attitudes were found to be the most advantageous for the child's cognitive development. Children whose parents were more democratic tended to demonstrate more original and strategic thinking, as compared to children of parents with non-democratic attitudes. In addition, significant negative correlations between both maternal directiveness and intrusiveness and children's ability to delay gratification have been found among toddlers and preschoolers (Russell, Londhe, & Britner, 2013; Silverman & Ippolito, 1995). It is worth to mention that some studies also revealed that maternal parenting behaviors mediated the associations between both the family's socioeconomic status (SES) and maternal verbal ability and child cognitive functioning (Pridham, Denney, Pascoe, Chiu, & Creasey, 1995; Rhoades, Greenberg, Lanza, & Blair, 2011).

As described above, the quality of mother-child interactions seems to be strongly associated with individual differences in preschoolers' cognitive processes, including EF. Positive caregiving behaviors are assumed to promote the internalization of regulatory strategies in children. Primarily, the mother serves as an external auxiliary

scaffolding for the child's immature cognitive processes. Through repeated experiences of regulation in interactions with their mothers, children are thought to internalize the acquired skills and to gradually integrate them into their repertoire of independent self-regulation skills (Bernier, Carlson, & Whipple, 2010). There is also some evidence that the quality of mother-child relationships plays a formative role in the development of language, and hence that child verbal ability mediates the association between some environmental factors (e.g., maternal autonomy support or family socioeconomic status) and child EF. For example, Matte-Gagne and Bernier (2011) found that children who experienced greater maternal autonomy support at 15 months had greater verbal expressive ability at 2 years, which in turn explained their increased ability to delay gratification (an aspect of hot EF) at 3 years.

Despite the growing interest in the role of parenting in childhood EF development, the links between maternal parenting attitudes and both hot and cool EF in preschool children have not yet been investigated. Nevertheless, since maternal attitudes represent a way of perceiving and evaluating the child, they seem to be worthy of investigation as potential antecedents of individual differences in preschool hot and cool EF.

Goals of the Present Study

This study aimed to broaden the existing knowledge about social determinants of individual differences in executive functioning of preschool children by answering the following main research questions: (1) Are there relationships between maternal parenting attitudes and cool and hot EF in preschool children? (2) Are the patterns of these relationships similar or different with respect to cool and hot EF? First, we generally predicted that maternal attitudes would be associated with both cool and hot EF in preschoolers. More specifically, we expected that positive maternal attitudes characterized by maternal acceptance, autonomy support and adequate protection would be positively related to both hot and cool EF in children, whereas negative maternal attitudes characterized by excessive demands and inconsistency would be negatively related to child hot and cool EF. Although the links between maternal parenting attitudes and child cool and hot EF have not yet been investigated, the aforementioned empirical evidence of robust associations between the quality of maternal parenting and individual differences in children's cognitive processes (i.e.: Cuevas et al., 2014; Russell et al., 2013) allows to expect the existence of such relations. Second, due to the fact that most mother-child interactions occur in emotionally evocative contexts and that hot EF are related to emotion regulation and social skills (Zelazo et al., 2005), hot aspects of EF should be more easily influenced by maternal parenting attitudes than cool EF. Therefore, we hypothesized that maternal parenting attitudes would be much more strongly and directly related to child hot EF than to cool EF (cf. Matte-Gagne & Bernier, 2011).

Due to the fact that the nature of parent-child interactions and their effects on child development may be dependent on both maternal verbal ability and child verbal ability (Matte-Gagne & Bernier, 2011; Pridham et al., 1995), we used hierarchical regression analyses to determine whether the hypothesized associations between maternal parenting attitudes and child EF were present when controlling for child and maternal verbal ability.

According to the state of our knowledge, it is the first attempt to answer the question about the role of maternal parenting attitudes in individual differences in preschool children's hot and cool EF. As Fay-Stammbach and colleagues (2014) noticed, the preschool years are a key period for understanding the parenting influences on child EF because of the protracted development of these cognitive processes.

Method

Participants

The sample included 48 biological mother-child dyads living in large metropolitan areas of Poland. The children were between ages 3:0 and 4:11 (M = 4.1 years, SD = 6.80 months). One boy had missing data on the Day-Night Stroop task due to his refusal to complete the task. The mothers were aged between 29 and 42 years (M = 34.32, SD = 3.26 years). The sample was quite homogeneous in terms of mothers' education: 84% of them had a master's level or a professional degree, 12% had a high school diploma, and 2% had some vocational education.

Measures

Child hot and cool executive functions. Children's EF tasks were selected on the basis of Carlson's (2005) evidence-based guide and recommendations about measurement of EF in typically developing preschoolers. The chosen tools were shown to be reliable and developmentally sensitive measures of EF appropriate for the age range of 3–4 years. The measures were respectively: the Dimensional Change Card Sort task (DCCS; Hongwanishkul et al., 2005), the Day-Night Stroop task (Gerstadt, Hong, & Diamond, 1994), the Children's Gambling Task (Kerr & Zelazo, 2004) and the Gift Delay task (Kochanska & Murray, 1996).

DCCS. Children were shown two boxes with target cards (i.e., a red rabbit and a blue boat) affixed to the front. The experimenter presented a series of cards (red and blue rabbits and boats) and instructed the children to sort cards by shape. After six trials, the rule was changed and children needed to sort the same cards by color. After the child sorted at least five cards correctly, a new card set was introduced. These cards were identical to the previous ones, except that a half of them had also black borders. The experimenter explained that if there is a black border on a card, then children should sort according to color, but if there is no border, then they should sort according to shape. There were 16 trials in the third phase. The total score was the sum of cards correctly sorted in the second and third phase. The task is considered to tap mainly the set shifting ability: the higher the score, the better the performance.

Day-Night Stroop task. Following the procedure of Gerstadt et al. (1994), the experimenter asked children to say "day" when shown black cards displaying stars and a moon and to say "night" when shown white cards displaying a sun. After a brief warm-up, 16 test trials were conducted with each card presented in a fixed, pseudorandom order. There were no rule reminders. The number of correct answers was the final score, indicating the child's ability to suppress a dominant response in order to provide a novel, more adequate one. Thus, higher scores indicated better performance.

Children's Gambling Task. The props were two decks of 40 cards each. The first deck consisted of cards showing two happy faces at the top and 0, 4, 5 or 6 sad faces at the bottom of the card. The cards from the second deck contained one happy and one sad face each. The happy faces equaled the number of wins, whereas the sad faces – the number of lost sweets or stickers. The cards from the first deck generally led to more wins than the cards from the second one. However, since the first deck also contained a card which caused a greater loss every now and then, the cards from the first deck gave a less favorable result in the long run in comparison to the second deck. The child's task was to win as many sweets as possible before the game ended (the experimental phase consisted of forty trials; the child was not informed about it). The order of cards in each deck was fixed and followed the win–loss contingencies used by Kerr and Zelazo (2004). The dependent variable was the number of advantageous choices minus the number of disadvantageous choices made in the last 20 trials. Negative scores indicated that a child made more disadvantageous choices than in the case of positive scores. Thus, higher scores indicated better performance. The task is thought to measure mainly the ability to flexibly appraise the emotional significance of stimuli.

Gift Delay task. The child was informed about the gift she was going to get "in reward for excellent cooperation". It was, however, crucial that the child turned around and did not look, as the reward was supposed to be a surprise which the experimenter had yet to wrap. While the child was sitting with his/her back turned, the experimenter was packing the gift (a toy) for sixty seconds, making a lot of noise with wrapping paper and sellotape, observing the child at the same time. Children's responses were scored online during the assessment. The dependent variable was the number of the child's glances at the gift (reverse scored, so that higher scores indicated worse performance). This task measures the child's ability to delay gratification.

Maternal parenting attitudes. The Parental Attitudes Scale in version for mothers (Plopa, 2008), which closely refers to Roe and Siegelman's (1963) typology of parenting behaviors, was administered. It consists of 50 items rated on a 1–5 scale, ranging from *I never do it* to *I always do it*. These items are divided into five subscales, assessing the intensity of the following attitudes: (1) Acceptance-Rejection – the higher the score on this subscale, the more maternal efforts to make the child feel safe and loved, while the lower the score, the higher the maternal emotional distance and insensitivity to her child's needs and problems; (2) Autonomy support – the higher the score, the more the mother supports her child's self-reliance and independence; (3) Protection – the higher the score, the higher the mother's concern and anxiety about the child; (4) Excessive demands – the higher the score, the less the mother accepts her child's plans, capabilities, and limitations; (5) Inconsistency – the higher the score, the more unstable the mother's attitude towards the child. Item scores were summed for each of those subscales, so that five scores were computed for each mother. In the case of the Acceptance-Rejection and Autonomy subscales, higher scores indicated the positive attitudes, while in the other subscales the higher the score, the more negative the attitude. This tool is intended to be used with parents of children aged 3–10 years. It was found to have good internal consistency (α's = .75–.88; Plopa, 2008).

Child verbal ability. The Picture Vocabulary Test – Comprehension (PVT; Haman, Fronczyk, & Luniewska, 2012), a test of receptive vocabulary for Polish speaking children aged 2;0–6;11, was employed. It consists of 88 four-picture boards with pictures relating to a key word, a phonetically similar word, a semantically similar word, or a word thematically related to the key word. Each board comes with a question about the key word. The child's task is to select the picture which best matches the key word. The authors report the high reliability (r_{tt} = .91) and validity (factor analysis and correlations with other measures of language development) of PVT. The number of correct answers was the final score.

Maternal verbal ability. Two tests, Synonyms and New Words, from the APIS-Z battery for the assessment of general intelligence (Matczak, Jaworska, Szustrowa, & Ciechanowicz, 1995) were used. The Synonyms test measures the knowledge of words. The participant is given 15 words and asked to find a synonym for each of them. The New Words test measures verbal fluency. The mothers were asked to find a word consisting of a certain number of letters, which would create a new word with each of the three remaining listed words. The tests were found to have high reliability (r_{tt} = .81 and .77, respectively) and validity (factor analysis and intergroup differences; Matczak et al., 1995). The sum of the correct answers from both tests was the final score.

Socioeconomic status of the family. A short personal questionnaire, filled in by the mothers, was used to assess the SES of the family. The questions referred to the parents' age, education, employment, and the age and gender of the examined child.

Procedure

Recruitment to the study was conducted in several kindergartens and was based on voluntary submissions. A written informed consent was obtained from both the head teacher of each kindergarten involved and the mothers of all preschoolers prior to their involvement in the investigation. Only biological mothers and their children took part in the study. The study was carried out in two sessions separated by a break of at least 30-minutes. The order of the tasks was: DCCS and PVT in the first session, and Day-Night Stroop, Children's Gambling Task, and Gift Delay in the second session. The children were assessed individually in a quiet room by a female experimenter, while their mothers were completing a questionnaire and two verbal tests at the same time in a separate room in the kindergarten. After completion of the study children received small gifts (sweets or stickers and crayons).

Results

First, we calculated descriptive statistics for all of maternal and child measures. Before computing the main analyses, we checked whether any of these focal measures were significantly related to the non-focal variables of parents' age, educational level and employment status, and child's gender. Results of these preliminary analyses showed no significant correlations between these variables. Also boys' and girls' EF scores did not differ significantly. To investigate associations between maternal attitudes and child EF, we computed bivariate correlations for those measures. Next, we used a series of hierarchical regression analyses to determine whether the expected associations were present after controlling for such potential confounds as child or mother verbal ability.

Descriptive Statistics

Parental variables. Table 1 shows the descriptive statistics for the scores obtained by the mothers on the Parental Attitudes Scale and for their total score on the test of verbal ability. The Shapiro–Wilk's statistics showed lack of normality in distributions of scores for maternal acceptance and excessive demands attitudes. The distributions of other variables in the group of mothers were normal. Mothers of girls and boys did not differ significantly in maternal attitudes toward their children.

Child variables. Table 1 shows the descriptive statistics for the scores achieved by children on the tests of EF and verbal ability. Distributions of scores for all tasks performed by the children differed from normal. We planned to use a composite score of a latent construct of correlated measures, because such composite scores are most reliable (Carlson, Mandell, & Williams, 2004). However, since the EF measures were not significantly correlated, we examined the components of EF separately to check their potential associations with maternal attitudes.

Table 1. Descriptive Statistics for Child and Maternal Measures

Measure	*M*	*SD*	Range
Child measures			
DCCS	12.13	4.02	3–19
Day-Night [a]	12.43	4.23	0–16
Gambling	1.08	9.82	-20–20
Gift Delay	2.17	3.00	0–11
PVT	50.12	18.24	10–77
Maternal measures			
Acceptance	45.71	3.44	34–50
Autonomy support	39.15	4.89	27–48
Protection	25.48	9.20	11–50
Excessive demands	25.69	7.81	12–48
Inconsistency	23.13	7.77	10–43
Maternal VA	13.13	6.87	7–29

Note. DCCS = Dimensional Change Card Sort; PVT = Picture Vocabulary Test; VA = verbal ability.

[a] $N = 47$.

Executive functions in relation to the controlled variables

First, the relationships between child EF and age, as well as child verbal ability and maternal verbal ability (controlled variables) were examined. For this purpose Pearson's, or in the case of variables whose distributions differed from normal, Spearman's correlations were calculated (see Table 2). The only correlation found between the child's age and measures of EF was the correlation with DCCS scores. Child verbal ability was positively related both to Day-Night Stroop task (an aspect of cool EF) and to the Gambling Task, a measure of flexible decision making. Also, a positive association between the child's age and her verbal ability was found. Maternal verbal ability and DCCS (a measure of child set-shifting as an aspect of cool EF) were positively correlated with each other.

Maternal parenting attitudes in relation to the controlled variables

No significant relationships between maternal verbal ability scores and parenting attitudes were found (see Table 2). Also no significant relationships between child verbal ability and maternal verbal ability, nor between child verbal ability and maternal parenting attitudes, were observed.

Relationships Between Children's Executive Functions and Maternal Parenting Attitudes

To examine the relationships between children's EF and maternal parenting attitudes the correlation coefficients were calculated. As shown in Table 2, it appeared that only

Table 2. Bivariate Correlations Between Children's Measures of EF, Mothers' Parental Attitudes, and Other Selected Variables

Measure and variable	AC	AU	PR	ED	NC	Maternal VA	Child VA	Child's age
DCCS	-.07	-.34**	.19	.15	-.15	.32*	.10	.33**
Day-Night	.01	-.31*	.30*	.07	-.01	.02	.47**	.18
Gambling	-.04	-.22	.10	-.08	-.13	-.14	.30*	.21
Gift Delay	-.19	-.13	.07	.12	.13	.22	-.25	-.15
Child's age	.09	.05	-.06	-.07	-.33*	-.10	.39**	–
Child VA	-.16	-.24	.15	.17	.13	.15	–	–
Maternal VA	-.25	-.25	.13	.24	-.20	–	–	–

Note. AC = Acceptance; AU = Autonomy; ED = Excessive demands; NC = Inconsistency; PR = Protection; DCCS = Dimensional Change Card Sort; Gambling = Children's Gambling Task; Child VA = child verbal ability; Maternal VA = maternal verbal ability.

* $p < .05$; ** $p < .01$ (all tests two-tailed).

cool EF were related to some of the maternal attitudes. In particular, it is interesting to note that the child's performance on the DCCS task, a measure of set-shifting, was negatively associated with maternal autonomy support. Furthermore, DCCS moderately and positively correlated with maternal verbal ability. In turn, the performance on the Day-Night Stroop task, a measure of inhibitory control, was moderately and inversely associated with maternal autonomy support and positively with maternal protection.

To determine the extent to which maternal autonomy support account for the child's performance on the DCCS task beyond the child's age and maternal verbal ability, a hierarchical linear regression analysis was conducted (see Table 3). Because the distribution of DCCS scores was slightly negatively skewed, to meet the assumption of normality, data from this task were prior to the regression analysis transformed by squaring the scores. The regression analysis was carried out in two steps. In the first step, the child's age and maternal verbal ability were entered as control variables predicting the child's DCCS performance. In the second step, maternal autonomy support was entered as a predictor. For each step, we report the increment in variance accounted for by the variables entered in that step, the standardized beta weights, and the squared semipartial correlations (sr^2), which indicate the proportion of unique variance accounted for by each variable (Cohen & Cohen, 1983).

When the child's age and maternal verbal ability were entered in the first step, they accounted for 26% of the variance in DCCS scores, $F(2, 45) = 8.06$, $p = .001$, with each variable contributing uniquely. The standardized beta coefficients for both the child's age and maternal verbal ability were significant (all p's $\leq .028$). Maternal autonomy support was entered in the second step, producing a significant R^2 change of 13%, $F(1, 44) = 9.72$, $p = .003$. However, it turned out that the relationship between the mothers' verbal ability and DCCS was no longer significant. The final regression equation accounted for 39% of the variance in DCCS scores, $F(3, 47) = 9.65$, $p < .001$. The beta coefficient for maternal autonomy support (-.38) was significant, $p = .003$, in the final equation. Beyond the child's age, mother's parental attitude of autonomy support predicted child set-shifting abilities.

The association between child set shifting and maternal autonomy support had negative direction and was independent of the child's age, what raised the possibility

Table 3. Hierarchical Linear Regression Testing Main Effects of Maternal Verbal Ability and Maternal Autonomy Support on the Child's DCCS Performance

Step	Inc. R^2	F-change	β	t-value	sr^2
Step 1	.26	8.06***			
Age			.44	3.45***	.21
Maternal verbal ability			.29	2.27*	.10
Step 2	.13	9.72**			
Autonomy support			-.38	-.3.12**	.13

Note. Inc. R^2 = Increment in variance accounted for; sr^2 = squared semipartial correlation.

* $p < .05$; ** $p < .01$; *** $p < .001$.

that autonomy support and the child's age may interact in their association with child set-shifting. For instance, younger children might need lower autonomy and more supervision to control their attentional resources, than older children. In turn, among older children, who already have developed a greater EF capacity, the high level of autonomy can have a positive effect on their EF. To address this possibility, interaction terms were created as the products of standardized (*z*-transformed) versions of child verbal ability and maternal protection variables. Their interactive effects were tested in a hierarchical linear regression. The two predictor variables were entered in the first step, and the interaction term was entered in the second. It was found that the interaction term was not significant ($\beta = 0.04$, $p = .75$).

In order to follow up the significant correlations between the Day-Night Stroop task and such variables as child verbal ability, maternal autonomy support, and maternal protection, a hierarchical logistic regression analysis was conducted (see Table 4). Due to the fact that the distribution of the scores for the Day-Night Stroop task was negatively skewed and attempts at data transformation did not improve their distribution, they were dichotomized in accordance with the requirements of the logistic regression analysis. The median value was chosen as the criterion for the dichotomization. Scores equal to or lower than the median (*Mdn* = 14) were classified as low, while those above the median were categorized as high[1].

Child verbal ability was entered in the first step and maternal autonomy support and protection attitudes were entered in the second step to examine whether they predicted the child's inhibitory control separately from verbal ability. The contribution of child verbal ability in the first step of the regression equation was statistically significant, χ^2 (1, $N = 47$) = 10.61, $p = .001$. The addition of autonomy support and protection attitude as predictors in the second step resulted in a significant increment in the prediction of inhibitory control, Nagelkerke R^2 (change) = .20, χ^2 (change: 2) = 9.86, $p = .007$. The final model with all three predictors accounted for a total of 47% of the variance in child inhibitory control, χ^2 (3, $N = 47$) = 20.47, $p = .001$, and the Hosmer-Lemeshow statistic showed a good fit ($p = .34$). According to the Wald criterion, the child's performance on the Day-Night task was predicted in the final model by child verbal ability ($p = .01$) and maternal protection ($p = .02$). When verbal ability is raised by one unit, children are 1.08 times more likely to belong to the Day-Night better-performance group. Maternal protection provided a unique contribution to the variance in child inhibitory control; when that variable is raised by one unit, children are 1.14 times more likely to belong to Day-Night Stroop task better-performance group. It also turned out that the relationship between the autonomy-support attitude of the mothers and children's inhibitory control was no longer significant. The final model had an overall classification success rate of 75% (70% 'high' Day-Night performers correctly classified; 79% correct for 'low' performers).

The associations between child inhibitory control and maternal protection were independent of child verbal ability, which raised the possibility that they may interact in their association with child inhibitory control. For instance, maternal protection could be a significant predictor of child inhibitory control only among children with low verbal ability. To address this possibility, interaction terms were created as the products of standardized (*z*-transformed) versions of child verbal ability and maternal protection variables. Their interactive effects were tested in a hierarchical logistic regression. The two predictor variables were entered in the first step, and the interaction term was entered in the second. It was found that the interaction term was not significant ($B = 0.19$; $SE = 0.60$; Wald = 0.001; $df = 1$; $p = .97$).

Table 4. Hierarchical Logistic Regression Testing Main Effects of Child Verbal Ability, Maternal Autonomy Support, and Maternal Protection on the Child's Day-Night Stroop Task Performance

Step	Inc. R^2 Nagelkerke	χ^2-change	*B*	*SE*	*Wald*	*Exp (B)* (Odds ratios)
Step 1	0.27	10.61***				
Child verbal ability			0.06**	0.02	7.92*	1.06
Step 2	0.20	9.86***				
Autonomy support			-0.03	0.08	0.13	0.97
Protection			0.13*	0.06	5.83*	1.14

Note. Inc. R^2 = Increment in variance accounted for; *SE* = standard error.

* $p < .05$; ** $p < .01$; *** $p < .001$.

[1] To assess severity of "passing" scores, we calculated binomial probabilities for scores on the Day-Night Stroop task. We assumed that child's chances of providing a correct response on each trial would be .50. The median split score for the Day-Night Stroop task was 14/16, which will occur by chance alone with a probability of $p = .004$. Thus, the high performer/low performer scores we used were stringent cut-off scores.

Discussion

The purpose of this study was to examine the relationships between maternal parenting attitudes and preschool children's cool and hot executive functions. In general, it was expected that children whose mothers show positive parental attitudes would have better cool and hot EF. The results partially supported this hypothesis, but only in the case of cool aspects of EF, which were found to be associated with maternal attitudes of autonomy support and protection. It was also expected that maternal parenting attitudes would be much more strongly related to child's hot EF than to cool EF. However, that hypothesis was not confirmed.

Maternal parenting attitudes and child cool EF

The results showed that maternal autonomy support accounted for unique variance in child set-shifting, above and beyond the child's age, and protecting attitude accounted for unique variance in child inhibitory control, above and beyond child verbal ability. The finding that maternal autonomy support was a negative predictor of set-shifting is quite surprising. On the one hand, some studies (e.g., Russell et al., 2013) show that excessive directiveness of the mother (which can be treated as a consequence of low autonomy granting) adversely affects the cognitive and emotional development of the child. On the other hand, the attention given to the child and close presence of the mother can be subjectively perceived, especially by preschoolers and younger children, as expressions of concern and care, and thereby may serve to shape the child's sense of security and trust, which in turn may facilitate her proper cognitive development. Another possibility is that the impact of the autonomy-support attitude on the child's development is moderated by the child's age. Perhaps in preschool years, when executive processes are developing, children need more supervision and support (scaffolding) from the outside, which requires a higher directiveness of the mother (and hence lower autonomy) – the external, "auxiliary" EF for the child – in directing and controlling the activities of the child's attention and memory during the interaction. By following parental directives, children become increasingly aware of the expectations and demands of the social environment, which leads to internalization of values and norms. When children develop a greater capacity for self-regulation, the high level of maternal directiveness (a low permission for the child's autonomy) can have a negative effect on their development. However, in our study the interaction term was not significant. This result can be due to small age variation in our sample. In future studies it would be worthwhile to use a wider, and therefore more diverse in terms of EF, age group.

Another possible explanation for the obtained results is that the negative association between maternal autonomy support and child cool EF reflects a paradoxical parenting effect. That is, low maternal support for the child's goals, choices and sense of volition might lead a child to explore some possibilities of how to express her own thoughts, interests, and ideas and to realize her independent, self-endorsed interests, despite the mother's prohibitions and control. Those attempts could presumably provide a child with an opportunity to exercise the ability to move back and forth between tasks, operations, or mental sets in response to changing goals or environmental experience, which in turn might strengthen her set-shifting ability. However, this is only a hypothetical explanation and this aspect of the results requires further exploration.

Moreover, it is worth to notice that Sabbagh, Xu, Carlson, Moses, and Lee (2006) showed that Chinese preschoolers outperformed their U.S. counterparts on all measures of executive functioning (inhibitory control, impulse control, working memory, and set-shifting), while Vinden (2001) demonstrated that Asian mothers tend to exhibit high parental control. Therefore, the surprising direction of observed relationships in our study can be due to some cultural factors. According to Szlendak (2003), Polish mothers' approach to parenting still remains quite conservative. As Bornstein and colleagues (2011) point out, many different parenting practices appear to be adaptive, but differently so for distinct cultural groups, while Lewis et al. (2009), on the other hand, demonstrate that executive skills are underpinned by key cultural processes. Therefore, further cross-cultural investigation is needed to address this problem.

The second regression analysis revealed that maternal protection attitude accounted for unique variance in child inhibitory control, beyond and above child verbal ability. Both predictors were positively related to child inhibitory control, which means that the higher the child verbal ability and maternal protection, the higher the child inhibitory control. The positive relationship between child verbal ability and inhibitory control obtained in the present study is consistent with a very large body of previous research and theory suggesting that children with better verbal skills are better equipped to solve executive problems (e.g., Jacques & Zelazo, 2005; Weiland, Barata, & Yoshikawa, 2014). For example, it seems to be consistent, among others, with the study by Carlson, Davies, and Leach (2005), wherein the verbal abilities of 3 and 4 years old children were positively related to their inhibitory control. Therefore, language is thought to play a crucial role in understanding and internalizing adults' rules, knowledge, and problem-solving strategies. There is also some evidence that the quality of parent–child relationship plays a formative role in the development of language, and hence that child verbal ability mediates the association between some environmental factors. However, our study failed to demonstrate the mediating or moderating role of child verbal ability in the association between maternal protection and child cool EF, instead showing these variables to be independent predictors of child EF. These results also seem to be consistent with Matte-Gagne's and Bernier's study (2011), which revealed that child verbal ability did not mediate the relationship between another maternal parenting characteristic – autonomy support during dyadic problem solving – and the child's performance on 'conflict' EF tasks, which tap mostly into

inhibitory control, working memory, and set shifting (as opposed to EF tasks involving strong, hot impulse control components). These results might suggest that maternal parenting has direct links to child inhibitory control or that there are other mediating routes which should be further explored.

It should be noted that the linear, positive correlation between maternal protection and child cool EF might make one think that even an excessive level of protecting attitude would still promote the child's EF. However, the answer is not clear. In the further examination, the raw scores in maternal protection scale were converted into sten scores provided for Polish mothers (Plopa, 2008), where sten scores from 1 to 4 indicate an optimal maternal protection, from 5 to 6 a moderately appropriate protection, and from 7 to 10 an overprotection. The analysis of the converted data showed that all of the scores obtained in this study fell within the acceptable level of this attitude (sten 1–6). Hence, the results we obtained can be interpreted to mean that optimal maternal protection towards the child promotes her inhibitory control. However, due to low variation in our maternal protection scores, the relationship between maternal protection and child EF deserves further empirical investigation, including examination of the role of the insufficient protection and overprotection.

Maternal parenting attitudes and child hot EF

In sharp contrast to the associations found for cool EF, analyses of hot EF showed that there were no significant relationships between these cognitive processes and maternal parenting attitudes. These results run contrary to findings obtained by Matte-Gagne and Bernier (2011) and Russell et al. (2013), in which some links between child delay of gratification and such maternal variables as autonomy support and directiveness (behavioral measures) were observed. However, our findings are consistent with at least two studies. Indeed, Bernier and colleagues (2012) did not find significant contributions of parental behavior to child delay of gratification, while Rochette and Bernier (2014) observed that higher-quality maternal behavior was not predictive of performance on impulse control tasks among children from middle-SES families (in contrast to low-SES families).

One potential explanation for the lack of association between preschoolers' hot EF and maternal parenting attitudes would be that at least one of the two measures that were used did not tap child hot EF adequately in our sample. Note that in the Gift Delay task, the standard deviation value was larger than the mean (see Table 1), which reflects a positively skewed distribution of the scores. Hence, although reported in the literature as adequate measure, the Gift Delay might not be an appropriate one in our sample. As far as our second measure of hot EF, the Gambling Task is concerned, the standard deviation value was also larger than the mean (see Table 1). However, the empirical (and theoretical) range of scores was between -20 and 20, and the mean was nearly in the middle of this range, thus it seems that this task fairly well differentiated one of the aspects of child EF. Consequently, the Gambling Task seems to be a more appropriate measure of hot EF than Gift Delay. Hence, in further research another reward-sensitive and age-appropriate measure of delay of gratification ability should be used (e.g., Forbidden Toy or Disappointing Gift – see: Carlson, 2005).

Another possibility is that differential susceptibility to environmental influences could play a crucial role in links between parenting attitudes and child's hot EF (Pluess & Belsky, 2010). For instance, Razza, Martin, and Brooks-Gunn (2012) revealed that maternal warmth predicted child delay of gratification only among high-anger children. Hence, in further research also temperamental factors should be controlled. Also, as Bernier and colleagues assume (2012, p. 20), presumably more proximal factors such as the mother's own self-regulatory capacities may impact the child's hot EF, for instance through observational learning. One more possibility is that it is the socioeconomic homogeneity of our sample that is responsible for the lack of relationships between maternal parenting attitudes and child hot EF (the majority of our mothers had higher education). Thus, in further research a greater number of mothers with lower education should be taken into account in order to verify whether they differ in terms of parental attitudes from mothers with higher education and whether it is related to the hot EF in their children. It may also be that hot EF are more susceptible to family dysfunction, including harsh parenting. Nevertheless, the lack of significant associations between maternal parenting attitudes and hot EF in their children seems to support the idea that distinct mechanisms may underlie the development of different aspects of child EF (Rochette & Bernier, 2014).

It should also be noted that for the hot EF tasks, risk taking and behavioral inhibition were measured, whereas the cool EF tasks measured set-shifting ability and inhibitory control. Thus, differences in associations between child and maternal variables and hot versus cool EF may also be due to differences in the types of EF domains measured. Research investigating other domains of child's hot and cool EF appears to be necessary to further examine the interrelationships between parenting, child language, and EF differences.

This study adds to a recent body of research that has begun to investigate social correlates of child EF. Our findings reveal that there are different and specific maternal predictors of individual differences in cool aspects of preschoolers' EF. It seems that some degree of maternal control is important for set-shifting development, whereas optimal levels of care, and hence the sense of comfort and security in relationship with the mother, promote development of child inhibitory control. The lack of significant associations between maternal parenting attitudes and child hot EF once again supports the aforementioned idea that there are distinct underpinnings of individual differences in the various aspects of child EF. Our results also point to the mediating role of parenting attitudes in the relationships between maternal verbal ability and child cognitive control. Although the exact

nature of the relation between language, parenting, and child EF deserves further empirical attention, it can be concluded that maternal parenting attitudes could be used as an early index of children at risk, especially for cool EF deficits.

Limitations of the study

It should be noted that the observed relationships between parental attitudes and children's EF are based on the findings of a correlational study, which does not allow to draw firm conclusions about the cause-and-effect relationships between our variables. The interpretation suggested here, namely that parental attitudes of mothers influence the development of children's EF, is just one of the possibilities. While seeking an alternative explanation for the observed relationships, it should be pointed out that certain parental attitudes may not be the cause but a consequence of the child's excessive impulsivity and low capacity for self-regulation. Application of a longitudinal research design would allow to determine the cause-and-effect relationships. Another argument for the use of such a design is the fact that although parental attitudes towards children are relatively stable, they are not immutable, but undergo some changes. The evolution of parental attitudes towards a child and its influence on the development of EF would be another issue requiring further investigation. An important subject variable is also the child's age, which possibly serves as a moderator of the relationship between the quality of parental interactions and the developmental outcomes of children. Therefore, studies involving a greater number of age groups are needed to provide a fuller picture of the role of parental attitudes in executive functioning of children.

Another limitation of our study is, as it has been previously mentioned, that the sample was quite homogenous in terms of the socioeconomic status (SES) of the family. An investigation of whether the observed relationships between maternal parenting attitudes and child EF are consistent across the full socioeconomic spectrum is essential in determining the range of generalization of our findings. Importantly, our results were obtained in the context of 'typical' families. There is a need for comparative research in the context of adverse environments to be conducted. Next, it should be noted that parent report methods are subject to social desirability bias and thus may provide an inaccurate picture of parenting. Further research with a more objective assessment of parenting attitudes should be conducted. Finally, also the specific contribution of fathers to children's EF should be taken into account.

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