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Family demographic profiles and their relationship with the quality of executive functioning subcomponents in kindergarten

Loren Vandenbroucke[1]*, Karine Verschueren[2], Eva Ceulemans[3], Bert De Smedt[1], Kim De Roover[3] and Dieter Baeyens[1]

[1]Parenting and Special Education, Faculty of Psychology and Educational Sciences, University of Leuven, Belgium

[2]School Psychology and Child and Adolescent Development, Faculty of Psychology and Educational Sciences, University of Leuven, Belgium

[3]Methodology of Educational Sciences, Faculty of Psychology and Educational Sciences, University of Leuven, Belgium

Executive functioning (EF), needed for goal-oriented behaviour, thoughts, and emotions, is important for various life domains. This study examined the relationship between family demographics and EF subcomponents. A kindergarten sample was tested on subcomponents of working memory, inhibition, and cognitive flexibility. Parents provided information on demographic variables. For 78 children both EF and demographic data were available. First, demographic profiles were identified within the sample. Two profiles were found: A low-risk profile of mainly two-biological-parent, high-income families with a highly educated mother who did not smoke during pregnancy and a high-risk profile of low-income families with a young, low-educated mother who more often smoked during pregnancy. Second, children with different demographic profiles were compared on EF subcomponents. Results indicate differential relations between family demographics and EF subcomponents: Whereas for most EF subcomponents no association with family demographics was found, high-risk children performed better on response shifting and tended to perform worse on verbal memory than low-risk children. Parenting stress decreased performance only for high-risk children. Although this study found limited impact of family demographics for EF, further longitudinal research can provide nuanced insights about which factors influence specific EF subcomponents during which developmental periods and guide targeted prevention of EF difficulties.

Executive functioning (EF) refers to the use of interrelated cognitive processes, that control goal-directed behaviour, thoughts, and emotions (Miyake & Friedman, 2012). EF is essential for everyday functioning, as it allows us to not only react passively to environmental stimuli, but to choose the way we act (Diamond, 2013). Therefore, it is not surprising that early EF quality has been related to outcomes in a diversity of domains later in life, even in adulthood. Previous research has linked EF to, for example, school

*Correspondence should be addressed to Loren Vandenbroucke, Parenting and Special Education Research Unit, Faculty of Psychology and Educational Sciences, University of Leuven, Leopold Vanderkelenstraat 32, Leuven, Vlaams-Brabant 3000, Belgium (email: loren.vandenbroucke@ppw.kuleuven.be).

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functioning (Blair & Razza, 2007; Gathercole, Durling, Evans, Jeffcock, & Stone, 2008; Moffitt *et al.*, 2011), physical health (Moffitt *et al.*, 2011), mental health (Baune, Fuhr, Air, & Hering, 2014), and socio-emotional development (McQuade, Murray-Close, Shoulberg, & Hoza, 2013; Rhoades, Greenberg, & Domitrovich, 2009). Studying factors that impact EF quality can provide handles to prevent a diversity of problems later in life.

Interest in the topic of EF has increased dramatically and much is known about maturation of EF and its biological foundations (Hughes, 2011). However, the impact of environmental or social factors on EF development and quality has remained understudied (Bernier, Carlson, & Whipple, 2010). Although research now shows that the family environment plays a role in EF development (see Hughes, 2011, for an overview), available evidence focuses on EF in general without distinguishing subcomponents within EF. The current study contributes to existing insights by investigating the relationship between family demographics and EF at the subcomponent level.

Executive functioning (sub)components

An increasing number of researchers support the idea that there are three core EFs, working memory, inhibition, and cognitive flexibility (Diamond, 2013; Miyake *et al.*, 2000). These develop early in life and form the basis for more complex, higher-order EFs, such as planning (Diamond, 2013; Miyake *et al.*, 2000). Adding to the complexity of the construct of EF, the core EFs can be further broken down into subcomponents.

Working memory is commonly described by the model of Baddeley (1986). It distinguishes two slave systems, the phonological loop and visuo-spatial sketchpad, that store verbal and visual-spatial information. The central executive can integrate, regulate, and manipulate this information. These subcomponents can be differentiated as early as 6 years of age (De Smedt *et al.*, 2009; Gathercole, Pickering, Ambridge, & Wearing, 2004).

Inhibition, the ability to constrain a dominant or automatic behaviour, thought or emotion in order to replace it with a more appropriate one (Miyake *et al.*, 2000), can be divided into cognitive and behavioural inhibition from the age of 4 (Bari & Robbins, 2013; Gandolfi, Viterbori, Traverso, & Usai, 2014). Cognitive inhibition includes selective attention (level of perception) and interference control (level of cognition) and allows us to focus on specific stimuli or thoughts (Diamond, 2013). Behavioural inhibition, or restraining oneself from a motor response, incorporates response inhibition and delay of gratification (Bari & Robbins, 2013; Diamond, 2013). In case of the latter, one restricts behaviour in order to obtain something desired.

Cognitive flexibility refers to being able to view a matter from different perspectives and efficiently handle these perspectives (Diamond, 2013). Fluency is used to flexibly generate a diversity of search strategies and ideas (Eslinger & Grattan, 1993), while attention shifting (level of perception) and response shifting (level of behaviour) allow to flexibly switch between response or cognitive sets (Diamond, 2013; Garon, Bryson, & Smith, 2008). To our knowledge, there is no clarity about the age at which these subcomponents can be distinguished.

More recently, researchers also differentiate between cool and hot EF (Zelazo & Carlson, 2012). Cool EFs control behaviour during abstract cognitive tasks. Hot EFs are used in tasks with an emotional or motivational aspect, for example, when successful completion leads to a reward (Kim, Nordling, Yoon, Boldt, & Kochanska, 2013). EF subcomponents can be cool, hot, or have aspects of both, depending on the task and context in which they are employed. Delay of gratification is an example of a hot EF subcomponent.

The role of context in EF development

EF development depends in part on maturation and parallels changes in the prefrontal cortex (PFC; Anderson, 2002). EFs emerge in infancy (Diamond, 2013), show an important developmental spurt between the ages of 3 and 7 (Zelazo & Carlson, 2012) and continue to progress into adolescence at a more gradual rate (Anderson, 2002; Diamond, 2002; Zelazo & Carlson, 2012). Different EF subcomponents can have different developmental trajectories. For example, response shifting starts to develop before attention shifting (Garon *et al.*, 2008).

Periods of rapid development there is remarkable neuroplasticity and EF development can be influenced by environmental factors (Huttenlocher, 2002). The family environment has been shown to be especially important for EF development during the preschool period (Hughes, 2011).

Most research examining the relationship between the family environment and EF has investigated EF as a general construct, without looking at its different subcomponents. It has, for example, been shown that high socio-economic status (SES) and sensitive parenting are associated with adequate EF development (Bernier *et al.*, 2010; Lengua *et al.*, 2014; Noble, Norman, & Farah, 2005). Bernier *et al.* (2010) suggest that parents in high-risk families might provide less adequate stimulation due to higher parenting stress. Other context factors that can affect EF are smoking (Julvez *et al.*, 2007) and maltreatment or neglect (Augusti & Melinder, 2013; Mothes *et al.*, 2015), through their impact on stress and brain development (Gautam, Warner, Kan, & Sowell, 2015; Hughes, 2011).

Studies using EF tasks measuring specific EF subcomponents, suggest that separate EF subcomponents are differentially affected by the environment. For example, Sarsour *et al.* (2011) show that single parenthood and parental sensitivity both negatively affect interference control (inhibition), but not attention shifting (cognitive flexibility) and the central executive (working memory). Similarly, the results of Rhoades, Greenberg, Lanza, and Blair (2011) showed that interference control, the central executive and attention shifting, were differentially related to (demographic) risk factors. Moreover, they showed that combinations of risks were more important for EF outcomes than individual risks.

Taken together, demographic and parenting variables can impact EF and different subcomponents can be impacted in different ways. However, previous studies measure EF in general or ignore some EF subcomponents. The current study, therefore, focuses on family demographic profiles in relation to specific EF subcomponents and, hereby, takes a broad scope of EF subcomponents into account.

Current study

The central aim of the current study is to examine how family demographic background relates to the quality of different EF subcomponents. First, this study looks at the presence of different family demographic profiles within the sample. Second, the EF performance of children from families with different demographic profiles is compared in order to investigate the relationship between family demographics and EF subcomponents. By using demographic profiles the co-occurrence of family risk factors is taken into account, rather than studying their effects in isolation (Cadima, McWilliam, & Leal, 2010; Rhoades *et al.*, 2011). Additionally, the role of parenting stress in the relationship between family demographics and EF subcomponents is investigated. Based on previous research, we expect that, in general, children from families with a high-risk profile have lower EF scores (Noble *et al.*, 2005) and that parenting stress contributes to this relationship (Bernier *et al.*, 2010). However, building on the studies of Rhoades *et al.* (2011) and Sarsour *et al.*

(2011) potential differential relationships between demographic profiles and specific EF subcomponents will be explored.

Methods

Participants

Typically developing kindergarten children were recruited through regular schools. This study and the recruitment procedure were approved by Ethics Committee X. Written informed consent was obtained for 107 children. Some children did not complete all EF tasks for various reasons (e.g., 5 children were absent at one testing session). For 90 children (84.1%), full EF data were obtained and 95 parents (88.8%) returned the questionnaires. For 78 children (72.9%), both EF data and questionnaire data were available.

Children had an age between 5.3 and 6.4 years at first testing ($M = 5.88$, $SD = 0.29$). There were 51 boys (47.7%). Most children (92.5%) were monolingual Dutch speaking; eight children were bilingual. Parents of five children were not born in Belgium: Both parents of one child (Kosovo), the mother of one child (Philippines), and father of three children (Ireland, the Netherlands, and Turkey). No visual or motor problems, medication use, or psychiatric disorders were indicated by the parents.

Measures

To asses EF, children completed 17 subtests. Each EF subcomponent was represented by at least one task. All subtests were preceded by verbal instructions and practice items to familiarize the child with the task. Parents completed questionnaires to provide information on demographic characteristics and parenting stress.

Working memory

The phonological loop, visuo-spatial sketchpad, and central executive were measured with the Dutch version of the Automated Working Memory Assessment (Alloway, 2007), a fully standardized test battery administered with a computer. Due to time restraints, eight out of twelve subtests were selected, based on psychometric properties of the different subtests. Test–retest reliability ranged between .84 and .90 (Alloway, 2007).

Digit Recall and Word Recall. These tasks required the child to reproduce a sequence of digits or words in the same order. They measured the phonological loop.

Dot Matrix and Block Recall. Children remembered and reproduced the spacing of a sequence of dots in a 4×4 matrix or a sequence of blocks on a board with nine irregularly spaced blocks in the same order. These tasks measured the visuo-spatial sketchpad.

Listening Recall and Backwards Digit Recall. In the former task, the child heard a series of sentences. After each sentence, the child judged whether it was true or false. After each series of sentences, the child reproduced the first word of each sentence. In Backwards

Digit Recall, the child reproduced a sequence of digits in the opposite order. Both tasks measured the central executive using verbal material.

Odd One Out and Mister X. In Odd One Out, the child identified one of three shapes that deviated from the others and indicated the locations of the 'odd' shapes after a series of shapes. In Mister X, the child saw two 'Mister X' figures holding a ball in one hand. The right figure could be rotated. First, the child indicated whether the right figure held the ball in the same hand as the left figure. After a series of figures, the child pointed where the ball of the right figure was located each time. These visual-spatial tasks assess the central executive.

The number of correct items was summed for each subtest, with a maximum score of 36 for Listening Recall and Backwards Digit Recall; 42 for Word Recall, Odd One Out, and Mister X; and 54 for Digit Recall, Dot Matrix, and Block Recall.

Inhibition

Selective attention, interference control, response control, and delay of gratification were measured. Computer tasks were programmed in E-Prime 2.0 (Schneider, Eschman, & Zuccolotto, 2002).

Flanker task. The child saw a horizontal row of five fish and indicated the direction of the middle fish (Rueda, Posner, Rothbart, & Clintin, 2004). It either swam in the same direction as the others (congruent trials) or in the opposite direction (incongruent trials). The child completed 144 trials (36 incongruent), divided in two blocks. In each trial, a fixation period (500 ms) was followed by the stimulus (700 ms) and a blank screen (1,800 ms). Participants had 2,000 ms to answer starting from stimulus appearance. The difference between congruent and incongruent trials was calculated for both accuracy and reaction time. The smaller these differences, the better participants' selective attention.

Rapid naming task. This task consisted of two control conditions and two experimental conditions (Van der Sluis, de Jong, & van der Leij, 2004). In each condition, children named 72 stimuli one by one as fast as possible. In the control conditions, children named animals (cat, dog, and bird) and figures (circle, triangle, and square). In the inhibition condition, children named small figures and ignored the interference of the larger figure surrounding it. In the shifting condition, children saw figures with an animal drawn in the centre of the figure. The child shifted between naming the animal when the figure was yellow and naming the figure when the figure was blue. The difference between the reaction time in the figure condition and the reaction time in the inhibition condition was an interference control outcome. The difference between the average reaction time in the control conditions and the reaction time in the shifting condition was used to measure attention shifting. Larger difference indicated worse interference control and attention shifting.

Stroop task. The child first pressed below a yellow square if a banana was shown on screen and below a red square when a strawberry was shown (control condition; based on

Bluell & Montgomery, 2014). The order of the squares (left–right) was randomized. Afterwards, the child pressed underneath the opposite colour (e.g., red for banana; interference control condition). There were two interference control conditions: A no reward condition and a reward condition. In the reward condition children received one candy for each correct trial. Each condition had 24 test trials, starting with fixation (500 ms), followed by the stimulus (700 ms), blank screen (1,300 ms), feedback (1,000 ms), and blank screen (500 ms). Children had 2,000 ms to respond after stimulus appearance. Accuracy and reaction time were recorded. The difference between control condition and no reward condition represented cool interference control. The difference between control condition and reward condition indicated hot interference control. The difference between cool and hot interference control was calculated for both reaction time and accuracy. High scores indicated children performed better on hot than on cool interference control. As such, it measures hot EF.

Go/No-go task. Children pressed the space bar when an X appeared on the screen and did not respond when an O appeared (based on Durston, Thomas, Worden, Yang, & Casey, 2002). There were 168 trials (42 no-go trials). A trial consisted of fixation (500 ms), stimulus presentation (700 ms), and blank screen (2,800 ms). Children had 2,000 ms to respond starting from stimulus appearance. Accuracy of no-go trials was the outcome measure for response inhibition.

Delay of gratification task. Children chose between a small immediate reward or larger delayed reward (Prencipe & Zelazo, 2005). There were three reward types (candy, material reward, fun activity with the experimenter) and three reward quantities (1 immediate vs. 2 delayed, 1 immediate vs. 4 delayed, 1 immediate vs. 6 delayed), resulting in nine trials given throughout the test sessions. The number of delayed rewards for each of the three reward quantities (2, 4 or 6 delayed) was used as outcome.

Cognitive flexibility

Fluency, attention shifting, and response shifting were assessed within cognitive flexibility.

Verbal fluency and unusual uses task. For verbal fluency, children named as many different words from a given category as possible within 60 s (Delis, Kaplan, & Kramer, 2001; Turner, 1999). Children first named animals and then words beginning with an F. In the unusual uses task, children listed as many functions of a table as possible within 150 s. For each condition, the number of correct words or functions indicated the fluency score.

Knock and Tap task. First, the child imitated the movements of the experimenter, a knock on the table with the fist or a tap on the table with the flat hand (Developmental Neuropsychological Assessment, NEPSY; Korkman, Kirk, & Kemp, 1998). Afterwards, the child switched response set and did the opposite of the experimenter. The test consisted of 24 trials. In a second part, a third hand movement was introduced: Hitting the table with the side of the fist. The child was instructed to not respond to this movement. There were

36 test trials. Children had two seconds to respond and earn a point for the trial. Higher scores indicate better response shifting abilities.

Demographic background and parenting stress

Demographic background. A self-constructed questionnaire based on Rhoades *et al.* (2011) was used. Parents reported the type of family (1 = two-biological-parent family, 0 = single-parent family, reconstituted family or other types). Families' monthly net income was coded as 0 for <1,000 euros, as 1 for 1,000–2,000 euros, as 2 for 2,000–3,000 euros, as 3 for 3,000–4,000 euros, as 4 for 4,000–5,000 euros, and as 5 for more than 5,000 euros. Maternal educational level was recorded (1 = at least a Bachelor's degree, 0 = no such degree). Mothers also reported their age at birth of their first child. Mothers were categorized as 0 below the 25th percentile, as 1 between the 25th and 75th percentile, and as 2 above the 75th percentile. Data on educational level and age at first birth were also gathered for fathers. Due to the high agreement between mother and father data, these variables were not used in further analyses. Mothers indicated whether they smoked during pregnancy (0 = no, 1 = at least once). Finally, a rooms-to-habitants ratio was calculated, indicating the space per person in the house. Families below the 25th percentile were recorded as having little space (coded as 0), others as having sufficient space (coded as 1).

Parenting stress. Parents completed the short version of the Dutch Parenting Stress Index (Abidin, 1995; Brock, Vermulst, Gerris, & Abidin, 1992). Parents judged 25 statements about difficulties experienced in parenting (e.g., raising this child is harder than I thought it would be) on a 6-point scale. Scores were summed to obtain a total score for parenting stress. Reliability coefficients range between .92 and .95 (Brock *et al.*, 1992).

Procedure

Children were tested individually in a quiet room at the school site during three sessions lasting 45 min each. All subtests were standardized and undergraduate students were trained by the first author before administering the tests. All children completed the subtests in the same order. Children received a small age-appropriate gift for participation.

Data analysis

Two preliminary analyses were performed. Firstly, a latent class analysis (LCA) was done in Latent Gold 4.0. (Vermunt & Magidson, 2005) to identify demographic groups within the sample. The balance between model fit and complexity of different cluster models was compared by means of the Bayesian information criterion (BIC) and the model with the best balance was selected. Secondly, exploratory factor analyses were conducted in IBM SPSS Statistics 22.0 (IBM Corp., 2013) for the core EFs to reduce the number of EF outcomes. A promax rotation was used allowing correlations between the factors. The number of factors was chosen with parallel analysis (Horn, 1965). For the main analysis, performance on the EF subcomponents was compared for children with different demographic profiles, by means of *t*-tests. Additionally, the role of parenting stress was

examined with regression analyses with the demographic profiles, parenting stress, and their interaction as predictors and EF subcomponent-score as dependent variable.

Cases with missing data were deleted list wise for the LCA, resulting in 78 participants included. In other analyses, cases were deleted pairwise to allow all available data to be used.

Results

Preliminary analysis

Demographic profiles

Tables 1 and 2 show descriptive statistics and correlations between the demographic variables. Several demographic variables were significantly correlated, suggesting that, similar to previous research (Cadima *et al.*, 2010; Rhoades *et al.*, 2011), the constellation of demographic variables rather than the individual variables are important in the description of family background. As relationships between the individual demographic variables and EF subcomponents will partially overlap, investigating the relationship between demographic profiles and EF subcomponents will be more meaningful. Therefore, demographic profiles were identified and used in further analysis.

To identify different groups of families based on demographic background, a Latent Class Cluster Model was used. Several cluster models were tested and compared (Table 3). A two-cluster model performed better than a one-cluster model in terms of the

Table 1. Descriptive statistics of the demographic variables

Variable	%
Family type	
Two-biological-parent family	89.7
Single-parent or reconstituted family	10.3
Net monthly income	
1,000–1,999 euros	7.7
2,000–2,999 euros	19.2
3,000–3,999 euros	39.2
4,000–4,999 euro	21.8
≥5,000 euro	11.5
Maternal educational level	
Secondary education or lower	23.1
Bachelor's degree or higher	76.9
Mother's age at first birth	
<24.9 years of age	23.1
25.0–29.2 years of age	51.3
>29.2 years of age	25.6
Smoking during pregnancy	
At least once	11.8
Crowded house	
<1.69 rooms per head	24.4

Note. Information on all six demographic variables was available for 78 parents.

Table 2. Correlations between the different independent variables

	1	2	3	4	5	6
1. Family structure						
2. Income	.28**					
3. Mother's educational level	.25*	.31**				
4. Mother's age at first birth	.26*	.14	.51**			
5. Smoking during pregnancy	−.24*	−.33**	−.43**	−.17		
6. Crowdedness	−.03	−.10	.18	.15	−.02	

Note. Family structure: 0 = two-biological-parent family; Mother's educational level: 0 = no Bachelor's degree or higher; Smoking during pregnancy: 0 = mother did not smoke during pregnancy; Crowdedness: 0 = a non-crowded house.
*$p < .05$; **$p < .01$.

Table 3. Model fit for Latent Class Cluster Models with one, two, three, and four clusters

Model	LL	BIC	AIC
1 cluster	−326,77	697,11	673,543
2 clusters	**−305,79**	**690,00**	**647,58**
3 clusters	−299,06	711,40	650,12
4 clusters	−295,23	738,58	658,45

Note. LL = log likelihood; BIC = Bayesian information criterion; AIC = Akaike information criterion. The 2 cluster model (indicated in bold) was chosen as the best fitting model.

balance between model fit and complexity, as indicated by the BIC. Adding additional clusters was detrimental for fit–complexity balance.

Table 4 shows the demographic variables of the families in each cluster. The first cluster consisted of 57 (73.08%) participants, while 21 participants were categorized in the second cluster. Both clusters differed on all demographic variables (with the exception of crowdedness in the house): Children in cluster 1 were more often part of a two-biological-parent family, with a high monthly income and an older mother with at least a bachelor's degree, who less often smoked during pregnancy compared to children in cluster 2. The first cluster represents a low-risk demographic profile, while the second cluster is a high-risk demographic profile.

EF outcome variables

Descriptives are shown in Table S1. The factor structures resulting from the factor analyses are shown in Tables 5–7. Working memory tasks loaded on two factors, verbal memory and visuo-spatial memory, explaining 43.7% and 16.1% of the variance. Three inhibition factors, delay of gratification, inhibition accuracy, and inhibition reaction time, were extracted, accounting for 23.6%, 16.0%, and 13.2% of the variance. Cognitive flexibility consisted of fluency and response shifting, explaining 29.6% and 24.4% of the variance.

Table 4. Demographic variables per cluster with the accompanying χ^2-test

Variable	Cluster 1 (%)	Cluster 2 (%)	χ^2	*p*
Family type				
Two-biological-parent family	94.7	76.2	5.74	.017
Single-parent or reconstituted family	5.3	23.8		
Net monthly income				
1,000–1,999 euros	3.5	19.0	19.05	.001
2,000–2,999 euros	10.5	42.9		
3,000–3,999 euros	45.6	23.8		
4,000–4,999 euro	24.6	14.3		
≥5,000 euro	15.8	0.0		
Maternal educational level				
Secondary education or lower	3.5	96.5	45.67	.000
Bachelor's degree or higher	76.2	23.8		
Mother's age at first birth				
<24.9 years of age	3.5	76.2	46.73	.000
25.0–29.2 years of age	61.4	23.8		
>29.2 years of age	35.1	0.0		
Smoking during pregnancy				
At least once	1.8	23.8	10.51	.001
Crowded house				
<1.69 rooms per head	22.8	28.6	0.28	.599
>1.69 rooms per head	77.2	71.4		

Note. $N = 78$, with 57 participants in cluster 1 ('Low risk') and 21 participants in cluster 2 ('High risk').

Table 5. Factor loadings of the EFA of the working memory subcomponents (cross-loadings are included from 0.30 or above)

EF variables	Factor 1 Verbal memory	Factor 2 Visuo-spatial memory
Word Recall	0.947	
Digit Recall	0.921	
Backwards Digit Recall	0.664	
Listening Recall	0.602	
Dot Matrix		0.760
Mister X		0.749
Odd One Out		0.709
Block Recall		0.647

Relationship between demographics and EF subcomponents

Correlations between demographic variables and EF subcomponents are presented in Table S2. To examine the relationship between families' demographic background and EF subcomponents, the average EF scores of the two demographic groups were compared using *t*-tests (Table 8). There was a significant difference on the factor response shifting, $t(68) = -2.15$, $p = .04$, with children in the high-risk profile scoring higher than children in the low-risk profile. This represents a medium to large effect ($d = -.67$). Furthermore, there was a trend to significance for the factor verbal memory, $t(75) = 1.94$, $p = .06$.

Table 6. Factor loadings of the EFA of the inhibition subcomponents (cross-loadings are included from 0.30 or above)

EF variables	Factor 3 Delay of gratification	Factor 4 Inhibition Acc	Factor 5 Inhibition RT
Delay of gratification 4	0.893		
Delay of gratification 6	0.743		
Delay of gratification 2	0.671	0.358	
Stroop-like Task (Acc)		−0.860	
No-go accuracy		0.542	
Flanker Task (Acc)		0.344	
Stroop-like Task (RT)			0.705
Objects Inhibition (RT)			−0.704
Flanker Task (RT)			0.428

Note. Acc = accuracy; RT = reaction time.

Table 7. Factor loadings of the EFA for the cognitive flexibility subcomponents (cross-loadings are included from 0.30 or above)

EF variables	Factor 6 Fluency	Factor 7 Response shifting
Unusual Uses Task	0.743	
Verbal Fluency Animal	0.717	
Objects Shifting Task (RT)	−0.676	
Verbal Fluency F	0.499	
Knock and Tap 2		0.828
Knock and Tap 1		0.823

Note. RT = reaction time.

Children in the low-risk profile scored higher than children in the high-risk profile. Cohen's *d* (.46) implies a small to medium effect. There were no significant differences for visual memory, fluency, delay of gratification, inhibition accuracy, and inhibition reaction time.

The role of parenting stress

Using regression analysis, the role of parenting stress in the relationship between family demographic profiles and response shifting and verbal memory was explored. For response shifting, there was a main effect of demographic profile, $\beta = 1.32$, $t(1) = 4.32$, $p < .01$, and parenting stress, $\beta = 1.33$, $t(1) = 3.75$, $p < .01$, and a significant demographic profile by parenting stress interaction, $\beta = -1.63$, $t(1) = -3.76$, $p < .01$. For children with a high-risk profile, response shifting decreased with increasing parenting stress. This was not the case for children with a low-risk profile (Figure 1). Verbal memory was predicted by parenting stress, $\beta = .95$, $t(1) = 2.56$, $p = .01$, and demographic profiles by parenting stress interaction, $\beta = -1.15$, $t(1) = -2.53$, $p = .01$. Figure 2 shows that parenting stress is negatively associated with verbal memory for high-risk children, but not for low-risk children.

Table 8. Averages of the EF subcomponent scores for both clusters and the accompanying *t*-tests

EF factor	Cluster 1 (n = 57), Low risk *M* (*SD*)	Cluster 2 (n = 21), High risk *M* (*SD*)	*t*	*p*
Working memory				
Verbal memory	0.13 (0.88)	−0.35 (1.18)	1.94	.057
Visual memory	0.08 (1.06)	0.07 (0.84)	0.04	.966
Inhibition				
Delay of gratification	0.12 (0.89)	0.24 (1.04)	−0.47	.640
Inhibition accuracy	−0.17 (0.90)	0.09 (0.77)	−1.04	.302
Inhibition reaction time	0.19 (0.90)	0.09 (0.76)	0.40	.690
Cognitive flexibility				
Fluency	0.08 (0.94)	−0.14 (1.28)	0.79	.434
Response shifting	−0.18 (1.13)	0.42 (0.57)	−2.15	.035

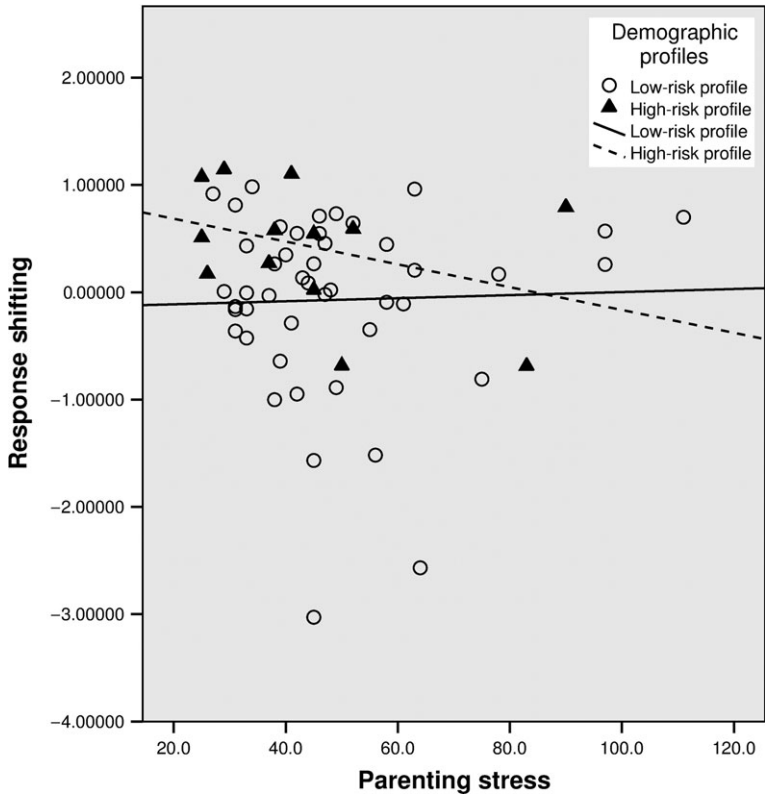


Figure 1. Scatterplot displaying the relationship between parenting stress and response shifting separately for the two demographic profiles. The full line represents the regression line for demographic profile 1 (low-risk profile) and the dashed line is the regression line for demographic profile 2 (high-risk profile).

Discussion

This study investigated the presence of demographic profiles in a sample of kindergarten children and the relationship between these profiles and EF. In this study, EF was

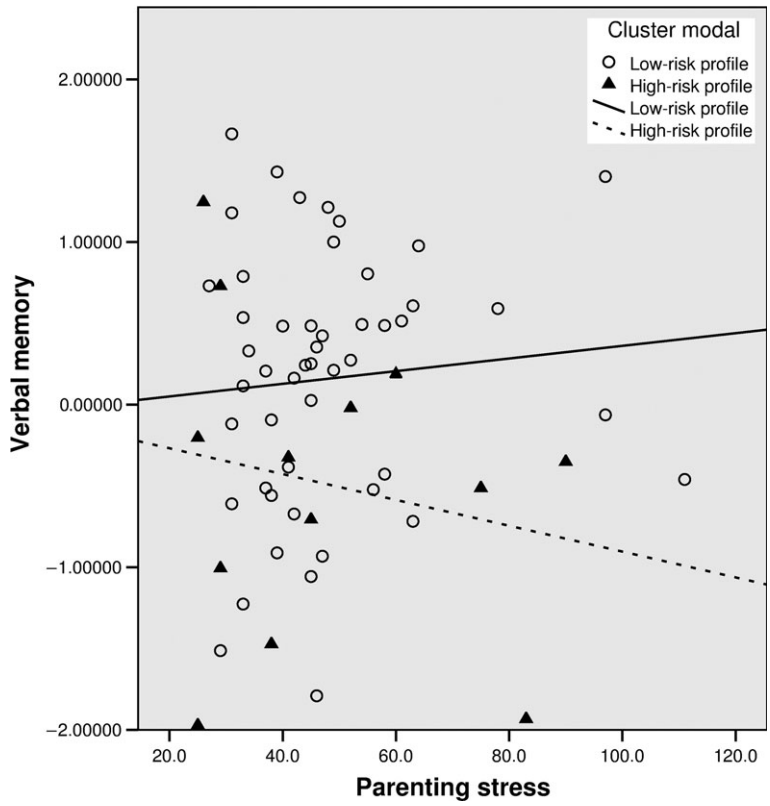


Figure 2. Scatterplot displaying the relationship between parenting stress and verbal memory separately for the two demographic profiles. The full line represents the regression line for demographic profile 1 (low-risk profile) and the dashed line is the regression line for demographic profile 2 (high-risk profile).

measured at the subcomponent level, allowing to nuance existing knowledge by gaining insights into possible differential relationship between family demographics and EF subcomponents. In the current sample, two demographic profiles were distinguish, which were related to response shifting and verbal memory, but not to other EF subcomponents.

Using LCA, two demographic profiles emerged in the current sample. The first profile represents a group of mainly two-biological-parent high-income families, with a highly educated mother who did not smoke during pregnancy. Families with the second profile were more often single-parent and reconstituted low-income families, with a young low-educated mother who more often smoked during pregnancy. Factors such as low SES (Noble *et al.*, 2005; Sarsour *et al.*, 2011) and smoking during pregnancy (Fitzpatrick, Barnett, & Pagani, 2014) are negatively associated with EF quality. As such, families with the first profile are at low risk for developing EF difficulties, while families with the second profile are at higher risk for developing EF difficulties.

The strongest association with family demographics was found for response shifting. However, results indicated better performance for high-risk children compared to low-risk children, when parents experienced little stress. This is in contrast to expectations, as

children in disadvantaged families are more exposed to family instability and unstructured environments, which can limit opportunities for parental stimulation (Bernier *et al.*, 2010), leading to poor EF skills. However, hypothetically, it is also possible that children in chaotic and unstructured environments switch between response sets more often and therefore practice this particular EF subcomponent more. Such a benefit would not generate to other EF subcomponents, such as verbal memory, which indeed was more difficult for high-risk children. It should be noted that response shifting was measured with one test in the current study and that this finding is specific for the test used. Obradovic (2010), for example, found a negative relationship between cumulative family risk and response shifting using a Peg Tapping test. Also, although there was variability between children on the response shifting task, in general most children scored relatively high. It cannot be excluded that (some of) the children in our high-risk profile represent a subsample of highly able children. Additionally, other family factors that were not taken into account, such as the number of siblings (McAlister & Peterson, 2013) or positive parent–child interactions (Lengua *et al.*, 2014), may have moderated the relationship.

Furthermore, parenting stress played a role in the relationship between family demographic profiles and EF subcomponents. Parenting stress was negatively associated with children's response shifting and verbal memory in high-risk families, but not in low-risk families. In the case of response shifting, children with a high-risk demographic profile scored higher than children with a low-risk profile, but only when their parents perceived little stress. When parents of high-risk children also scored high on parenting stress, their response shifting performance decreased significantly. Parenting stress increases stress levels in children, which in turn can result in lower EF performance (Wagner *et al.*, 2015). Also, parenting behaviours and parent–child interaction can be influenced (Crnic, Gaze, & Hoffman, 2005) resulting in a less stimulating environment for the child. Parents from high-risk children may be more sensitive for such influences as it cumulates to other risk factors.

That some EF subcomponents were related to family demographics while others were not suggests that EF subcomponents can be impacted differently by environmental factors. Nevertheless, other explanations can be given for the lack of significant results for the other EF subcomponents. It should be noted that the sample size was not very large. Small effects might not be detected, although previous studies with similar sample sizes were able to reveal such impact (Bernier *et al.*, 2010). There was also rather limited variability in the demographic backgrounds of the families. Although there were differences in mothers' educational levels, family types, and income groups, the majority of children lived in high-income, two-biological-parent families with a high-educated mother. This may have limited the opportunities of finding significant relationships with the EF subcomponents.

Limitations and directions for future research

Based on previous research, a link was expected between family demographic background and EF (Bernier *et al.*, 2010; Lengua *et al.*, 2014; Noble *et al.*, 2005; Rhoades *et al.*, 2011; Sarsour *et al.*, 2011). The current study, with a homogenous sample with regard to age, only found limited associations between family demographics and EF. However, family demographics might not influence the quality of EF subcomponents to the same extent throughout development, but rather exert their impact primarily during periods of rapid EF development of a specific subcomponent. An important developmental spurt for EF begins at the age of 2 (Zelazo & Carlson, 2012). Research suggesting an

impact of family demographic background has often focused on this younger age group (Bernier *et al.*, 2010; Lengua *et al.*, 2014; Rhoades *et al.*, 2011). The importance of family demographics may be more limited at school age and become more relevant again at the transition to adolescence during a developmental spurt (Zelazo & Carlson, 2012). Future research should further examine the relationship between family environment and EF subcomponents in longitudinal designs. This can provide more nuanced insights into what factors in the family environment are important for the development of specific EF subcomponents and, as such, guide targeted prevention and intervention of EF difficulties and prevent a cascade of problems (see Diamond, 2013, for an overview) later in life.

Furthermore, the results of the current study should be seen in the light of some limitations. First, tests were always administered in the same order, leading to possible influences of fatigue and other confounding factors. Such factors may have impacted performance on tests at the end of a session, such as Block Recall and Digit Recall (session 1), the Stroop task (session 2), and the Knock and Tap task (session 3), more than at the beginning of a session and may have influenced the results. In addition, it should be noted that multiple tests were needed in order to answer the research questions of the current study, which may have inflated the risk of type I errors.

Lastly, this study specifically looked at the importance of family demographics for EF subcomponents and the role of parenting stress herein. Other factors, such as parenting style (Roskam, Stievenart, Meunier, & Noël, 2014), teacher–student relationship (Berry, 2012), or physical activity (Becker, McClelland, Loprinzi, & Trost, 2014), have also been shown to influence EF development and quality. The current study cannot account for such additional influences. Future research should focus on these factors as well when examining how specific EF subcomponents can be impacted. Also, the current study did not take into account that children's EF quality can be affected by the family in different ways. It is, for example, possible that parents in high-risk families have themselves more poorly developed EFs and that a relationship between family demographics and EF is due to genetic contributions (Deater-Deckard, 2014). Future studies should therefore consider the complex genetic and environmental influences and gene–environment interactions implicated in EF development (see Deater-Deckard, 2014, for an overview).

Conclusions

As EFs are essential for everyday functioning, interest in research regarding EF development and influencing factors has increased dramatically. During the kindergarten period, an adequate family environment is especially important for positive EF development. Nevertheless, little is known about specific relationships between family demographics and different EF subcomponents. The current study contributed to existing literature by examining such associations. Results indicate that the demographic background of families is related to children's performance in response shifting and verbal memory, but not to other subcomponents of working memory, inhibition, and cognitive flexibility. Although these results should be nuanced in the light of some limitations, this study provides a first step in unravelling the impact of the family environment on EF. Future research is needed, investigating such relationship at the EF subcomponent level in order to gain further insights into potential differential relationships in order to guide prevention and intervention of EF- and related problems.

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Supporting Information

The following supporting information may be found in the online edition of the article:

Table S1. Descriptive statistics of all EF-outcome measures.
Table S2. Bivariate correlations between demographic variables and executive functioning subcomponents.