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Exploring predictors of change in behavioral problems over a 1-year period in preterm born preschoolers

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ABSTRACT

Objective: Although predictors of the prevalence of behavioral problems in preterm-born children have been frequently studied, predictors of behavioral change in these children remain unknown. Therefore, in this study we explore predictors of short-term changes in problem behavior in preterm-born preschoolers, an age period characterized by rapid behavioral change.
Method: Two- to 5-year-old children born with a gestational age < 32 weeks and/or birth weight < 1500 g were eligible, because of their high risk for behavioral problems. Following screening, 59 children with a *t*-score ≥ 60 on either the internal, external or total problem scale of the Child Behavior Checklist were included in the study. Linear mixed modeling was used to investigate predictors of change in behavior over a 1-year period.
Results: Higher levels of parenting stress, parent perceived child vulnerability, and parental hostility towards the child and lower educational levels of the mother significantly predicted increases in externalizing behavior. The higher the age of the child, the more internalizing problems decreased.
Conclusions: Parenting stress, parent perceived child vulnerability and parental hostility towards the child were the only modifiable predictors of increases in externalizing behavior, whilst no modifiable predictors of internalizing behavior were found. There may be a reciprocal interaction between stress in parents and child externalizing problems. Furthermore, stress and worries may directly influence parents' reports on behavioral measures, because it could cause them to be concerned by behavior otherwise perceived as normal. Therefore, future interventions for parents of preterm-born children should primarily address parental stress and concerns regarding their child.

1. Introduction

Preterm-born children are at higher risk of developing emotional and behavioral problems than healthy term-born children (Bhutta, Cleves, Casey, Cradock, & Anand, 2002; Gray, Indurkhya, & McCormick, 2004). These problems may affect school achievement and family functioning during childhood and adolescence (Delobel-Ayoub et al., 2009; Taylor et al., 2001). Although the prevalence and correlates of behavioral problems in preterm-born children are frequently studied, less attention has been paid to predictors of change in internalizing (self-directed) and externalizing (directed outward) behavior. Especially during the preschool

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period, when problem behaviors emerge and are prone to rapid changes, identifying predictors of change would be helpful in deciding which factors should be addressed by behavioral interventions for preterm-born children (Gray et al., 2004; Spittle et al., 2009).

The prevalence of behavioral problems in preterm-born children is approximately 20%, versus 10% in term-born children (Bhutta et al., 2002; Gray et al., 2004). Furthermore, the onset of these problems in preterm-born children is reported to occur as early as 2 years of age (Spittle et al., 2009). Transactional theories on the development of behavioral problems in preterm-born children suggest that the interplay between parents' preexisting personality and family factors, prenatal experiences, and emotional distress during the neonatal intensive care unit (NICU) admission period, may result in a parenting style that differs from that of parents of healthy term-born children (Miles & Holditch-Davis, 1997). This parenting style may be due to both parenting stress and the perception of parents of their preterm-born preschooler as still being vulnerable (De Ocampo, Macias, Saylor, & Katikaneni, 2003). In combination with preterm-born children's neurological predisposition to emotional and behavioral problems, these overprotective and inconsistent parenting practices may negatively impact the behavior of the child (Campbell, 2006; Clark, Woodward, Horwood, & Moor, 2008).

There is little empirical knowledge on the developmental trajectory of internalizing and externalizing behavior in preterm-born children. Therefore, we describe developmental trajectories of behavioral problems in term-born children. It could however be argued that problems may be more persistent in preterm-born children due to the neurological basis of their behavioral problems. In term-born children, behavioral seems to change most rapidly during the preschool period. In a study investigating 1171 children aged 2–9 years, mothers and teachers indicated that externalizing behavior changed most rapidly from 3 to 4 years (Miner & Clarke-Stewart, 2008). The decrease during this 1-year period was larger than the total decrease in externalizing behaviors from 4 to 9 years of age. A study on partly the same sample, following 1232 children from age 2 to age 12, found the largest change in externalizing behavior between 3 and 4.5 years of age (Fanti & Henrich, 2010). This study also investigated internalizing behavior, which showed the greatest change between 2 and 3 years of age.

Regarding general trajectories of behavioral problems in term-born children, externalizing behavior has been shown to decrease during preschool age (Mesman et al., 2009; Miner & Clarke-Stewart, 2008; Owens & Shaw, 2003). This could be explained by parents' attempt to socialize their children, and biological maturation in children's capacities for perspective taking and frustration tolerance (Campbell, 1995). These processes may be similar in preterm-born and term-born children. In contrast to externalizing behavior, findings on the developmental trajectory of internalizing behavior are contradictory. In some studies, internalizing problems seems to remain relatively stable during the preschool years in term-born children (Keiley, Bates, Dodge, & Pettit, 2000). An explanation for this stability could be that internalizing behavior is related to child temperament, and therefore less susceptible to external influences (Sterba, Prinstein, & Cox, 2007). However, in other studies internalizing behaviors decrease and/or increase during the preschool period. One study that measures behavioral problems almost yearly found that internalizing problems increased from age 2 to 4.5 years, and decreased from 4.5 to 6 years (Fanti & Henrich, 2010). The authors suggest that these fluctuations in internalizing behavior reflect vulnerability to environmental stressors. This could indicate that preterm-born children may show even larger fluctuations in internalizing behavior, since they are neurologically more vulnerable. Nonetheless, another study reported a general increase in internalizing behavior from 2 to 6 years (Gilliom & Shaw, 2004), and explains this to be due to the maturation of cognitive abilities of the child, which enables the child to self-reflect. There is no reason to assume that these maturation processes are different in preterm-born children.

The development of behavioral problems in preterm-born preschoolers remains to be explored, but more is known about predictors of the prevalence of behavioral problems in these children. Numerous child, family, and socioeconomic predictors have been investigated, but the most prominent predictors of behavioral problems during preschool age seem to be parental psychological distress, stress, and depression (Delobel-Ayoub et al., 2009; Gray et al., 2004; Huhtala et al., 2012; Miceli et al., 2000; Poehlmann et al., 2012). Furthermore, maternal cigarette smoking during pregnancy and a lower maternal age are also often found to be predictors of problem behavior (Delobel-Ayoub et al., 2009; Gray et al., 2004; Stoelhorst et al., 2003). Other predictors of an increased prevalence of behavioral problems for which there is less evidence are lower gestational age of the child, being small for gestational age (SGA), non-native ethnicity, child developmental delay, low parental education, and parent perceived child vulnerability (De Ocampo et al., 2003; Delobel-Ayoub et al., 2009; Gray et al., 2004; Huhtala et al., 2012). Some predictors seem to act differently for specific types of problem behavior. For example, SGA, parental depression, and parental negative affect seem to predict internalizing problems, but not externalizing problems (Huhtala et al., 2012; Stoelhorst et al., 2003; Treyvaud et al., 2009).

Regarding the prediction of change in internalizing and externalizing behavioral problems, information is scarce for preterm-born children and even in term-born children it seems difficult to establish consensus among studies about these predictors. In term-born preschoolers, most research is focused on the development of externalizing behavior. Ineffective and irritable parenting predicted increases in externalizing behavior from 5 to 7 years in children from a low socioeconomic neighborhood (Hollenstein, Granic, Stoolmiller, & Snyder, 2004; Snyder, Cramer, Afrank, & Patterson, 2005). In another study, maternal psychopathology and having fewer siblings predicted an increase in externalizing behavior from 2 to 3 years of age (Mesman et al., 2009). Predictors of changes in internalizing problems in term-born preschoolers were found in a study on 1.5- to 6-year-olds, which found that lower levels of maternal sensitivity predicted an increase in internalizing problems (Keiley et al., 2000).

Although several studies have investigated predictors of the prevalence of internalizing and externalizing behavioral problems in preterm-born children, it is not known whether these predictors also predict short-term changes in problem behavior, and whether they act differently for internalizing and externalizing behavior. Therefore, in this study we explored whether predictors that have been found to predict the prevalence of problem behavior, also predict short-term behavioral change in preterm-born preschoolers. Determining these predictors is especially important in preterm-born children, because modifiable predictors could be an important foundation for the development of effective interventions for these children. The predictors that we investigate are those that have

been found to influence the level of behavioral problems in preterm-born children and changes in behavioral problems in term-born children: (child characteristics) age, birth weight, gestational age, being small for gestational age, developmental delay, ethnicity; (family characteristics) maternal age, maternal smoking during pregnancy, parenting stress, parental sensitivity, parental respect for child autonomy, parental hostility towards the child, parent perceived vulnerability of the child, siblings in the family; (socioeconomic characteristics) parental education. We expect that predictors that are associated with an increased prevalence of behavioral problems, such as parental psychological distress, also predict a negative change in behavioral problems. To estimate the effects of child, family, and socioeconomic characteristics on internalizing and externalizing behavioral problems of the child, we used linear mixed modeling. Within linear mixed models, predictors of behavioral changes from baseline to successive time-points can be reliably assessed in small samples (Maas & Hox, 2005).

2. Method

2.1. Participants

Participants were originally recruited for a larger study that investigated the effectiveness of a parenting intervention in preterm-born and asphyxiated term-born children (Schappin et al., 2013). Therefore, all children have behavioral problems in the (sub) clinical range of the CBCL. In the present study, the term-born children with perinatal asphyxia were excluded since the focus is on behavioral change in preterm-born children. Parents of a cohort of 1291 infants born between September 2004 and October 2007, and subsequently admitted to the NICUs of the Wilhelmina Children's Hospital (Utrecht, The Netherlands) and Isala Clinics (Zwolle, The Netherlands) were recruited by mail. Children of 2- to 5-years-of-age, born at a gestational age < 32 weeks and/or birth weight < 1500 g, whose parents reported a *t*-score ≥ 60 on the internal, external, or total problem scale of the CBCL during screening (Achenbach & Rescorla, 2000), were eligible. Excluded were children with cognitive and/or motor impairments (defined as a developmental quotient < 70 and/or a Gross Motor Function Classification System score > 3 (Palisano, Rosenbaum, Bartlett, & Livingston, 2008)), and children with parents who did not speak Dutch. The GMFCS score was retrieved from children's medical record or calculated based on information in the medical records.

Between May 2009 and March 2010, we invited parents to participate in our study. From the total cohort of 1291 children, 970 (75%) were born preterm and eligible for inclusion in the present study. Of these children, 431 (44%) children's parents completed the CBCL and 96 (22%) children met the inclusion criteria. Of these 96 children, 59 (61%) children's parents consented to participate. During the study, 5 children dropped out due to parents not being able to take leave from work, a mother's second complicated pregnancy, severe illness in the family, and parents who repeatedly failed to complete questionnaires. The primary caregiver completed all questionnaires, which was the mother in 96.6% of cases ($n = 57$).

2.2. Procedure

Data for this study were collected as part of a randomized, clinical trial investigating the effectiveness of a parenting intervention (Schappin et al., 2013). In this randomized trial, there was no significant intervention effect. Nevertheless, to control for the effect of the intervention in the current study, all analytic models were adjusted for participation in the intervention or control group. Included data from the larger study were neonatal data obtained from the children's medical records, baseline family background characteristics, baseline parental questionnaire data on child development, parenting stress, parent perceived child vulnerability, and observations of parental sensitivity, respect for child autonomy, and hostility towards the child. For behavioral problems, baseline measures, post-test measures at 6 months, and 12-month follow-up measures were retrieved from the larger study. Questionnaires were sent to the families and completed at home. Parents' informed consent was obtained separately for the screening and randomized phase of the study. Approval for the study was obtained from the institutional review boards of both centers.

2.3. Measures

2.3.1. Predictors

Predictors, defined as baseline child, family and socioeconomic characteristics are presented in Table 1.

2.3.2. Child characteristics

Age was measured at baseline. Birth weight and gestational age were retrieved from medical records. SGA birth was defined as a weight below the 10th percentile for the gestational age. Developmental delay was present if one or more developmental domains (communication, gross motor, fine motor, problem-solving and personal-social development) of the parent-reported Ages and Stages Questionnaire were in the clinical range during screening (Squires, Potter, & Bricker, 1990). Ethnicity of the child was deducted from parent's ethnicity, which was retrieved by means of a family background questionnaire.

2.3.3. Family characteristics

Maternal smoking during pregnancy was retrieved from medical records. Maternal age and the number of siblings in the family were reported by parents in the family background questionnaire.

Parenting stress was measured with the Dutch version of the Parenting Stress Index (PSI), which produces the total score of 123 items measuring parenting stress in parents of children aged 1 month to 12 years (De Brock, Vermulst, Gerris, & Abidin, 1992).

Table 1
Characteristics of Children and Parents (N = 59).

	% or Mean	Range
Child characteristics		
Age, mean mo (*SD*)	44.7 (10.1)	29–63
2 year olds, % (*n*)	27% (16)	
3 year olds, % (*n*)	37% (22)	
4 year olds, % (*n*)	32% (19)	
5 year olds, % (*n*)	3% (2)	
Males, % (*n*)	57.6% (34)	
Twins[a], % (*n*)	15.3% (9)	
European ethnicity, % (*n*)	98.3% (58)	
BW, mean g (*SD*)	1262.0 (343.8)	590–2020
GA, mean wk (*SD*)	29.3 (2.1)	24–34
SGA, % (n)	15.3% (9)	
IVH grade III–IV, % (*n*)	8.5% (5)	
NICU stay, median d	14.0	2–72
Number of siblings, median	1	0–3
Developmental delay		
1 Domain in clinical range, % (*n*)	10.2% (6)	
≥2 Domains in clinical range, % (*n*)	13.6% (8)	
Family characteristics		
Maternal age, mean y (*SD*)	33.4 (5.5)	20–45
Maternal education, mean y (*SD*)	14.7 (2.0)	11–18
Paternal education, mean y (*SD*)	14.4 (2.6)	7–18
Maternal occupational status		
Employed	91.5% (54)	
Hours per week (*SD*)	23.3 (7.5)	
Welfare	1.7% (1)	
Paternal occupational status		
Employed	98.2% (55)	
Hours per week (*SD*)	38.8 (7.3)	
Welfare	–	
Maternal marital status, % (*n*)		
Married	62.7% (37)	
Registered partnership	10.2% (6)	
Single, divorced	1.7% (1)	
Single, never married	25.4% (15)	
Mother smoked during pregnancy, % (*n*)	11.9% (7)	
Mother visited social worker/psychologist in previous 6 mo, % (*n*)	13.6% (8)	

BW, birth weight; GA, gestational age; SGA, small for gestational age; IVH, intraventricular hemorrhage; NICU, neonatal intensive care unit.
[a] Including 1 set of triplets.

Sample items of the PSI are “It takes a long time and it is very hard for my child to get used to new things” and “Since having a child, I feel that I am almost never able to do things that I like to do”. Separate cutoff points for mothers and fathers divide the raw score in 7 stress levels, ranging from very low (1) to very high (7). Reliability of the PSI in our sample was Cronbach’s alpha 0.94, which is acceptable.

Parent perceived child vulnerability was measured with a modified version of the Vulnerable Child Scale (VCS), a 16-item questionnaire which describes parents’ health concerns about their children, yielding a total vulnerability score (Perrin, West, & Culley, 1989). Sample items of the VCS are “I often check on my child at night to make sure he/she is ok” and “I often think about calling the doctor about my child”. The range of the VCS is 1–4, with high scores indicating less vulnerability. Because of low reliability of the VCS in our sample, question 5 “My child usually has a healthy appetite”, question 9 “My child seems to have as much energy as other children of the same age”, and question 15 “I am sometimes unsure about my ability to care for my child as well as I should” were removed from the questionnaire. This improved reliability to Cronbach’s alpha 0.70, which is satisfactory.

Parental sensitivity, respect for child autonomy, and hostility towards the child were observed measures. The observation task used in this study was the Three Boxes Task, adapted from the National Institute of Child Health and Human Development Early Child Care Research Network (National Institute of Child Health and Human Development, 1999). Although this task has slightly different versions for different ages of the child, for comparability reasons we chose to use the 36 months version throughout our study. The task consists of three consecutive structured play tasks and cleaning up: first, toys were available for dyadic imaginary play; second, drawing materials were available for dyadic play or teaching by parents; and third, parents should tell the child to play on its own (appropriate toys were available) while the parent completed a questionnaire. For a complete description of the task, see Schappin et al. (2014).

The scoring system used to measure parental sensitivity, respect for child autonomy, and hostility towards the child was the Mother-Child Structured Interaction Qualitative Rating Scales, which is used with the Three Boxes Task (National Institute of Child Health and Human Development, 1993). As for the observation task itself, we chose to use only the 36 months version of the scoring

system. The Qualitative Rating Scales consists of five parent items, four child items, and one dyadic item. All items are scored on a 7-point range from 1 (very low) to 7 (very high). For this study, we chose the parent items 'supportive presence' (i.e. parental sensitivity), 'respect for child autonomy' and 'hostility' to tap into the definitions used by Treyvaud et al. (2009) and Snyder et al. (2005): negative affect, negative parenting, and irritable parenting. Each item has an extended description for behaviors that fall under the points that can be scored for that item. For example, parents score 4 points (moderate) on parental sensitivity when "This parent does a respectable job of being available when her/his child needs support. She/he may lean closer as the child shows small signs of frustration and praise the child's efforts to show that she/he is available and supportive, but inconsistency in this style makes her/his support unreliable or unavailable at crucial times in the session" (National Institute of Child Health and Human Development, 1993).

The Qualitative Rating Scales were scored from standardized videotapes by an independent observer who was blind to both the intervention-status and the time of measurement of the parent-child dyads in the original intervention study. To be as precise as possible, the three structured play tasks were scored individually and then summed, so the scores ranged from 3 to 21. The same observer, an experienced child psychologist, scored all videotapes. A second observer, a junior child psychologist, scored approximately 10% of the videos. The second author (LW) trained both observers. Agreement within 2 points was Cohen's kappa = 0.52 (moderate; $p < .001$) for the item parental sensitivity, Cohen's kappa = 0.69 (substantial; $p < .001$) for the item respect for child autonomy, and Cohen's kappa = 1.00 (almost perfect; $p < .001$) for the item hostility towards the child.

2.3.4. Socioeconomic characteristics

The number of years of education of both mother and father were collapsed into one mean number of years of education for each family. The family mean number of years of education was M = 14.6, SD = 2.0.

2.3.5. Dependent variable: child behavior

Child behavior was measured with the preschool CBCL, a widely used parent-report measure used to assess child emotional and behavioral problems (Achenbach & Rescorla, 2000). It consists of 99 problem items that yield raw scores and standardized *t*-scores for 7syndrome scales and overarching internalizing, externalizing, and total problem behavior. The internalizing scale consists of the syndrome scales emotionally reactive, anxious/depressed, somatic complaints, and withdrawn behavior. The externalizing scale consists of only two syndrome scales: attention problems and aggressive behavior. On the syndrome scales, *t*-scores < 65 are regarded as normal, whilst *t*-scores of 65–70 indicate sub-clinical problems, and *t*-scores ≥70 indicate problems in the clinical range. On the summary internalizing, externalizing, and total problems scale, *t*-scores < 60 are regarded as normal, whilst *t*-scores of 60–64 indicate sub-clinical problems, and *t*-scores ≥64 indicate problems in the clinical range. The reliability of the internalizing and externalizing scales, used in our analyses, were Cronbach's alpha 0.76 for the internalizing problems scale and Cronbach's alpha 0.84 for the externalizing problems scale, which are both acceptable values.

2.4. Data analyses

Changes in internalizing and externalizing problems and predictors thereof were analyzed with linear mixed models. Linear mixed models have the advantage over repeated measures analysis of variance that they are able to handle missing data and uneven spacing between time-points. First, we estimated a model with time as a fixed effect and a random effect for the intercept to investigate the development of behavior without predictors. In linear mixed models, fixed effects indicate mean changes during the study period. The random intercept indicates the variability of individual scores in the level of problem behavior. For this model, we estimated effect sizes for changes over time using the guidelines of Hedges (2007). Second, we estimated a model with all predictors as fixed effects and also a random effect for the intercept. An interaction term between time of measurement and age of the child was included in the model to estimate whether changes in problem behavior over a 1-year period were different for children of different ages. If the interaction term was not significant, it was deleted from the model.

All models were adjusted for participation in either the intervention or control group of the larger intervention study. Raw CBCL scores were used in the analyses instead of *t*-scores, since raw scores indicate changes in the rating of behavior over time, whereas *t*-scores are standardized scores that indicate the relative position of an individual to a standardized sample. Because we expected interrelatedness among predictor variables (multicollinearity), we checked correlation matrices of the predictor variables and discarded predictors with correlations of Pearson $r \geq 0.40$ (Tabachnik & Fidell, 2001). Model fit was assessed using IBM SPSS version 21.0, with REML estimation (IBM, 2012).

3. Results

3.1. Participants

The 59 families that participated in this study did not differ from the 37 eligible families that declined participation on any of the background variables, and there were no significant differences in demographic and neonatal characteristics between the total cohort and the study participants. Baseline characteristics of children and parents are presented in Table 1.

3.2. Internalizing and externalizing behavioral problems

Descriptive statistics of the variables in the linear mixed model and percentages of (sub)clinical cases are presented in Table 2.

Table 2
Descriptive Statistics for Predictors and Standardized Outcomes.

	Range	Baseline (n = 59)			6 Months (n = 51)			12 Months (n = 49)			Overall change*	
		Mean	*SD*	% (sub)clinical	Mean	*SD*	% (sub)clinical	Mean	*SD*	% (sub)clinical	p	Cohen's d
Predictors												
Parenting stress	1–6	5.3	1.1									
Parent perceived vulnerability	1–4	3.1	0.4									
Sensitive parenting	3–21	12.2	1.9									
Parental respect for child autonomy	3–21	10.8	2.5									
Parental hostility	3–21	4.3	1.6									
Behavioral Problems *t*-score												
Total problems	0–100	61.3	5.5	49.1%	56.9	7.5	31.4%	56.5	8.1	34.6%	.023	0.65
Internalizing problems	0–100	59.7	8.5	57.6%	57.1	9.3	33.4%	56.3	9.5	44.9%	.107	0.32
Emotionally reactive	0–100	62.3	7.7	45.8%	59.3	7.7	31.4%	59.9	8.2	30.6%	.072	0.32
Anxious/depressed	0–100	55.2	6.9	23.7%	55.0	7.0	15.7%	54.6	6.8	16.3%	.667	0.01
Somatic complaints	0–100	60.7	8.0	45.8%	58.7	7.6	35.3%	57.9	7.4	18.4%	.030	0.40
Withdrawn behavior	0–100	58.8	6.9	18.7%	57.9	8.1	15.7%	56.8	6.1	8.2%	.297	0.25
Externalizing problems	0–100	61.4	8.5	69.5%	55.8	8.2	39.2%	56.4	8.7	36.8%	< .001	0.71
Attention problems	0–100	61.5	7.5	28.8%	57.1	7.4	27.4%	57.8	7.3	22.5%	.008	0.50
Aggressive behavior	0–100	62.0	8.3	33.9%	57.1	6.5	13.7%	57.3	7.2	16.3%	< .001	0.67

*Based on mixed model analysis of raw CBCL scores.

From baseline to 6 months, the mean *t*-scores on all CBCL scales showed a clinically meaningful decrease, from above the subclinical level on some scales to below the subclinical level on all scales. On the total CBCL *t*-score, 67% of children showed a decrease or remained stable. The decrease in *t*-scores was less marked from 6 to 12 months, when some scores increased slightly and others continued to decrease. The percentage of children that showed a decrease in total CBCL *t*-scores or remained stable in this time period is 58%.

Due to a lack of variability in the predictor child ethnicity (only 1 child had a non-European ethnicity), this predictor could not be used in our analyses. Furthermore, because of low interrater reliability, the predictor parental sensitivity was also excluded from the analyses. The correlation matrix of all remaining predictors was checked for correlations Pearson $r > 0.40$, to avoid multicollinearity (Supplement 1). Birth weight and gestational age were highly correlated ($r = 0.64$, $p < .001$). Because birth weight was also significantly (but not with values of $r > 0.40$) related to SGA birth ($r = 0.33$, $p = .012$) and child developmental delay ($r = 0.26$, $p = .050$), we chose to discard birth weight from the analyses. Maternal smoking during pregnancy was correlated with age of the child ($r = -0.44$, $p < .001$) and SGA birth ($r = -0.43$, $p = .001$). Because of the large evidence base for the relation between maternal smoking during pregnancy and the prevalence of child behavioral problems, we chose to keep maternal smoking in our analyses and discard the variable SGA birth from the analyses. However, because the age of the child played a crucial role in the ability to answer our research question, we chose to leave this predictor in the analyses.

The linear mixed model of internalizing problems showed an interaction effect between the age of the child and change in internalizing problems (Table 3). The older the child, the more internalizing problems decreased during the 1-year study period (Fig. 1). There were no other significant predictors of change in internalizing problems. The significant random intercept ($p = .002$) indicates that there was individual variation in the level of internalizing problems.

Externalizing problems significantly decreased during the 1-year study period (Table 3 Fig. 1). A higher level of parenting stress, parent perceived child vulnerability and parental hostility towards the child predicted an increase in externalizing problems during the 1-year study period. Furthermore, a lower level of parental education also predicted an increase in externalizing problems. The random intercept was not significant, indicating that there was no significant individual variation in levels of externalizing behavior.

3.3. Regression to the mean

To investigate whether changes in behavioral problems were not merely regression to the mean, we calculated the intercept-slope correlations for internalizing and externalizing behavioral problems. These correlations were Pearson $r = -0.48$ for internalizing behavior and $r = -0.54$ for externalizing behavior, which indicates that high baseline scores are indeed correlated with large decreases in scores. However, these effects are small to medium and regression to the mean therefore only slightly influences our findings.

4. Discussion

This explorative study demonstrated that in preterm-born preschoolers with (sub)clinical levels of behavioral problems, short-term changes in externalizing behavior could be predicted by family and socioeconomic characteristics. The predictors that were identified were consistent with previously found predictors of the prevalence of behavioral problems in preterm-born children (De Ocampo et al., 2003; Delobel-Ayoub et al., 2009; Huhtala et al., 2012). Furthermore, in line with previous findings, externalizing

Table 3
Multivariable Linear Mixed Models for Predictors of the Developmental Trajectory of Child Behavioral Problems (n = 56).

	Internalizing problems		Externalizing problems	
	Estimate (SE)	P	Estimate (SE)	P
Fixed Main Effects				
Time (months)	0.73 (0.45)	.109	−0.38 (0.11)	.001
Time*Age child	−0.02 (0.01)	.046	–	
Child characteristics				
Age (years)	0.18 (0.14)	.186	−0.12 (0.10)	.213
GA (weeks)	0.50 (0.42)	.246	−0.09 (0.32)	.778
Developmental delay	0.67 (2.23)	.765	0.63 (1.70)	.713
Family characteristics				
Maternal age (years)	0.07 (0.18)	.716	−0.02 (0.14)	.891
Smoking	0.13 (3.55)	.971	−1.39 (2.70)	.610
Parenting stress	1.18 (0.87)	.180	2.64 (0.66)	< .001
Autonomy	−0.77 (0.50)	.127	0.74 (0.38)	.056
Hostility	−0.71 (0.61)	.251	1.03 (0.46)	.031
Perceived vulnerability	−2.27 (2.73)	.410	4.70 (2.06)	.028
Siblings	−1.98 (1.35)	.152	−0.64 (1.03)	.537
Socioeconomic characteristics				
Parental education	0.30 (0.49)	.543	−1.38 (0.38)	.001
Random effect				
Intercept	27.55 (9.07)	.002	9.03 (5.45)	.098

Models are corrected for intervention participation. GA, gestational age.

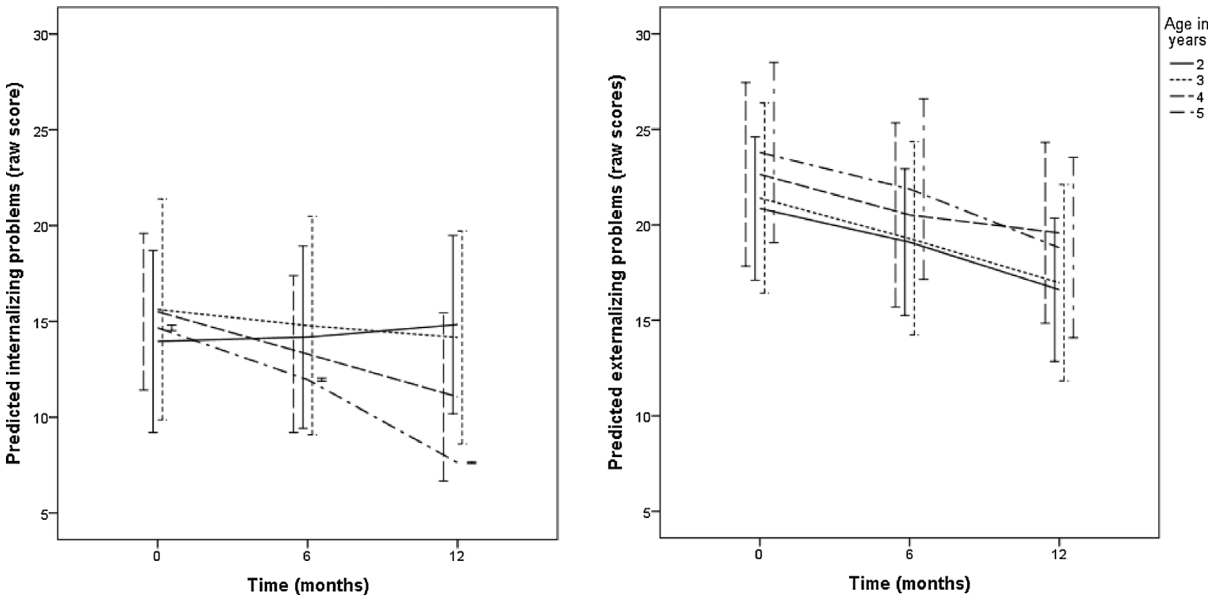

Fig. 1. Development of Internalizing and Externalizing Problems in Preterm Born Preschoolers.
Error bars indicate 1 SD.

problems decreased during the 1-year study period (Keiley et al., 2000; Mesman et al., 2009). We found that internalizing problems remained stable for the younger children in our sample and decreased for the older children.

The significant predictors of change in externalizing problem behavior in this study were parenting stress, parent perceived child vulnerability, parental hostility towards the child, and maternal level of education. This is consistent with findings on predictors of the prevalence of externalizing behavioral problems in preterm-born children (De Ocampo et al., 2003; Delobel-Ayoub et al., 2009; Gray et al., 2004; Huhtala et al., 2012), but not with findings on predictors of behavioral change in term-born children (Hollenstein et al., 2004; Mesman et al., 2009). Although the scarcity of studies on the prediction of change in internalizing and externalizing problems in term-born children may explain why the predictors that we found have not been found earlier, it is also possible that the population of preterm-born children is specific enough to have different predictors of change in internalizing and externalizing behavior.

Parenting stress, parent perceived child vulnerability, and parental hostility towards the child were the three modifiable predictors in our study. Consistent with our findings, in studies that investigated predictors of the prevalence of behavioral problems in

preterm-born children the cluster of stress, distress, and depression of parents was the most prominent predictor of total behavioral problems during the preschool age (Delobel-Ayoub et al., 2009; Gray et al., 2004; Huhtala et al., 2012; Miceli et al., 2000; Poehlmann et al., 2012). This could be explained by a reciprocal interaction between stress in parents and child behavioral problems. Furthermore, stressed and especially worried parents may have an altered perception of their child's behavior, and may be concerned by behavior that they would otherwise perceive as normal. This could directly influence parents' reports on behavioral measures such as the CBCL.

Regarding the level of maternal education, in a study on behavioral outcomes of very low birth weight preschoolers, a higher level of maternal education at 2 years of age predicted less total child behavioral problems on the CBCL at 3 years of age (Huhtala et al., 2012). It is often found that low socioeconomic circumstances, for which the level of education is an indication, are related to behavioral problems (Appleyard, Egeland, Van Dulmen, & Sroufe, 2005; Gray et al., 2004; Stoelhorst et al., 2003). Although the mechanism behind this relation has not often been investigated, some studies indicate that a lack of sensitive or warm parenting may explain why the children of low educated or deprived mothers have more behavioral problems (Tamis-LeMonda, Briggs, McClowry, & Snow, 2009). Furthermore, the suggestion that parenting styles play an important role in the development of behavioral problems is in accordance with the theoretical preterm parental distress model (Miles & Holditch-Davis, 1997). In line with these studies, we found that parental hostility towards the child predicted a significant increase in externalizing behavior. Future research is necessary on the mediating role of parenting style on the relation between socioeconomic circumstances and children's externalizing behavior.

Like other studies, we found that externalizing problems decreased over the 1-year study period (Keiley et al., 2000; Mesman et al., 2009). Although it is tentative to ascribe the decline in externalizing problems to a maturation effect, the predictor child age did not have an impact on externalizing problems in our study. So, the decrease in externalizing problems could not be explained by the children getting older. Another possible explanation is that parental stress decreased due to a Hawthorne effect, resulting in lower parent-reported externalizing problem behavior towards the end of the study. When we included children with high parent-reported levels of behavioral problems, we may have unintentionally also included stressed and worried parents. Stress and worries in parents may negatively impact child behavior and could alter parents' perceptions of their child's behavior. Due to the attention these parents received during their participating in our study, their stress and worries could have decreased which may have led to lower parent-reported levels of externalizing problems. Because we included children with high-parent reported levels of behavioral problems, regression to the mean may have also influenced our findings. However, our estimation of this effect revealed that is was small to medium in size and approximately the same for externalizing and internalizing behavior. This suggests that if our findings would be entirely explained by regression to the mean, we should have found the same trajectory for externalizing and internalizing behavior, which is not the case.

Our finding that internalizing problems decreased for the older children in our sample but not four the younger children, is largely in line with the pattern of development found by Fanti and Henrich (2010). In this study, internalizing problems increased from age 2–4.5 years, and decrease from 4.5 to 6 years. In comparison, in our sample internalizing behavior was stable at 2 and 3 years, and decreased at 4 and 5 years. The initial high level of internalizing problems in some children in our sample may have caused a ceiling effect in which problems are unlikely to increase even further. On the other hand, they also reflect these children's difficult start in life and accompanying parenting stress. It seems that these internalizing problems decrease to 'normal levels' in the older children in our sample, indicating that the vulnerability of these children is of a passing nature. Clinical experiences also suggest that when children enter school at four years of age, parents are reassured that their child's behavior does not deviate from that of their classmates and may report less problem behavior. Nonetheless, it could be that preterm born children stay vulnerable to stressors in the environment and may show fluctuating internalizing behavior, also after the age of 5 (Fanti & Henrich, 2010; Sterba et al., 2007).

Our study had several limitations. First, our findings may be influenced by regression to the mean. The size of the intercept-slope correlation was however small to medium and in line with findings in non-clinical samples (Miner & Clarke-Stewart, 2008). Second, our measures were mainly maternal reports, since they were predominantly the primary caregivers. Therefore, we have only the mother's perspective on parenting stress and child behavior. Third, due to problems with multicollinearity we were not able to test all predictors of interest. Furthermore, the generalizability of our findings may be limited, since we specifically investigated preterm-born children with a gestational age < 32 weeks and/or a birth weight < 1500 g who already had behavioral problems. Study strengths should also be noted. This study is the first to examine predictors of short-term change in problem behavior in preterm-born preschoolers.

In summary, this study demonstrated that in preterm-born preschoolers with (sub)clinical levels of behavioral problems, short-term behavioral change can be predicted by family and socioeconomic characteristics. In general, externalizing behavior decreased during the study period whilst internalizing behavior remained stable for the youngest children in our sample and decreased for the older children. Parenting stress, parent perceived child vulnerability and parental hostility towards the child were the only modifiable predictors of an increase in externalizing behavior, whilst for internalizing behavior no modifiable predictors were found. There may be a reciprocal interaction between stress in parents and child externalizing problems. Furthermore, stress and worries may directly influence parents' reports on behavioral measures, because due to stress they may be concerned by behavior that they would otherwise perceive as normal. Therefore, future interventions for parents of preterm-born children should primarily address parental stress and concerns regarding their child.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.infbeh.2017.12.003.

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