Timing and chronicity of maternal depression symptoms and children's verbal abilities

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Abbreviations: MDS – Maternal Depression Symptoms; CES-D – Center for Epidemiologic Studies Depression Scale; PPVT-R – Peabody Picture Vocabulary Test-Revised; MI – Multiple Imputation; SAS – Statistical Analysis System

Table of Contents Summary: This study addresses a gap in maternal depression research by examining the association between timing and chronicity of maternal depression symptoms and children's verbal abilities.

Abstract

Objective – To test the associations between the timing and chronicity of maternal depression symptoms (MDS) and children's long term verbal abilities.

Study Design – Participants were *n*=1073 mother-child pairs from a population-based birth cohort in Canada. MDS were assessed at ages 5 months, 1½, 3½, and 5 years using the Center for Epidemiologic Studies Depression Scale (CES-D). Verbal abilities were measured at 5, 6, and 10 years using the Peabody Picture Vocabulary Test-Revised (PPVT-R). Multiple linear regression models were used to estimate the association between timing (early: 5 months and/or 1½ years vs late: 3½ and/or 5 years) and chronicity (5 months, 1½, 3½ and 5 years) of exposure to elevated MDS and children's mean PPVT-R scores.

Results – Children exposed to chronic MDS had lower PPVT-R scores than children never exposed (*Mean difference=9.04[95%CI=2.28-15.80*]), exposed early (10.08*[3.33-16.86]*) and exposed late (8.69*[1.85-15.53]*). There were no significant differences between scores of children in the early compared to the late exposure group (1.41*[-1.11-3.93*]). We controlled for mother-child interactions, family functioning, SES, PPVT-R administration language, child's birth order, and maternal IQ, psychopathology, education, native language, age at birth of child, and parenting practices. Maternal IQ, (η^2=0.028), native language (η^2=0.009), and MDS (η^2=0.007) had the largest effect sizes.

Conclusion – Exposure to chronic MDS in early childhood is associated with lower levels of verbal abilities in middle childhood. Further research is needed in larger community samples to test the association between MDS and children's long term language skills.

Introduction

Approximately 9% of women will meet diagnostic criteria for major depression during pregnancy or in the early years of parenthood (1), so that a large number of young children are exposed. Both clinical and sub-clinical levels of maternal depression symptoms (MDS) carry risk for the offspring (2). Several studies have found lower levels of cognitive functioning, including verbal abilities, in children of depressed mothers (3-7). However, little is known about whether timing and/or chronicity of MDS during early childhood – a time at which the child is highly dependent on the mother – is associated with children's long term verbal abilities.

Because infants are largely dependent on maternal care and stimulation, early exposure (e.g. birth-2 years) to MDS may have a larger impact on a child's cognitive development than an exposure later in childhood (e.g. 3-5 years) (8). However, the chronicity of MDS – that is, the persistence of symptoms over time – has been often associated with negative behavior and smaller achievement gains in primary school (9, 10) . Overall, children exposed to chronic MDS may have a greater risk of accumulating disadvantage over time and are therefore more likely to experience lasting negative effects (11). Notably, few studies have aimed at distinguishing the impact of early versus late versus chronic exposure to MDS on longer-term outcomes.

The Present Study

We modeled the association between timing and chronicity of MDS exposure and children's verbal abilities using a population-based cohort study. We hypothesized that i) children exposed to early MDS would have lower scores on a test of verbal abilities compared to children exposed later during early childhood and that, ii) children exposed to elevated MDS over a longer period of time would have lower scores on this measure than children exposed for shorter periods.

Methods

Participants. Data were drawn from the Quebec Longitudinal Study of Child Development, whose protocol was approved by the Quebec Institute of Statistics and the Sainte-Justine Hospital Research Centre ethics committees. Participants were recruited via the Quebec Birth Registry using a stratified procedure based on living area and birth rate. The initial sample included *n*=2120 infants born in Quebec in 1997-1998. Our analysis sample included *n*=1073 mother-child pairs for whom data was available for MDS at 2 or more time-points from 5 months to 5 years, verbal abilities for at least one-time-point from 5 to 10 years and all covariates. At each data collection, informed written consent was obtained from all participants.

Measures. *MDS* were assessed at 5 months, 1½, 3½ and 5 years using a short version (5-12 questions) of the Center for Epidemiologic Studies Depression Scale (CES-D) (12). Responses were standardized to a score between 0 and 10. This version of the CES-D is highly correlated with the original (13). The CES-D does not provide a clinical diagnosis of depression, rather, it captures MDS. It is a valid and reliable measure of MDS assessing the occurrence and severity of symptoms during the previous week. Responses ranged between 0 (none) to 3 (all the time): all scores were significantly correlated with each other (r=0.36-0.44; $p<.0001$). A threshold of 2.67 (out of 10) was used to approximate the conventional cut-off (16/60) for elevated MDS from the original CES-D (12, 14, 15). We created a single variable for MDS with four categories of interest including mothers who: (1) never met criteria for elevated MDS (‘no exposure’; 63.8%, n=684), (2) met criteria for 'early exposure' (at either 5 months and/or 1½ years; 18.1%, n=194), (3) met criteria for 'late exposure' (at either 3½ and/or 5 years; 16.8%, n=181), and (4) mothers who met criteria for chronic exposure (at 5 months, 1½, 3½ and 5 years; 1.3%, n=14).

Verbal abilities were assessed at ages 5, 6 and 10 years using the Peabody Picture Vocabulary Test-Revised (PPVT-R) (16); the child was presented with pictures and had to identify the picture that matched the word read out by the interviewer . Test scores were age-corrected and used in linear regression models. Preliminary analyses showed that the pattern of associations between the exposure and outcome was largely similar across ages. Longitudinal research shows that development of verbal abilities in young children remains relatively stable over time (17, 18). PPVT-R scores at ages 5, 6, and 10 were strongly correlated with each other (r=0.54-0.64; $p<.0001$), therefore, outcomes between 5 and 10 years were combined into a single mean score (n=480 had a PPVT-R score at all 3 ages, n=380 had at least 2 and n=213 had at least 1 score). Tests were administered in either French (19) or English, therefore we controlled for the language of test administration in analyses. To facilitate interpretation, our global verbal abilities score was converted to a standardized score (mean=100, SD=15).

Maternal education, verbal IQ, maternal language spoken at home (dichotomized as English and/or French and/or another language or neither French nor English), age at birth of target child (dichotomized as ≤21 years or <21 years) (20), and birth order of target child were assessed at baseline and considered as potential controls (21, 22). To isolate the role of MDS in children's verbal abilities, we controlled for two main types of maternal psychopathology symptoms that may co-occur with MDS. General, trait-like maternal anxiety was assessed when the target child was 4½ years using validated items inspired by DSM-IV criteria (23). Antisocial behavior in adolescence was assessed by asking mothers whether they had exhibited five different conduct problems (24). The scale ranged from 0 to 5. Mother-child interactions at baseline were assessed by an observer using the Home Observation Measurement of the Environment (25). Maternal parenting practices and family functioning at baseline were self-

reported using the Parental Cognitions and Conduct toward the Infant Scale (26) and the family dysfunction scale (27), respectively. Socio-economic status (SES) of the family at baseline was derived from five variables including maternal education (years of schooling), spouse's education and occupational status, maternal occupational status and household income. The final SES composite was standardized for all families. Tables 1 to 7 in the appendix present an exhaustive list of all items used. Further information on the questionnaires and methods of data collection can be found online at (http://www.jesuisjeserai.stat.gouv.qc.ca).

***Statistical Analyses*.** Data analyses included 3 steps: 1) first, we selected control variables on the basis of a) previous literature indicating an association between a given variable and/or MDS and children's verbal abilities and, b) epidemiological guidelines for modeling longitudinal data, whereby potential confounders are selected at baseline and not at subsequent time points (28, 29) and, c) bivariate association at $p<.05$ between a control variable and either MDS or verbal abilities. 2) Next, linear regression models were used to examine the association between the timing and chronicity of MDS and children's verbal abilities. 3) Finally, to adjust for attrition, we identified variables which differed significantly between the initial and analysis samples and created inverse probability weights based on these variables.

In post-hoc regression analyses we tested the association between the number of times a mother had elevated MDS and children's verbal abilities using the same covariates. We created a categorical variable with five categories of mothers who: (1) never had elevated MDS (63.8%, n=684), (2) had elevated MDS once (21.4%, n=230), (3) twice (9.2%, n=99), (4) three times (4.3%, n=46), and (5) four times (1.3%, n=14). All statistical analyses were conducted in SAS 9.4.

Results

Our analysis sample (n=1073) significantly differed from our initial cohort sample (n=2120). Mothers included in our analysis sample were less likely to: have male children (50% in analysis sample versus 57% in initial sample, χ^2=9.31, *p=0.002*), be unemployed (45% versus 55%, χ^2=22.39, *p<.0001*), not have a high school diploma (14% versus 23%, χ^2=13.50, *p=0.004*), be single parents (14% versus 22%, χ^2=35.36, *p<.0001*), report higher MDS (1.41 versus 1.68, F=14.47, *p=0.0001*), and to come from a low SES background (0.15 versus -0.19, F=22.42, *p<.0001*), compared to those in the initial cohort sample. We found the same pattern of results with and without weights calculated from these variables, therefore only the latter are reported here.

Table 1 presents descriptive statistics for the study sample. Maternal education, socioeconomic status (SES), anxiety, and youth antisocial behaviour, and family functioning significantly differed across MDS exposure groups. Mothers with elevated MDS were more likely to not have a high school diploma, to come from a low SES background, have higher scores of maternal anxiety and youth antisocial behavior, and came from more dysfunctional families. To select covariates for our regression models, we tested bivariate associations between potential confounders and our exposure and outcome variables. Only the variables significantly associated with either MDS or children's verbal abilities were entered in subsequent multivariate models. These included SES, language of PPVT-R administration, birth order of target child, maternal anxiety, antisocial behavior (youth), age at birth of target child, education, languge spoken at home, verbal IQ, and mother-child interactions, maternal parenting, and family functioning.

Associations between MDS and children's verbal abilities. Results of the regression analyses are presented in Table 2. Model 1 presents the unadjusted bivariate associations between MDS and mean combined PPVT-R scores and model 2 presents the results while adding control variables. Mean differences between the different exposure groups (early, late, chronic and no exposure) and their 95% confidence intervals are presented in Figure 1. The effect sizes of the association between MDS and covariates and children's verbal abilities are presented in Figure 2. Maternal IQ had the largest effect size (η^2=0.028), followed by whether or not the mother spoke English and/or French at home (η^2=0.009), family SES (η^2=0.007) and MDS (η^2=0.007).

MDS were associated with verbal abilities before and after adjusting for covariates. Children in the chronic exposure group had significantly lower PPVT-R scores than children in the no exposure (*Mean difference*=9.04, *[95%CI=2.28-15.80*]), early exposure (10.08, *[3.33-16.86]*), and late exposure (8.69, *[1.85-15.53]*) groups. Children in the late exposure group had lower PPVT-R scores than children in the no exposure group; however, this difference was not significant when we adjusted for covariates (0.35, *[-1.70-2.40*]). Children in the early exposure group had marginally higher mean scores than children in the no exposure group (-1.06, [*-3.15-1.04*]), but again, this difference was not significant in the adjusted model. There were no significant differences in PVVT-R scores among the early and late exposure groups.

The number of times children were exposed to elevated MDS was marginally significantly associated with children's verbal abilities in the adjusted model (*p=0.0915*). Nevertheless, children's level of verbal abilities differed according to the number of times their mothers experienced elevated MDS. Specifically, children exposed at all 4 times (i.e. chronic exposure group) had significantly lower scores than children never exposed (9.14*[2.37-15.92]),* and those exposed once (9.30[*2.49-16.11*]), twice (9.95[*2.99-16.91*]), and three times (9.35[*1.94-*

16.75]) to elevated MDS, thus supporting the results of our initial analyses. There were no significant differences between the mean PPVT-R scores of the other groups.

Discussion

The objective of this study was to model the association between the timing and chronicity of maternal depression symptoms (MDS) in early childhood (first 5 years of life) and children's long-term verbal abilities (5 to 10 years). In our population-based birth cohort (*n*=1073), 37.8% of mothers reported elevated MDS (e.g. experiencing few symptoms a lot of the time or many symptoms at least some of the time over the past week) at least once during the first 5 years of the target child's life. However, only children exposed to chronic MDS had significantly lower verbal abilities during middle childhood (ages 5 to 10 years). Specifically, children exposed chronically had lower scores than those never exposed and those exposed early or late. This association remained after controlling for a wide range of potential confounders of the MDS and receptive language skills association. Maternal verbal IQ and native language, as well as family SES, were the main predictors of children's verbal abilities, with a total effect size of (η^2=0.044). MDS had a relatively small effect size (η^2=0.007). These results illustrate that multiple family factors are involved in the long-term development of verbal abilities and points to the importance of addressing the wider psychosocial environments of families affected by MDS in interventions.

To our knowledge, this is the first study to examine whether the timing and chronicity of MDS are associated with receptive verbal skills with effects lasting into middle childhood (age 10 years). In a previous short-term study (i.e. one year), persistent MDS were associated with less optimal language development (30). However, MDS were only assessed twice and language development was measured when children were 12 months. In another study, chronic MDS were associated with executive functioning at age 6 years (31), but the association with language was not specifically investigated. Our results indicate that children most affected by MDS in the

long-term (i.e. middle childhood) are those exposed intensively over the entire early childhood period, between 5 months and 5 years. This suggests that repeated exposure to MDS across the early childhood period, but not transient exposure (i.e. only early or only late) during this period, is associated with children's verbal abilities in the long-term (up to age 10 years).

We used a cut-off of 2.67/10 on a short version of the CES-D to indicate "elevated MDS". Elevated MDS corresponds to a mother who reported experiencing 6 out of the 12 symptoms "often" (e.g. "I had trouble keeping my mind on what I was doing", "I felt lonely") or experiencing 4 symptoms "always" over the last 7 days. We found the same pattern of results using different cut-offs for elevated symptoms, suggesting that it is the repeated exposure to elevated MDS during early childhood which influences children's verbal abilities.

A number of psychosocial factors, including lack of social support, in-home violence, and use of childcare services (32-36) could explain or modify the associations between MDS and child development (22, 34). For instance, child care services moderated the association between maternal depression and children's socioemotional development in this sample (34). Here, our objective was to investigate whether earlier, later or chronic exposure to maternal depression was differentially related to verbal abilities. The identification of mediating or moderating factors should be the focus of a subsequent investigation where there is a time window between exposure and outcome allowing for mediating processes to be examined. Still, we selected control variables that could confound the association between MDS (exposure) and verbal abilities (outcome). We followed epidemiological guidelines for modeling longitudinal data when selecting these variables, whereby confounders are selected at baseline and not at subsequent time points (28, 29). Note, however, that despite the inclusion of a wide range of control variables, unmeasured psychosocial factors could still potentially explain part of the

associations between MDS and verbal abilities. Importantly, the present study does not rely on a genetically informative design and genetic liabilities underlying depression and cognitive abilities (37) could not be accounted for in this study.

Questions about the timing of effects of depressive symptoms on child development has often been framed within the context of the debate concerning "sensitive periods", that is whether there are specific periods when the occurrence of experiences has heightened importance even if the exposure is transient. However, support for sensitive periods in correlational and longitudinal studies is weak (38). Some authors suggest that the pathway between exposure to MDS and child impaired development may be a reduction in social synchrony (co-ordinated interaction between mother and child) and a reduction in the mother's ability to regulate her emotions for appropriately responding to environmental demands (39). The present results, together with previous ones showing negative impact of chronic MDS, suggest that children may be able to cope with such stressful situations for a limited period, but their self-regulation capacities may become overwhelmed if the stressor is chronic.

Strengths and Limitations

The study relies on high quality and detailed longitudinal data to examine the association between the timing and chronicity of MDS exposure during early childhood and children's verbal abilities in middle childhood. Specifically, both the exposure and outcome variables were repeatedly measured over more than 4 years, thus reducing measurement error and allowing us to test long-term associations. In addition, MDS were self-rated and children's verbal abilities were assessed via a validated task conducted by a research assistant, thereby minimising the risk of shared methods variance (40). Finally, great care was taken in the choice of covariates

included in the model in order to minimize the effects of maternal and home characteristics that could bias the association between MDS and language development.

Some limitations should be noted. First, as in most longitudinal studies, this study suffers from loss of participants. We addressed the issue of attrition by creating inverse probability weights from variables associated with attrition and comparing our results with and without these weights. Second, we identified only a small number of chronically depressed mothers (i.e. 1.3%), but larger numbers of mothers with intermittent depression (18.1% early MDS and 16.8% late MDS). The differences in these proportions could be due to the intermittent nature of depressive symptoms (41) and to variations in stressful life events and social support (42). Note, however, that mothers with chronic symptoms were significantly different from other mothers: they were more likely to not have a high school diploma and to be of a lower socioeconomic status, factors which have been previously associated with maternal depression (7, 43). Importantly, we found an association between chronic MDS and children's vocabulary while controlling for these factors. Furthermore, sensitivity analyses using inverse probability weights to adjust for attrition suggested that results reported here are robust.

Recall that this is a population-based study. Clinical assessment of depression was not available in this sample, which limits our capacity to make inference to populations with clinically significant levels of depression. However, we relied on a widely used and validated instrument for assessing maternal depression in population samples such as ours, where prevalence of clinically severe mental health problems is relatively low but prevalence of symptoms is high.

Overall, this study shows that exposure to chronic maternal depression during the first 5 years of life is a potential risk factor for lower levels of receptive language skills, and this risk

may extend up to middle childhood. Further research is needed to replicate these findings in samples with larger numbers of chronically depressed mothers in order to understand the underlying mechanisms of this association and to test the impact of prevention programs to support mothers who experience lasting depression after the birth of a child.

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Tables and Figures

Table 1. Sample characteristics according to maternal depression symptoms (MDS) exposure groups

	Exposure to Depression Symptoms				Total	p-value on
	No [a] (*n*=684 63.8%)	Early (*n*=194 18.1%)	Late (*n*=181 16.8%)	Chronic (*n*=14 1.3%)	sample (*n*=1073)	χ^2 test or ANOVA F-test
Variable [n, (%)] or [mean (SD)]						
Child Characteristics						
Sex [n, (%)]						0.945
Boys	338 (49.9)	98 (51.0)	88 (49.7)	6 (42.9)	530 (50.0)	
Girls	339 (50.1)	94 (49.0)	89 (50.3)	8 (57.1)	530 (50.0)	
Birth order [n, (%)]						0.888[b]
1	325 (47.5)	101 (52.1)	84 (46.4)	6 (42.9)	516 (48.1)	
2	258 (37.7)	70 (36.1)	69 (38.1)	6 (42.9)	403 (37.6)	
3	75 (11.0)	14 (7.2)	21 (11.6)	1 (7.1)	111 (10.3)	
4	16 (2.3)	6 (3.1)	6 (3.3)	1 (7.1)	29 (2.7)	
5	10 (1.5)	3 (1.5)	1 (0.6)	0 (0.0)	14 (1.3)	
Raw PPVT scores [mean (SD)]						
5 years	69.29 (17.3)	66.09 (19.1)	65.43 (21.0)	53.00 (20.9)	67.95 (18.4)	0.006
6 years	82.84 (14.8)	79.83 (17.7)	82.51 (15.3)	66.75 (17.9)	82.03 (15.6)	0.001
10 years	121.53 (18.9)	121.58 (18.4)	120.49 (18.4)	102.17(27.1)	121.11(19.0)	0.006
Maternal Characteristics						
Age at birth [n, (%)]						0.844
< 21 years-old	21 (3.1)	7 (3.6)	6 (3.3)	1 (7.1)	35 (3.3)	
≥ 21 years old	663 (96.9)	187 (96.4)	175 (96.7)	13 (92.9)	1038 (96.7)	
Language spoken at home [n, (%)]						0.499[b]
French and/or English	670 (97.9)	189 (97.4)	174 (96.1)	14 (100.0)	1047 (97.6)	
Neither French nor English	14 (2.1)	5 (2.6)	7 (3.9)	0 (0.0)	26 (2.4)	
Education [n, (%)]						0.000
No high school diploma	83 (12.1)	36 (18.5)	26 (14.4)	2 (14.3)	147 (13.7)	

High school diploma	161 (23.5)	54 (27.8)	48 (26.5)	6 (42.8)	269 (25.1)	
Post high school diploma	198 (29.0)	68 (35.1)	66 (36.4)	4 (28.6)	336 (31.3)	
University diploma	242 (35.4)	36 (18.6)	41 (22.7)	2 (14.3)	321 (29.9)	
Socioeconomic Status [mean (SD)]	0.27 (1.0)	-0.18 (0.8)	0.08 (0.9)	-0.25 (0.9)	0.15 (1.0)	<.0001
Verbal IQ [mean (SD)]	8.18 (1.0)	8.00 (1.0)	8.05 (1.1)	7.55 (1.5)	8.12 (1.0)	0.016
Anxiety [mean (SD)]	0.97 (1.0)	1.83 (1.4)	1.52 (1.3)	3.42 (1.9)	1.25 (1.2)	<.0001
Youth antisocial behavior [mean (SD)]	0.72 (0.9)	0.87 (0.9)	0.92 (1.0)	1.07 (1.1)	0.78 (0.9)	0.017
Family Environment Characteristics						
Mother-child interaction [mean (SD)]						
Stimulation	4.88 (2.3)	4.62 (2.3)	4.70 (2.3)	4.57 (2.8)	4.80 (2.3)	0.480
Verbalization	6.83 (1.5)	6.69 (1.5)	6.66 (1.6)	6.17 (2.1)	6.77 (1.5)	0.193
Parenting practices [mean (SD)] [c]	9.09 (1.0)	8.99 (1.1)	8.98 (0.9)	8.89 (0.5)	9.05 (1.0)	0.364
Family functioning [mean (SD)] [d]	1.33 (1.16)	2.18 (1.6)	1.66 (1.3)	3.41 (1.7)	1.57 (1.3)	<.0001

[a] "No" = mothers who did not meet the criteria for elevated depression symptoms at any time-point. "Early" = mothers who met criteria at either 5 months and/or 1½ years. "Late" = mothers who met criteria at either 3½ and/or 5 years. "Chronic" = mothers who met criteria at 5 months, 1½, 3½ and 5 years

[b] 38% and 30% of cells had expected counts less than 5 for maternal language spoken at home and birth order of target child, respectively

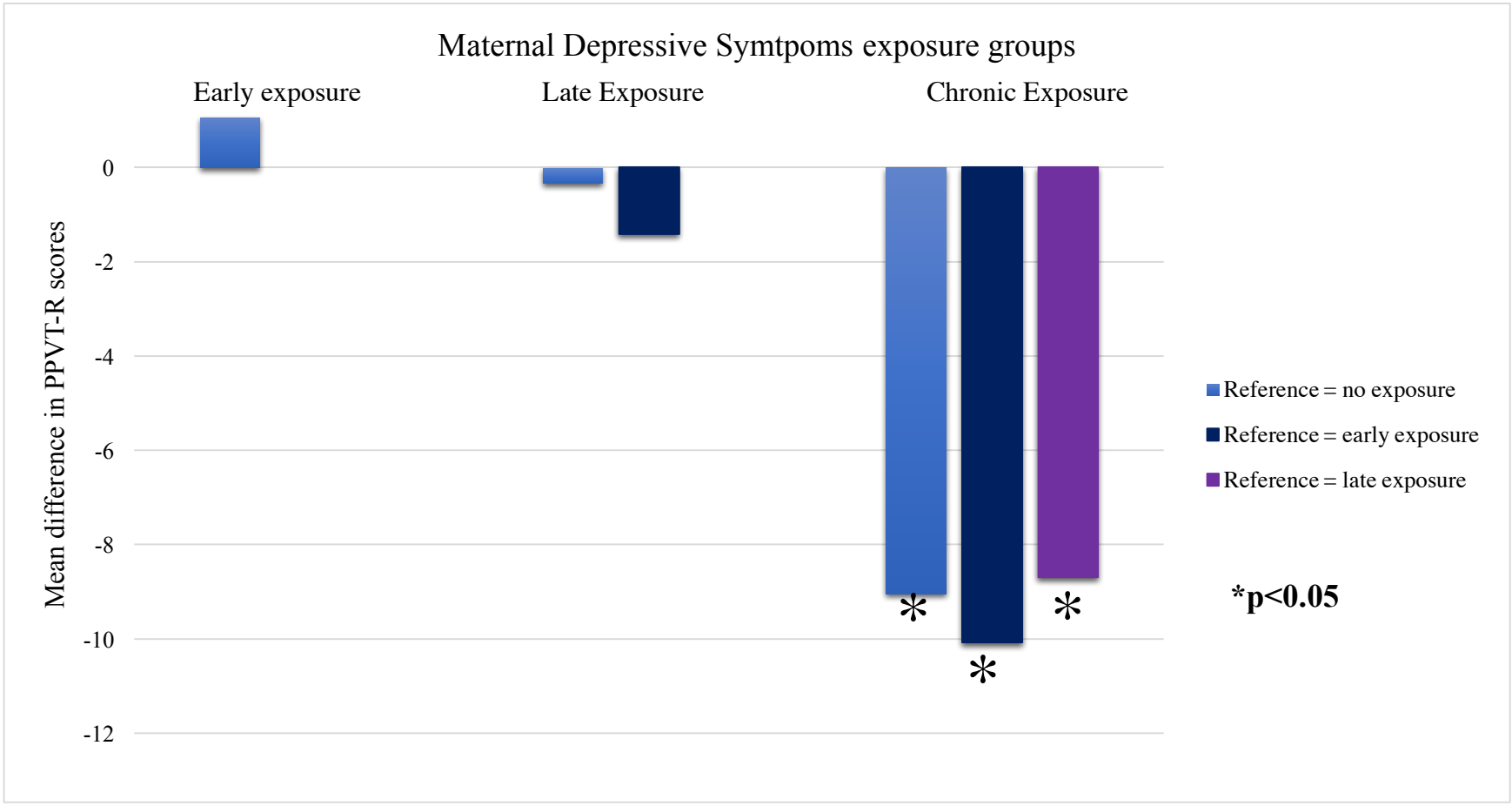
[c] Higher scores indicate increased frequency of positive parenting practices

[d] Higher scores indicate higher levels of family dysfunction

Table 2. Linear regression models of association between timing/chronicity of maternal depression symptoms (MDS) (0-5 years) and verbal abilities scores (5-10 years); n = 1073

	Model 1		Model 2	
	F	p-value	F	p-value
Step 1. Maternal Depression	**8.87**	**<.0001**	**3.01**	**0.029**
Step 2. Control Variables				
PPVT Administration Language			1.67	0.197
Maternal anxiety			2.78	0.096
Maternal antisocial behavior (youth)			2.13	0.145
Maternal age at birth of target child			0.09	0.770
Maternal education			0.78	0.392
Socioeconomic Status			**9.22**	**0.003**
Maternal verbal IQ			**35.03**	**<.0001**
Family functioning			0.57	0.451
Maternal parenting practices			2.57	0.109
Mother-child interactions (verbalization)			0.36	0.546
Mother-child interactions (stimulation)			0.35	0.552
Maternal native language			**10.79**	**0.001**
Child's birth order			**4.07**	**0.044**

Figure 1. Mean difference in child (5-10 years) verbal abilities scores across maternal depression symptoms (MDS) exposure group, adjusted for covariates; n = 1073



Legend for Figure 1

Note: Mean differences obtained from multivariate model including all covariates.

Covariates included in model: PPVT administration language. Maternal anxiety, maternal antisocial behavior (during her youth), maternal age at birth of target child, verbal IQ, education, SES; Mother-child interactions (verbalization, stimulation); maternal native language; birth order of target child; Maternal parenting practices and family functioning.

Figure 2. Effect sizes of MDS and covariates in linear regression model adjusted for covariates, n=1073