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ORIGINAL ARTICLE

The effects on children of depressed mothers' remission and relapse over 9 months

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Background. The high rate of depression among children of depressed mothers is well known. Suggestions that improvement in maternal acute depression has a positive effect on the child have emerged. However, data on the mechanisms of change have been sparse. The aim was to understand how remission and relapse in the mother might explain the changes in the child's outcome.

Method. Participants were 76 depressed mothers who entered into a medication clinical trial for depression and 135 of their eligible offspring ages 7–17 years. The mothers and children were assessed at baseline and periodically over 9 months by independent teams to understand the relationship between changes in children's symptoms and functioning and maternal remission or relapse. The main outcome measures were, for mothers, the Hamilton Depression Rating Scale (HAMD), the Social Adjustment Scale (SAS) and the Parental Bonding Instrument (PBI) and, for children, the Children's Depression Inventory (CDI), the Columbia Impairment Scale (CIS), the Multidimensional Anxiety Scale for Children (MASC) and the Children's Global Assessment Scale (CGAS).

Results. Maternal remission was associated with a decrease in the child's depressive symptoms. The mother's subsequent relapse was associated with an increase in the child's symptoms over 9 months. The effect of maternal remission on the child's improvement was partially explained by an improvement in the mother's parenting, particularly the change in the mother's ability to listen and talk to her child, but also reflected in her improvement in parental bonding. These findings could not be explained by the child's treatment.

Conclusions. A depressed mother's remission is associated with her improvement in parenting and a decrease in her child's symptoms. Her relapse is associated with an increase in her child's symptoms.

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Key words: Child depression, maternal depression, parental functioning, remission.

Background

The high rate of depression and anxiety among children of depressed mothers has implications for early intervention (Lieb *et al.* 2002; Weissman *et al.* 2006*a*; Beardslee *et al.* 2011). Depression is a complex disorder and environmental stress probably triggers episodes. Having an acutely depressed parent is a stressful experience for a child. Suggestions that improvement in maternal depression has a positive effect on the children have emerged. However, data on what changes in the relationship based on independent assessments of mothers and children have been sparse (Gunlicks & Weissman, 2008).

We have shown in the Sequenced Treatment Alternative to Depression (STAR*D) study, a large effectiveness trial designed to determine how to achieve remission for depression in adults, that remission of maternal depression after 3 months of medication treatment was significantly associated with a reduction in children's depressive symptoms (Weissman *et al.* 2006*a*). These results were sustained in the children 1 year after maternal remission (Wickramaratne *et al.* 2011). A statistically significant decrease in symptoms was seen in the children of mothers who remitted early (within the first 3 months) or late (over the 1-year follow-up), compared to the children of mothers

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who did not remit (Pilowsky *et al.* 2008). Garber *et al.* (2011) also independently showed similar relationships between depressed mothers and a reduction in their children's depressive symptoms. As STAR*D was a pragmatic trial, to mimic clinical practice there were sparse assessments of both the children and the mothers. Here we describe the 9-month results of a new study examining the relationship between maternal remission and relapse and child outcome.

Method

Children of depressed mothers participating in a randomized, double-blind clinical trial testing the effects of escitalopram, bupropion, or their combination for 12 weeks, followed by an open trial for an additional 24 weeks (total 9 months) (Stewart *et al.* 2013) were independently assessed. Adult study participants were out-patients aged 18–65 years, with non-psychotic major depressive disorder (MDD), and without a lifetime history of bipolar disorder, schizophrenia, schizo-affective disorder, or a current substance use disorder. Patients with current medical and psychiatric conditions, except those already, were included unless a medical condition contraindicated the use of the medications. Parents were considered eligible for the Child Study if they participated in the adult treatment study, had at least one child aged 7–17 years who was living at least half of the time with the treated parent, and with no developmental disability that would preclude participation. All willing eligible parents and children were enrolled. Only mothers are included in these analyses. Treatment was not provided to the children but they were not excluded if they were in treatment. Referrals were given if needed or requested. The protocol was approved by the institutional review boards and took place in New York City, USA and Ottawa, Canada.

Adult Study

The mothers' initial diagnoses were established by the Structured Clinical Interview for DSM-IV Axis I Disorders, Patient Edition (SCID-I/P; First *et al.* 2008). The severity of depressive symptoms was estimated by the 17-item Hamilton Depression Rating Scale (HAMD-17; Hamilton, 1967), ranking symptoms from 0 (not present) to 4 (extreme), or 0 to 2 for symptoms that are difficult to quantify reliably. Scores range from 0 to 50. A score of $\leqslant 7$ was considered to represent remission; $\geqslant 23$ severe (Endicott *et al.* 1981). To describe the outcome in these analyses, remission was defined as a HAMD-17 score $\leqslant 7$, and <14 for the remainder of the study; relapse as a HAMD-17 score $\geqslant 14$ after obtaining remission status (HAMD-17 $\leqslant 7$); and non-remission as a HAMD-17 score >7 for the whole duration of the study or until drop-out.

The Social Adjustment Scale – Self-Report (SAS-SR) assessed performance in work, social and leisure activities, relationships with extended family, role as a marital partner, parental role, and financial status (Weissman *et al.* 1978; Gameroff *et al.* 2012). The parenting questions involved interest in child activities, ability to talk and listen to your child, getting along with your child, and feeling affection towards your child. Answers were on a five-point scale with high scores indicating more impairment. The mother's perception of their own parenting was assessed using the Parental Bonding Instrument (PBI), a self-report measure (Parker *et al.* 1979; Murphy *et al.* 2010). The two main dimensions are care and control. Mothers who scored low on caring (12 items, e.g. 'was not affectionate', 'did not seem to understand what child needed') and high on control (13 items, e.g. 'did not want child to grow up', 'tried to control everything child did') were classified as having affectionless control. The child was independently asked the same questions from the PBI as the mother.

Child Study

The Child Study assessments were conducted by an independent team who knew that participating mothers were depressed and were participating in the adult study, but did not have access to parental depression assessments or treatment status. Parents and children were assessed at baseline within 2 weeks of the initiation of parental treatment and at 4, 8, 12, 24 and 36 weeks after baseline on all clinical measures except the PBI, which was given at baseline, 3 and 9 months only. During the clinical trial, the mothers were also assessed at weeks 1, 2, 3 and 10.

Children's psychiatric disorders were established by direct separate interviews of mothers and children using the Schedule for Affective Disorders and Schizophrenia for School-Age Children – Present and Lifetime Version (K-SADS-PL; Kaufman *et al.* 1997). Children were interviewed first. Depressive symptoms were assessed by the Children's Depression Inventory (CDI), a self-report measure for children and adolescents (Kovacs, 1992; Brotman *et al.* 2008) covering mood, hedonic capacity, vegetative signs, self-concept and interpersonal behaviors. Each item was scored as 0 (symptom is absent), 1 (mild) or 2 (definite). The Multidimensional Anxiety Scale for Children (MASC) was used to assess four domains of anxiety symptoms: physical, social, harm avoidance, and separation (panic). Children's responses are on a four-point Likert scale in answers to the question: 'How often is

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the statement true for you?' (March, 1997; March *et al.* 1997; March & Parker, 1999). Children's functioning was assessed by the Columbia Impairment Scale (CIS), resulting in an overall impairment score rated from 0 (no problem) to 4 (serious problem) (Bird *et al.* 1993). The Child Global Assessment Scale (C-GAS) is a clinician-rated overall estimate of functioning (range 0–100), with scores>90 indicating superior functioning and scores<70 indicating impaired global functioning (Shaffer *et al.* 1983). The children also completed the PBI regarding their perception of their mother's parenting. The assessment is described under the Adult Study.

All mental health treatment received by the child historically at baseline and during the 9 months from mothers in response to systematic questions was recorded. Mothers were asked if the child received treatment for a psychiatric condition or emotional problem during a specific time. Any affirmative answer was followed up with inquiries about details. Six interviewers with prior clinical experience with children and adolescents trained in the study assessments and monitored over the course of the study under the supervision of child psychiatrists (D.J.P. and M.F.F.) completed the child assessments. Full details of the training, monitoring and reliability of symptoms and diagnostic measures are described in Batten *et al.* (2012).

Data analysis

Differences in the means of continuous variables by maternal remission status for mothers' baseline characteristics were determined by using analysis of variance, and differences in the distribution of categorical variables by maternal remission status were analyzed using contingency table analysis and associated χ^2 tests or Fisher's exact tests when counts were low. Differences in children's baseline characteristics by maternal remission status were analyzed using linear mixed models for continuous variables and logistic regression analyses in the context of the generalizing estimating equations (GEE) approach (Liang & Zeger, 1986) to adjust for correlation between siblings. Baseline characteristics found to be significantly different were adjusted for in subsequent analyses.

Differential effects of remission status on child outcomes were investigated as follows. When the child outcome was a continuous variable, linear mixed effects regression models were fitted to the data with the child outcome variable as the dependent variable and maternal treatment status and time (study week) as independent variables, in addition to an interaction term representing remission status × time. Age and sex of child, along with site, were included as covariates. Correlations between repeated measures over time, and also potential non-independence of observations between siblings, were handled by including nested random effects in the model, with subjects nested within family (Singer, 1998). When child outcomes were either binary variables (child diagnoses) or count variables (child symptoms), logistic regression (for binary outcomes) and Poisson regression (for outcomes that are counts) were used in the framework of the GEE approach to determine differential effects of maternal treatment on these outcomes. Repeated measures over time and non-independence of siblings were accounted for by using an independence correlation matrix because the clusters are perfectly nested (repeated measures over time within siblings) (Berensky *et al.* 2000). Potential confounding variables were handled as described for continuous outcomes.

Associations of maternal remission status with change in the mother's depressive symptoms and functioning were analyzed using linear mixed effects regression analyses, which account for the nesting of time within person to test linear and curvilinear (quadratic) trends over time and their interaction with remission status. Missing covariate data were imputed using the multiple imputation procedure in SAS version 9.3 (SAS Institute Inc., USA) based on existing responses for all SAS-SR items to maximize available data to test for mediated moderation analysis of the significant remission effects on child outcomes.

For those child outcomes that showed statistically significant differences in trend parameters over time by maternal remission status, we investigated whether differential effects of changes in maternal functioning (as measured by the SAS-SR roles) over time could explain these differences by including maternal functioning variables as time-varying covariates in models with relevant child outcomes as dependent variables, and tested for main effects and/or interactions of maternal functioning over time by maternal remission status.

Results

Two hundred and forty-five subjects aged 18–65 years were recruited at two psychiatric out-patient clinics in New York City and Ottawa (Fig. 1). A total of 110 subjects had age-eligible children (7–17 years), and of these 175 eligible children, 168 agreed to participate. Eleven of the 93 subjects were fathers. These 11 fathers and their 23 children were excluded from this study because the aim was to study the effect of maternal remission on offspring, resulting in a total of 82 mothers and their 145 children who consented and received a baseline assessment. Six of these mothers did not receive treatment and along with their 10 children were excluded from the study, leaving a total of 76 mothers who entered the Adult Study and 135 children. Of the

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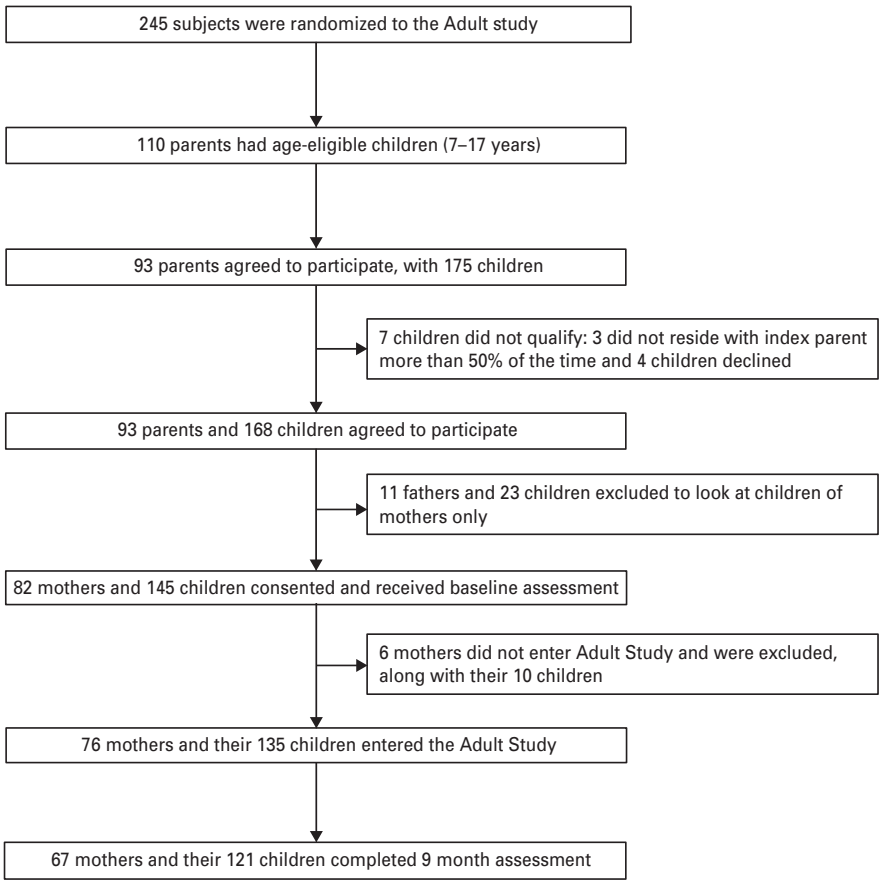

Fig. 1. Study flow chart.

82 mothers and 145 children who received baseline assessment, 67 mothers (82%) and 121 children (83%) completed the full 9-month assessments.

There were no significant differences in demographic or clinical characteristics between the 67 mothers who completed the study and the nine who dropped out; neither were there any statistically significant differences in these characteristics between 121 children who completed the study and the 14 children of mothers who dropped out (see Supplementary Table S1).

Characteristics of mothers and children

Of the mothers who received treatment, 55/76 (72.4%) met remission criteria at or before the 9-month follow-up assessment. The average time to remission was 51.2 (S.D. = 38.3) days. Of the 55 mothers who remitted, 21.8% (12/55) met criterion for a relapse during the 9 months. The remission status of the mothers who dropped out before study completion was based on the status at the time of drop-out. Table 1 summarizes the baseline characteristics of mothers and their children by maternal remission/relapse status. There were no significant differences on any of the maternal or child baseline demographic or clinical characteristics.

Maternal remission and child outcomes over 9 months

Changes in child outcomes were compared by maternal remission status (remitters, relapsers, non-remitters) while adjusting for child age, gender, site and sibling correlation (Table 2). During the 9-month follow-up, there was a statistically significant improvement in all outcomes (with the exception of diagnoses and child-reported symptoms on the K-SADS, which only showed a trend) of children of remitting mothers, as reflected in their associated β coefficients presented in Table 2. By contrast, children of relapsing mothers and children of non-remitting mothers showed no statistically significant improvements over this same period of time on any of the child outcomes. Formal tests of interaction found that there were statistically significant differences between mothers' remission status for the following outcomes: CGAS, CDI, MASC Social Anxiety and MASC Total. Pairwise comparisons for these outcomes showed that there were significant differences in children of mothers who remitted

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Table 1. *Characteristics of mothers and children by maternal 9-month depression remission status*

Characteristics	Total	Maternal 9-month remission status			Statistics[a]
		Remitter	Relapser	Non-remitter	
Mother	(*n*=76)	(*n*=43)	(*n*=12)	(*n*=21)	
Age (years), mean (S.D.)	40.6 (6.4)	40.2 (7)	42.5 (5.6)	40.4 (5.5)	0.62
Education, *n* (%)					
Some high school or less	15 (19.7)	7 (16.3)	5 (41.7)	3 (14.3)	8.26
High school graduate	18 (23.7)	14 (32.6)	1 (8.3)	3 (14.3)	
Some college	19 (25)	10 (23.3)	3 (25)	6 (28.6)	
⩾College graduate	24 (31.6)	12 (27.9)	3 (25)	9 (42.9)	
Ethnicity, *n* (%)[b]					
White	37 (48.7)	16 (37.2)	6 (50)	15 (71.4)	0.38
Other[c]	39 (51.3)	27 (62.8)	6 (50)	6 (28.6)	
Marital status, *n* (%)					
Married with spouse	33 (43.4)	19 (44.2)	6 (50)	8 (38.1)	0.46
Single/divorced/separated	43 (56.6)	24 (55.8)	6 (50)	13 (61.9)	
Employment status, *n* (%)					
Employed full-time/part-time	42 (55.3)	23 (53.5)	6 (50)	13 (61.9)	3.76
Homemaker	3 (3.9)	3 (7)	0 (0)	0 (0)	
Full-time student/unemployed	23 (30.3)	13 (30.2)	5 (41.7)	5 (23.8)	
Other	8 (10.5)	4 (9.3)	1 (8.3)	3 (14.3)	
Receiving public assistance, *n* (%)	28 (36.8)	17 (39.5)	6 (50)	5 (23.8)	3.12
Household income, *n* (%)					
<US$15 K	26 (34.2)	17 (39.5)	4 (33.3)	5 (23.8)	2.53
US$15–US39 K	12 (15.8)	6 (14)	3 (25)	3 (14.3)	
>US$40 K	35 (46.1)	18 (41.9)	5 (41.7)	12 (57.1)	
Children per family, mean (S.D.)	1.8 (0.9)	1.8 (1)	2 (1)	1.6 (0.7)	0.62
Clinical characteristics					
HAMD-17, mean (S.D.)	21.8 (4.4)	21.8 (4.6)	23 (4.4)	21 (4.1)	0.74
MDD severity (current), *n* (%)[d]					
Mild	4 (5.3)	3 (7)	0 (0)	1 (4.8)	3.29
Moderate	26 (34.2)	12 (27.9)	4 (33.3)	10 (47.6)	
Severe	46 (60.5)	28 (65.1)	8 (66.7)	10 (47.6)	
Any anxiety disorder, *n* (%)[b]	27 (35.5)	20 (46.5)	1 (8.3)	6 (28.6)	4.82
Child	(*n*=135)	(*n*=77)	(*n*=24)	(*n*=34)	
Age (years), mean (S.D.)	11.8 (3.3)	11.8 (3.3)	11.7 (3.6)	12 (3.3)	0.09
Living status, *n* (%)					
Two-parent household[e]	77 (57)	44 (57.1)	12 (50)	21 (61.8)	0.8
Mother only	58 (43)	33 (42.9)	12 (50)	13 (38.2)	
Female, *n* (%)	62 (45.9)	37 (48.1)	10 (41.7)	15 (44.1)	0.36
Education, *n* (%)					
Grade 1–6	64 (47.4)	38 (49.4)	10 (41.7)	16 (47.1)	0.44
Above 6th grade	71 (52.6)	39 (50.6)	14 (58.3)	18 (52.9)	
Ever received treatment, *n* (%)	34 (25.2)	17 (22.1)	4 (16.7)	13 (38.2)	4.39

HAMD-17, 17-item Hamilton Depression Rating Scale; MDE, major depressive episode; MDD, major depressive disorder; S.D., standard deviation.

Numbers vary due to missing data.

[a] *t* statistics for age comparisons, and χ^2 statistics or Fisher's exact test for all other comparisons.

[b] Cochran–Mantel–Haenszel test statistic reported after adjusting for site.

[c] Includes 34 Hispanics, two African Americans, one American Indian, one parent who identified as more than one race, and one unknown.

[d] Severity defined as mild (HAMD-17<14), moderate (14 ⩽ HAMD-17 ⩽21) or severe (HAMD-17 ⩾22).

[e] Includes any combination of biological, adopted, or step mother and father.

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Table 2. *Maternal remission effects on child outcomes over 9 months*[a]

	Mean at each time point[b]						Time trend	
Child outcome[c]	Baseline	1 month	2 months	3 months	6 months	9 months	*β*	*p*
CGAS								
Remitters	71.65	74.96	73.35	74.75	75.52	75.57	0.096	0.0079
Relapsers	73.79	73.30	74.17	73.46	74.63	70.13	−0.085	0.1713
Non-remitters	72.62	75.44	73.35	76.28	77.04	73.52	0.033	0.5695
Group × time								0.0391
Pairwise								
Remitters *v.* non-remitters							0.063	0.3503
Relapsers *v.* non-remitters							−0.118	0.1637
Remitters *v.* relapsers							0.181	0.0114
CDI								
Remitters	9.73	7.08	6.31	6.42	5.77	5.02	−0.097	<0.0001
Relapsers	6.30	6.55	5.92	4.83	3.87	5.33	−0.046	0.1127
Non-remitters	8.38	7.31	7.72	5.14	6.00	7.72	−0.019	0.4874
Group × time								0.0333
Pairwise								
Remitters *v.* non-remitters							−0.079	0.014
Relapsers *v.* non-remitters							−0.027	0.4902
Remitters *v.* relapsers							−0.052	0.1228
Diagnosis[d]								
Remitters	42.9	22.1	29.90	27.3	23.4	22.1	−0.017	0.0767
Relapsers	33.3	20.8	20.80	25.00	16.7	29.2	−0.006	0.6806
Non-remitters	50.00	41.2	38.20	35.3	32.4	26.5	−0.013	0.1802
Group × time								0.833
K-SADS Symptoms-Child report								
Remitters	1.58	1.14	1.42	1.36	1.10	1.01	−0.011	0.0534
Relapsers	1.17	1.40	1.43	1.38	0.79	1.92	0.007	0.27
Non-remitters	1.65	1.59	1.25	0.69	1.15	1.64	−0.002	0.8961
Group × time								0.2919
K-SADS Symptoms-Parent report								
Remitters	2.55	1.68	1.65	1.50	1.34	1.16	−0.02	<0.0001
Relapsers	2.00	1.95	1.87	1.79	1.04	1.96	−0.006	0.4001
Non-remitters	1.97	1.97	2.09	1.24	1.35	1.80	−0.007	0.4996
Group × time								0.3056
CIS								
Remitters	11.41	9.03	8.20	7.39	6.99	7.55	−0.087	0.0002
Relapsers	8.61	9.05	8.00	8.00	6.87	8.54	−0.017	0.6579
Non-remitters	12.18	10.44	10.84	8.93	9.88	11.40	−0.016	0.6672
Group × time								0.1296
MASC-Social Anxiety								
Remitters	11.32	8.97	7.54	7.37	6.37	6.97	−0.102	<0.0001
Relapsers	10.39	9.55	8.96	6.88	8.17	8.38	−0.039	0.1689
Non-remitters	9.97	9.72	9.00	6.79	7.54	8.32	−0.034	0.1947
Group × time								0.0388
Pairwise								
Remitters *v.* non-remitters							−0.067	0.0321
Relapsers *v.* non-remitters							−0.005	0.9061
Remitters *v.* relapsers							−0.062	0.0567

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Table 2 (*cont.*)

Child outcome[c]	Mean at each time point[b]						Time trend	
	Baseline	1 month	2 months	3 months	6 months	9 months	β	p
MASC-Separation/Panic								
Remitters	8.89	7.59	6.65	7.14	6.04	6.47	−0.055	<0.0001
Relapsers	7.61	8.60	7.63	7.25	8.70	7.08	−0.005	0.8146
Non-remitters	8.06	7.97	8.03	6.69	6.77	7.32	−0.024	0.2453
Group × time								0.1074
MASC-Physical Symptoms								
Remitters	9.77	7.49	6.49	6.57	5.86	6.89	−0.059	0.0012
Relapsers	5.78	6.90	5.71	5.21	4.91	5.88	−0.011	0.7308
Non-remitters	9.00	6.84	7.03	6.45	7.31	8.48	−0.005	0.8555
Group × time								0.1732
MASC-Total								
Remitters	48.08	41.07	36.90	37.63	33.73	36.21	−0.262	<0.0001
Relapsers	40.70	41.80	37.17	34.17	35.61	36.17	−0.11	0.1204
Non-remitters	44.97	41.97	39.88	36.59	38.54	40.24	−0.097	0.1451
Group × time								0.0456
Pairwise								
Remitters *v.* non-remitters							−0.164	0.0359
Relapsers *v.* non-remitters							−0.013	0.8929
Remitters *v.* relapsers							−0.151	0.0647

CGAS, Children's Global Assessment Scale; CDI, Children's Depression Inventory; K-SADS, Schedule for Affective Disorders and Schizophrenia for School-Age Children; CIS, Columbia Impairment Scale; MASC, Multidimensional Anxiety Scale for Children.

[a] All models were controlled for child age, gender, site and within-family correlation.

[b] Seventy-seven children of 43 remitters, 24 children of 12 relapsers, 34 children of 21 non-remitters.

[c] There was a trend or statistically significant decrease over time in all child outcomes among children of remitting mothers.

[d] Rates of diagnosis are displayed because diagnosis is a dichotomous outcome.

compared to children of non-remitting mothers on improvement in CDI, MASC Social Anxiety score and MASC Total score; significant differences in children of remitters *versus* children of relapsers in rate of change in CGAS; and a trend for differences in rates of improvement for children of remitting mothers compared to children of relapsing mothers for MASC Social Anxiety and MASC Total scores.

Relationship between maternal remission and maternal functioning over 9 months

There were significant differences in the rate of change in maternal functioning (as measured by the SAS-SR) by maternal remission status in all domains (Table 3 *a*). However, the patterns of differences varied by domain. Although there was a statistically significant improvement in time for overall functioning in all categories, the rate of improvement was significantly better in mothers who remitted than in those who relapsed or did not remit. Similar patterns were observed for the family and social and leisure roles, although for these domains the rate of improvement for non-remitting mothers was only at trend level. In the roles of work and finance, only remitting mothers showed significant improvement.

Maternal functioning showed significant improvement for each individual item and the total score only in remitted mothers. No significant improvement over time was observed on any of these items for mothers who relapsed or those who did not remit. Figure 2 shows graphically the overall parental functioning by maternal remission studies. Rates of change in parenting as measured by the PBI mother's report (Table 3 *b*) showed statistically significant differences on the overprotection measure by maternal remission status, with remitting mothers reporting a significant improvement on the overprotection measure over time, and non-remitting mothers showing a trend for improvement. There was no significant improvement reported by relapsing mothers. PBI child reports on overprotection showed similar patterns although

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Table 3. *Maternal remission effect on (a) maternal outcomes and (b) parental bonding outcomes over 9 months*

Outcome	*n*	Baseline	Time trend		Change over time
			β	*p*	
(*a*) Maternal outcomes[a,b,c]					
SAS-SR Total					
Remitters	43	2.73	−0.029	<0.0001	−1
Relapsers	12	2.86	−0.009	0.0278	−0.32
Non-remitters	20	2.75	−0.01	0.0367	−0.36
Group × time		*F*=12.13	df=2, 266	<0.0001	
SAS-SR Work					
Remitters	19	2.32	−0.026	0.0002	−0.94
Relapsers	5	3.03	0.033	0.0298	1.19
Non-remitters	11	3.38	−0.011	0.535	−0.4
Group × time		*F*=6.43	df=2, 107	0.0023	
SAS-SR Family					
Remitters	41	2.98	−0.039	<0.0001	−1.4
Relapsers	10	2.92	−0.017	0.0274	−0.61
Non-remitters	17	2.88	−0.014	0.0955	−0.5
Group × time		*F*=6.33	df=2, 235	0.0021	
SAS-SR Social and Leisure					
Remitters	43	3.22	−0.036	<0.0001	−1.3
Relapsers	12	3.27	−0.014	0.0229	−0.5
Non-remitters	20	3.27	−0.012	0.0907	−0.43
Group × time		*F*=8.1	df=2, 266	0.0004	
SAS-SR Finance					
Remitters	42	2.71	−0.025	<0.0001	−0.9
Relapsers	10	2.40	−0.006	0.5764	−0.22
Non-remitters	20	2.25	0.005	0.6521	0.18
Group × time		*F*=3.59	df=2, 258	0.0289	
SAS-SR Parental Functioning					
Remitters	35	2.30	−0.022	<0.0001	−0.79
Relapsers	8	2.00	0.001	0.8379	0.04
Non-remitters	17	2.04	−0.002	0.8023	−0.07
Group × time		*F*=8.09	df=2, 218	0.0004	
SAS-SR Parental Functioning Item no. 1: Interest in child's activities					
Remitters	35	2.31	−0.024	<0.0001	−0.86
Relapsers	8	2.38	−0.006	0.509	−0.22
Non-remitters	17	2.12	0	0.9714	0
Group × time		*F*=3.1	df=2, 215	0.0468	
SAS–SR Parental Functioning Item no. 2: Able to talk to and listen to child					
Remitters	35	2.51	−0.034	<0.0001	−1.22
Relapsers	8	2.25	−0.003	0.6769	−0.11
Non-remitters	17	1.94	−0.008	0.3927	−0.29
Group × time		*F*=7.63	df=2, 215	0.0006	
SAS-SR Parental Functioning Item no. 3: Getting along with child					
Remitters	34	2.56	−0.018	0.0002	−0.65
Relapsers	8	1.88	0.013	0.1248	0.47
Non-remitters	17	2.53	−0.006	0.5271	−0.22
Group × time		*F*=5.25	df=2, 215	0.006	
SAS-SR Parental Functioning Item no. 4: Feeling affection towards child					
Remitters	34	1.88	−0.014	0.0003	−0.5
Relapsers	8	1.5	0.002	0.7325	0.07
Non-remitters	17	1.59	0.005	0.5289	0.18
Group × time		*F*=3.9	df=2, 217	0.0217	

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Table 3 (*cont.*)

Outcome	*n*	Baseline	Time trend		Change over time
			β	*p*	
(*b*) Parental bonding outcomes[d,e]					
PBI-Care (children's report)					
Remitters	68	28.12	0.003	0.8661	0.11
Relapsers	24	28.20	0.014	0.667	0.5
Non-remitters	34	28.50	0.006	0.8315	0.22
Group × time		F=0.04	df=2, 105	0.9635	
PBI-Overprotection (children's report)					
Remitters	68	15.18	−0.055	0.01	−1.98
Relapsers	24	15.17	−0.017	0.6084	−0.61
Non-remitters	34	15.56	−0.103	0.0015	−3.71
Group × time		F=1.8	df=2, 105	0.1708	
PBI-Affectionless Control (children's report)					
Remitters	68	25%	−0.008	0.2565	−7.4%
Relapsers	24	16.7%	0.014	0.3798	8.3%
Non-remitters	34	26.5%	−0.012	0.5005	−11.8%
Group × time		χ^2=1.19	df=2	0.5523	
PBI-Care (mother's report)					
Remitters	66	28.29	0.038	0.0738	1.37
Relapsers	23	28.30	−0.021	0.5359	−0.76
Non-remitters	34	29.15	−0.018	0.5731	−0.65
Group × time		F=1.68	df=2, 103	0.192	
PBI-Overprotection (mother's report)					
Remitters	66	15.89	−0.092	<0.0001	−3.31
Relapsers	23	17.17	0.004	0.8929	0.14
Non-remitters	34	13.86	−0.05	0.0969	−1.8
Group × time		F=3.39	df=2, 103	0.0374	
PBI-Affectionless Control (mother's report)[d]					
Remitters	66	18.2%	−0.015	0.5062	−7.6%
Relapsers	23	17.4%	0.039	0.1314	+21.7%
Non-remitters	34	20.6%	−0.009	0.4724	−8.8%
Group × time		χ^2=2.68	df=2	0.2624	

SAS-SR, Social Adjustment Scale Self-Report; PBI, Parental Bonding Instrument; df, degrees of freedom.

[a] Models involving SAS-SR were adjusted for site. A negative *β* over time suggests improvement.

[b] Forty-three remitters, 12 relapsers, 21 non-remitters.

[c] There was a trend or statistically significant decrease over time in all outcomes among remitting mothers.

[d] Models involving the PBI were adjusted for child age, gender, site and within-family correlation. A negative *β* over time suggests improvement, except for PBI-Care.

[e] Seventy-seven children of 43 remitters, 24 children of 12 relapsers, 34 children of 21 non-remitters.

formal tests of interaction did not reach the level of statistical significance.

Relationships between maternal functioning/bonding and the effect of maternal remission status on child symptoms

Table 4 shows the results of the analyses to determine whether changes in maternal social functioning or bonding over time explained the observed effect of maternal remission status on the child. The change in SAS-SR Total score partially explained the effects of maternal remission status for the child's MASC Social and MASC Total scores; for these scores, there were significant differences in linear change slopes between children of remitting mothers and children of non-remitting mothers only. Therefore, we focused our analysis on this pairwise comparison. The significant differential change over time in MASC Social and MASC Total scores by maternal remission status was

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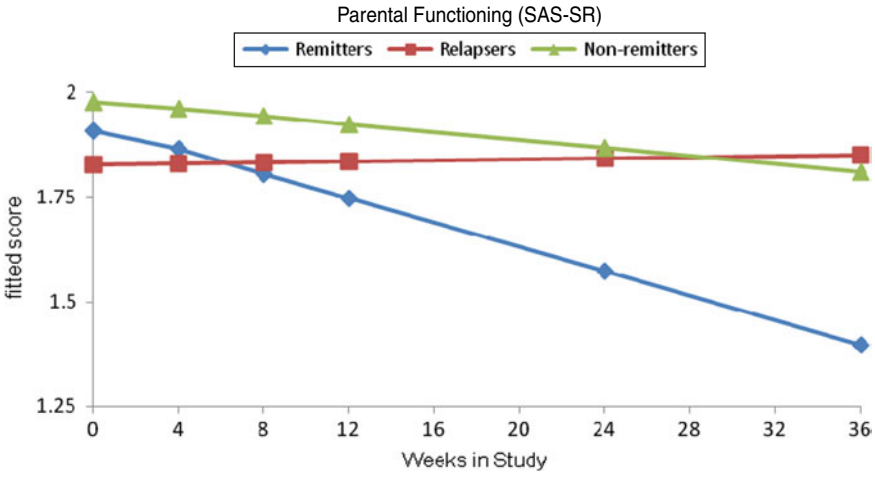

Fig. 2. The individual β values over time by remission status indicate that remitting mothers ($\beta=-0.015$, $t=-4.03$, $p=0.0003$) improved the most, followed by non-remitting ($\beta=-0.005$, $t=-0.89$, $p=0.3802$) and relapsing mothers ($\beta=0.001$, $t=0.11$, $p=0.9112$). Pairwise comparisons show significant differences between remitting and relapsing mothers ($\beta=-0.015$, $t=-2.30$, $p=0.0217$), and no significant differences between remitting and non-remitting mothers ($\beta=-0.010$, $t=-1.62$, $p=0.1114$) and between relapsing and non-remitting mothers ($\beta=0.005$, $t=0.71$, $p=0.4761$). (Lower score=less impairment.)

decreased with the inclusion of SAS-SR Total score (as a time-dependent covariate). In addition, the SAS-SR Total score was found to be a predictor of child's MASC Social and MASC Total scores. Further investigation revealed that change in the SAS-SR Parental Functioning score also partially explained the effects of maternal remission status on MASC Social and Total scores in a similar manner.

The differential effects of parental functioning item no. 2 (i.e. 'able to listen to and talk to my child') by maternal remission status partially explained the effect of maternal remission status on change over time in the child's CDI scores, along with MASC Social and MASC Total scores. Similar to the MASC Social and MASC Total scores, for CDI scores there were also significant differences in linear change slopes between children of remitting mothers and children of non-remitting mothers only. As a result we focused our analysis on this pairwise comparison. The statistically significant interaction between change in CDI score over time and maternal remission status (denoted by the p value corresponding to the two-way interaction term week × remission status; $\beta=-0.08$, $p=0.0213$) decreased with the inclusion of the main effect of the average parental functioning item no. 2 and its interaction with maternal remission status ($\beta=-0.06$, $p=0.0952$). In addition, the interaction between average parental functioning and maternal remission status was statistically significant, implying that the association between parental functioning scores and child CDI symptoms varied with maternal remission status ($p=0.038$). For MASC Social and MASC Total scores, the significant differential change in these scores over time by maternal remission status was decreased by the inclusion of parental functioning item no. 2 as a time-dependent covariate. In addition, parental functioning was found to be a predictor of MASC Social and MASC Total scores (Table 4).

We also found that mother's report of overprotection (assessed by the PBI) showed similar results to the parental functioning item no. 2, with the relationship between the PBI overprotection score and MASC Social score partially explaining the effects of maternal remission status (lower portion of Table 4), although these findings were not as strong as that seen for the SAS-SR parenting item no. 2, probably because the PBI assessments were made at fewer time points than the SAS-SR. Furthermore, the PBI has been shown to be stable over time and not strongly affected by current symptoms (Murphy *et al.* 2010).

Treatment received by children over 9 months

We looked at treatment received by the children over the 9 months to see if it might explain the differential effects of mother's remission status. There was no difference in the number of children receiving some mental health treatment by mother's final remission status either at baseline (remission: 22.4%; relapse: 16.7%; no remission: 38.2%) or during the course of the 9 months (19.7, 16.7 and 26.5% respectively). Two children were hospitalized over the 9 months, one child a remitter and one of a non-remitter.

Discussion

The increased rate of depression in offspring of depressed mothers is one of the best replicated findings

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Table 4. *Maternal parental functioning and bonding and child outcomes*

	Unadjusted model		Adjusted model	
	β	*p* value	*β*	*p* value
SAS-SR Total				
MASC-Social				
Week × remission status	−0.07	0.0316	−0.05	0.0921
Parental functioning			0.73	0.0208
MASC-Total				
Week × remission status	−0.17	0.0356	−0.13	0.1098
Parental functioning			1.94	0.0292
Parental Functioning Total				
MASC-Social				
Week × remission status	−0.07	0.0316	−0.05	0.0954
Parental functioning			0.88	0.0011
MASC-Total				
Week × remission status	−0.17	0.0356	−0.13	0.1071
Parental functioning			2.17	0.0017
Parental Functioning Item no. 2				
CDI				
Week × remission status	−0.08	0.0213	−0.06	0.0952
Parental functioning			−0.30	0.4616
Parental functioning × remission status			0.96	0.038
MASC-Social				
Week × remission status	−0.07	0.0316	−0.05	0.128
Parental functioning			0.65	0.0028
MASC-Total				
Week × remission status	−0.17	0.0356	−0.13	0.1199
Parental functioning			1.40	0.0115
PBI-Overprotection (*mother's report*)				
MASC-Social				
Week × remission status	−0.06	0.0998	−0.05	0.1268
PBI-Overprotection			0.11	0.0617

SAS-SR, Social Adjustment Scale Self-Report; MASC, Multidimensional Anxiety Scale for Children; CDI, Children's Depression Inventory; PBI, Parental Bonding Instrument.

[a]Added parental functioning/bonding.

All analyses were controlled for child-centered age and gender, site and within-family correlation. All models were restricted to remitters and non-remitters.

in psychiatry. This study, along with several others with different design, clearly shows the relationship between the mother's acute depressive symptoms and the child's current clinical status (Gunlicks & Weissman, 2008). Our study adds to the findings by showing that maternal remission is associated with an improvement in children's depressive symptoms whereas maternal relapse after remission is associated with an increase in children's symptoms. The effect of maternal remission status on the child is partially explained by the mother's perceived improvement in parenting. Of interest, not all other domains of maternal social functioning improved at the same rates. These findings on maternal remission and child's improvement at 9 months are similar to our STAR*D findings at 1 year in that we found a continuing decrease in the child's symptoms over time (Pilowsky *et al.* 2008). We also found that most of the maternal remission occurred within the first 3 months after initiation of treatment. In STAR*D, the benefit for children was greater when mothers remitted early; however, children of late remitting mothers also experienced a statistically significant decrease in symptoms. In the current study, we could not compare early to late remitters as the majority of remitting mothers remitted before 3 months.

Our findings are also similar to those reported by Garber *et al.* (2009), who showed that improvement

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in parents' depressive symptoms predicted changes in children's depressive symptoms over 2 years. Of note, the findings in children in the Garber study were on the same symptom measures (CDI) as this study, and were also partially explained by improvements in parenting behavior. In the Garber study the measure of parental behavior was supportiveness and acceptance of the child. Neither the STAR*D study nor the Garber study examined the effect of parental relapse. However, Garber *et al.* (2009) showed that subsequent increases in parental depression were associated with similar changes in offspring. Finally, a randomized clinical treatment study of adolescents at risk for depression because of a previous history of depression found treatment less effective in preventing onset of their illness in the adolescents, if a parent was currently depressed when the adolescent's treatment began (Garber *et al.* 2009; Beardslee *et al.* 2013).

Limitations

There are limitations to this study. The data are observational. Treatment assignment was randomized for the first 3 months but not between 3 and 9 months, so that we cannot draw any conclusions about the effects of treatment. Inherent in the observational design is potential selection bias or hidden confounds. The sample of children when divided by mother's remission status is small. We did not have direct observation of mother/child interactions. Future studies may benefit from their inclusion. Finally, we did not assess maternal personality disorders, which may have affected outcome.

Clinical implications

Strong linkages between maternal depression and youth symptoms highlight the potential clinical benefits of coordinating the mental health care of parents and their children (Weissman & Olfson, 2009). Recent efforts to develop targeted personalized treatment with biomarkers may help the speed of parental clinical remission. Directly targeting parental skills might also accelerate the impact of maternal remission on children, as has been suggested for parents with alcohol problems (Lam *et al.* 2008). Outcomes for depressed adults, especially if they are parents, also need to be broadened from clinical symptoms and remission to include social and parental functioning to understand and monitor the effects of maternal depression on the children (De Silvia *et al.* 2013). How to recruit and maintain depressed mothers into any treatment for themselves, especially if they are poor, will require better access and novel methods of delivery through primary and collaborative care as the US health care system evolves (Simon *et al.* 2009).

Supplementary material

For supplementary material accompanying this paper visit http://dx.doi.org/10.1017/S003329171400021X.

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