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An exploratory study of the relationship between mother–infant interaction and maternal cognitive function in mothers with mental illness

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Abstract *There is evidence for a deleterious effect of maternal mental illness on mother–infant interaction. Presence of mental illness and lowered maternal cognitive function independently predict quality of interaction, but their combined effect on interaction is unclear. A pilot study was conducted to explore the relationship between maternal serious mental illness (SMI), cognitive function, and mother–infant interaction. Six mothers with SMI (two with schizophrenia and four with depression) and 12 mothers with no psychiatric history were recruited, together with their infants (all aged between 5 and 18 weeks). Mother–infant*

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interaction was assessed using the Crittenden Care Index. The Cognitive Drug Research computerised assessment battery provided measures of memory and attention. In support of previous literature, mothers with SMI were significantly less sensitive during interactions with their infants. They also demonstrated impairment relative to controls on an index of speed of memory processing. A hierarchical regression model revealed that presence of maternal mental illness was a significant predictor of maternal sensitivity, but when speed of memory processing was accounted for, the strength of this relationship was reduced, suggesting that the relationship between maternal mental illness and mother–infant interaction may be partially mediated by level of cognitive function. Further study is warranted.

Introduction

The impact of maternal mental illness on the quality of mother–infant interaction has received considerable attention. Studies of mothers diagnosed with depression or schizophrenia have found important differences in the quality of interaction, compared to mothers with no psychiatric history (Cohn *et al.*, 1990; Murray *et al.*, 1996; Riordan *et al.*, 1999). Given the importance of early mother–infant interaction for many aspects of infant development (Tronick, 1989), any impediment to this process could have significant consequences. However, the mechanisms underlying poorer quality of mother–infant interaction in mothers with mental illness are not well understood (Riordan *et al.*, 1999). These mechanisms may include factors such as severity of symptoms, medication, the mother's own attachment relationship with her mother, and other life stressors (Murray *et al.*, 1996; Riordan *et al.*, 1999; Ward & Carlson, 1995). Another potential influence on the quality of mother–infant interaction is maternal cognitive function. Impairment in a number of domains of cognitive function has been demonstrated in individuals diagnosed with mental illnesses (e.g. Addington *et al.*, 2005; Fossati *et al.*, 1999). It is, therefore, of interest to consider whether poorer quality of mother–infant interaction in mothers with mental illness is partly explained by cognitive deficit, but to our knowledge, this has not previously been investigated.

Early mother–infant interaction is important for infant social, cognitive and emotional development (e.g. Murray *et al.*, 1996; Tronick, 1989), and for the formation of a secure attachment (Belsky & Isabella, 1988). Experimental disruption of mother–infant interaction has revealed that infants are sensitive to both the timing and quality of the maternal response (Murray, 1986). When mothers are instructed not to respond, their infants display initial protest behaviour, including frowning and lip biting, followed by withdrawal (Murray, 1986). Longer-term exposure to disrupted interactions may impact upon the infant's development, as they are thought to respond by developing a self-directed style of interacting, relying on self-regulatory behaviours such as thumb-sucking to regulate their internal state. This may interfere with their interactions with their environment, hindering cognitive and social development (Tronick, 1989, Weinberg & Tronick, 1998).

Mothers with schizophrenia have been shown to be less affectionate and responsive compared to controls (Goodman & Brumley, 1990; Riordan *et al.*, 1999). The consequences of this are avoidance by the infant of maternal advances (Riordan *et al.*, 1999), and poorer quality of intellectual function and social behaviour in later childhood (Goodman & Brumley, 1990). Mothers with depression also display less positive affect when interacting with their infants (Cohn *et al.*, 1990). They are

reportedly less sensitive to their infant's cues compared to non-depressed mothers, and express fewer affirmations and more negations of their infant's behaviours (Murray *et al.*, 1996). Poorer interactional synchrony (Field *et al.*, 1990) and a reduction in the turn-taking behaviour typically present in mother–infant interactions have also been demonstrated in cases where the mother has depression (Cohn *et al.*, 1986). Maternal depression also affects the attachment relationship between mother and child, increasing the likelihood of insecure attachment development (Goldberg, 2000). Disrupted maternal communication may be one mechanism through which this occurs (Lyons-Ruth, 2003). Mothers with depression whose infants display disorganised attachment are more likely to display contradictory communications or inappropriate responses to infant cues (Lyons-Ruth *et al.*, 1999). The frequency of such disrupted parental communications has been shown to be significantly related to infant disorganised attachment (Lyons-Ruth, 2003).

Schizophrenia and depression are associated with a variety of cognitive impairments, particularly in the domains of memory, attention and executive functioning (Addington *et al.*, 2005; Bozikas *et al.*, 2005; Egeland *et al.*, 2000; Fossati et al., 1999; Harvey *et al.*, 2004; Keefe *et al.*, 2004; Manoach *et al.*, 2005; Nathaniel-James *et al.*, 1996; Porter *et al.*, 2003). Similar deficits have been demonstrated in both disorders (e.g. Egeland *et al.*, 2003, Fossati *et al.*, 1999, Moritz *et al.*, 2002), although some studies have found differences between them on measures of selective attention (Egeland *et al.*, 2003), and the patterning of executive impairments (Fossati *et al.*, 1999). Despite evidence of differences in the neurocognitive profiles associated with schizophrenia and depression, there is precedence for combining different diagnoses in research samples (e.g. Riordan *et al.*, 1999; Weinberg & Tronick, 1998).

Such cognitive deficit may constrain social functioning in schizophrenia (Kuperberg & Heckers, 2000), manifesting as poorer performance on daily living tasks (Dickerson *et al.*, 1999), and social problem-solving skills (Addington & Addington, 1999). Similarly, interacting with one's infant may rely on the mother's cognitive skills, such as her ability to sustain attention and appropriately pace interaction based on her infant's response. In support of this hypothesis, studies have shown that mothers with intellectual disabilities are less affectionate, responsive, accommodating and contingently reinforcing in their interactions with their infants, when compared to non-intellectually disabled mothers (Feldman *et al.*, 1989). In summary, reduced cognitive capacity and abnormal mother–infant interaction are both features described in mothers with intellectual disabilities, and this gives reason to predict that mother–infant interaction in mothers with mental illness, who themselves are vulnerable to cognitive deficit, may partially depend on the level of maternal cognitive function.

The aims of this study were twofold. The first was to replicate previous research by demonstrating significant differences in the quality of mother–infant interaction in mothers diagnosed with a serious mental illness (SMI), compared to a control group. It was also hypothesised that mothers with SMI would demonstrate lowered cognitive function compared to the control group. The second aim was to extend the current literature by examining the relationship between maternal mental illness, maternal cognitive function and the quality of mother–infant interaction.

Method

Data were collected as part of a wider study conducted by a Perinatal Mental Health Service in Southampton, UK. All mother–infant dyads were seen for one assessment in

their own home. Approval was granted by the Southampton Local Research Ethics Committee.

Participants

Only those mothers considered well enough to give informed consent were approached; a member of the clinical team who knew the mother well made this decision. On this basis, 14 mothers with SMI were identified, one was later considered too unwell to be approached, one was discharged, and one could not be contacted. Eleven mothers were subsequently approached; four declined to participate, one agreed to participate and then could not be contacted. The remaining six mothers consented to being included in the study. All mothers had received a primary diagnosis of either schizophrenia ($n=2$), or a depressive disorder (mild, moderate or severe depressive episode, recurrent depressive disorder or major depression: $n=4$) according to ICD-10 criteria (World Health Organisation, 1992). Current symptoms were assessed by the mother's key worker using the Brief Psychiatric Rating Scale (BPRS)—Expanded (Lukoff *et al.*, 1986). The median BPRS total score was 35.5, with a range of 30–55, representing mild–moderate level of current symptoms. All mothers were taking medication prescribed for their mental illness at the time of the study: three were prescribed Imipramine (a tricyclic anti-depressant), one was prescribed fluoxetine (a selective serotonin reuptake inhibitor), and one olanzapine (an atypical anti-psychotic). One mother was prescribed lithium, sodium valproate (anti-mania medications), and lorazepam (an anxiolytic). Mothers were not excluded from the sample for the presence of other mental health problems (for example, social anxiety), as high levels of co-morbidity are a feature of this client group. However, women were excluded for the following reasons: history of head injury or learning disability, primary diagnosis of personality disorder, significant alcohol or drug use likely to impair cognitive functioning, current eating disorder, or history of electro-convulsive therapy treatment. All mothers were currently living with the father of the index infant. None of the mothers reported experiencing any periods of separation from their infants, and this was confirmed by a review of recent hospital records. Two of the six mothers had been admitted to a psychiatric unit together with their infant, one was an inpatient at the time of data collection and one had been discharged. Three of the six mothers had never been admitted to a psychiatric hospital. Previous hospitalisations were not known for one mother. One infant was born three weeks prematurely; the others were full-term pregnancies. None of the mothers or infants had experienced significant medical problems or pregnancy or birth complications.

Twelve mothers were recruited for the control group, two for each participant in the SMI group. They were recruited through the National Childbirth Trust[1] (NCT) ($n=6$), or through colleagues and acquaintances ($n=6$). None was well known to the researcher. Mothers were selected according to infant age, to ensure that they were comparable with the age of the infants of mothers in the SMI group. All mothers were married or co-habiting with their infant's father. Mothers in the control group were screened for the presence of current mental health symptoms using the Psychosis Screening Questionnaire (PSQ; Bebbington & Nayani, 1995) and the Edinburgh Postnatal Depression Scale (EPDS; Cox, Holden, & Sagovsky, 1987). All participants screened negative for psychosis and scored below the clinical threshold of 12 on the EPDS (median 2.5, range 0–8). They were also asked about previous psychiatric support. Nine mothers had received no such support, two mothers had received

counselling more than five years previously (one for bereavement, one for university-related stress), and one mother experienced occasional panic attacks during pregnancy for which she had not sought treatment and which had ceased at the time of the study. None of the mothers had experienced any periods of separation from their infant since birth.

Socio-demographic information for both groups can be found in Table 1. Exploratory analyses showed that there were no significant differences between the two groups on any of these variables (all $p>0.1$).

Measures

Crittenden Care Index (Crittenden, 2004). The CARE index is based on attachment theory (Crittenden, 2001) and is proposed to evaluate adult–infant patterns of interaction. It provides an assessment of the specific relationship or dyad, rather than the individual (Crittenden, 2004). Infants were placed in a bouncy chair or similar, and the mother sat opposite. A mirror was positioned adjacent to the infant to reflect the mother's facial expressions, and the video camera was positioned behind the mother, facing the infant and the mirror. For 5 min, mothers were asked to play with their infant in their usual way and were permitted to use toys if they wished. This procedure has been used in other mother–infant interaction studies (e.g. Murray *et al.*, 1996). Data were coded off-line by a trained assessor who was blind to the mental health status of the mothers. The assessor had undergone an intensive training course using the CARE Index to rate video-taped play sessions between mothers and infants aged 0–15 months. Following the course, the assessor achieved inter-rater reliability of 0.75 or above on at least 4 of the 7 variables, a level considered high enough for the use of the CARE Index for clinical and research purposes. In addition, 4 (22%) randomly selected, video-taped sessions were rated by a second assessor who had also achieved reliability in the use of the CARE Index for clinical and research purposes. Inter-rater reliability was assessed using the single measure intra-class correlation coefficient (ICC), using a two-way mixed model and the absolute agreement definition. The ICC for Maternal Sensitivity was 0.81, Maternal Unresponsiveness 0.87, Maternal Control 0.85, Infant Cooperative 0.57, Infant Compulsive 0.96, Infant Difficult 0.99 and Infant Passive 0.98.

Mothers and infants were rated on seven aspects of interactional behaviour: facial expression, verbal expression, position and body contact, affection, turn-taking, control

Table 1. *Socio-demographic information for the two groups.*

	Control (n=12)	SMI (n=6)
Infant age (weeks) [a]	11.5 (5–17.5)	10.5 (7–12)
Infant gender [b]	67% male (n=8)	83% male (n=5)
Maternal age (years) [a]	34 (25–40)	34 (29–39)
Maternal educational level (PSI) [b]	50% level 5	33% level 5
	25% level 4	0% level 4
	25 % level 2/3	67% level 2/3
Baby order [b]	50% first baby (n =6)	83% first baby (n =5)

Notes. [a] Median and range reported, Mann–Whitney test performed. [b] χ^2 test (Fisher's Exact). Educational level (taken from the Parenting Stress Index: PSI): 5=achieved post-graduate qualification, 4=obtained undergraduate degree, 3=attended college or university, 2=completed compulsory education.

and choice of activity (Crittenden, 2004). These ratings contributed to three adult scales: 'Sensitive', 'Controlling' and 'Unresponsive', and four infant scales: 'Cooperative', 'Difficult', 'Compulsive' and 'Passive'. Maternal Sensitivity is the central construct around which the index is organised, and is defined as 'any pattern of behaviour that pleases the infant and increases the infant's comfort and attentiveness and reduces its distress and disengagement' (Crittenden, 2004, p. 3). For mothers with low sensitivity scores, the Controlling and Unresponsive scales characterise the manner of their insensitivity. Similarly, for infants with low scores on the Cooperative scale, the remaining infant scales (Infant Compulsive, Infant Difficult, and Infant Passive) indicate the nature of this behaviour. The CARE index has been validated for use with families from different social classes and cultural backgrounds (Leventhal *et al.*, 2004). The infant version was used in this study, which is appropriate from birth to 15 months (Crittenden, 2004).

Parenting Stress Index (adapted with permission from Abidin, 1995). The Parenting Stress Index (PSI) is a self-report questionnaire designed for use with parents of children aged between 1 month and 12 years, yielding measures of sources of stress within the parent–child system. The full PSI consists of 120 items, which contribute to seven 'Parental Domains' and six 'Child Domains', with an additional Life Stress scale. The majority of items are scored on a 5-point scale, ranging from 'strongly agree' to 'strongly disagree', with 10 items scored using multiple-choice questions. The life stress questions are answered 'yes' or 'no'. For each subscale, higher scores indicate more stress. The PSI has adequate internal consistency, test–retest reliability, and concurrent, construct, predictive and discriminant validity (Abidin, 1995). It has been validated for use across samples varying in ethnicity and socioeconomic status (Hutcheson & Black, 1995). Given that the full PSI is lengthy, the following subscales were selected as being of most interest either to the present study, or to the additional research conducted by the Perinatal Service (adapted with permission from the publishers): the child subscales of 'Reinforces Parent', 'Mood', and 'Demandingness' were administered, together with the parental subscales of 'Competence', 'Role Restriction' and 'Attachment'. The Life Stress scale was also included.

The Cognitive Drug Research (CDR) Computerised Assessment System (Simpson, Surman, Wesnes, & Wilcock, 1991). The CDR computerised assessment system was used to assess multiple domains of cognitive function, and was administered after the video-taped play session in all cases. Tasks were presented on a laptop computer and participants responded using a two-button response box marked YES and NO. The battery took approximately 40 min to complete, and comprised the following subtests in order of presentation: word recall, simple reaction time, digit vigilance, choice reaction time, rapid visual information processing, spatial working memory, numeric working memory, delayed word recall, word recognition, picture recognition and visual analogue scales of mood. Variables from the subtests were combined into composite scores representing five domains of cognitive function, using formulae derived from a previous factor analysis of the CDR system (Wesnes *et al.*, 2000): Power of Attention; Continuity of Attention; Quality of Episodic Memory; Quality of Working Memory; and Speed of Memory. The CDR battery has been used in numerous studies, has been shown to be sensitive to cognitive impairment (Scholey & Kennedy, 2004), and has

been validated against alternative assessments of cognitive functioning (e.g. Simpson *et al.*, 1991).

Data analysis

Non-parametric tests for two-independent samples (Mann–Whitney) were used to test for group differences, with the significance level set at $p<0.05$, and trends approaching significance ($p<0.09$) reported. The second hypothesis was tested with an hierarchical regression model. This allowed for the determination of the proportion of variance in mother–infant interaction associated with presence or absence of SMI, and the extent to which this relationship was mediated by level of cognitive function.

Results

Group differences

The median and range for each measure is indicated in Table 2.[2] Significant group differences were found for measures of mother–infant interaction, perceived maternal competence, and cognitive function.

Table 2. *CARE index, Parenting Stress Index, and the Cognitive Factor Scores by participant group.*

	Control ($n=12$)	SMI ($n=6$)	Group difference
CARE Index			
Maternal Sensitivity	8.5 (3–13)	5 (4–9)	$P=0.041$
Maternal Control	4 (1–11)	7.5 (4–9)	ns
Maternal Unresponsiveness	0.5 (0–5)	1.5 (0–5)	ns
Infant Cooperative	7.5 (3–13)	3 (3–8)	$P=0.018$
Infant Compulsive	0 (0–7)	1 (0–4)	ns
Infant Difficult	2 (0–7)	4 (2–5)	ns
Infant Passive	3 (0–6)	3.5 (1–8)	ns
Parenting Stress Index			
Parent- Competence	24.5 (16–28)	32.5 (22–59)	$P=0.013$
Parent- Attachment	12 (9–17)	13.5 (8–21)	ns
Parent- Role restriction	18.5 (14–28)	21.5 (8–29)	ns
Life stress	7.5 (4–31)	18 (4–29)	ns
Infant- Reinforces parent	11 (6–15)	11.5(6–21)	ns
Infant- Demandingness	17(14–25)	17(10–27)	ns
Infant- Mood	10.5(5–14)	9.5 (7–19)	ns
Cognitive Measures			
Power of Attention	1153.1 (1058.4– 1353.7)	1163.8 (1047.7– 1954.2)	ns
Continuity of Attention	92.5 (90– 95)	92.5 (89–94)	ns
Quality of Working Memory	1.9 (1.7– 2.0)	1.9 (1.2– 1.9)	ns
Quality of Episodic Memory	233.3 (171.7– 283.3)	200.8 (158.3– 238.3)	ns
Speed of Memory	3304 (2953–3682.5)	4145 (3180.5– 4643.3)	$P=0.018$

Note. For the CARE Index scales, a higher score indicates higher frequency or intensity of observations of behaviours indicative of that style. For the Parenting Stress Index, higher scores indicate poorer ratings. For the Cognitive Factors, higher scores indicate better performance, with the exception of Power of Attention and Speed of Memory, where higher scores equate to poorer performance. Median and range of scores are reported, and Mann–Whitney tests were used to determine the statistical significance of group differences.

(i) Mother–infant interaction and perceived maternal competence. Significant group differences were found for the Maternal Sensitivity scale, and the Infant Cooperative scale. Examination of the median scores indicates that mothers with mental illness were rated as significantly less sensitive, and their infants were rated as significantly less cooperative. Consistent with this finding, there was a significant difference between the groups on self-reported Parental Competence, indicating that the mothers with mental illness also perceived themselves as significantly less competent than the control group. Further inspection of the CARE index scores for the mothers with SMI revealed higher Controlling scores (median=7.5) compared to Unresponsive scores (median=2), suggesting that mothers were rated as less sensitive because they were being controlling. Only one mother received a higher Unresponsive score (5) compared to her Controlling score (4). For the infants, the picture was more variable. Two infants received their highest scores on the Passive scale (8, 8), two received their highest scores for Difficult (5, 5), one for Compulsive (4), and one for Cooperative.

(ii) Cognitive function. The groups were comparable on all measures of cognitive functioning, except for Speed of Memory processing, where higher scores are indicative of poorer performance in the mothers with SMI.

The relationship between mother–infant interaction and cognitive function

Investigation was limited to those measures of mother–infant interaction and cognitive function that were found significantly to differentiate between the two groups at the univariate level, namely Maternal Sensitivity and Speed of Memory. Maternal Sensitivity was chosen over 'Infant Cooperative' and PSI Parental Competence because adult sensitivity is the central construct within the CARE index (Crittenden, 2004), and of primary interest in this study. Additionally, there is precedence for using only this scale from the CARE index (Leventhal *et al.*, 2004). Measures of maternal sensitivity have been included in many studies, with poorer maternal sensitivity repeatedly demonstrated in mothers with depression (Cohn *et al.*, 1990, Murray *et al.*, 1996) and with schizophrenia (Goodman & Brumley, 1990; Riordan *et al.*, 1999). Finally, the high levels of co-linearity between Maternal Sensitivity and Infant Cooperative, r (18)=0.96, make inclusion of the latter in the regression model inappropriate. The PSI parental competence measure was not included in this analysis because the focus of this study was the relationship between maternal mental illness, maternal cognitive functioning and the quality of mother–infant interaction, rather than perceived parental competence.

In accordance with guidelines published by Baron and Kenney (1986), for Speed of Memory to act as a mediator of mental illness, three criteria must be met: (i) both the mediator (Speed of Memory) and the predictor (presence/absence of SMI) must be related to the dependent variable (maternal sensitivity); (ii) there must be a relationship between the predictor (presence of SMI) and the mediator (Speed of Memory); (iii) after controlling for the effects of the mediator variable (Speed of Memory), the relationship between mental illness and maternal sensitivity should be significantly reduced, while the relationship between the mediator (Speed of Memory) and the dependent variable (maternal sensitivity) remains significant. As revealed in Table 3, Spearman's Rho correlations (one-tailed) confirmed the first two of these criteria, indicating that reduced maternal sensitivity was associated with presence of SMI, and

Table 3. *Spearman's Rho correlations between the three variables of interest.*

r_s	Presence of SMI	Maternal Sensitivity
Presence of SMI	–	–
Maternal Sensitivity	−0.49†	–
Speed of Memory	0.57‡	−0.57‡

† $p<0.05$, ‡ $p<0.01$.

with higher Speed of Memory scores (indicative of poorer performance). Speed of Memory was also significantly slower in mothers with SMI.

A hierarchical multiple regression analysis was performed to indicate the proportion of variance in maternal sensitivity associated with presence of SMI, and the proportion additionally associated with level of Speed of Memory function. Multiple regression assumes multivariate normality of all variables (a criterion met by Maternal Sensitivity and Speed of Memory), and usually requires larger samples. However, multiple regression is also a relatively robust method and as such its exploratory use with small samples is warranted. Howell (1992) has recommended that it can be used if the residuals are normally distributed. Assessment of the standardised and unstandardised residuals for the regression analysis showed that this requirement was also met (cf. Frost *et al.*, 2001). The dependent variable was Maternal Sensitivity. Predictor variables were entered in the following order: Model 1. Group – control (1) vs. SMI (2); Model 2. Group, Speed of Memory score (higher scores indicate poorer performance) (Table 4).

Both Model 1, $F(1, 17)=4.93$, $p=0.041$, and Model 2, $F(2, 17)=3.75$, $p=0.048$ were significant. Group was a significant independent predictor of maternal sensitivity, accounting for 23.5% of the variance. Group, together with Speed of Memory accounted for 33.3% of the variance in maternal sensitivity, but the additional contribution of Speed of Memory (R^2 change, 9.8%) did not significantly increase the sensitivity of the model as a whole. The inclusion of this variable in the model reduced the significance of the relationship between maternal sensitivity and presence/absence of mental illness suggesting that the relationship between group and maternal sensitivity may be mediated by level of Speed of Memory function. However, in this model the association between speed of memory function itself and maternal sensitivity no longer reached statistical significance, $\beta=-0.45$, $p=0.159$ (Table 4). Visual inspection of the data of the severity of the women's illness, as measured by the BPRS, showed that it was the women with higher BPRS scores (more severe symptoms), irrespective of diagnosis, who had higher scores on the Speed of Memory function (poorer performance) and lower scores on maternal sensitivity (poorer

Table 4. *Hierarchical regression of predictors of maternal sensitivity.*

Model	*B*	SE B	β	*p*	R^2	R^2 change	*F* change
1.Group	−2.750	1.239	−0.485	0.041	0.235	0.235	4.92
2.Group	−0.959	1.699	−0.169	0.581			
Speed of Memory	−0.003	0.002	−0.445	0.159	0.333	0.098	2.20

performance). This suggests that cognitive impairment may be present in women with more severe mental illness, and that, as hypothesised, this factor may exert some influence on the relationship between presence/absence of SMI and reduced maternal sensitivity.

Discussion

This small, pilot study provides support for previous research (Cohn *et al.*, 1990; Murray *et al.*, 1996; Riordan *et al.*, 1999) by demonstrating that mothers with SMI obtain significantly lower ratings of maternal sensitivity, when compared with mothers without mental illness. Low maternal sensitivity appeared to result from a more controlling style of interaction. Infant behaviours were varied. Two infants received their highest scores on the Passive scale, two on the Difficult scale, and one on the Compulsive scale, with one infant receiving the highest score on the Cooperative scale. Cognitive deficit was also demonstrated in the domain of memory processing speed. These findings are in accordance with the literature which has demonstrated reduced cognitive function in individuals with SMI (e.g. Addington *et al.*, 2005; Porter *et al.*, 2003). Additional inspection of the data indicated that mothers with more severe symptoms, irrespective of diagnosis, demonstrated poorer cognitive performance and lower scores on maternal sensitivity. This is also consistent with research associating more severe symptomatology with poorer cognitive functioning (e.g. Porter *et al.*, 2003) and with more impaired maternal interaction with her infant (Lyons-Ruth, Zoll, Connell, & Grunebaum, 1986. The present pilot study offers an important extension to this literature by demonstrating, for the first time, that the relationship between presence of SMI and poorer quality of mother–infant interaction may be partially mediated by level of cognitive function, although this requires verification. If confirmed, this represents a potential alternative perspective to our understanding of mother–infant interaction in mothers with SMI, and may provide a basis for the development of intervention strategies.

Supporting previous findings (Cohn *et al.*, 1990; Murray *et al.*, 1996; Riordan *et al.*, 1999), the presence of maternal mental illness was found to be a significant predictor of maternal sensitivity, accounting for over a fifth of the variance. The inclusion of memory processing speed in the model weakened the association between maternal sensitivity and maternal mental illness. Further examination of these data showed a relationship between severity of maternal mental illness and mother–infant interaction that may be at least partially mediated by level of cognitive function. Impairments in processing speed may mean that mothers respond more slowly to their infants, disrupting synchronicity and contingent reinforcement. Murray (1986) demonstrated this by using a video procedure similar to that used in the present study, but the mother's responses to her infant's behaviours were relayed to the infant via a life-size video screen, with a 30 s delay. The infants seemed confused by this disruption of the synchronicity typically present in mother–infant interactions, and displayed protest behaviours such as grimacing and lip biting. Poorer interactional synchrony (Field *et al.*, 1990) and higher levels of negation of the infant's behaviour, including discordant responses (Murray *et al.*, 1996) have been demonstrated in mothers with depression, as have lower levels of turn-taking behaviour and poorer mutual responsiveness (Cohn *et al.*, 1986). Lyons-Ruth (2003) has demonstrated that the frequency of disrupted parental affective communications with their infant is associated with disorganised infant attachment.

Tronick (1989) argued that infants respond to such poorly coordinated interactions by developing a self-directed style of interacting, relying on self-regulatory behaviours such as thumb sucking to regulate their emotional state. This behaviour may reflect the infants' attempts to manage the distress they experience in response to poorly coordinated interactions with their mother, and may also represent a less cooperative interactional style. This could explain why infants of mothers in the SMI group were rated as significantly less cooperative than infants of mothers in the control group. This less cooperative, self-directed style may make it more difficult for mothers to interact with their infants in a sensitive manner, and a cycle of worsening mother–infant interaction potentially could develop. It would be of interest to apply the protocol of Murray (1986) to infants of mothers with SMI, but such an intervention may not be ethically justified in infants already vulnerable to a lower quality of maternal interaction.

The finding that mothers with SMI performed significantly poorer than controls on speed of memory processing is consistent with previous research demonstrating impaired processing speed in patients with depression and in patients with schizophrenia (Egeland *et al.*, 2003). However, in view of previous research (Addington *et al.*, 2005; Egeland *et al.*, 2003; Porter *et al.*, 2003), it is somewhat surprising that no evidence was found of other cognitive impairments in these mothers with SMI. There are a number of possible explanations. Firstly, not all patients experience significant cognitive impairments (Kuperberg & Heckers, 2000). Several studies demonstrating impairments in patients with mental illness have also demonstrated comparable performance of patients and controls on some tasks, including measures of memory and executive function (Fossati *et al.*, 1999; Nathaniel-James *et al.*, 1996). Additionally, the small sample size may have limited the study's power accurately to detect group differences. Based on an alpha of 0.5, power of 0.80, and a ratio of control to patient participants of 2:1, for significant group differences on the other CDR measures, we would have needed the following numbers of patient:control participants: Power of Attention, 48:96; Continuity of Attention, 202:404; Quality of Working Memory (transformed), 18:36; and Quality of Episodic Memory, 11:22. Thus, Working and Episodic Memory differences may have been found with larger samples and would certainly be interesting additions to the regression model in future studies. Finally, although a more detailed measure-by-measure analysis, rather than using the five composite scores may have revealed more trends, this would have significantly increase the likelihood of Type 1 error and would not have addressed the issue of statistical power. Moreover, there is precedence for the five-factor method in the CDR (Scholey & Kennedy, 2004; Wesnes *et al.*, 2000).

It is of interest that mothers in the SMI group rated themselves as less competent than mothers in the control group. This suggests that mothers were aware of their lack of sensitivity in the mother–infant interaction task. However, the extent to which self-reports of competence reflect actual competence is uncertain. Self-report measures are influenced by the mother's emotional and cognitive state (Melhuish, Gambles, & Kumar, 1988). Mothers in the SMI group may have lacked confidence in their parenting ability, or interpreted their parenting with the negative cognitive bias typically associated with depression (Beck, 1976). Frankel and Harmon (1996) found that mothers with depression made significantly more negative evaluations about their parenting ability compared to mothers in a control group, although their interactions and attachment relationships with their children were unimpaired. This suggests that

mothers with SMI may view themselves as less competent than they really are. The potential impact of this belief was not considered in this study although, according to the principles of self-efficacy theory (Bandura, 1977), an individual's behaviour is strongly influenced by their belief in their ability to perform that behaviour. Mothers who believe that they are not very competent may behave in a less competent manner. This has received some support from Teti and Gelfand (1991) who found that the poorer the mother's sense of self-efficacy regarding her maternal role, the poorer her interactions with her infant.

The finding that level of cognitive function may influence the relationship between presence of SMI and poorer quality mother–infant interaction is novel and, thus, the basis for this conclusion requires consideration. This was a pilot study conducted with a small sample; however, significant results were obtained, suggesting sufficient statistical power. Although power to find a group difference in Maternal Sensitivity was moderate (for alpha 0.05, ratio of control to patient participants 2:1, power=0.63), the difference in Speed of Memory was certainly adequately powered (power=0.94). Recruiting mothers with mental illness—particularly in the early post-partum period—proved difficult; an issue reflected in the small sample sizes of similar studies (e.g. Riordan *et al.*, 1999). Another possible limitation of the present study is the inclusion of participants with differing diagnoses, but this has also been a feature of other studies (e.g. Weinberg & Tronick, 1998). Heterogeneity of patient samples has been criticised (e.g. Porter *et al.*, 2003), but may be justified in difficult-to-recruit samples; the influence of different mental illnesses may be examined in subsequent studies, once a general effect is highlighted. Moreover, there are documented similarities between these patient groups with respect to pattern of cognitive function, suggesting that any mediation may hold across diagnoses; studies have demonstrated impairment in executive functioning, attention and memory in both patients with schizophrenia (Addington *et al.*, 2005; Nathaniel-James *et al.*, 1996; Wang *et al.*, 2005) and depression (Harvey *et al.*, 2004; Porter *et al.*, 2003). Finally, as in other studies (for example, Bozikas *et al.*, 2005; Harvey *et al.*, 2004) this pilot study did not consider the possible influence of psychotropic medications on cognitive functioning. Tricyclic antidepressants may impair cognitive and psychomotor function (Lane & O'Hanlon, 1999), antipsychotic medications may cause psychomotor slowing (Palmer & Heaton, 2000) and impair reaction times (Blyler & Gold, 2000), and newer anti-psychotic medications can cause fatigue (Gothelf *et al.*, 2003). In contrast, some medications are regarded as potentially cognitive enhancing, including selective serotonin re-uptake inhibitors (SSRIs) (Rose, Simonotto, Spencer, & Ebmeier, 2006), and newer anti-psychotic medications (Harvey *et al.*, 2004). Impairment due to general psychomotor slowing may be expected to affect all reaction time scores, but in these mothers with SMI the deficit was restricted to the speed of response on the memory tasks. Future research should address this potential confound.

A further recommendation for future studies would be the collection of additional information regarding the mothers. For example, indicators of socio-economic status may be informative, e.g. family income. The degree to which such factors influence mother–infant interaction in the presence of significant maternal mental illness is not clear. Of greater relevance may be the recording of further information concerning the course of the maternal mental illness, such as the number of depressive episodes and number of hospitalisations. Poorer cognitive functioning has been associated with recurrent rather than single episode depression (Basso & Bornstein, 1999), and

hospitalisation is associated with higher levels of depressive symptomatology which, in turn, may be associated with maternal interactional behaviours, for example affect expression (Lyons-Ruth *et al.*, 1986).

Despite these important limitations, our study is of potential relevance to professionals working with mothers with SMI, suggesting that maternal level of cognitive functioning should be considered when mother–infant interaction is being evaluated. If replicated, our findings may serve to extend understanding of the nature of mother–infant interaction in mothers diagnosed with SMI, and perhaps pave the way towards the further development of intervention strategies designed to improve the quality of mother–infant interactions, promoting greater self-efficacy in mothers and protecting vulnerable infants.

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Notes

1. The National Childbirth Trust (NCT) is a UK charity for pregnancy, childbirth, and parenting, offering information, advice and support to parents and families. Their services include mother and baby groups, antenatal and postnatal courses, advice, support and counselling, and training for health professionals.
2. A number of the measures violated normality assumptions (Shapiro–Wilk). On the Care Index, these were Maternal Unresponsiveness, and the Infant measures: Co-operativeness, Compulsiveness and Difficult. On the CDR, these were Power of Attention and Quality of Working Memory. Transformation was only effective for Quality of Working Memory. As a result, non parametric measures of central tendency and group comparisons are presented in Table 2.

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