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Preliminary evidence for neural responsiveness to infants in mothers with schizophrenia and the implications for healthy parenting

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ABSTRACT

Schizophrenia is a severe mental illness that may significantly affect maternal sensitive behaviour. Neural correlates of maternal behaviour represent a potentially valuable means of differentiating objectively between healthy mothers expressing variations in maternal sensitivity. As mothers with schizophrenia (MWS) show deficits in behavioural responses to infants compared to healthy mothers, we explored whether maternal brain responses to infant stimuli would be significantly reduced in MWS. We also examined whether differences in maternal behaviour between healthy and ill mothers (during play interactions with own infant) were associated with differences in brain activation to infant stimuli.

We found no evidence of differential 'maternal brain' responses or 'maternal behavioural' responses in 11 new MWS compared to 20 healthy new mums; neither were neural responses to infants linked to behavioural or cognitive aspects of the mother's relationship with her infant in MWS. These preliminary findings suggest maternal sensitivity differences between MWS and healthy mothers, suggested in previous studies, may be reversible in stable treated MWS.

1. Introduction

Improvements in the care of women with serious mental illness (SMI) and the widespread introduction of second generation antipsychotics (SGAs) since the mid 1990's mean that more women with schizophrenia are becoming mothers (Abel, 2013). However, the parenting outcomes for mothers with schizophrenia (MWS) remain poor (Abel et al., 2016). In a small, prospective cohort of 100 mothers admitted to a mother and baby joint inpatient unit (MBU) in the UK, over half had lost their infant to care services within the first year (Kumar et al., 1995). A decade later, half of 1500 mothers admitted to UK MBUs were discharged with social service interventions (Abel et al., 2005).

Clinicians and MBU staff suggest that adverse parenting outcomes in new mothers with schizophrenia are related to the potential risks they pose to their children (Abel et al., 2005). Observational studies also suggest that mothers with schizophrenia interact less sensitively and responsively towards their infant compared to mothers with other SMI (Wan et al., 2007, 2008a) and that mothers with schizophrenia with more pronounced negative symptoms received poorer mother-infant interaction ratings by staff (Snellen et al., 1999). For their part, seriously ill mothers report feeling stigma from clinical staff that they are not "good enough" as parents (Edwards and Timmons, 2005) and women have long been known to fear removal of their child by social care services (Park et al., 2006). Consistent with this, antenatal and MBU workers report that such stigma sometimes leads to negative preconceptions about women's parenting abilities which may, in turn, influence a woman's chances of positive parental outcomes (Gillham and Wittkowski, 2015; Salmon et al., 2003). Higher perceived risk may also mean that clinical staff are particularly vigilant when mothers have a schizophrenia diagnosis and are, perhaps, "looking to find fault" (Healy et al., 2015; Ranning et al., 2015). Such potential biases suggest/implicate a pressing need for more objective and standardised measures in the clinical assessment of maternal caregiving. Two recent but uncontrolled studies describe significant improvements in mother-infant interaction between admission and discharge in MBU mothers who had received video-guided parent training. However, participants were not randomised and there was no control group in this open-label, before and after designed trial (Kenny et al., 2013; Pawlby et al., 2010).

Over the last decade, we and others have accumulated evidence for the use of functional MRI (see Swain et al., 2014 for review) to describe

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the neural correlates of maternal care behaviour in healthy new mothers. Here, for the first time, we extend this approach to new mothers with schizophrenia making use of our established, more ecologically valid fMRI methodology. This uses videos of infants (as opposed to static images) in order to examine how new mothers respond to their infants (Elmadih et al., 2016; Ranote et al., 2004; Wan et al., 2014).

In the same way that neuronal markers have been exploited successfully to predict response to treatment in depression (Elliott et al., 2011), neural correlates of maternal behaviour present valuable potential biomarkers for monitoring the effects of interventions in mothers with insensitive caregiving, with or without SMI. The original premise of the methodology adopted in the current study was based on the knowledge that in behavioural studies (offline) mothers with schizophrenia show reduced responses to infants/own infants (Wan et al., 2007, 2008a). In fMRI studies, healthy mothers show a distinct difference in neural responses to own vs unknown infant cues (Elmadih et al., 2016). The neural activation in the contrast between own and unknown infant in these mothers (healthy mothers), is thought in part to derive from the ability of healthy mothers to distinguish greater or lesser salience of cues i.e. the cues from their own infant would be appraised as having greater salience than those of an unknown infant. It has been observed that people with schizophrenia have relative difficulty in recognising and processing sensory cues, perhaps particularly those with potential emotional imperative/content (Javitt, 2009). We therefore hypothesised that schizophrenia mothers, as compared to healthy mothers, would show impaired response to own vs unknown infant cues, as this is related to reduced processing of emotional salience.

Our hypothesis was that in new mothers with schizophrenia, compared to healthy mothers, maternal brain responses to own versus unknown infant stimuli would be significantly reduced. Specifically, we anticipated that mothers with schizophrenia would show relative deficits in activation in the following brain areas: dopaminergic reward areas of the frontal cortex; basal ganglia and periaqueductal grey; emotional processing limbic areas, anterior cingulate cortex (ACC) and the amygdala; areas implicated in oxytocin secretion within the hypothalamus; and areas for facial recognition within the fusiform cortex. We also wish to understand whether maternal sensitivity differences between healthy and ill mothers during play interactions were associated with differences in brain activation to infant stimuli which we have reported in healthy mothers expressing variations in maternal sensitivity (Elmadih et al., 2016). As with our corresponding study in healthy mothers (Wan et al., 2014), this study also considered mothers' perceived warmth from their infant in an attempt to capture the mother's emotional "bond" or, conversely, potential difficulties in early mother-infant bonding.

2. Methods

The study was approved by the National Health Service North West Multi-Site Research Ethics Committee (ref: 05/MRE08/69). Sessions were conducted at participants' homes and the Wellcome Trust Clinical Research Facility (WTCRF), Central Manchester University Hospital NHS Foundation Trust.

2.1. Participants

Thirty-one mothers (mean age = 31.5, S.D. = 6.25) of infants aged 3 to 10 months were recruited from the north west of England. Twenty were healthy mothers recruited through local advertising; 11 were mothers with a clinical diagnosis of schizophrenia (MWS) (ICD-10/F20) (ICD-10, 1992). MWS were recruited from either a MBU in Manchester during admission or at discharge, or from antenatal clinics in Manchester or Liverpool. MWS and control women were well matched for educational level, ethnicity and infant age (Table 1).

At the time of participation, all mothers were clinically well, having mild or no symptoms, so that they could provide informed consent to participate in a procedure requiring multiple visits with their infant to the Clinical Research Facility. At the time of scanning, 4 of the MWS were inpatients and 7 were outpatients who had recently been discharged from the MBU. The lack of current symptomatology was reflected in the low mean Positive and Negative Syndrome Scale (PANSS) total score = 47.10, range = 32–73, SD = 14.93. Five mothers reported no current positive symptoms. On average, mothers had been separated from their infants for 2.10 days (SD = 3.96) since birth; 2 mothers had been separated for longer, but for relatively brief periods: 9 days, and 10 days. Participants' demographics are shown in Table 1.

2.2. Procedure

All participants were invited to attend on two occasions. During the first visit, two video clips of their infant were recorded either at home or in the Clinical Research Facility (as the mother preferred). The first video recording lasted between 6 and 10 min and was used to evaluate sensitive responsiveness of the mother in free play with her infant on a floor mat. A mother was asked to play with her infant as she normally would. A standard small set of toys were provided but the instruction was for the mother to use them as she wished and at her own discretion. The second video lasted 5–10 min and was recorded to generate the fMRI stimuli; it was edited down to a 2-minute clip of the infant's head and shoulders in a fairly neutral facial expression used in the scanning visit. The researcher also collected background information on the mother (e.g. age, marital status) using a simple demographic questionnaire; mothers completed the Edinburgh Postnatal Depression Scale (EPDS) (Cox et al., 1987) and the Mothers' Object Relations Scale-Short Form (MORS-SF; Davies et al., 2008). This questionnaire measures two factors, "Warmth" and "Invasiveness", on a 7 item Likert scale

Table 1
Participant demographics for healthy mothers and mothers with schizophrenia (MWS).

	Healthy mothers (n = 20)		Mothers with schizophrenia[a] (n = 11)		F-value
	Mean [SD]	Range	Mean [SD]	Range	
Maternal age (years)	32 [6.84]	20–43	31 [5.40]	21–41	0.12
Infant age (months)	6.20 [1.64]	4–10	6.90 [2.07]	3–9	0.75
EPDS score	5.85 [3.82]	0–14	7.80 [7.48]	0–22	0.91
	Frequency		Frequency		$\chi 2$
Current psychiatric medication	0 (0%)		11 (100%)		31.0**
Ethnicity					0.03
European white	14 (70%)		8 (73%)		
Asian/black/mixed	6 (30%)		3 (27%)		
Highest qualification					0.33
High school (GCSE) or below	7 (35%)		5 (50%)		
Degree or above	13 (65%)		6 (50%)		
Living with partner	19 (95%)		6 (55%)		5.88*
Occupation					3.0
Professional/managerial	5 (25%)		1 (10%)		
Others	15 (75%)		9 (90%)		
Parity					0.27
Primiparous	12 (60%)		5 (50%)		
Multiparous	8 (40%)		5 (50%)		
% Infant female	7 (35%)		5 (50%)		1.11
Breastfeeding	15 (75%)		2 (20%)		12.13**

[a] Missing data for 1 mother with schizophrenia for the occupation, breastfeeding, parity and infant gender.
* $p < 0.05$.
** $p < 0.01$.

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