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Mismatch Negativity, Social Cognition, and Functioning in Schizophrenia Patients

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Abstract

Background—Cognition and social cognition have been found to influence functional outcome in schizophrenia patients. However, little is known about the underlying neural substrates that are associated with social cognition or daily functioning. Prior studies found associations between mismatch negativity (MMN), an event-related potential response indexing early auditory processing, and functioning in schizophrenia patients.

Methods—In this study we examined MMN, social cognition (social perception and theory of mind) and four domains of functioning (work, independent living, social networks, and family networks) in 33 schizophrenia patients and 42 demographically comparable healthy controls.

Results—Schizophrenia patients exhibited reduced MMN activity at fronto-central electrode sites compared to healthy controls. Within the schizophrenia sample, greater MMN activity at fronto-central sites correlated with better work and independent living (but not social or family networks), and with better social perception.

Conclusions—These results suggest that MMN activity is more closely tied to some outcome domains (work and independent living) than others. MMN has been previously shown to be associated with basic cognition and functional outcome in schizophrenia, but these findings are the first to our knowledge to show MMN associations with social cognition. These results are consistent with cascade models of information processing in which deficits in early perceptual processing have a downstream impact on higher order social cognition and community functioning.

Introduction

Schizophrenia patients exhibit deficits across a broad array of domains, including auditory and visual processing, cognition, and social and daily functioning. There has been strong interest in examining the determinants of poor social functioning in schizophrenia. Several studies have noted a relationship between cognition and functioning in schizophrenia (1–3). Social cognition appears to be related to both cognition and community functioning, and may mediate

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the relationship between the two (4–8). Social cognition is broadly defined as the ability to construct representations of oneself and of others, and of the relationship between oneself and others (9). Impairments in various domains of social cognition have been reported, including social perception (10), theory of mind (11), and facial affect processing (for a review, see 12). While much work has been done examining the relationships among cognition, social cognition, and functional outcome in schizophrenia, less work has been done with models that include perceptual processes. The current study used an electrophysiological measure of early auditory perception, mismatch negativity (MMN), to examine how deficits in early auditory processing may contribute to poor social cognition and community functioning in schizophrenia patients.

In a typical MMN design a series of standard tones (e.g., 1000 Hz, 50 ms tones) are presented on 90% of trials whereas deviant tones (e.g., 1000 Hz, 100 ms tones) are presented on the remaining 10% of trials. Subjects are usually instructed to ignore the tones and either perform some secondary auditory task or watch a silent movie. MMN is calculated as the difference between the event-related potentials (ERPs) elicited by the deviant and standard tones. MMN has a typical onset of approximately 50 ms, peaks at approximately 200 ms, and has a maximal fronto-central distribution. MMN is thought to reflect an automatic perceptual measure of change detection or an echoic memory process in humans (13). Recent theories suggest that MMN may reflect predictive coding of auditory stimuli (14) or a regularity violation response (15), processes that involve more than just feedforward auditory information.

MMN deficits have been observed in schizophrenia patients in a number of studies (16–18) with a recent meta-analysis reporting a mean effect size of approximately 1.0 (19). MMN has been shown to be relatively immune to the effects of antipsychotic medication in schizophrenia patients (20). It has been hypothesized that NMDA receptor-mediated glutamate dysfunction underlies MMN deficits in schizophrenia as well as other neuropsychiatric diseases (21). Several groups have reported correlations between MMN and the Global Assessment of Functioning (GAF) scale in chronic schizophrenia patients (16,22–24), and at least one study found that the association was stable over a one-year period (25). Significant associations between MMN and GAF scores have also been noted in healthy subjects (26). These studies imply that deficits in early auditory processing, as measured by the MMN, have a downstream impact on community functioning.

The present study aimed to replicate previous findings of an association between MMN and functional outcome in schizophrenia and to examine whether MMN in schizophrenia is related to measures of social cognition. We hypothesized that MMN would be related to social cognition for two reasons: 1) MMN amplitudes have been associated with both basic cognition and community functioning, and social cognition has correlations with both of these factors (1); and 2) other measures of early perceptual processing in both visual and auditory modalities (e.g., tone matching or detecting pitch changes in tunes, visual masking) have been shown to be related to social cognition (27,28). In this study, MMN and two measures of social cognition (a social perception task and a theory of mind task) were examined in schizophrenia patients and healthy controls. In addition, measures of community functioning were collected in the schizophrenia sample.

Methods

Participants

Thirty-three patients with schizophrenia (29 men, 4 women) and 42 normal controls (35 men, 7 women) participated in the study. All subjects were part of a larger study of early visual processing (Early Visual Processing in Schizophrenia; P. I.: Michael Green). Schizophrenia patients were recruited from outpatient treatment clinics at the Veterans Affairs (VA) Greater

Los Angeles Healthcare System and through presentations in the community. Twenty-seven patients were receiving atypical antipsychotic medication, 2 patients were receiving typical antipsychotic medication, and 4 were taking both typical and atypical antipsychotic medication at the time of testing. All patients were administered the Structured Clinical Interview for DSM-IV Axis I Disorders (SCID; 29) and met diagnostic criteria for schizophrenia. Patients had to be between 18 and 60 years of age. Patients were excluded from participation if they had substance abuse or dependence in the last six months, mental retardation, a history of loss of consciousness for more than one hour, an identifiable neurological disorder, or were not sufficiently fluent in English.

Normal control participants were recruited through flyers posted in the community and advertisements in local newspapers and internet postings. Normal controls had to be between 25 and 55 years of age. An initial screening interview excluded potential normal controls who had any identifiable neurological disorder or head injury, had a first-degree relative with schizophrenia or another psychotic disorder, were not sufficiently fluent in English, had a personal history of schizophrenia or other psychotic disorder, bipolar disorder, recurrent depression, had a lifetime history of substance dependence, or had any substance abuse in the last 6 months. Potential normal control participants were interviewed with the SCID-I and portions of the Structured Clinical Interview for DSM-IV Axis II Disorders (SCID-II; 30), and were excluded if they had any of the following Axis II disorders: avoidant, borderline, paranoid, schizoid, or schizotypal.

All SCID interviewers were trained through the Treatment Unit of the Department of Veterans Affairs VISN 22 Mental Illness Research, Education, and Clinical Center (MIRECC) to a minimum kappa of 0.75 for key psychotic and mood items. All participants had the capacity to give informed consent and provided written informed consent after all procedures were fully explained in accordance with procedures approved by the Institutional Review Board at the VA Greater Los Angeles Healthcare System.

Table 1 lists the group demographics, as well as symptom ratings on the Brief Psychiatric Rating Scale (BPRS; 31) and the Scale for the Assessment of Negative Symptoms (SANS; 32) for the patients. Because most of our patient participants were recruited from VA clinics, the sample is predominantly male. Patients were clinically stable and exhibited mild clinical symptomatology. Table 1 shows the mean scores of the BPRS clusters (with a possible score ranging from 1–7; 33) and SANS global scores (with a possible score ranging from 0–5).

Procedures

EEG Recording Procedure—Participants were presented with binaural tones (1-kHz 85-dB sound pressure level, with near instantaneous rise-fall times) with a fixed stimulus onset asynchrony of 700 milliseconds using a stimulus generator (SR-HLAB; San Diego Instruments, Inc., San Diego, CA). Standard ($p = 0.90$, 50-millisecond duration) and deviant ($p = 0.10$, 100-millisecond duration) tones were presented to participants in a fixed, pseudorandom order using foam insert earphones (Model 3A; Aearo Company Auditory Systems, Indianapolis, IN). A block of 100 trials (90 standard stimuli and 10 deviant stimuli) was created and presented repeatedly throughout the experiment. The block had the constraints that at least 4 standard tones appeared between successive deviant tones. Participants watched a silent, benign movie to divert attention from the stimuli.

Participants had their electroencephalographic (EEG) activity recorded continuously during MMN assessment using a Neuroscan NuAmps amplifier (Compumedics USA, Charlotte, NC). Data were sampled at 1,000 Hz with filter settings of 0.5 to 100 Hz. Thirty four equidistant cap-mounted, sintered Ag-AgCl electrodes (Falk Minow Services, Germany) were positioned using a modified international 10–20 system placement scheme. Additionally, four electrodes

were used to measure horizontal electrooculogram (EOG; placed on the outer canthus of the left and right eye) and vertical EOG (placed above and below the left eye). All electrodes were referenced to the nose and a forehead ground was employed. Testing lasted approximately 20–25 minutes. During testing, online averages of gross artifact-free deviant trials were collected across a –100 to 500 ms epoch for all electrodes. Trials with signals $\pm 100 \mu\text{V}$ at all electrode sites, including EOG sites, were excluded. Data collection was terminated when participants reached 150 artifact-free deviant trials.

All data were processed using Neuroscan Scan 4.3 software. Data were first corrected for eye-blink artifacts using standard blink correction algorithms (34). Data were then epoched at –100 to 500 ms relative to stimulus onset, and were baseline corrected to the average prestimulus interval (–100 ms to 0). Further artifact rejection automatically rejected epochs that were $\pm 50 \mu\text{V}$ in frontal sites (F7, F8, Fp1, Fp2, F3, F4, Fz), similar to published strategies (16,35, 36).

The mismatch response was generated by subtracting the ERP response to the standard tones from the ERP response to the deviant tones. Schizophrenia patients and healthy controls had a mean (S. D.) of 162 (27) and 156 (22) trials, respectively, for deviant tones following blink correction and artifact rejection. Schizophrenia patients required more total trials (an average of 1769 total trials) that were free of gross artifact during recording than healthy controls (an average of 1692 total trials), thus resulting in slightly more clean deviant trials for schizophrenia patients after blink correction and offline artifact rejection. The MMN waveforms were then low-pass filtered at 20 Hz (zero-phase shift and 24-dB/octave roll-off). For statistical analyses, MMN was defined as the mean voltage from 135 to 205 ms.

Social Cognition Measures

Profile of Nonverbal Sensitivity (PONS): The PONS (37) was used to assess social perception. Only the first 110 scenes from the full set of 220 scenes were used. Two-second video clips of a Caucasian female were displayed. Each scene contained, either singly or in combination, facial expressions, voice intonations or bodily gestures. After watching each scene the participant was asked which one of two labels (e.g., talking to a child or saying a prayer) best described that scene. Demands on sustained attention or reading comprehension were reduced by having the test administrator read aloud the two labels prior to the presentation of the scene while the participant read the labels from a 4-by-6 inch index card. A practice session was administered using 5 scenes out of the other 110 scenes not shown in order to ensure that participants understood the task. The total number of correct responses, out of a total of 110, was used in the analyses.

The Awareness of Social Inference Test (TASIT): The TASIT Part III (Social Inference – Enriched) Form A (38) was administered to all participants. Part III consists of sixteen 15–60 second video clips of method actors depicting scenes of either lies or sarcasm. During each clip information is provided to the viewer about the nature of the conversation between the actors. Participants must use the information provided to make inferences about the thoughts, intentions, beliefs and feelings of the actors engaged in conversations that involve either lies or sarcasm. Four forced-choice yes/no questions were asked at the end of each scene about what one of the characters was: 1) doing to the other character(s); 2) trying to say to the other character(s); 3) thinking; and 4) feeling. One practice scene was given at the beginning of the session to familiarize the participant with the task and types of questions. The total number of correct yes/no responses, out of a total of 64, was used in the analyses.

Functional Outcome Measures—Four subscales from the Role Functioning Scale (RFS; 39) were used to assess functional status: independent living skills, social (both family and

non-family) functioning and work functioning. The RFS subscale ratings range from 1 (severely impaired) to 7 (maximal functioning), and include anchor points that detail both the quantity and quality of functioning. The RFS was administered as part of an approximately 30-minute interview and rated by one of several trained interviewers in our laboratory. Information was provided solely by the patient; ratings were not based on any other outside information. Previous reports find high consistency in ratings on the RFS among trained interviewers, with an intraclass correlation coefficient of 0.80 (39). Table 1 contains the means and standard deviations for the four outcome subscales for the schizophrenia patients.

Data Analysis—A chi square test for group differences in gender distribution and between-group t-tests were used to examine differences in demographic variables and social cognition variables. A repeated measures analysis of variance (ANOVA), with electrode as the within subject variable and group as the between subject variable, was used to assess patterns of MMN activity. Greenhouse-Geisser corrections (ϵ) were used in the repeated measures ANOVAs that contained more than one degree of freedom. Follow-up between-group t-tests were used to compare MMN activity at each electrode; effect sizes are expressed as Cohen's d . Pearson's r correlations between MMN, social cognition and functional outcome measures were examined. An alpha level of $p = 0.05$ was used for all analyses except for the t-tests on group differences in MMN, where alpha was set at a more conservative level ($p = 0.01$) to control for multiple comparisons.

Results

Mismatch Negativity

Grand average MMN waveforms for each group are shown in Figure 1 and topographical maps are shown in Figure 2. As can be seen, both groups exhibited MMN activity in the expected fronto-central regions, though the patients exhibited clearly reduced MMN amplitudes. A 2 (group) X 34 (electrode) repeated measures ANOVA was performed to determine if there was differential responding across electrodes between groups. This initial analysis step, while not completely protecting analysis from Type I errors, instills confidence that the follow-up t-tests are not entirely due to chance. The ANOVA revealed significant main effects of group, $F(1, 73) = 10.34, p < 0.005$, electrode, $F(33, 2409) = 181.00, p < 0.001, \epsilon = 0.084$, and a significant electrode X group interaction, $F(33, 2409) = 4.69, p < 0.005, \epsilon = 0.084$. Age was not a significant covariate in a separate ANOVA and was not considered in further analyses (age main effect: $F = 0.12, p > 0.70$; electrode X age interaction: $F = 1.77, p > 0.15$). Follow-up t-tests revealed several electrodes in the fronto-central region with significantly smaller MMN amplitudes in the schizophrenia patients compared to the healthy controls (see Table 2). Out of 34 electrodes, 16 electrodes in the patient group and 19 electrodes in the control group showed MMN (i.e., negative voltages) that was significantly different from zero, all p 's < 0.05 ; these electrodes were in the expected fronto-central regions where MMN is commonly seen.

Social Cognition

One schizophrenia patient and one healthy control performed at near-chance levels on the PONS and were not included in any analysis involving the PONS. Thirty-one patients completed the PONS and 32 patients completed the TASIT. Thirty-nine controls completed the PONS and 37 controls completed the TASIT. A between-group t-test on the TASIT revealed a marginal group difference, $t(67) = 1.70, p < 0.07$, with schizophrenia patients showing a smaller mean (S. D.) score of 47.2 (8.2) compared to the healthy controls' score of 50.5 (6.2), for an effect size of 0.41. A between-group t-test on the PONS revealed a marginal group difference, $t(68) = 1.83, p < 0.08$, with schizophrenia patients showing a mean (S. D.) score of 80.1 (5.0) compared to the healthy controls' score of 82.5 (5.7), for an effect size of 0.45.

Correlations

Correlations between MMN, social cognition and functional outcome measures in schizophrenia patients were only examined in the 16 electrodes that showed a negative amplitude, as described above. The PONS significantly correlated with MMN activity at 13 out of the 16 electrodes exhibiting MMN: Fp1, Fz, F3, F4, FC1, FC2, FC5, FC6, C3, Cz, C4, Cp1 and Cp2 (r 's -0.36 to -0.50). The TASIT did not show any significant correlations with MMN activity. Work functioning was significantly correlated with MMN activity at 4 out of the 16 electrodes exhibiting MMN: F8, FC6, C4, CP2 (r 's -0.37 to -0.45). Level of independent living was significantly correlated with 6 out of the 16 electrodes exhibiting MMN: FC5, FC6, C3, C4, CP1, CP2 (r 's -0.37 to -0.51). Social and family networks did not show significant correlations with MMN activity. For the healthy controls, there were very few significant associations (only two out of 19 electrodes exhibiting MMN correlated with the PONS, and none with the TASIT). The correlations between MMN, functional outcome and social cognition in the 16 electrodes which showed negative amplitudes (i.e., MMN) in the patients can be seen as topographical maps in Figure 3 and are listed in Table 3. In Figure 3, the bright red color represents significant correlations (i.e., r 's < -0.35); electrodes which did not exhibit mismatch negativity had their values set to 0 (medium blue color in the figure).

Discussion

This study is the first, to our knowledge, to examine correlations among MMN activity, daily functioning and social cognition in schizophrenia patients. First, we replicated the finding of poorer MMN activity in schizophrenia patients compared to healthy controls. Second, the results of the study are consistent with prior reports showing significant correlations between MMN activity and daily functioning, using an expanded scale of daily functioning. Third, MMN was significantly correlated with one measure of social cognition, the PONS, but not the TASIT. These results imply that MMN is related to daily functioning, specifically work and independent living, as well as a measure of social cognition (i.e., social perception).

We found several significant correlations between MMN activity at fronto-central and central sites, work functioning and independent living in schizophrenia patients. Previous studies that have examined the relationship between MMN and functioning used the GAF to assess functioning (e.g., 16,40). We elected to use a functioning scale that examined separate domains of functioning, rather than a single global score of functioning such as the GAF. Our results show that MMN may be more related to aspects of work and independent living than social or family functioning. This relationship between MMN and work and independent living is consistent with other studies that sometimes find stronger relationships between basic cognition and work and independent living (4,41) than for social or family functioning.

Significant correlations were found between MMN activity and the PONS, but not the TASIT. The association between MMN and social cognition mirror findings in the visual domain (42). The PONS might have been more amenable than the TASIT to associations with MMN due to the brief nature of the stimuli used. It may be the case that MMN is more closely related to social cues that occur very quickly, as used in the PONS. While both social cognition tasks rely on perceptual cues and making inferences of the state of mind of the actors, the PONS is more reliant on processing of perceptual cues while the TASIT is more reliant on inferring the state of mind of the actors. As the PONS requires that decisions be made based mainly on the perceptual cues provided, it may be more closely related to a perceptually-driven ERP component such as the MMN. Alternatively, there may be subtle psychometric differences between the PONS and the TASIT that account for the pattern of correlations with MMN, even though we did not observe any notable problems in the range and distribution of either measure.

This study had a few limitations. First, all of the schizophrenia patients were taking antipsychotic medications at the time of testing. While it has been reported that antipsychotic medication does not appear to influence MMN activity in schizophrenia patients (e.g., 43, 44), much less is known about the effects of antipsychotic medication on social cognition in schizophrenia. Second, we did not have as broad of a range of functioning in our schizophrenia patient sample compared to other studies. For example, Light and Braff (16) reported data from schizophrenia patients living completely independently, being treated as outpatients, and inpatients. We may potentially be underestimating the relationship between MMN, community functioning, and social cognition by not having a wider range of functioning. Third, we found a non-significant trend for group differences on the two social cognitive performance measures, even though we have found significant group differences on these same measures previously (11,42). Hence, we may have included an unusually good performing subgroup of patients, but if so, that did not obscure the MMN differences, or the relationships between MMN and social cognition for the PONS. Finally, we used tones that had a near instantaneous rise/fall time which may have produced an onset/offset transient “click.” This click may have inadvertently attracted attention of the subjects, as both groups showed a robust P3a response. This click could have potentially affected the MMN whereby attention was drawn to the standard tones, increasing the amplitude of the ERP to the standard tones and diminishing the difference wave (i.e., MMN). A future study should more carefully control the stimulus properties to address such possible confounds.

In conclusion, we replicated past findings of associations between MMN and functioning in schizophrenia patients, and extended these findings to relationships with social cognition. We were further able to characterize the nature of the relationship by demonstrating that MMN was more closely related to work and independent living status rather than social and family measures. Future studies will need to be conducted to determine if MMN is related to different domains of social cognition, particularly those that are in the auditory domain (e.g., affective prosody). The results of this study suggest that neural deficits in early auditory processing may have downstream consequences on higher order social cognition and community functioning in schizophrenia patients. It has been demonstrated that interventions targeting early perceptual processing are effective in improving aspects of cognition, such as verbal working memory and verbal learning (45). Future interventions that target early perceptual processing may also be effective in improving social cognition and functional outcome in schizophrenia patients.

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Figure 1.
Grand average MMN waveforms for schizophrenia patients (in red) and healthy controls (in blue). Scale bar can be seen in the legend and at electrode Fz for reference.

Figure 2.

Topographical map of MMN activity for healthy controls (on the left) and schizophrenia patients (on the right). MMN activity can be clearly seen at fronto-central sites for both groups, though patients are showing much smaller MMN amplitudes compared to the controls. Scale ranges from +4.5 μ V (hot colors) to -4.5 μ V (cold colors).

Figure 3.

Topographical representation of correlations between MMN activity, functioning scores and social cognition scores for schizophrenia patients. Activity is plotted as Pearson's r scores, and range from +0.10 (cold colors) to -0.50 (hot colors).

Table 1

Group demographics, patient symptom ratings and patient functioning scores

	Mean	SD
<i>Normal Controls (35 male/7 female)</i>		
Age	41.0	9.4
Education	12.9	1.0
<i>Schizophrenia Patients (29 male/4 female)</i>		
Age	44.5	8.1
Education	12.5	1.7
Total BPRS Score	46.1	9.1
<i>BPRS Subscales</i>		
Positive Symptoms	2.9	1.2
Negative Symptoms	1.8	0.7
Affective Flattening	2.2	1.3
Alogia	0.8	1.0
Avolition	2.6	1.5
Anhedonia	2.8	1.4
Attention	1.6	1.6
Work Functioning	2.8	2.0
Independent Living	4.0	1.5
Family Networks	4.4	1.7
Social Networks	3.5	1.7

Table 2

Mean (S. D.) mismatch negativity amplitudes, effect size and t-test values of between-group differences for each electrode site examined.

Electrode	Schizophrenia Patients	Healthy Controls	Effect Size [‡]	t-value
FP1	−0.87 (0.63)	−1.24 (0.87)	0.50	2.10
FP2	−0.91 (0.72)	−1.12 (0.78)	0.28	1.18
F7	−0.65 (0.70)	−1.21 (0.80)	0.75	3.19*
F8	−0.52 (0.81)	−1.04 (0.92)	0.60	2.58
Fz	−1.54 (1.19)	−2.69 (1.32)	0.91	3.90*
F3	−1.37 (0.93)	−2.54 (1.19)	1.10	4.64*
F4	−1.51 (1.12)	−2.47 (1.19)	0.83	3.55*
FC1	−1.36 (1.08)	−2.75 (1.39)	1.12	4.74*
FC2	−1.44 (1.23)	−2.68 (1.40)	0.94	4.02*
FC5	−0.82 (0.75)	−1.85 (1.14)	1.07	4.47*
FC6	−0.90 (1.05)	−1.82 (1.14)	0.84	3.59*
C3	−0.88 (0.92)	−2.11 (1.40)	1.04	4.38*
Cz	−1.19 (1.25)	−2.30 (1.47)	0.81	3.46*
C4	−0.95 (1.07)	−1.90 (1.34)	0.78	3.31*
CP1	−0.54 (0.98)	−1.49 (1.40)	0.79	3.31*
CP2	−0.53 (1.04)	−1.41 (1.32)	0.75	3.16*
CP5	0.05 (0.82)	−0.68 (1.27)	0.69	2.90*
CP6	0.10 (1.07)	−0.45 (1.20)	0.76	2.10
P7	1.14 (0.99)	0.82 (1.29)	0.28	1.18
P3	0.22 (0.92)	−0.46 (1.31)	0.60	2.52
Pz	0.14 (0.98)	−0.55 (1.33)	0.59	2.48
P4	0.33 (1.02)	−0.24 (1.25)	0.50	2.11
P8	1.24 (1.12)	0.94 (1.23)	0.26	1.12
T7	0.18 (0.76)	−0.20 (1.21)	0.38	1.60
T8	0.30 (1.11)	−0.12 (1.23)	0.36	1.54
TP9	1.29 (0.99)	1.20 (1.27)	0.08	0.34
TP10	1.55 (1.15)	1.38 (1.22)	0.15	0.62
T1	0.60 (0.88)	0.54 (0.90)	0.06	0.26
T2	0.92 (0.88)	0.74 (0.90)	0.20	0.86
PO9	1.46 (1.03)	1.27 (1.24)	0.17	0.72
PO10	1.66 (1.21)	1.34 (1.24)	0.26	1.12
O1	1.11 (1.24)	0.83 (1.28)	0.22	0.95
O2	1.20 (0.99)	0.87 (1.29)	0.28	1.20
Iz	1.45 (1.03)	1.18 (1.24)	0.24	1.00

[‡]Standardized mean difference (Cohen's d)

* Denotes p values < 0.01

Pearson's r correlation coefficients between electrodes exhibiting MMN (i.e. negative values), social cognition and functional outcome measures in the schizophrenia patients.

Table 3

Electrode	PONS	TASIT	Work Functioning	Independent Living	Family Networks	Social Networks
FP1	-.40*	-.24	-.28	-.21	-.06	-.02
FP2	-.35	-.17	-.27	-.11	.11	-.02
F7	-.09	-.15	-.14	-.30	-.23	-.15
F8	-.27	-.09	-.37*	-.22	.12	-.07
Fz	-.44*	-.16	-.19	-.16	.01	.13
F3	-.38*	-.18	-.16	-.28	-.09	.03
F4	-.44*	-.15	-.26	-.19	.03	.12
FC1	-.45*	-.19	-.21	-.27	-.11	.03
FC2	-.50*	-.17	-.25	-.26	-.06	.08
FC5	-.36*	-.17	-.34	-.51*	-.21	-.10
FC6	-.37*	-.12	-.44*	-.42*	-.03	-.02
C3	-.46*	-.19	-.30	-.42*	-.25	-.15
Cz	-.50*	-.20	-.27	-.32	-.20	.07
C4	-.45*	-.20	-.45*	-.47*	-.19	-.12
CP1	-.41*	-.16	-.32	-.37*	-.34	-.18
CP2	-.43*	-.22	-.40*	-.40*	-.35	-.21

PONS = Profile of Nonverbal Sensitivity; TASIT = The Awareness of Social Inference Test

* Denotes p values < 0.05