

## Prosodic discrimination in patients with schizophrenia

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**Summary** Fifteen patients with prominent positive symptoms of schizophrenia and 15 normal controls performed verbal prosodic and pure musical discrimination tasks, with changes in pitch and timing parameters. The patients' performance was comparable to that of controls on the discrimination of terminal pitch changes, but significantly poorer on the more difficult internal pitch discrimination. The latter deficit was positively correlated with the severity of their positive symptoms. The results suggest that patients have a deficit in processing fundamental aspects of prosody, which is associated with the presence of positive symptoms.

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Auditory verbal hallucinations and persecutory delusions are cardinal features of schizophrenia. Their pathophysiology is unclear; one prominent model (Frith & Done, 1988) proposes that auditory verbal hallucinations occur because self-generated inner speech is misperceived as externally generated speech owing to a failure to recognise one's own inner speech and that delusions may develop as secondary phenomena. Functional imaging has suggested a prominent involvement of the right temporal cortex, which has been associated with processing affective prosodic information (George *et al*, 1996), when patients are experiencing auditory hallucinations (Shergill *et al*, 2000a). Prosodic information may contribute to accurate verbal self-monitoring and its disturbance may contribute in the aetiology of such positive symptoms of psychosis (Shergill *et al*, 2000b; Johns *et al*, 2001). Although the discrimination of affective prosody has been

demonstrated to be abnormal in patients with schizophrenia (Murphy & Cutting, 1990; Ross *et al*, 2001), there has been little investigation of the more elementary processing of the perception of pitch and temporal pattern which contribute to affective prosody (Scherer, 1986). In this study we examined prosodic discrimination in patients with schizophrenia experiencing prominent persecutory symptoms.

### METHOD

#### Participants

Fifteen patients with schizophrenia (mean age 36.9 years, s.d.=11.6) were studied. Patients were recruited from wards and clinics at the South London and Maudsley National Health Service Trust, London, and selected if they were currently exhibiting prominent positive symptoms. Diagnosis was based on DSM-IV criteria for schizophrenia (American Psychiatric Association, 1994), a detailed clinical interview and review of the hospital case notes. For the control group, 15 individuals without a history of psychiatric illness (mean age 34.4 years, s.d.=12.3) were recruited through advertisement from the same geographical area as the patients and matched with respect to age, gender, verbal IQ and years of education. Applicants were excluded if they met criteria for substance misuse or had a history of neurological illness. Nine patients and nine controls were male; all participants were right-handed. Patients and controls did not differ in education (mean 15.3 years and 16.6 years respectively) or in estimated verbal IQ by National Adult Reading Test (Nelson, 1982) (mean 110 and 114, respectively). Patients were assessed using the Brief Psychiatric Rating Scale (BPRS; Overall & Gorham, 1962). All participants provided written informed consent after a full description of the study and the study was approved by the local ethics committee.

#### Stimuli and materials

An English version of the music and prosody discrimination task (Patel *et al*, 1998) was used for the study. The stimuli for the test consist of lexically matched sentence pairs, listed in Nicholson *et al* (2003), and their musical (non-verbal) analogues. Both the sentence pairs and the musical pairs could differ on one of the three different prosodic attributes. The three variations were: (a) statement–question pairs differing in terminal pitch pattern; (b) focus–shift pairs differing in their internal pitch pattern; (c) timing–shift pairs, which differed in the placement of pauses.

The analogous music pairs were generated from the fundamental frequency and temporal patterns of the syllables used in the verbal sentences, with a fixed pitch for each syllable.

#### Procedure

Each participant was seated in a quiet room and digitised stimuli were presented by computer over headphones. The three pairs of sentences or musical phrases (i.e. statement–question pairs for terminal pitch discrimination, focus–shift pairs for internal pitch discrimination and timing–shift pairs for rhythm discrimination in prosodic and musical discrimination tasks) were presented in a total of six counterbalanced blocks. Each block was composed of one of the six stimulus types and contained a total of 32 trials with 16 same pairs and 16 different pairs. The average length of stimulus was 2.0 s (s.d.=0.5). The intrapair interval was 1 s and the interpair interval was 5 s. Participants were asked to indicate whether members of the pair were identical on the presentation of a visual cue.

### RESULTS

Statistical analyses were carried out using the Statistical Package for the Social Sciences (SPSS) version 10.0 for Windows. All except one patient were treated with antipsychotic medication, the majority with atypical antipsychotic medication, but were still moderately symptomatic with a mean score of 39.6 (s.d.=12) on the BPRS. All patients had prominent persecutory positive symptoms, with 13 patients scoring 4 or more on individual items related to distressing hallucinatory behaviour or persecutory delusions.

The accuracy of the task was defined as the number of pairs correctly judged as

same or different. Between-group differences were assessed with the Mann-Whitney *U*-test because the scores were not normally distributed. Exact *P*-values calculated using SPSS, were reported. During the prosody discrimination tasks, patients showed a significant reduction in the accuracy of the internal pitch (focus-shift pairs) discrimination compared with controls (see data supplement to the online version of this paper). The musical analogue of this task also demonstrated a significant decrement in patients compared with controls. There was no difference in the patients' ability to detect terminal pitch alterations (statement-question pairs) in either the verbal or musical forms. The patients did demonstrate a non-significant decrement in the accuracy of the detection of timing shift (rhythm) changes in both verbal and musical forms (see data supplement to the online version of this paper). The correlation of each task performance with positive symptom scores of BPRS was tested using the Spearman rank correlation coefficient. The accuracy of the internal pitch discrimination of sentences was negatively correlated with positive symptom score in patients ( $r = -0.56$ ,  $P = 0.03$ ). There was no correlation with other performance data.

## DISCUSSION

Our findings suggest that patients with schizophrenia have a deficit in discriminating fundamental acoustic features underlying prosodic and music perception. Although the ability of patients to discriminate the terminal pitch alterations within both prosodic and musical tasks was unimpaired, they showed a deficit during the internal pitch discrimination in both modalities. Because the internal pitch discrimination places greater demands on maintaining and comparing pitch patterns than the terminal pitch discrimination task (Patel *et al*, 1998), poor performance on the former task in patients might be attributable to a deficit in the working memory process. However, this would also be expected to lead to similar decrements in the performance of the timing-shift (rhythm) pairs, which was not the case. It suggests that working memory aspects may be a contributory factor but are not the fundamental cause of the observed deficits. An additional working memory task might have helped to control for this. It is possible that increasing the sample size might make some of the trends in the data more significant.

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The correlation analysis showed that the disturbance of internal pitch discrimination of the verbal prosodic sentences was associated with the presence of positive symptoms, suggesting that a specific deficit in discriminating prosodic features might contribute to the genesis of positive psychotic symptoms. This is consistent with reported disturbance of self-monitoring of distorted (changes in pitch) speech evident in patients with schizophrenia experiencing hallucinations and delusions (Johns *et al*, 2001). In our study, both groups of participants demonstrated similar patterns of discrimination performance on the different tasks (terminal pitch, internal pitch or rhythm) between verbal and musical prosodic analogues. This is compatible with a notion that verbal prosodic and musical information share common neural resources (Patel *et al*, 1998), and that this is dysfunctional in patients with schizophrenia. However, the association of internal pitch discrimination with positive symptoms, observed in the correlational analysis, was only evident in the verbal prosodic domain, suggesting a specific abnormality of verbal rather than musical prosody for the formation of positive symptoms. This requires further clarification.

Previous studies have shown that patients with schizophrenia fail to make a categorical judgement of emotion according to prosodic difference (Murphy & Cutting, 1990; Ross *et al*, 2001). There is a suggestion that the mechanism underlying accurate discrimination of affective prosody relies on pitch perception (Scherer, 1986); difficulties in pitch discrimination may therefore contribute to the disturbed perception of emotional prosody in schizophrenia. However, we did not directly assess the relation between pitch perception and emotional prosody in this study. Future work could usefully explore the relation of deficient pitch discrimination with abnormal affective prosody in schizophrenia and their role in formation of positive symptoms.

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