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Face processing in schizophrenia: defining the deficit

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ABSTRACT

Background. Abnormalities of face affect naming and face recognition occur in schizophrenia but it is not clear whether the deficits reflect wider underlying impairments of perception, memory, language or executive function.

Method. Twenty-six patients with schizophrenia were compared with 23 healthy volunteers on neuropsychological tests and tests of face and affect processing. Face and non-face tests were compared at four levels of processing: visuo-spatial perception, recognition memory, language and naming, and executive function. We examined relationships with drug dose, duration of illness and pre-morbid and current IQ.

Results. Patients and controls did not differ in estimated pre-morbid IQ but current IQ was 12 points lower in patients. At each level of processing there were correlated deficits of face and non-face processing in the patients that were mostly independent of IQ decline. Impaired face and non-face visuo-spatial function and recognition performance were generally correlated with drug dose. Impairments in naming face emotions were correlated with other non-face naming tasks independently of drug dose. Patients performed less well than controls in classifying faces by emotion while ignoring identity and this was associated with poorer performance in Wisconsin Card Sorting.

Conclusions. The pattern of results suggests that deficits in face processing reflect three wider neuropsychological impairments: a drug-related impairment of visual imagery, and disease-related impairments of semantic retrieval and executive function.

INTRODUCTION

A number of studies have reported that patients with schizophrenia perform less well than controls in neuropsychological tasks that involve face stimuli (Whittaker *et al*. 1994). However, it is not clear whether this indicates a specific difficulty in face processing in schizophrenia or whether it is part of a general cognitive decline. In keeping with a specific deficit, we found that patients were impaired in recognizing faces but not in recognizing words from previously presented lists using the Warrington recognition tasks (Whittaker *et al*. 1994). We also found, as have others, that patients were less accurate than controls in naming emotions in faces. The present study aimed to determine whether deficits in face processing, particularly of affect, reflect underlying problems in visuo-spatial perception, recognition memory, semantics or executive function.

In Cutting's study (1981), groups of patients with schizophrenia, depression and other diagnoses were required to judge friendliness and meanness from pictures of faces. Non-affective control tasks included judging the age of faces and a colour judgement task. Patients with acute schizophrenia were more impaired than the groups with chronic schizophrenia and other diagnoses especially on the face affect task.

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Other studies suggest affect naming may be part of a more general deficit in face processing. Feinberg *et al*. (1986) reported that patients with schizophrenia were more impaired than depressives and controls, not only in face affect but also in a face identity task. Archer *et al*. (1992, 1994) reported that patients with schizophrenia performed less well than depressives on face recognition in addition to face affect naming. Archer *et al*.'s 1994 study had the advantage of using naturalistic moving faces rather than static photographs. Novic *et al*. (1984) found that patients were impaired on matching faces by identity and by emotion and that the two deficits were intercorrelated.

From the evidence it seems that patients suffering from schizophrenia have impairments of processing information in images of faces that are more pervasive than patients with other psychiatric disorders. One possibility is that the deficits relate to duration of illness. Walker *et al*. (1980) found that children with schizophrenia and younger adults were predominantly impaired on naming negative affects whereas older patients were impaired across a range of affects. Schizophrenia is associated with a global intellectual decline (Crow & Mitchell, 1975; Hyde *et al*. 1994) and deficits in face processing could be part of this. Equally, impairments in specific neuropsychological domains in schizophrenia such as visuo-spatial function (Cutting, 1985), executive function (Weinburger *et al*. 1992; Frith, 1992), or memory (Saykin *et al*. 1991, 1994; McKenna *et al*. 1994) could produce apparent deficits in the corresponding functions in face processing. For example, Bryson *et al*. (1997) examined 63 patients with schizophrenia with regard to standardized norms on neuropsychological tests and tests of face affect. They found that schizophrenic patients' impairments on tests of face processing were closely related to impairments of executive function. Recently, Addington & Addington (1998) reported correlated impairments in face processing and attentional tasks.

METHOD

Subject groups

Twenty-six patients suffering from schizophrenia participated in the study. All patients had received a diagnosis of schizophrenia at least 12 months prior to the beginning of the study, and were able to give informed consent. All patients completed a semi-structured clinical interview and standard ratings of symptomatology. Case-notes were reviewed and when possible a nearest relative or keyworker was interviewed about symptomatology. Control subjects with no reported history of psychiatric disorder were recruited predominantly from hospital staff.

Neuropsychological and face processing tests

Procedure

Subjects were tested over several sessions, rather than in a single testing session, since complete testing took 4–5 h. Furthermore, we wished to ensure that optimum performance on tests was obtained from all subjects. Nevertheless, not all patients completed all tests as indicated in the results section. All subjects were assessed on the National Adult Reading Test (NART) (Nelson, 1982), to give an assessment of pre-morbid IQ and the Quick Test (Ammons & Ammons, 1962), as a measure of current IQ which has been used in other studies of patients with schizophrenia (e.g. Corcoran & Frith, 1996).

Perception

Face-perception was assessed using a task in which a target face is matched to a different view of the same face in a sample of six under variable lighting conditions and variable pose conditions (Benton & Van Allen, 1973; Benton *et al*. 1983). Non-face perception was assessed using the Visual Object and Space Perception (VOSP) Battery (Warrington & James, 1991). This battery has nine subscales, including tests of object naming made difficult by manipulation of the image and tests of spatial awareness, e.g. dot counting.

Recognition

Face-recognition was measured by presenting a series of 50 faces for 3 s each and then asking subjects to identify which of 50 pairs of faces had been seen (Warrington, 1984). The non-face recognition tasks were analogous forced-choice paradigms for 50 words (Warrrington, 1984) as well as locally developed tests of recognition of 14 designs and of 20 nonsense words. Recognizing and naming famous faces was assessed by asking subjects to identify whether faces were

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familiar. If subjects judged the face familiar, they were asked to name the individual shown and their occupation (A. W. Young, personal communication).

Language

Naming ability and language skills were assessed on three tests that did not involve faces and two that involved faces and affect. To assess face affect naming, patients and controls were asked to choose the appropriate emotion-word from a list of the seven basic emotions to describe 30 colour pictures of posed facial emotions (after Ekman & Friesen, 1984). An analogous test was developed that did not use faces. This required naming of emotions in descriptions of faces and in descriptions of experiences (affective scenarios). The development of the test is described below. The non-face naming and language tests were naming objects (Graded Naming Test) (McKenna & Warrington, 1983), matching words or objects by meaning (Pyramid and Palm Trees) (Howard & Patterson, 1992), and comprehension of sentences (Test of Reception of Grammar) (Bishop, 1982).

Executive function

The non-face tasks were Wisconsin Card Sort Test (WISC) (Heaton, 1981) and verbal fluency for letters. The corresponding face processing task required subjects to sort a set of four faces each with four emotions by emotion while ignoring identity or by identity while ignoring emotion (Hobson, 1986).

Test development

The tests of affect naming were devised and standardised for this study and the previous study (Whittaker *et al.* 1994). Colour photographs were made of the volunteer's facial expression of emotion. Pictures were selected that produced agreement in eight out of ten raters. Pictures were presented untimed and the subject chose the appropriate emotion from a typed list – happy, sad, angry, afraid, disgusted, surprised, neutral. The face-affect descriptions comprised six sentences of the form: her face was pale, her eyes were wide-open and she was trembling; how did she feel? The affective scenarios comprised 22 sentences describing experiences of the form: Eric realized that his car had been stolen, how does Eric feel? In addition to the basic emotions, ten of the items in this group probed higher order, developmentally more complex affects (Harris, 1989) namely pride, shame, guilt, embarrassment and suspicion (example: Henry realized that he had been talking to the girl he fancied with his trouser zip undone, how does Henry feel?). Patients read each description, which was concurrently read aloud to them by the experimenter. The choice of words, from which a response was to be selected, was listed at the top of each page.

Statistical analysis

Most results from both groups were normally distributed, but there were differences in variance in some comparisons. Therefore, Mann–Whitney tests were used for group comparisons. To covary effects of current IQ, analysis of variance was carried out on rankings of data (Shirley, 1981). Numbers of subjects in comparisons varied from test to test because not all subjects completed all tests. Spearman's rank order correlations were calculated between test performance and the confounds of estimated neuroleptic dose in chlorpromazine equivalents (Foster, 1989) and estimated duration of illness. Two-tailed probability values are quoted in all tables for all tests.

Spearman's rank order correlations were also calculated between each face task and its equivalent non-face tasks. All significant correlations are quoted in the text.

RESULTS

Demographic and clinical details

Patients and controls were well matched for age: patients (mean $\pm$ S.D.) $36{\cdot}2 \pm 9{\cdot}6$ years, controls $36{\cdot}0 \pm 11{\cdot}0$ years. Both groups included one left-handed subject. The patient group included 21 males and 5 females, in the control group there were 14 males and 9 females. All patients were chronically symptomatic, had a mean duration of illness of 15 years and were receiving neuroleptic medication, usually in the form of depot or clozapine. Pre-morbid NART IQ was similar in controls ($114{\cdot}9 \pm 8{\cdot}2$) and patients ($111{\cdot}0 \pm 8{\cdot}02$). Current IQ as measured by the Quick Test was reduced in patients ($91{\cdot}5 \pm 15{\cdot}85$) compared to controls ($104{\cdot}2 \pm 8{\cdot}7$, $P < 0{\cdot}01$).

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Table 1. *Tests of face and non-face visuo-spatial perception*

Test (maximum score)	Patient mean (S.D.)/*N* (IQR)	Control mean (S.D.)/*N* (IQR)	*U* test *P* (*U*)	Drug dose correlation	Duration correlation	IQ Ancova *P* (*F*)
Benton face matching (54)	45·05 (4·45)/22 (44–18)	47·77 (2·8)/22 (47–50)	0·01 (136·5)	−0·64**	−0·17	0·12 (2·52)
Incomplete letters (20)	19·50 (0·66)/24 (19–20)	19·48 (0·51)/23 (19–20)	0·68 (259·0)	−0·26	−0·14	0·73 (0·13)
Naming silhouettes (30)	17·29 (3·76)/24 (14–20)	21·86 (3·54)/22 (18–25)	< 0·01 (93·5)	−0·27	−0·23	0·001 (11·56)
Position discrimination (20)	18·33 (1·17)/24 (18–19)	18·32 (1·91)/22 (18–19)	0·75 (252·0)	−0·38(*)	0·12	0·51 (0·44)
3-dimensional analysis (10)	7·70 (2·53)/23 (6–10)	9·32 (1·36)/22 (9–10)	< 0·01 (135·5)	−0·37(*)	−0·20	0·12 (6·99)

Table shows Benton face matching results and selected sub-tests from the Visual Object and Space Perception Battery. All subjects tested included in analysis. (S.D., Standard deviation; IQR, interquartile range; *N*, number of subjects.) Correlations are within patient group only. IQ Ancova shows main effect of diagnosis on ranked data with current IQ (Quick test) as covariate.
(*) $P < 0{\cdot}1$; * $P < 0{\cdot}05$; ** $P < 0{\cdot}01$.

Table 2. *Tests of face and non-facial recognition memory*

Test (maximum score)	Patient mean (S.D.)/*N* (IQR)	Control mean (S.D.)/*N* (IQR)	*U* test *P* (*U*)	Drug dose correlation	Duration correlation	IQ Ancova *P* (*F*)
Warrington faces (50)	39·21 (7·08)/19 (35–44)	44·47 (4·26)/17 (42–49)	0·02 (70·0)	−0·53*	−0·31	0·11 (2·72)
Famous faces (30)	25·05 (5·99)/19 (23–29)	28·82 (3·97)/17 (26–30)	0·45 (138·0)	0·07	−0·01	0·71 (0·14)
Complex designs (14)	11·25 (2·81)/20 (10–13)	13·06 (1·03)/17 (13–14)	< 0·01 (82·5)	−0·54*	−0·37	0·02 (6·29)
Warrington words (50)	45·22 (4·12)/18 (43–48)	46·88 (3·12)/17 (45–50)	0·17 (111·5)	−0·29	−0·23	0·56 (0·34)
Nonsense words (20)	17·74 (2·99)/19 (17–20)	18·65 (1·27)/17 (18–20)	0·68 (149·0)	−0·39(*)	−0·27	0·73 (0·12)

Table shows face and non-face recognition memory tasks. All subjects tested included in analysis. (S.D., Standard deviation; IQR, interquartile range; *N*, number of subjects.) Correlations are within patient group only. IQ Ancova shows main effect of diagnosis on ranked data with current IQ (Quick test) as covariate.
(*) $P < 0{\cdot}1$; * $P < 0{\cdot}05$; ** $P < 0{\cdot}01$.

Effects of IQ, duration of illness and neuroleptic dose

Face and non-face tests at corresponding levels of processing are shown in the tables: visuo-spatial perception (Table 1), memory (Table 2), linguistic (Table 3) and executive function (Table 4). At each level, patients were impaired relative to controls. Almost all the statistically significant group differences remained significant ($P < 0{\cdot}02$) in the IQ-covariance analysis of ranked data; the exceptions are indicated in the text. Correlations with drug dose and duration of illness were mostly in the expected direction although many were not statistically significant; they are described in the following sections.

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Table 3. *Language and naming; face, and non-face stimuli*

Test (maximum score)	Patient mean (S.D.)/*N* (IQR)	Control mean (S.D.)/*N* (IQR)	*U* test *P* (*U*)	Drug dose correlation	Duration correlation	IQ Ancova *P* (*F*)
Face affect photographs (30)	19·60 (3·24)/20 (17–22)	23·12 (2·80)/17 (21–26)	< 0·01 (68·0)	−0·30	−0·60**	0·01 (6·78)
Face affect descriptions (6)	4·60 (1·19)/20 (4–6)	5·41 (0·80)/17 (5–6)	0·03 (101·0)	−0·03	−0·33	0·15 (2·18)
Affect scenarios (29)	23·35 (5·33)/17 (20–28)	26·94 (1·60)/17 (26–29)	0·02 (78·5)	−0·40	−0·34	0·16 (2·07)
Graded naming (30)	16·58 (4·20)/24 (13–20)	21·87 (4·14)/23 (18–20)	< 0·01 (99·5)	−0·22	0·20	0·02 (6·45)
Semantic access for words (52)	50·37 (1·80)/19 (50–52)	50·81 (0·98)/16 (50–52)	0·67 (139·5)	−0·35	0·04	0·61 (0·27)
Semantic access for pictures (52)	49·63 (1·67)/19 (48–51)	50·65 (1·41)/17 (50–52)	0·04 (99·0)	−0·11	−0·28	0·17 (1·93)
Reception of grammar (80)	77·00 (2·40)/19 (75–79)	77·77 (2·05)/17 (76–80)	0·35 (132·5)	−0·22	−0·12	0·64 (0·22)

Table shows language and naming tasks, for face, affect and non-face, non affect tasks. All subjects tested included in analysis. (S.D., Standard deviation; IQR, interquartile range; *N*, number of subjects.) Correlations are within patient group only. IQ Ancova shows main effect diagnosis on ranked data with current IQ (Quick test) as covariate.
(*) $P < 0{\cdot}1$; * $P < 0{\cdot}05$; ** $P < 0{\cdot}01$.

Table 4. *Executive tasks with face and non-face stimuli*

Test (maximum score)	Patient mean (S.D.)/*N* (IQR)	Control mean (S.D.)/*N* (IQR)	*U* test *P* (*U*)	Drug dose correlation	Duration correlation	IQ Ancova *P* (*F*)
Faces by identity (64)	57·00 (6·34)/15 (50–64)	62·41 (4·62)/17 (63–64)	< 0·01 (55·0)	−0·77**	−0·64**	0·02 (6·41)
Faces by emotion (64)	57·20 (6·10)/15 (52–62)	59·88 (2·91)/17 (59–62)	0·34 (102·5)	−0·64**	−0·45(*)	0·99 (0·00)
Wisconsin Card Sort – categories (6)	3·44 (2·09)/15 (2–6)	5·82 (0·53)/17 (6–6)	< 0·01 (51·0)	−0·46(*)	−0·32	< 0·01 (12·74)
Verbal Fluency (FAS)	37·90 (10·46)/20 (30–47)	54·13 (13·38)/16 (41–68)	< 0·01 (51·5)	−0·13	−0·17	< 0·01 (11·87)

Table shows results for tasks assessing executive function, for face affect and non-face stimuli. All subjects tested included in analysis. (S.D., Standard deviation; IQR, interquartile range, *N*, number of subjects.) Correlations are within patient group only. IQ Ancova shows main effect diagnosis on ranked data with current IQ (Quick test) as covariate.
(*) $P < 0{\cdot}1$; * $P < 0{\cdot}05$; ** $P < 0{\cdot}01$.

Visuo-spatial function (Table 1)

Patients were impaired on matching a face to a sample of faces (Benton Test), although the difference became borderline significant after IQ covariation ($P = 0{\cdot}12$, see Table 1). However, patients were not impaired in identifying incomplete letters or in discriminating the positions of stimuli in the VOSP (Table 1). There were impairments in naming an object from a

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silhouette shown from an unusual angle and in matching a block design to its rotated equivalent (3D analysis). Benton face matching performance in patients correlated with 3D analysis ($r = 0{\cdot}50$, $P = 0{\cdot}02$), but not with the other components of the VOSP. Benton face matching and VOSP impairments correlated with drug dose (Table 1).

Recognition memory (Table 2)

Patients performed significantly less well than controls in recognizing the 50 faces of the Warrington Recognition Memory test ($P = 0{\cdot}11$ after IQ covariation). They were also impaired in recognizing designs. However, recognition memory for real words and for nonsense words was normal and there was no impairment in recognizing or naming famous faces. Impaired recognition memory for faces correlated with impaired recognition for designs ($r = 0{\cdot}57$, $P < 0{\cdot}05$) and both were inversely correlated with drug dose.

Naming and language tests (Table 3)

Patients were impaired on naming affect in photographs of faces. They were also significantly impaired in naming affects from descriptions of faces and scenarios but these differences did not remain statistically significant in the IQ covariance analysis. There were no corresponding impairments on comprehension of grammer and tests of semantic access. However, patients were impaired on graded naming (naming of objects). Affect naming from photographs correlated with: graded naming ($r = 0{\cdot}38$, $P = 0{\cdot}1$), naming affect from face descriptions ($r = 0{\cdot}52$, $P = 0{\cdot}02$), and naming affect scenarios ($r = 0{\cdot}63$, $P = 0{\cdot}007$). None of the negative correlations with drug dose were statistically significant (Table 3).

To determine whether the deficit in face affect naming might reflect a more general naming difficulty, an analysis of covariance on ranked data was carried out with covariates for graded naming and VOSP object naming; the effect of diagnosis on face affect naming was no longer statistically significant ($F = 1{\cdot}62$; df 1, 19; $P = 0{\cdot}22$).

Executive function (Table 4)

Patients were impaired on the Wisconsin Card Sort Test, verbal fluency and in sorting faces by identity (Hobson, 1986). However, patients were not impaired in sorting faces by emotion ignoring identity. Nevertheless, sorting by emotion and by identity were both correlated with Wisconsin Card sorting ($r = 0{\cdot}50$ and $0{\cdot}72$ respectively) but not with verbal fluency ($r = 0{\cdot}07$ and $0{\cdot}18$ respectively).

DISCUSSION

The aim of the study was to determine whether patients with schizophrenia have impairments of face processing which are unrelated to other neuropsychological impairments. The design was to compare face and non-face tasks at four levels of processing, perception, recognition memory, language and executive function. In addition, we investigated the role of general intellectual function and the possible confounds of neuroleptic dose and duration of illness.

In the patient group IQ, medication dose and duration of illness showed significant relationships with several of the neuropsychological test scores. However, all except four of the group differences remained statistically significant ($P < 0{\cdot}02$) in the analysis of covariance with current IQ, and the four exceptions remained so at borderline levels. It is difficult to know the extent to which group differences in test performance are due to drugs and chronicity since these factors apply only to patients. Furthermore, correlations with drugs or chronicity may simply reflect greater severity of illness rather than direct causal effects.

Previous studies have reported impaired Benton face matching in schizophrenia (Blanchard & Neale, 1994) but none have examined equivalent visuo-spatial perception function using standardized tests such as the VOSP tests. Patients were not impaired on all visuo-spatial tasks. They performed at maximum levels in identifying incomplete letters and in discriminating position. Visuo-spatial impairments were seen in the 3D test which requires the image to be mentally rotated. This is also a requirement of the Benton face matching task – the target face and the sample faces are photographed from different angles. Since performance on the Benton and 3D VOSP tasks were correlated in the patients, the results suggest that schizophrenia may involve an impaired ability to manipulate mental images. This may contribute

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to the frequently reported impairments of visuo-spatial working memory since this also depends on the ability to manipulate mental images (Park & Holzman, 1992).

Patients were impaired in recognizing faces (Warrington Recognition Memory Test), but were unimpaired on word recognition as we have previously found (Whittaker *et al.* 1994). Since the faces were initially novel to subjects, but the words, inevitably, were familiar, we tested recognition of a list of nonsense words. Nevertheless, making the verbal stimuli unfamiliar did not induce impaired performance in the patients. Thus, the patients have intact verbal recognition. In our previous study, we could not exclude the possibility that impaired face but normal verbal recognition was part of a wider impairment of visuo-spatial recognition. In the present study, patients were impaired on design recognition and this correlated with impaired face recognition. Impaired visuo-spatial recognition in schizophrenia may be part of the impaired ability to process mental images suggested above, since recognizing designs and faces involves mental matching of current stimuli against stored images. However, it is notable that performance on the Benton, Warrington faces, design recognition and 3D rotation were appreciably influenced by neuroleptic dose. Since this is not true of other tests (see below), impaired visuo-spatial manipulation could be an effect of neuroleptics.

We have replicated our previous finding that patients with schizophrenia are inaccurate in naming emotions in faces. There was also a correlated impairment in the ability to name emotions in written descriptions of faces. It could be argued that this requires the creation of a mental image of a face whose emotion in then named – as in the task with photographs. However, it seems more likely that impaired face emotion naming is part of a wider impairment of semantic memory because there was a correlated impairment in naming emotions in the descriptions of experiences. The semantic difficulty is not apparently confined to emotions since there was a major group difference in graded naming which correlated with face-emotion naming. Furthermore, patients were strikingly impaired in naming silhouettes of everyday objects from unusual viewpoints (VOSP). The group difference in face affect naming was no longer statistically significant when graded naming and VOSP silhouette naming were entered as covariates. This suggests the face emotion deficit reflects a more general semantic difficulty.

At first sight the essentially normal performance of patients on the Pyramids and Palm Trees Tests for semantic access seems incompatible with impaired semantic function in schizophrenia. However, two points lessen the difficulty. First, all subjects performed close to ceiling and so the tests may be insufficiently difficult to discriminate between the two groups. Secondly, the test items do not require recall since pairs of words and of objects to be matched are presented – in contrast to the object and silhouette naming tasks. The normal performance of patients on the Pyramids and Palm Trees Tests may indicate that the impairment of naming lies in retrieval from the semantic stores rather than in the store itself. This agrees with the conclusion of Allen *et al.* (1993) in their study of verbal fluency. The findings corroborate other evidence that impairment of access to information in semantic stores occurs in schizophrenia (Chen *et al.* 1994). In contrast to the visuo-spatial impairments, drug dosage had no statistically significant influence on any of the naming tasks. This might suggest that impaired naming may lie closer to the neurocognitive core of schizophrenia than impaired visuo-spatial function. Indeed, Crow (1997) has speculated that schizophrenia is a disorder associated with the evolution of language, which involves abnormal relations between objects and signifiers (i.e. names).

The Hobson task requires subjects to group the same set of individual faces by their emotion or by their identity, one dimension (emotion or identity) requires attention while attention to the other has to be suppressed. This is analogous to the requirement for Wisconsin Card sorting to suppress attention to the irrelevant stimulus dimensions. While matching faces by identity was impaired in patients, matching by emotion was not. However, performance on both was correlated with Wisconsin Card sort performance which itself was markedly impaired in patients as has often been reported (Weinberger *et al.* 1986). We included verbal fluency as a control executive function task for the Hobson test but clearly the Wisconsin Card sorting test has the closer homology is terms of attentional

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requirements. As others have reported, impaired verbal fluency and Wisconsin Card sorting maybe independent deficits in schizophrenia (e.g. Mahurin *et al.* 1998).

We conclude that there is little evidence that schizophrenia involves specific impairments in processing information in faces. We have replicated previously reported impairments in face identity and emotion perception and of recognition but found they are probably due to three wider neuropsychological impairments: a drug-related impairment of visual mental imagery, and disease-related impairments in semantic retrieval and in executive function.

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REFERENCES

Addington, J. & Addington, D. (1998). Facial affect recognition and information processing in schizophrenia and bipolar disorder. *Schizophrenia Research* **32**, 171–182.

Allen, H. A., Liddle, P. F. & Frith, C. D. (1993). Negative features, retrieval processes and verbal fluency in schizophrenia. *British Journal of Psychiatry* **163**, 769–775.

Ammons, R. B. & Ammons, C. H. (1962). *The Quick Test*. Psychological Test Specialists: Missoula, MT.

Archer, J., Hay, D. C. & Young, A. W. (1992). Face processing in psychiatric conditions. *British Journal of Clinical Psychology* **31**, 45–61.

Archer, J., Hay, D. C. & Young, A. W. (1994). Movement, face processing and schizophrenia: evidence of a differential deficit in expression analysis. *British Journal of Clinical Psychology* **33**, 517–528.

Benton, A. L., Hamsher, K, de S. Varney, N. R. & Spreen, O. (1983). *Contributions to Neuropsychological Assessment: A Clinical Manual*. Oxford University Press: Oxford.

Benton, A. L. & Van Allen, M. W. (1973). *Test of Facial Recognition: Manual*. University of Iowa: Iowa City.

Bishop, D. V. M. (1982). *TROG – Test for Reception of Grammar*. Medical Research Council/Chapel Press: London.

Blanchard, J. J. & Neale, J. M. (1994). The neuropsychological signature of schizophrenia: generalised or differential deficit. *American Journal of Psychiatry* **151**, 40–48.

Bryson, G., Bell, M. & Lysaker, P. (1997). Affect recognition in schizophrenia: a function of global impairment or a specific cognitive deficit. *Psychiatry Research* **71**, 105–113.

Chen, E. Y. H., Wilkins, A. J. & McKenna, P. (1994). Semantic memory is both impaired and anomalous in schizophrenia. *Psychological Medicine* **24**, 193–202.

Corcoran, R. & Frith, C. D. (1996). Exploring theory of mind in schizophrenia. *Psychological Medicine* **26**, 521–530.

Crow, T. J. (1997). Is schizophrenia the price that *Homo sapiens* pays for language? *Schizophrenia Research* **28**, 127–141.

Crow, T. J. & Mitchell, W. S. (1975). Subjective age in chronic schizophrenia: evidence for a subgroup of patients with defective learning capacity. *British Journal of Psychiatry* **126**, 360–363.

Cutting, J. (1981). Judgement of emotional expression in schizophrenics. *British Journal of Psychiatry* **139**, 1–6.

Cutting, J. (1985). *The Psychology of Schizophrenia, 1st edn*. Churchill Livingstone: Edinburgh.

Ekman, P. & Friesen, W. V. (1984). *Unmasking the Face*. Consulting Psychologists Press Inc.: Palo Alto, California.

Feinberg, T. E., Rifkin, A., Schaffer, C. & Walker, E. (1996). Facial discrimination and emotional recognition in schizophrenia and affective disorders. *Archives of General Psychiatry* **43**, 276–279.

Foster, P. (1989). Neuroleptic equivalence. *Pharmaceutical Journal* 30 Sept., 431–432.

Frith, C. D. (1992). *The Cognitive Neuropsychology of Schizophrenia*. Lawrence Erlbaum Associates, Publishers: Hove.

Harris, P. L. (1989). *Children and Emotion: The Development of Psychological Understanding*. Blackwell: Oxford.

Heaton, R. K. (1981). *Wisconsin Card Sort Test Manual*. Psychological Assessment Resources: Odessa, FL.

Hobson, R. P. (1986). The autistic child's appraisal of expressions of emotion. *Journal of Child Psychology and Psychiatry* **27**, 321–342.

Howard, D. H. & Patterson, K. (1992). *The Pyramids and Palm Trees Test: A Test of Semantic Access from Words and Pictures*. Thames Valley Test Company: Bury St. Edmunds.

Hyde, T. M., Nawroz, S., Goldberg, T. E., Bigelow, L. B., Strong, D., Ostrem, J. L., Weinberger, D. R. & Kleinman, J. E. (1994). Is there a cognitive decline in schizophrenia: a cross-sectional study. *British Journal of Psychiatry* **164**, 494–500.

McKenna, P. J. & Warrington, E. K. (1983). *The Graded Naming Test*. NFER-Nelson: Windsor.

McKenna, P. J., Mortimer, A. M. & Hodges, J. R. (1994). Semantic memory and schizophrenia. In *The Neuropsychology of Schizophrenia* (ed. A. S. David and J. C. Cutting), pp. 215–219. Lawrence Erlbaum Associates: Hove.

Mahurin, R. K., Velligan, D. I. & Miller, A. L. (1998). Executive-frontal lobe cognitive dysfunction in schizophrenia: a symptom subtype analysis. *Psychiatry Research* **79**, 139–149.

Nelson, H. E. (1982). *The National Adult Reading Test* (*NART*). NFER-Nelson: Windsor.

Novic, J., Luchin, D. J. & Perline, R. (1984). Facial affect recognition in schizophrenia: is there a differential deficit? *British Journal of Psychiatry* **144**, 533–537.

Park, S. & Holzman, P. S. (1992). Schizophrenics show spatial working memory deficits. *Archives of General Psychiatry* **49**, 975–982.

Saykin, A. J., Gur, R. C., Gur, R. E., Mozley, D., Mozley, L. H., Resnick, S. M., Kester, B. & Stafiniak, P. (1991). Neuropsychological function in schizophrenia: selective impairment in memory and learning. *Archives of General Psychiatry* **48**, 618–624.

Saykin, A. J., Shtasel, D. L., Gur, R. E., Kester, D. B., Mozley, L. H., Stafiniak, P. & Gur, R. C. (1994). Neuropsychological deficits in neuroleptic naive patients with first episode schizophrenia. *Archives of General Psychiatry* **51**, 124–131.

Shirley, E. A. C. (1981). A distribution-free method for analysis of covariance based on ranked data. *Applied Statistics* **30**, 158–162.

Walker, E., Marwitt, S. J. & Emory, E. (1980). A cross-sectional study of emotion recognition in schizophrenics. *Journal of Abnormal Psychology* **89**, 428–436.

Warrington, E. K. (1984). *The Recognition Memory Test*. NFER-Nelson: Windsor.

Warrington, E. K. & James, M. (1991). *The Visual Object and Space Perception Battery*. Thames Valley Test Company: Bury St. Edmunds.

https://doi.org/10.1017/S0033291701003701 Published online by Cambridge University Press

Weinberger, D. R., Bernam, K. F. & Zec, R. F. (1986). Physiologic dysfunction of dorsolateral prefrontal cortex in schizophrenia. *Archives of General Psychiatry* **43**, 114–124.

Weinberger, D. R., Berman, K. F., Suddath, R. & Fuller Torrey, E. (1992). Evidence of dysfunction of a prefrontal-limbic network in schizophrenia: a magnetic resonance imaging and regional cerebral blood flow study of discordant monozygotic twins. *American Journal of Psychiatry* **149**, 890–897.

Whittaker, J. F., Connell, J. & Deakin, J. F. W. (1994). The neurobiology of receptive and expressive social communication in schizophrenia. *International Journal of Psychopathology Research* **27**, 262–267.

https://doi.org/10.1017/S0033291701003701 Published online by Cambridge University Press