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Perceptual organization deficits in psychotic patients

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Abstract

It has been proposed that a characteristic of schizophrenic processing is an abnormality of top-down processing. The relationship between impaired top-down processing and symptoms of reality distortion was investigated using a 'degraded interference' task. In this task, fragmented stimuli (Stroop words, control words and crosses) are presented on a computer screen, and the extent to which they are visually integrated is inferred by their interfering properties. It was predicted that psychotic individuals would fail to show an interference effect with degraded Stroop stimuli. This predicts the *absence* of a delay in reaction time in the experimental condition, which therefore cannot be attributed to a generalized deficit. A sample of inpatients experiencing positive symptoms was compared to a healthy control group. The results provided support for a deficiency in top-down processing, with the psychotic group failing to show the significant degraded interference effect found in the healthy controls. Degraded interference was associated with low verbal IQ, but with no other symptomatic or demographic variables.

Keywords: Schizophrenia; Top-down processing; Perceptual organization; Degraded Stroop

1. Introduction

There is a plethora of experimental work attempting to pinpoint the cognitive abnormality underlying schizophrenia which leads to the symptoms of intrusions and discontinuities in conscious experience. Hemsley (1987) has suggested that 'it is a weakening of the influences of stored memories of regularities of previous input on current processing which is postulated as basic to the schizophrenic condition' (p. 182). Thus, the use of 'top-down' processing (also known as 'conceptually driven', or 'Gestalt' processing), in which new stimuli are compared with stored regularities and memories of past experience for their interpretation, is thought to be reduced in schizophrenic processing. Such a dysfunction is likely to affect processing throughout the cognitive repertoire, including the automatic sphere of processing involved in visual perception. In this context abnormal top-down influences will lead to a failure to make use of the structure and patterning of sensory input to reduce processing demands in the organization of perceptions, resulting in an inabil-

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ity to perceive stimuli in a Gestalt or holistic fashion.

Such an impairment has also been articulated by Cutting (1985) as 'schizophrenics concentrate on detail at the expense of theme' (p. 300), and by Knight (1984) as 'individual elements of a stimulus are processed separately rather than as parts in cohesive wholes' (p. 120). Some experiences reported by individuals with schizophrenia strongly suggest such a deficit: 'I may look at a garden, but I do not see it as I normally do. I can only concentrate on details. For instance I can lose myself looking at a bud on a branch, but then I do not see anything else' (Matussek, 1952, p. 92).

Several studies have demonstrated that patients with schizophrenia are deficient in perceptual organization in a variety of tasks, including visual search (Cox and Levanthal, 1978; Knight, 1992; Silverstein et al., 1996a) and numerosity paradigms (Schwartz-Place and Gilmore, 1980; Rabinowicz et al., 1996; Wells and Leventhal, 1984). Typically, individuals with schizophrenia display relatively superior target detection or counting of elements in conditions with little stimulus grouping compared to baseline, an advantage not shown by controls where normal processing interferes with effective performance in such conditions. In general, these data have been interpreted as indicating that the impairment involves top-down influences on perceptual processing.

Empirical evidence for the specificity of this dysfunction has been accumulating for some time. Firstly, patients with schizophrenia do not show a perceptual organization deficit when processing aspects of visual form that do not require matching current percepts to memory representations (i.e. top-down influences; Peterson, 1994), such as symmetry (Knight et al., 2000) or closure (Chey and Holzman, 1997). These types of feature have been termed 'geons' (Bierderman, 1987) and are considered to be the fundamental visual primitives to which the visual system is predisposed to respond.

Secondly, Schwartz-Place and Gilmore (1980) reported that controls demonstrated superior grouping of stimuli that occurred 33% of the time when these stimuli were presented in the context of other grouped stimuli (Study 2) compared to when they were presented among non-grouped stimuli (Study 1). In contrast, patients with schizophrenia did not demonstrate this superiority in their Study 2. This implies that the perceptual organization deficit may reflect an impairment in the ability to generate top-down feedback to earlier perceptual processes.

Finally, Silverstein et al. (1996a,b) provided conclusive evidence that deficiencies in perceptual organization in patients with schizophrenia are not simply a product of 'bottom-up' processing, wherein stimulus components are grouped solely on the basis of physical characteristics, but also involve top-down factors. Silverstein et al. (1996a) showed that a clear perceptual organization deficit could be eliminated by a task manipulation thought to aid in context processing, i.e. an enhancement of top-down feedback to perceptual processes (Kosslyn and Koening, 1992). Silverstein et al. (1996b) found that a contextual manipulation that allowed controls to reduce the interfering effect of an irrelevant stimulus in an auditory task, did not affect schizophrenia patients' performance, i.e. they had a reduced ability to utilize contextual (top-down) cues. In contrast, a task manipulation which relied on physical (bottom-up) characteristics improved performance in both controls and patients.

Recently, attempts have been made to link cognitive disturbances with the expression of specific aspects of schizophrenic symptomatology. The diagnostic category represented by schizophrenia encompasses a widely heterogeneous set of symptoms, from paranoia to catatonia. A limitation in interpreting cognitive and perceptual studies of schizophrenia is that the symptom constellations of the sample are often not provided, and it is unclear whether one particular symptom cluster is over- or under-represented in the sample. Furthermore, there are no clear dividing lines between schizophrenia and normal functioning (Claridge, 1994; Peters et al., 1999), or between schizophrenia and the affective disorders (Kendell, 1991). This has led to the recent adoption of a symptom approach across diagnostic categories, which so far appears promising (e.g. Bentall et al., 1994; Garety et al., 1991).

Hemsley (1993) relates cognitive aberrations specifically to the development of positive symptomatology. Mixed results have been obtained in the few studies which have attempted to link symptoms with a perceptual deficit. Ferman et al. (1999), using a directed global–local paradigm, found that high positive symptom severity was associated with local interference, i.e. when attention was focused on the global level of the hierarchy, the to-be-ignored local forms interfered with processing the global forms. However, other studies found that the deficit was not related to symptoms per se, but to the stage (Silverstein et al., 1996a) or subtype (Knight and Silverstein, 1998) of the illness.

The present study set out to investigate the information processing style of psychotic individuals. A 'symptom-approach' was adopted, whereby subjects were selected by virtue of their psychotic symptomatology rather than their diagnosis. Top-down processing was measured using a 'degraded interference' task, which used fragmented Stroop stimuli. Healthy subjects exposed to degraded stimuli should automatically integrate the cues to gain semantic information from the stimulus, and should therefore be able to detect the distracting colour words, resulting in a Stroop interference effect, i.e. longer reaction times (RTs). For psychotic individuals, however, with reduced resources for top-down processing, the degraded Stroop words may appear as random colour patterns, and therefore fail to produce the usual Stroop effect[1]. A pilot study (John, 1989, unpublished thesis) indicated a lack of RT inhibition of degraded Stroop words relative to non-words (control Xs) in patients with schizophrenia but not in controls. It should be noted that impaired performance (i.e. relatively slower RTs) in the degraded Stroop condition (DSC) is predicted in the *healthy*, rather than the psychotic population, so that any differential performance cannot be attributed to the non-specific generalised deficit typical of schizophrenia. Inferring information-processing deficits from superior performance in psychotic patients is an obvious improvement on many previous methodologies, where it is often impossible to disentangle the impairment of theoretical interest from general poor performance. Indeed, Knight and Silverstein (2001) advocate that while the 'superiority strategy', i.e. finding a task in which a predicted specific deficiency yields performance superiority, is the most difficult to implement, it is the most powerful of all the process-oriented approaches they recommend for studying deficiencies in schizophrenia.

[1] Please note that we are not implying that the Stroop interference effect per se involves top-down processes, but merely that the integration of the degraded Stroop stimuli is subject to top-down influences.

2. Methods

2.1. Design

A 2×3 mixed design was used. The between-participants factor was the grouping variable (two levels: psychotic and healthy), and the within-participants factor was the type of condition (three levels: control, degraded control, and degraded Stroop). The control condition (CC) consisted of a row of coloured Xs, the degraded control condition (DCC) of degraded words representing units of time, and the DSC of degraded colour words. There were six trials in each condition, each trial consisting of nine successive stimuli. This particular trial configuration was chosen to be compatible with negative priming experiments being carried out simultaneously in the authors' laboratory (Peters et al., 2000). Trials were presented in a fixed random order.

2.2. Participants

In-patients were selected from the Maudsley and the Bethlem Royal Hospitals. Only patients who were described by the responsible clinician as currently having some psychotic features, with no history of neurological impairment or alcohol abuse, were selected, irrespective of diagnosis. Complete data on the degraded interference task were obtained for 11 individuals, 4 women and 7 men. They had a mean age of 31 years, ranging from 22 to 39, a mean total length of stay in hospital of 46.5 weeks (S.D. = 72.5), and a mean age of onset of 25 years (S.D. = 6).

All individuals scored two (i.e. moderate severity) or more on at least one positive symptom (hallucinations, delusions and incoherence of speech) of the Manchester Scale (MS; Krawiecka et al., 1977). This information was confirmed by case-note review. The MS was completed by the psychiatrist in charge of the patient's care (the Senior House Officer; SHO), who was an experienced clinician and interviewer. All SHOs were based on the ward 4–5 days a week and would interview the patients at least once weekly for ward round reports. The MS measures both the presence and severity of symptoms on a five-point scale over the past week. Eight symptoms are recorded, falling into three main categories: affective (depression and anxiety); positive (delusions, hallucinations, and incoherence and irrelevance of speech); and negative (poverty of speech, flattened incongruous affect, and psychomotor retardation). The MS symptom items had a Cronbach alpha coefficient of 0.85, indicating adequate internal reliability. Although inter-rater reliability was not ascertained in this study, Krawiecka et al. (1977) report acceptable concurrent reliability (independent ratings of a single videotaped interview), whilst Manchanda et al. (1986) have demonstrated high reliability (both inter-rater and test–retest) for most items, but especially the positive features, which were of particular interest in this study. Jackson et al. (1990) also confirmed the reliability and concurrent validity (using the Scale for the Assessment of Positive Symptoms, Andreasen, 1984) of the positive symptoms. The MS is reported by Garety and Wessely (1992) to have acceptable psychometric properties for the measurement of positive symptoms, and Manchanda et al. (1986) concluded that the MS is a superior scale to the Brief Psychiatric Rating Scale (BPRS; Overall and Gorman, 1962). It therefore seems reasonable to assume that the ratings obtained in the present study were reliable, especially for the positive symptoms, which were of central interest.

The mean score of the psychotic group on the MS affective symptoms was 2.8 (S.D. = 2.3), on the positive symptoms 7.4 (S.D. = 2.0), and on the negative symptoms 1.7 (S.D. = 2.6). All patients but one were on a combination of medications at the time of testing, including typical neuroleptics, lithium, and antidepressants. All patients had normal colour vision, and normal or corrected-to-normal acuity. The synonyms part of the Mill Hill Vocabulary Scale (MHVS; Raven, 1982) was used as a measure of verbal IQ (mean verbal IQ[2] = 95.2, S.D. = 8).

Eight of the psychotic group were diagnosed with schizophrenia or paranoid schizophrenia, two with acute psychosis not otherwise specified (ICD-10, World Health Organisation, 1992), and one with schizoaffective disorder.

The healthy control group consisted of 13 individuals, eight women and five men, from the Institute of Psychiatry Subject Pool. They had all indicated on the demographics form that they had no psychiatric history and were not taking any prescribed drugs at the time of testing. They all had normal colour vision, and normal or corrected-to-normal acuity. They had a mean age of 31 years, ranging from 21 to 54, and a mean verbal IQ of 98.8 (S.D. = 9.7)

There was no significant difference between the two groups in age, verbal IQ or gender (age: $F = 0.03$, d.f. = 1,22, $P = 0.9$; verbal IQ: $F = 0.9$, d.f. = 1,21, $P = 0.4$; gender: $\chi^2 = 1.5$, d.f. = 1, $P = 0.2$).

2.3. Apparatus

Stimuli were presented on an Atari 1040ST computer and Atari SC1224 colour monitor. Participants' responses were recorded by a voice–key interface to the computer. The computer timed the RTs to the nearest 5 ms. A four-button box, each button representing a different colour, was used manually by the experimenter (EP) to enter the participants' verbal responses. The button-box was connected via a games port to the computer which could therefore automatically record errors.

2.4. Stimuli

The stimuli in the DSC consisted of the words 'BLUE', 'GREEN', 'YELLOW' and 'RED' displayed in upper-case characters and were either of blue, yellow, red or green hue. The word 'BLUE' never appeared in blue, and the same was true for all other colours.

[2] This mean is based on $n = 10$, since 1 participant did not complete the Mill Hill Vocabulary Scale.

The stimuli in the DCC consisted of the words 'MONTH', 'YEAR', 'DAY' and 'DECADE' displayed in upper-case characters and were either of blue, yellow, red or green hue. The degraded control words were chosen from the category representing 'units of time' (Battig and Montague, 1969) to control for the fact that the Stroop words all belonged to the same semantic category. The control and Stroop words were also matched in length, and in familiarity ($t = -1.86$, d.f. $= 6$, $P = 0.13$, two-tailed test; Battig and Montague, 1969).

The degraded words in the DSC and the DCC were automatically degraded by the computer by removing 45% of pixels[3] from the words in a random fashion. Fig. 1 shows a representation of one of the degraded words.

A row of either three, four, five or six coloured Xs was used for the CC, again displayed in either red, green, yellow or blue.

A pattern mask was added after presentation of all stimuli in all conditions to remove the possibility of any after-image following the stimuli. The pattern mask consisted of a grid made up of horizontal and vertical lines of the same four colours, all four colours appearing simultaneously after the 100-ms presentation of each stimulus. All stimuli appeared in the centre of the screen, and subjects sat 27 inches away from the monitor.

A recognition task was included to be filled out immediately after completion of the task. Twenty words were presented to participants, typed in capital letters. The words included the four colour words and the four words representing units of time used in the task. An extra 12 words consisted of (a) four other colour words ('GOLD', 'BROWN', 'ORANGE', 'GREY'), matched in length and reasonably matched in familiarity to the colour words exposed during the task ($t = 2.74$, d.f. $= 6$, $P = 0.06$); (b) four units of time ('SECOND', 'WEEK', 'HOUR', 'CENTURY'), matched in length and familiarity to the control words presented in the task ($t = -0.15$, d.f. $= 6$, $P = 0.9$, two-tailed tests); (c) and four words representing types of relatives ('SON', 'WIFE', 'SISTER', 'AUNT'), matched in length and familiarity to both types of words used in the task ($F = 2.42$, d.f. $= 2,9$, $P = 0.14$; Battig and Montague, 1969).

[3] The degradation level was piloted in a sample of nine normal participants who were exposed to six trials each consisting of nine successive stimuli (54 exposures in total), three trials of the DCC and three of the DSC. Three participants were exposed to words degraded by 40%, three to words degraded by 45%, and three by 50%. Participants were asked to identify the stimuli displayed on the screen, and participants' responses were recorded manually. Correct identifications were made for 84% of the words at the 40% degradation level, 61% at the 45% level, and 18% at the 50% level. The 45% level was therefore chosen to avoid floor or ceiling effects.

2.5. Procedure

Participants were informed that 'something' would be displayed on the screen, and were instructed to name the ink colour of each stimulus. They were asked to respond as quickly and as accurately as possible. The (EP) sat by the participants' side throughout the task to ensure they remained on task.

Each stimulus presentation consisted of the following: a black fixation cross displayed for 500 ms, followed by the stimulus. After 100 ms the pattern mask appeared and remained on display until the subject triggered the voice-key; the next fixation cross was then presented immediately after the (EP) coded the subject's response via a button press. This was repeated until the participant had been exposed to nine items. One trial therefore consisted of nine stimuli presentations, all of the same condition (i.e. nine CC words in a row, or nine DSC words in a row, etc.). At the end of each trial the participant's mean RT and the number of errors made were displayed on the screen. The participant then pressed the space bar to access the next trial.

All participants were given three practice trials (one CC trial, one DCC trial, and one DSC trial). There were then six trials (i.e. 6×9 stimuli presentations) in each condition. The task consisted of six DCC trials, six DSC trials, and six CC trials, presented in a fixed random order.

Immediately after completion of the task the participants were asked whether they had detected what the stimuli consisted of during the task. If the participant replied she/he had seen some words, the recognition task was administered. The recognition task was not given if the participant did not report having seen any words.

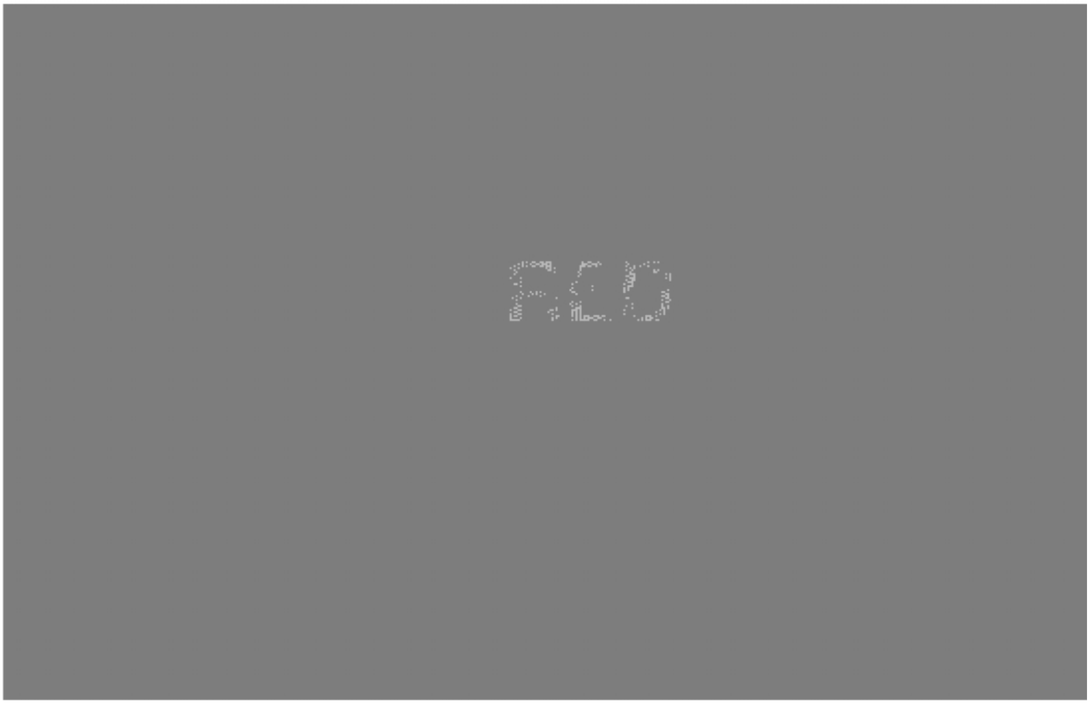

Fig. 1. Example of degraded word stimulus.

Only the RTs for items two to nine in each trial ($n=48$ for each condition) were included in the analysis. All RTs where an error had occurred were automatically excluded. All outliers (RT> 1.5 s) were also automatically excluded by the computer programme. The difference in mean RT between the DSC and the DCC represented the amount of 'degraded interference'.

3. Results

Fig. 2 shows the boxplots of the RT data for the three conditions in each group. The RT data were submitted to a log transformation before being entered into a 2×3 mixed ANOVA, in order to avoid the inhomogeneities of variance caused by the greater standard deviations in the psychotic group. The results showed a significant overall difference between the groups ($F=21.1$, d.f.$=$1,22, $P<0.001$) with the psychotic group having slower RTs. The group by condition interaction was significant ($F=5.7$, d.f.$=$2,44, $P<0.01$). Interaction terms from within-subject repeated contrasts revealed that this interaction was due to significant differences between the groups in both DSC vs. DCC ($F=4.4$, d.f.$=$1,22, $P<0.05$) and DCC vs. CC ($F=4.6$, d.f.$=$1,22, $P<0.05$).

Related sample *t*-tests on the log-transformed data were carried out for each group separately to determine where significant differences between conditions lay. Our hypotheses predicted that the healthy control group, but not the psychotic group, would be significantly slowed down by the DSC words relative to the DCC words. As predicted, there was a significant difference between DSC and DCC in the control group ($t=9.4$, d.f.$=$12, $P<0.001$), but not in the psychotic group ($t=1.7$, d.f.$=$10, $P>0.1$; two-tailed tests). Similarly, there was a significant difference between DCC and CC in the control group ($t=3.5$, d.f.$=$12, $P<0.01$), but not in the psychotic group ($t=1.6$, d.f.$=$10, $P>0.1$; two-tailed tests).

A 2×3 mixed ANOVA was also computed on the error data (also submitted to a log transformation); the means of the number of errors made in each condition are displayed in Table 1.

A significant group difference was found ($F=8.6$, d.f.$=1,22$, $P<0.01$), with the psychotic group making more errors overall. The group by condition interaction was not significant ($F=0.76$, d.f.$=2,44$, $P>0.05$), nor were the within-subject repeated contrast interactions (DSC vs. DCC: $F=1.4$, d.f.$=1,22$, $P>0.05$; DCC vs. CC: $F=1.2$, d.f.$=1,22$, $P>0.05$), indicating that there was no differential pattern of errors between the groups.

In the patient sample, no significant correlations were found between degraded interference, measured by (DSC RT−DCC RT), and age, length of stay in hospital, age at onset, MS affective scores, MS positive symptom scores, MS negative symp-

Table 1
Means and standard deviations (in parentheses) of number of errors made in each condition

	Psychotic group ($n=11$)	Control group ($n=13$)
Degraded Stroop	9.9 (9.3)	3.3 (2.5)
Degraded control	5.6 (6.4)	0.9 (1.1)
Crosses	2.1 (2.1)	0.3 (0.5)

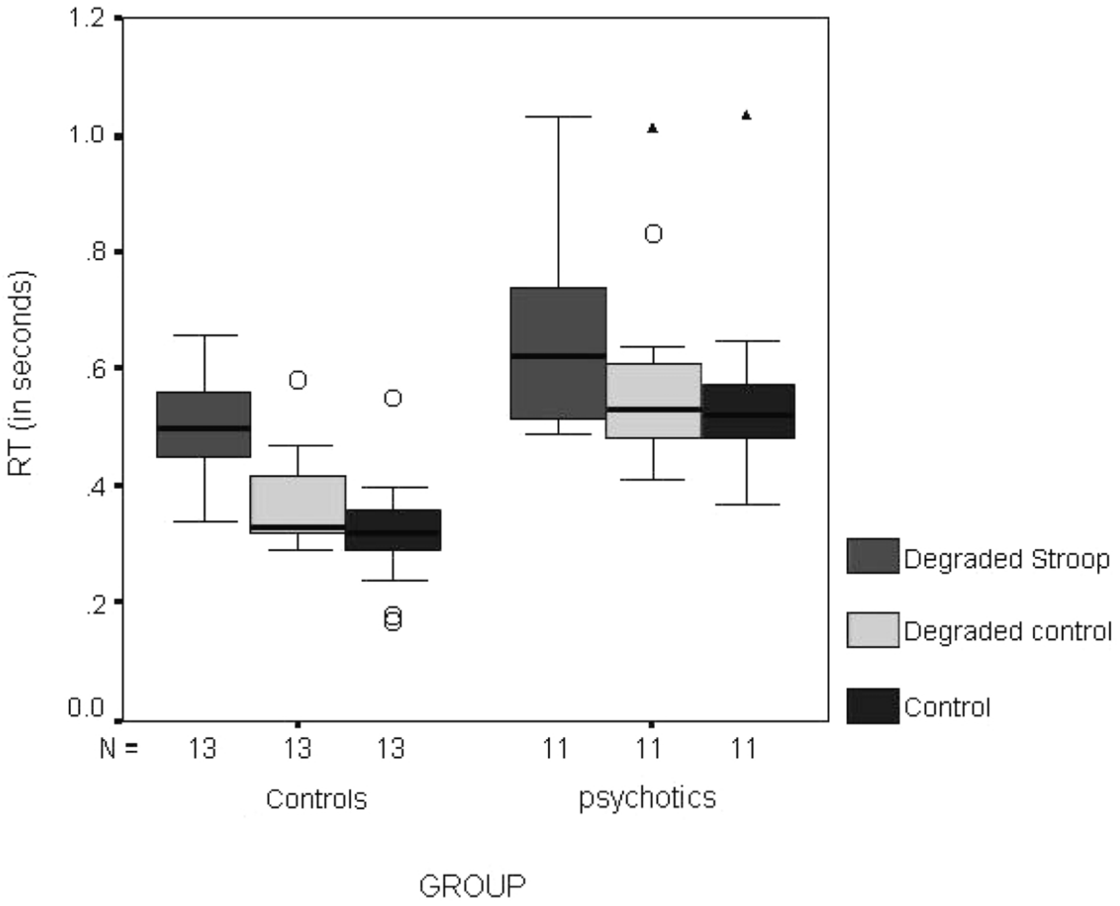

Fig. 2. Boxplots of the RT data for the three conditions in each group. Boxes represent the interquartile ranges (containing 50% of values); the lines extending from the box represent the full range from the highest to the lowest values, excluding outliers (circles) and extremes (triangles). The line across each box indicates the median. Outliers are cases with values between 1.5 and 3 box lengths from the upper of lower edge of the box; extremes are cases with values more than 3 box lengths from the upper of lower edge of the box.

tom scores, or any of the individual MS symptom scores. However, a significant positive correlation was found with verbal IQ ($r=0.73$, $n=10$, $P<0.05$; two-tailed test). This finding was specific to the patient group (control group: $r=0.43$, $n=13$, $P>0.05$; two-tailed test).

Participants' responses on the recognition task were divided into those who correctly identified the four colour words and those who correctly identified fewer than four of these words. Units of time words were infrequently recognised. Hits only were analyzed, as false positives were infrequent. Only one (who identified three words) out of 13 subjects in the control group identified fewer than four words. However, in the psychotic group, four out of 11 identified fewer than four words (including two who failed to notice that any of the stimuli consisted of words). This difference just failed to reach significance ($\chi^2=3.24$, d.f.$=1$, $P=0.07$).

4. Discussion

Our results provide support for the hypothesis that psychotic patients show a reduced ability to use top-down processing. Intact processes would lead to the automatic integration of the degraded Stroop words used in this study, resulting in a normal Stroop effect. However, no differences in RTs were found between DSC and DCC in the psychotic patients, unlike in the healthy controls. Cross-group comparisons confirmed that the degraded interference effect (i.e. DSC – DCC) was significantly smaller in the psychotic group. The finding that psychotic patients were not significantly slowed down by the degraded control words compared to crosses, unlike the controls, is a further indication that they were not integrating the degraded words, since normal integration would lead to slower processing of any words, compared to non-words. The performance of the two groups was not due to a differential pattern of errors across the three conditions, which were similar for both groups, although the psychotic group made significantly more errors than the control group overall. There was no speed-error trade-off since the psychotic group was also slower overall.

These results extend previous findings demonstrating a reduced ability to use top-down processing in schizophrenic patients (e.g. John and Hemsley, 1992; Knight, 1992; Knight and Silverstein, 1998; Silverstein et al., 1996a,b; Silverstein and Palumbo, 1995). Although the sample was small, nevertheless the absence of significant RT delays in the key conditions in the psychotic group is a much more powerful methodology in demonstrating processing impairments than the usual finding of slow performance on cognitive tasks (Knight and Silverstein, 2001). Furthermore, the use of Stroop words in this task makes our results even more persuasive, since psychotic patients typically show an exaggerated Stroop effect (Cohen and Servan-Schreiber, 1992), implying that intact top-down processing would in fact have resulted in a significantly *larger* degraded interference effect in the psychotic patients.

A symptom-approach was adopted in the present study to circumvent the problems of comparing heterogeneous patients with schizophrenia with other, equally heterogeneous individuals. While our approach ensured that all the participants were currently experiencing positive symptoms, eight of the 11 patients had a diagnosis of schizophrenia. It therefore cannot be determined whether the deficit found relates to positive symptoms or to the diagnosis of schizophrenia. The fact that no relationship was found with any of the symptom measures would suggest that the link is more likely to be with the latter. However, it should be noted that while the MS is a reliable measure to detect the presence or absence of a symptom, it is not the most sensitive to symptom severity. Furthermore, patients were selected only if they scored at least two on one or more positive symptoms, thereby artificially reducing the range, and therefore strength, of the correlation in an already small sample. Further work is needed to disentangle the relationship between diagnosis, symptoms and perceptual aberration. Longitudinal studies of patients who proceed from inpatient to outpatient status would also be helpful in determining whether perceptual organization deficiencies are stable over time or relate to the acute exacerbation of symptoms associated with inpatient samples.

No significant relationships were found between degraded interference and most of the other demographic variables measured in this study. However, a significant positive correlation was found between verbal IQ and the amount of degraded interference in the patient group only. Poor premorbid functioning, which may be at least partly related to IQ, has also been associated with current perceptual organisation ability (Knight, 1992). In a similar vein, Garety et al. (1991) reported that abnormal cognitive functioning on a probability reasoning task was confined to a sub-sample of deluded patients with lower verbal IQ and more likely to be currently subject to anomalous experiences, rather than being characteristic of the whole group. These data suggest that even within individuals who exhibit the same positive symptomatology there may be a wide variation in information-processing style. It is unclear from the present study whether a low IQ is responsible for the reduced ability to use top-down processing, whether the abnormal processing causes low IQ, or whether the two are unrelated, but in conjunction create a vulnerability to experiencing psychotic symptoms. The first proposition is perhaps the least likely, since low IQ was not significantly related to degraded interference in the healthy controls. However, again further work using large samples is obviously necessary to clarify this issue.

All patients were on neuroleptic medication at the time of testing. There is a large literature documenting the detrimental effects of neuroleptics (both of the typical and atypical varieties) on cognitive performance. However, Knight (1992) found no relationship between either oral dose or blood level of depot medication and performance on perceptual organization tasks, and the performance of medicated and unmedicated patients did not differ on a number of other perceptual organization tasks (Rabinowicz et al., 1995), suggesting that it is unlikely that a perceptual organization deficit could be caused or mediated by medication. Furthermore, the 'superiority strategy' (Knight and Silverstein, 2001) of the present design ensured that the predicted cognitive dysfunction led to superior task performance, thereby bypassing the difficulties of interpreting performance deficits in medicated patients. Nevertheless, definitive conclusions about the role of medication, if any, in degraded interference can only be obtained by further work comparing medicated and unmedicated samples.

A further limitation of the current study was the failure to adopt a tripartite classification of symptoms. Studies have identified positive, negative and disorganised dimensions of schizophrenia signs and symptoms (e.g. Liddle, 1987). In three studies, abnormalities in perceptual organization in schizophrenia were associated with greater disorganised (but not positive, negative or general) symptoms (Knight and Silverstein, 1998; Silverstein et al., 1998, 2000). In the present study no relationships were found between interference scores and the disorganization symptoms measured by the MS (such as 'incoherence of speech' and 'flattened incongruous affect'). However, as noted above, there are limitations to the conclusions which can be drawn from individual symptom scores. Clearer results could be obtained by testing patients with predominantly disorganised symptoms on the degraded Stroop paradigm, and comparing them to positive and/or predominantly negative symptom groups.

To conclude, the results confirmed the prediction that individuals experiencing positive symptoms would show reduced use of top-down processing strategies in the interpretation of incoming visual information. This deficit was associated with lower verbal IQ. Further work is necessary to obtain a clearer understanding of the cognitive dysfunctions mediating positive symptomatology.

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References

Andreasen, N.C., 1984. Scale for the Assessment of Positive Symptoms (SAPS). University of Iowa, Iowa City, IA.

Battig, W.F., Montague, W.E., 1969. Category norms for verbal items in 56 categories: a replication and extension of the Connecticut category norms. Journal of Experimental Psychology, Monograph 80, 1–46.

Bentall, R.P., Kinderman, P., Kaney, S., 1994. The self, attributional processes and abnormal beliefs: towards a model of persecutory delusions. Behaviour Research and Therapy 32, 331–341.

Bierderman, I., 1987. Recognition-by-components: a theory of human image understanding. Psychological Review 94, 115–147.

Chey, J., Holzman, P.S., 1997. Perceptual organization in schizophrenia: the employment of Gestalt principles. Journal of Abnormal Psychology 106, 530–538.

Claridge, G.S., 1994. Single indicator of risk for schizophrenia: probable fact or likely myth? Schizophrenia Bulletin 20, 151–168.

Cohen, J.D., Servan-Schreiber, D., 1992. Context, cortex and dopamine: a connectionist approach to behavior and biology in schizophrenia. Psychological Review 99, 45–77.

Cox, M.D., Levanthal, D.N., 1978. A multivariate analysis and modification of a preattentive perceptual dysfunction in schizophrenia. Journal of Nervous and Mental Disease 166, 709–718.

Cutting, J., 1985. The Psychology of Schizophrenia. Churchill Livingstone, Edinburgh.

Ferman, T.J., Primeau, M., Delis, D., Jampala, C.V., 1999. Global–local processing in schizophrenia: hemispheric asymmetry and symptom-specific interference. Journal of the International Neuropsychological Society 5, 442–451.

Garety, P.A., Hemsley, D.R., Wessely, S., 1991. Reasoning in deluded schizophrenic and paranoid patients. Journal of Nervous and Mental Disease 179, 194–201.

Garety, P.A., Wessely, S., 1992. The assessment of positive symptoms. In: Barnes, T., Nelson, H. (Eds.), The Assessment of Psychoses. Chapman & Hall, London,.

Hemsley, D.R., 1987. An experimental psychological model for schizophrenia. In: Hafner, H., Gattaz, W.F., Janzavik, W. (Eds.), Search for the Causes of Schizophrenia. Springer, Berlin,.

Hemsley, D.R., 1993. A simple (or simplistic?) cognitive model for schizophrenia. Behaviour Research and Therapy 31, 633–645.

Jackson, H., Burgess, P., Minas, I., Joshua, S., 1990. Psychometric properties of the Manchester Scale. Acta Psychiatrica Scandinavica 81, 108–113.

John, C.A., 1989. Depth of processing and the perceptual integration of information in schizophrenia. Unpublished M.Sc. Thesis, University of London.

John, C.A., Hemsley, D.R., 1992. Gestalt perception in schizophrenia. European Archives of Psychiatry and Clinical Neuroscience 241, 215–221.

Kendell, R.E., 1991. The major functional psychoses: are they independent entities or part of a continuum? Philosophical and conceptual issues underlying the debate. In: Kerr, A., McClelland, H. (Eds.), Concepts of Mental Disorder. Gaskell, London,.

Knight, R.A., 1984. Converging models of cognitive deficit in schizophrenia. In: Spaulding, W.E., Cole, J.K. (Eds.), Theories of Schizophrenia and Psychosis. University of Nebraska Press, London,.

Knight, R.A., 1992. Specifying cognitive deficiencies in poor premorbid schizophrenics. In: Walker, E.F., Dworkin, R.H., Cornblatt, B.A. (Eds.), Progress in Experimental Personality and Psychopathology Research, Vol. 15. Springer, New York, pp. 253–289.

Knight, R.A., Manoach, D.S., Elliott, D.S., Hershenson, M., 2000. Perceptual organization in schizophrenia: the processing of symmetrical configurations. Journal of Abnormal Psychology 109, 575–587.

Knight, R.A., Silverstein, S.M., 1998. The role of cognitive psychology in guiding research on cognitive deficits in schizophrenia. In: Lenzenweger, M., Dworkin, R.H. (Eds.), Experimental Psychopathology and the Pathogenesis of Schizophrenia. APA Press, Washington, DC, pp. 247–295.

Knight, R.A., Silverstein, S.M., 2001. A process-oriented approach for averting confounds resulting from general performance deficiencies in schizophrenia. Journal of Abnormal Psychology 110, 15–30.

Kosslyn, S.M., Koening, O., 1992. Wet Mind: The New Cognitive Neuroscience. Free Press, New York.

Krawiecka, M., Goldberg, D., Vaughan, M., 1977. A standardised psychiatric assessment scale for rating chronic psychotic patients. Acta Psychiatrica Scandinavica 55, 299–308.

Liddle, P.F., 1987. Syndromes of chronic schizophrenia: a reexamination of the positive–negative dichotomy. British Journal of Psychiatry 151, 145–151.

Manchanda, R., Saupe, R., Hirsch, S., 1986. Comparisons between the Brief Psychiatric Rating Scale and the Manchester Scale for the rating of schizophrenia symptomatology. Acta Psychiatrica Scandinavica 74, 563–568.

Matussek, P., 1952. Studies in delusional perception. Psychiatrie und Zeitschrift Neurologie 189, 279–318.

Overall, J.E., Gorham, D.R., 1962. The Brief Psychiatric Rating Scale. Psychological Reports 10, 799–812.

Peters, E.R., Pickering, A., Kent, A., Glasper, A., Irani, M., David, A.S., Day, S., Hemsley, D.R., 2000. The relationship between 'cognitive inhibition' and psychotic symptoms. Journal of Abnormal Psychology 109, 386–395.

Peters, E.R., Joseph, S.A., Garety, P.A., 1999. The assessment of delusions in normal and psychotic populations: Introducing the PDI [Peters et al. Delusions Inventory]. Schizophrenia Bulletin 25, 553–576.

Peterson, M., 1994. Object recognition processes can and do operate beyond figure-ground organization. Current Directions in Psychological Science 3, 105–111.

Rabinowicz, E.F., Knight, R.A., Bruder, G., Owen, D.R., Gorman, J., 1995. Short-term visual memory deficits in schizophrenia: medication effects and electrophysiological correlates. Poster presentation at the meeting of the Society for Research in Psychopathology, Iowa City, IA.

Rabinowicz, E.F., Opler, L.A., Owen, D.R., Knight, R.A., 1996. The dot enumeration perceptual organization task (DEPOT): evidence for a short-term visual memory deficit in schizophrenia. Journal of Abnormal Psychology 105, 336–348.

Raven, J.C., 1982. The Mill Hill Vocabulary Scale: 1982 Revision. Lewis, London.

Schwartz-Place, E., Gilmore, G., 1980. Perceptual organisation in schizophrenia. Journal of Abnormal Psychology 89, 409–418.

Silverstein, S.M., Palumbo, D.R., 1995. Nonverbal perceptual organization output disability and schizophrenia spectrum symptomatology. Psychiatry 58, 66–81.

Silverstein, S.M., Knight, R.A., Schwarzkopf, S.B., West, L.L., 1996a. Stimulus configuration and context effects in perceptual organization in schizophrenia. Journal of Abnormal Psychology 105, 410–420.

Silverstein, S.M., Matteson, S., Knight, R.A., 1996b. Reduced top-down influence in auditory perceptual organization in schizophrenia. Journal of Abnormal Psychology 105, 663–667.

Silverstein, S.M., Bakshi, S., Chapman, R., Nowlis, G., 1998. Perceptual organization of configural and nonconfigural visual patterns in schizophrenia: effects of repeated exposure. Cognitive Neuropsychiatry 3, 209–223.

Silverstein, S.M., Kovacs, I., Corry, R., Valone, C., 2000. Perceptual organization, the disorganization syndrome, and context processing in chronic schizophrenia. Schizophrenia Research 43, 11–20.

Wells, D.S., Leventhal, D., 1984. Perceptual grouping in schizophrenia: replication of Place and Gilmore. Journal of Abnormal Psychology 93, 231–234.

World Health Organisation, 1992. The ICD-10 Classification of Mental and Behavioural Disorders. World Health Organisation, Geneva.