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Global–local processing in schizophrenia: Hemispheric asymmetry and symptom-specific interference

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Abstract

The hypothesis of atypical functional hemispheric asymmetry in schizophrenia is tested using the directed global–local paradigm, a lateralizing measure of visual perception. Results indicate low error rates ($< 2\%$) for schizophrenia and normal control groups, but longer response times for the schizophrenia group. In the normal group, detection speed of global and local forms did not differ. In contrast, the schizophrenia group responded significantly faster to local relative to global forms, which supports the asymmetry hypotheses of left hemisphere overactivity–right hemisphere underactivity in schizophrenia. The normal group exhibited a global interference effect (slowed response latency to the local target in the presence of a dissimilar global distractor). When the schizophrenia group was examined according to symptom type and severity, high positive symptom severity was associated with local interference (slowed response latency to the global target in the presence of dissimilar local distractors). Negative symptoms were not associated with interference from the competing local or global forms. Patients with a combination of high positive and low negative symptoms showed significantly greater local interference than patients with high negative and low positive symptoms. Interconnected temporal and frontal systems are postulated to contribute to this pattern of perceptual processing efficiency and distractibility in schizophrenia. (*JINS*, 1999, *5*, 442–451.)

Keywords: Schizophrenia, Global–Local, Attention, Interference, Distractibility, Hemispheric asymmetry

INTRODUCTION

Attempts to identify dysfunctional neural systems in schizophrenia have prompted theories of functional hemispheric asymmetry that address whether information is processed more efficiently or accurately in one hemisphere than the other. Early support for left hemisphere overactivation in schizophrenia involved studies showing rightward initial lateral eye movement to verbal, spatial, and emotional material (Gur, 1978; Schweitzer et al., 1978) and greater detection accuracy in the right visual field (Schweitzer, 1982). The idea of right hemisphere underactivity in schizophrenia is supported by findings of impaired visual processing skills on tasks typically ascribed to right hemisphere function (Cutting, 1981, 1992; Feinberg et al., 1986; Kolb & Whishaw, 1983; Walker et al., 1980). Although lateralization of verbal and visual processing is well documented (Blonder et al., 1991; Kimura, 1969; Rizzolatti et al., 1971), comparing performances in different modalities (i.e., verbal *vs.* visual) and matching different tasks on levels of difficulty and complexity may be challenging (Chapman & Chapman, 1978). The division of labor between the hemispheres is not absolute and different aspects of verbal and visual processing are carried out by each hemisphere. Left hemisphere specialization for analytic processing of verbal (i.e., word units) and visual (i.e., featural detail) information, and right hemisphere specialization for holistic processing for verbal (i.e., contextual theme) and visual (i.e., configural gestalt) information have been demonstrated (Gardner et al., 1983; Mehta & Newcombe, 1991; Newcombe et al., 1987; Van Kleeck & Kosslyn, 1989).

Aberrant attention and visual perception have long been considered core deficits of schizophrenia (Braff, 1993; McGhie & Chapman, 1961; Shakow, 1962). Prior research suggests that schizophrenia may be associated with more

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efficient processing of feature details than the gestalt. When schizophrenia and normal control groups are compared, patients with schizophrenia perform better on visual estimation tasks when stimulus arrays violate gestalt grouping principles, whereas controls perform better when gestalt principles are present (Schwartz-Place & Gilmore, 1980; Wells & Leventhal, 1984). The idea of segmentalized perception posited by Shakow (1962) argues that patients with schizophrenia process stimulus fragments first and at the expense of the stimulus as a whole. Not only would this type of processing strategy lead to inefficient processing of the configural whole, but it may lead to an overemphasis on noncritical features and to a depletion of available attentional resources before processing the critical features. Indeed, an impaired capacity to differentiate between relevant and irrelevant stimulus fragments has been demonstrated in schizophrenia (Bemporad, 1967; Frith et al., 1983; Liddle, 1987a; Neale, 1971; Nuechterlein & Dawson, 1984; Reich & Cutting, 1982). Moreover, trouble appreciating how visual features combine to make a whole may be associated with deficient facial affect recognition in schizophrenia (Morrison et al., 1988).

The study of hemispheric specialization for higher-order visual processing has been enhanced by the use of hierarchical visual stimuli composed of small local forms arranged into a large global form (Navon, 1977). Hemispheric specialization for the visual processing of parts and wholes has been demonstrated in individuals with apparently normal neurologic development. A meta-analysis of visual-field studies with non-brain-injured participants reveal faster processing of local forms in the left hemisphere, and faster processing of global forms in the right hemisphere (Van Kleeck, 1989). Damage to the right hemisphere results in slower or less accurate processing of global relative to the local level of the hierarchy, whereas damage to the left hemisphere results in slower or less accurate local processing (Delis et al., 1986, 1988; Doyon & Milner, 1991; Lamb et al., 1989, 1990; Robertson et al., 1988).

The global–local paradigm is a useful tool for investigating hemispheric asymmetry in schizophrenia because it is a lateralizing behavioral measure within a single modality. In addition, it incorporates the following benefits: The same type of stimulus can exist at both levels of the hierarchy, there are explicit boundaries between the levels, and the conditions differ only in the direction of attentional focus (Delis et al., 1986; Navon, 1977).

In addition to perceptual processing efficiency, interference from unattended visual information (i.e., distractibility) can be assessed with a version of the global–local paradigm that directs attention to one level of the hierarchy. This is accomplished by measuring response time (RT) to the target level when forms at each level of the hierarchy are identical (e.g., local target *2*, global distractor *2*) compared to when they are dissimilar (e.g., local target *2*, global distractor *3*). Normal participants show a global interference effect which refers to slowed response latency to local targets when forms at the to-be-ignored global level are dissimilar compared to when they are similar (Lamb et al., 1989; Navon, 1977; Paquet, 1992, 1994). Normal participants are not slowed in processing the global form in the presence of dissimilar local features and, therefore, do not demonstrate a local interference effect (Lamb et al., 1989; Navon, 1977; Paquet, 1992, 1994).

While some studies have demonstrated heightened distractibility in schizophrenia (Cornblatt & Erlenmeyer-Kimling, 1985; Finkelstein, 1983; Paus, 1991), it has also been shown that attention may be so fixed that distractibility is lower than normal (Huey & Wexler, 1994). Since, attention is not a unidimensional phenomenon, different experimental paradigms may be measuring different types of attention. Furthermore, in schizophrenia it is possible that distractibility may be a function of symptom presentation and symptom severity. Studies of the phenomenology of schizophrenia have identified positive, negative and disorganized dimensions of schizophrenia signs and symptoms (Andreasen & Olsen, 1982; Bilder et al., 1985; Klimidis et al., 1993; Liddle, 1987b). A limitation in interpreting cognitive and perceptual studies of schizophrenia is that the symptom constellations of the sample are frequently not provided and it is unclear whether one particular symptom cluster is over- or underrepresented in the sample. The purpose of this study is to determine whether there is evidence of atypical hemispheric asymmetry in schizophrenia when using a lateralizing task of visual attention. In addition, the relationship between schizophrenia symptoms in association with global–local processing efficiency and distractibility is explored.

METHODS

Research Participants

Fifteen male patients who satisfied the DSM–III–R (American Psychiatric Association, 1987) criteria for either Schizophrenia or Schizoaffective Disorder were recruited from the acute psychiatric care unit at the North Chicago Veterans Affairs Medical Center. Individuals were excluded from participation if they had a past history of, or coexisting, neurologic disorder (e.g., head trauma or epilepsy), substance abuse, or cardiac disease. The normal control group was recruited through posted advertisements with $10.00 compensation. The control group consisted of 17 male hospital and university staff without known psychiatric or neurologic history. All participants reported normal or corrected-to-normal vision and gave informed written consent to participate.

The National Adult Reading Test (NART) was administered to estimate premorbid intellectual capability (estimated premorbid FIQ; Nelson, 1982; Nelson & O'Connell, 1978). The schizophrenia and control groups do not differ in age, education, or estimated FIQ (see Table 1). Pearson product-moment correlations for the entire sample revealed an expected relationship between education and estimated

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Table 1. Demographic information and NART estimated premorbid FIQ

	Group						
	Schizophrenia ($N = 15$)			Control ($N = 17$)			
Variable	*M*	(*SD*)	Range	*M*	(*SD*)	Range	*t*
Age	40.6	(8.2)	27–52	36.2	(10.5)	19–52	1.34
Education	12.6	(1.1)	11–15	12.7	(1.2)	11–16	−0.26
NART premorbid FIQ estimate	101.0	(7.4)	89–115	101.0	(8.2)	83–115	−0.09

FIQ ($r = .38$, $p < .05$). There was no statistically significant correlation between age and education ($r = .03$, $p > .10$), or age and estimated FIQ ($r = .07$, $p > .10$) indicating no apparent relationship between age and estimated intellect or educational achievement.

Age of onset of schizophrenia symptoms was not available for 1 patient, who was 43 years old at time of testing. The mean age of onset for the remaining 14 patients ranged from 18 to 28 years, with a mean of 22.4 ($SD = 2.85$). The mean duration of illness in years ranged from 5 to 33, with a mean of 18.1 ($SD = 9.27$). None of the patients had been taking depot neuroleptics for at least 6 months. Thirteen patients were taking neuroleptic medication which included haloperidol, thiothixene, fluphenazine or trifluoperazine with an average dose expressed in chlorpromazine equivalents using an equivalency chart (Workman & Tellian, 1994) of 750 mg per day. The average dose of benztropine was 3.5 mg per day.

Clinical Assessment

Each patient was assessed with the Scale for the Assessment of Negative Symptoms and the Scale for the Assessment of Positive Symptoms (SANS and SAPS, respectively; Andreasen & Olsen, 1982). The structured clinical assessments for positive and negative symptoms were carried out by two board certified psychiatrists within 5 days of task administration. Separate negative, positive and disorganized symptom scores were derived based on studies using factor analysis with the SANS and SAPS (Bilder et al., 1985; Klimidis et al., 1993). The negative symptom score was calculated by summing the flat affect, alogia, anhedonia, and avolition scores from the SANS. The positive symptom score was obtained by a sum of SAPS scores for hallucinations and delusions. The disorganization score consisted of the sum of the bizarre behavior and formal thought disorder scores from the SAPS. Table 2 presents the ranges, median scores, and symptom combinations of the schizophrenia group. Pearson correlations show that positive and disorganized scores were not significant ($r = .48$, $p = .07$), and there is no significant correlation between positive and negative ($r = -.25$, $p = .36$), or negative and disorganized ($r = .19$, $p = .51$) symptoms. Nonetheless, when symptom dimension and severity are dichotomized, the majority of the group shows a combination high positive–low negative or high negative–low positive symptoms (see Table 2).

Apparatus and Stimuli

All computer stimuli were black on a white background and were presented in the center of the computer screen (Macintosh Plus). The distance between the participant and the stimuli was approximately 48 cm. The hierarchical stimuli consisted of small-sized *1*s or *2*s making up a large-sized *1* or *2* (see Figure 1). Identical digits at each level made up the consistent condition, and dissimilar digits at each level made up the inconsistent condition. A single digit control condition for large and small sized digits was presented in separate blocks of trials. The vertical visual angle subtended 6.75° for both the global and large forms, and subtended 0.38° for both the local and small forms.

Procedure

Standard instructions for the Global–Local directed attention task were verbally explained to each participant. Each condition (global and local) was initiated with a block of 16 unrecorded practice trials. Reiteration of instructions and feedback was provided during the practice trials. All participants successfully reached practice criterion of 10 correct responses within 16 trials. Participants were instructed to pay attention to the small (local) numbers for one block of 64 trials, and to attend to the large (global) numbers for

Table 2. Frequency of high and low scores on positive, negative, and disorganization schizophrenia symptom dimensions

Frequency of occurrence (total = 15)	Positive	Negative	Disorganized
1	+	+	+
1	+	+	−
3	+	−	+
2	+	−	−
2	−	+	+
3	−	+	−
3	−	−	−

Note. Positive range (8–38), median score = 16; negative range (15–84), median score = 29; disorganized range (0–17), median score = 5. Individual scores greater than the median are considered high in symptom severity, and symbolized with a "+". Individual scores less than the median are considered low in symptom severity, and symbolized with a "−".

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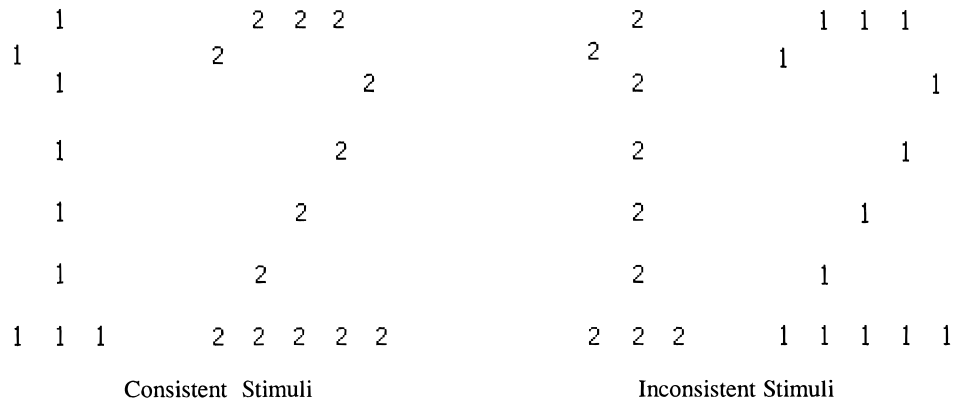

Fig. 1. Global–local hierarchical figures. Consistent stimuli contain identical forms at global and local hierarchical level (e.g., large *1* made up of small *1*s). Inconsistent stimuli contain dissimilar forms at the global and local hierarchical level (e.g., large *1* made up of small *2*s).

another block of 64 trials. They were asked to press the computer key labeled *1* with their left index finger (the ‘b’ key), if they saw a *1* at the designated level, or to press the key labeled *2* (the ‘n’ key) with their right index finger, if they saw a *2*. A sign reading either “large” or “small” was placed above the monitor to remind the participant of the level they were to attend to within a particular block of trials. It took 10 to 15 min to complete each directed attention condition.

A separate control task was included with the same design parameters. Stimuli consisted of *single* large and *single* small-sized stimuli with the vertical visual angles of the global and local forms, respectively. Trials included a block of 32 small-sized *1*s and *2*s, and a separate block of 32 large-sized *1*s and *2*s, each preceded by eight unrecorded practice trials. It took 5 to 10 min to complete each single digit control condition. This task was included to determine whether stimulus detection speed was dependent on absolute size of the stimuli.

A trial was initiated when the examiner pressed the computer mouse. Each trial began with a 200-ms tone and a 500-ms presentation of a square in the center of the screen which served to alert the participant that a trial was beginning and that a stimulus was about to appear within the boxed area. After the termination of the square, there was a blank screen for 500 ms followed by the presentation of the hierarchical stimulus in the center of the screen. The procedure of using an alerting tone and visual fixation has been used in other studies of global–local processing (Filoteo et al., 1992; Lamb et al., 1989). The stimulus remained on the screen until the participant pressed the key or until 4000 ms had elapsed. Participants were asked to respond as quickly and as accurately as possible. Accuracy and response latency were recorded by the computer. Global–local and single digit conditions were presented in a quasibalanced, random order of presentation.

RESULTS

Error rate for both global–local and single digit detection tasks was low (less than 2%) for each group. The possibility of a speed–accuracy tradeoff was examined by determining whether there was a significant negative correlation between RT and errors. There was no evidence of a speed–accuracy tradeoff for the normal ($r = .58$, $p > .05$) or schizophrenia ($r = .24$, $p > .05$) groups. Further analyses were carried out on median reaction time data for correct responses. Median reaction times are used because they are less sensitive to extreme scores.

Single Digit Detection Latency

Student’s *t* tests revealed no difference in reaction time to small and large sized stimuli for the schizophrenia group [$t(14) = -.93$, $p > .05$]. The control group, however, was slower to detect the small compared to the large-sized single digits, [$t(16) = 3.75$, $p = .002$]. Since visual acuity frequently declines with age, Pearson correlations between age and the difference between large and small digit reaction time (large–small) were carried out. The control group showed a significant correlation between age and large–small digit difference scores ($r = -.67$, $p = .004$), indicating a relationship between detection speed of small-sized digits in older participants. This pattern was not evident in the schizophrenia group ($r = .02$, $p > .05$). For purposes of statistical control of the systematic variability attributable to absolute digit size, RT difference between large and small single digits was used as covariate in subsequent analyses involving the control sample.

Global–Local Processing Efficiency

Comparison between schizophrenia and control groups

Although it is not surprising to find greater performance variability in psychiatric patients, discrepant variances make comparisons between patient and control groups difficult due to violations in the assumptions of parametric statistics. Therefore, group parametric comparisons were carried out on data after logarithmic transformations normalized the data distributions and reduced the heterogeneity of variance between groups. A 2 (group: schizophrenia *vs.* control) × 2 (hierarchical level: global *vs.* local) × 2 (stimulus consistency: consistent *vs.* inconsistent) repeated measures ANCOVA with digit size as the covariate showed a significant main effect for group [$F(1,29) = 36.80$, $p < .001$], indicating slower RTs for the schizophrenia group compared to controls (see Figure 2). There was a significant Group × Level interaction [$F(1,29) = 5.92$, $p = .02$], and *post-hoc* mean comparisons using *t* tests with Bonferroni corrections revealed significant differences between global and local reaction times for the schizophrenia group ($p < .05$) but not the control group. This indicates a local processing advantage (global disadvantage) for the schizophrenia group that is not present in the control group. Interactions for Group × Consistency [$F(1,29) = 0.39$, $p > .05$], or Group × Level × Consistency [$F(1,29) = 0.95$, $p > .05$] were not statistically significant. Separate analyses were conducted to address patterns of performance within each group.

Analysis of control group

Data from the normal controls was analyzed with a 2 (hierarchical level: global *vs.* local) × 2 (stimulus consistency: consistent *vs.* inconsistent) repeated measures analysis of covariance (ANCOVA) with digit size as the covariate. The main effect for level was not significant [$F(1,15) = 1.22$, $p > .05$]. The main effect of consistency was significant [$F(1,15) = 12.053$, $p = .003$], indicating slower RT for inconsistent compared to consistent hierarchical stimuli. There was a statistically significant interaction of Level × Consistency [$F(1,15) = 7.315$, $p = .02$]. Follow-up ANOVAs using the Bonferroni correction as criterion for significance indicate that local inconsistent stimuli were detected more slowly than local consistent stimuli [$F(1,15) = 11.9$, $p = .004$], but detection speed of global inconsistent stimuli were not significantly slower than global consistent stimuli [$F(1,15) = 0.57$, $p > .05$]. Put differently, normal controls showed interference from the global level when engaged in local level processing (a global interference effect), but were not distracted by the to-be-ignored local forms during global processing.

Analysis of schizophrenia group

A 2 (level: global, local) × 2 (consistency: consistent, inconsistent) repeated measures ANOVA was used in the analysis of RT data for the schizophrenia group. Results demonstrated a significant main effect for level [$F(1,14) = 4.44$, $p < .05$], no significant effect of consistency [$F(1,14) = 1.35$, $p > .05$], and no significant Level × Consistency interaction [$F(1,14) = 0.08$, $p > .05$]. The mean difference between global and local reaction time was 146 ms and Figure 2 illustrates this local processing advantage (global processing disadvantage). Out of the 15 patients with schizophrenia, 12 patients were faster to process the local relative to the global forms. This effect of level is maintained even when 5 patients with extremely long RTs (average global and local median RT > 1000 ms) are excluded from analysis, indicating that the local advantage–global disadvantage is not likely to be an artifact of extremely long RTs.

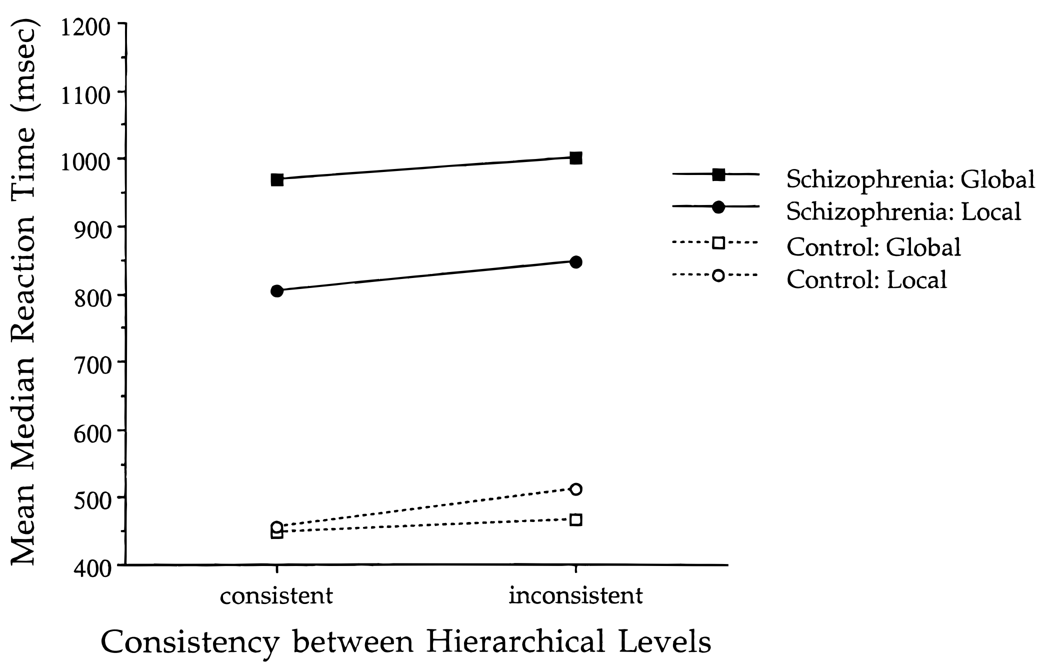

Fig. 2. Response latency to consistent *versus* inconsistent hierarchical stimuli for schizophrenia and control groups.

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Schizophrenia Symptoms in Relation to Perceptual Processing Efficiency and Interference

Given the heterogeneity of symptom presentation and small sample size, the analyses of symptoms in relation to global–local processing are considered exploratory. Pearson correlations reveal no relationship between age and severity of symptoms (see Table 3). There are also no significant correlations between symptom presentation and the local advantage–global disadvantage as measured by Global–Local difference scores (see Table 3). In the globally directed condition, the degree of interference from unattended local forms denoted by a *Consistency* index (Inconsistent − Consistent difference score) was positively and significantly related to the severity of positive symptoms. The Mann–Whitney U test was used to further examine the interference effects. The schizophrenia group was partitioned into groups of high and low symptom severity (see Table 2). There was no difference in overall response time between patients with high and low positive symptom severity (exact two-tailed, $p > .10$). In the globally directed condition, there was a statistically significant difference between high and low positive symptom groups for Inconsistent − Consistent difference scores (exact two-tailed $p = .005$) indicating a local interference effect associated with severe positive symptoms. Similarly, patients with a combination of high positive–low negative symptoms show greater interference from the to-be-ignored local level (local interference) when compared to those with the combination of high negative–low positive symptoms (exact two-tailed, $p = .009$). On locally directed trials, there was no significant difference between high and low positive symptom severity for Inconsistent − Consistent difference scores, indicating no difference in the degree of interference from to-be-ignored global forms between groups distinguished by positive symptom severity (exact two-tailed $p = .47$).

DISCUSSION

When attention was directed to one level of a visual hierarchy, patients with schizophrenia showed a local advantage–global disadvantage in perceptual processing efficiency that was not present in the normal control group. Specifically, patients with schizophrenia had significantly faster detection latency for stimuli at the local relative to the global level of visual hierarchical figures. The majority of the patients (12/15) showed this local precedence and this pattern was not directly attributable to extremely long reaction times. This discrepancy in processing the parts relative to the whole is consistent with older studies of schizophrenia that show less efficient use of gestalt organizational principles (Asarnow & MacCrimmon, 1981; Bemporad, 1967; Neale, 1971; Schwartz-Place & Gilmore, 1980; Wells & Leventhal, 1984). It is also consistent with Shakow's notion of segmentalized perception which suggests that patients with schizophrenia attend to the visual detail first and perhaps at the expense of perceiving the entire configuration (Shakow, 1962).

The majority of the patients with schizophrenia were less efficient at processing the configural whole than the feature details of the hierarchical visual stimuli, and this pattern of performance was not related to the severity of clinical symptoms. When analyzed as a group, schizophrenia was not associated with a single pattern of interference from the unattended level. In contrast, the normal control group demonstrated a global interference effect, which refers to distractibility from dissimilar global forms when attending to the local level and replicates previous findings (Lamb et al., 1989; Navon, 1977; Paquet, 1994; Peressotti et al., 1991; Van Kleeck, 1989). When interference was examined in relation to symptom type and severity in the schizophrenia group, different patterns of interference emerged. In the globally directed condition, the degree of interference from unattended dissimilar local forms increased as the severity of positive symptoms increased. Patients with high positive symptom severity and those with high positive–low negative symptom severity show evidence of a local interference effect. That is, when attention was focused on the global level of the hierarchy, the to-be-ignored local forms interfered with processing the global forms. Such a relationship would suggest a heightened distractibility to feature detail in association with severe positive symptoms. Patients with low positive symptom severity, and those with a combination of high negative symptom–low positive symptom severity did not show the local interference demonstrated by their counterparts, nor did they demonstrate the global interference effect seen in normal controls. These patients may

Table 3. Correlations between symptom severity and consistency

Variable	Positive	Negative	Disorganized
Age (years)	−.34	.24	.07
Global − Local RT	−.09	−.27	.21
Global condition			
Inconsistent − Consistent RT	.55*	−.41	.17
Local condition			
Inconsistent − Consistent RT	.12	−.07	.09

*$p < .05$.

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be demonstrating an abnormally minimal level of distractibility to either level of the hierarchy, a pattern that may be congruent with getting stuck on an area of attentional focus. It is not clear whether the degree of positive symptom severity alone is responsible for this effect, or if it requires a specific combination of symptom severity.

In normal controls, there was no difference in the processing speed of global and local levels of the hierarchy. Although much has been discussed regarding a global precedence effect in normals (Navon, 1977), further work has revealed that this effect is dependent on several task parameters (e.g., task demands, visual angle, eccentricity; Luna et al., 1995; for review see Kimchi, 1992). A transition from global to local precedence has been demonstrated with the crossover point occurring at about 6° to 7° visual angle (Kinchla & Wolfe, 1979; Luna et al., 1995) and at this visual angle, some have found a local advantage (Lamb & Robertson, 1989; Massman et al., 1993) while others have found a global advantage (Luna & Robertson, 1995). In addition, some studies included older participants (Lamb & Robertson, 1989; Massman et al., 1993), others included undergraduates (Luna et al., 1995) and the current study included a young to middle aged group. Using an entirely different paradigm, Scialfa et al. (1987) demonstrated that older age is associated with taking small perceptual samples and using a more restricted field of view. One possible explanation for the current findings of no difference in global and local processing speed in normals may be a complex interaction of age with visual angle and eccentricity of targets from the fovea.

Similar to other studies of RT in schizophrenia, overall response latency was significantly slower for patients with schizophrenia compared to controls (Braff, 1993; Green & Walker, 1986). Since the performance of many daily activities require both efficiency and accuracy, tasks that involve the simultaneous collection of both speed and accuracy provide a sensitive measure that helps to identify the conditions in which information processing may be breaking down. A potential pitfall of tasks that include reaction time and accuracy are speed–accuracy tradeoffs and also the possibility that task demands may be too great and a criterion of accuracy may not be met. On the directed global–local task, normal controls and patients with schizophrenia are quite accurate and show no evidence of gross target misidentification or speed–accuracy tradeoffs. This is consistent with other studies of normal participants using the directed attention paradigm (Filoteo et al., 1992; Lamb et al., 1989; Luna et al., 1995). In patient groups, error rates have been shown to be less than 10% for patients with focal vascular lesions (Lamb et al., 1989), but are more variable in Alzheimer's disease where they may exceed 25% (Filoteo et al., 1992; Massman et al., 1993).

This study has limitations that deserve mention. A large number of patients were excluded due to a history of substance abuse. This may limit the generalizability of results, since a history of substance abuse is disproportionately high in institutionalized patients with schizophrenia (Brunette et al., 1997; Jeste et al., 1996) and its role in cognitive impairment in schizophrenia is not yet clear (Addington & Addington, 1997; Jeste et al., 1996). There is the potential of some limitation of generalizability to women since the sample is comprised of men. Given the small sample size, the data on symptom specific interference effects should be considered exploratory. The terms high and low symptom severity are based on scores that fall around the median score designated by this sample only and should be considered only in terms of those scores designated in Table 2. It may be useful for future research to develop consistent norms of symptom severity in schizophrenia for the purpose of examining symptom clusters in relation to cognition or other variables.

Despite self-report of normal or corrected-to-normal vision, the normal control group was slower to process the small relative to the large single digits. The relationship between age and detection of the small *versus* large digits was significant in normals only, and likely reflects the inclusion of some older participants in the normal sample whose vision was in need of correction. Reduced visual acuity may slow detection speed of the local forms in the hierarchical figure but may also fragment the perception of the large form. This discrepancy highlights the usefulness of including a single digit control condition to verify task-specific visual acuity and to identify when design or statistical control is warranted.

Studies that have addressed the effects of neuroleptics on tasks of attention, distractibility, and information processing in schizophrenia show improved task performance with medication (which may reflect improved symptoms with treatment) or no change (Bergman et al., 1995; Cassens et al., 1990; Oltmanns et al., 1978; Spohn & Strauss, 1989; Tomer & Flor-Henry, 1989). Inpatient *versus* outpatient samples may differ based on range of symptom severity, presumably with the latter group showing diminished symptom severity. Longitudinal studies of patients who proceed from inpatient to outpatient status would be helpful in determining whether patterns of global–local perception and attention are stable over time or associated with the acute exacerbation of symptoms. This study of directed attention suggests that degree of interference from competing stimuli varies as a function of symptom presentation and severity and therefore, may be more susceptible to the acute effects of the illness. However, the local precedence effect associated with directed attention is not associated with symptom severity, which suggests that it may reflect a more stable feature in schizophrenia.

Directed perceptual processing and distractibility from unattended stimuli may involve at least two separate but integrated components of a frontal–temporal neural network thought to be affected in schizophrenia. Abundant evidence indicates that the extrastriate neural system that governs visual perception involves the temporal cortex (Corbetta et al., 1990; Haxby et al., 1991; Lamb et al., 1989; Mishkin et al., 1983). The neurodevelopmental hypothesis of temporal lobe involvement in schizophrenia (Crow, 1990) garners support from studies that have revealed abnormal temporal lobe cytoarchitecture (Arnold et al., 1991; Jakob & Beckmann, 1986). Additionally, functional brain imaging studies also demonstrate increased activation of the left relative to the right temporal lobe (Al-Mousawi et al., 1996; Gur et al., 1985; Siegel et al., 1993). Schizophrenia is a heterogeneous disorder that likely affects functional neural systems. The functional temporal lobe asymmetry demonstrated by the directed global–local paradigm in schizophrenia may reflect left temporal overactivation, right temporal underactivation or both. The concepts of left hemisphere dysfunction (Gur, 1978) and right hemisphere dysfunction (Cutting, 1992) are not necessarily mutually exclusive.

The frontal lobe and the anterior cingulate gyrus have efferent and afferent connections with the temporal lobe (Barbas, 1988; Pandya et al., 1981; Vogt & Pandya, 1987), and involvement of these regions in schizophrenia has been well documented (Andreasen et al., 1997; Benes et al., 1991, 1992; Hazdenar et al., 1997; Weinberger et al., 1988; Wolkin et al., 1992). Damage to the orbitofrontal region has been associated with heightened distractibility to irrelevant stimuli and enslavement to noncritical environmental cues (Godefroy & Rousseaux, 1996; Lhermitte et al., 1986). Theoretically, abnormal function of this region may be associated with the heightened interference from local feature detail associated with severe positive symptoms in schizophrenia. Damage to the dorsal and mesial frontal (anterior cingulate) regions have been associated with apathy (Barris & Schuman, 1953; Laplane et al., 1981), trouble shifting attentional set (Fuster, 1989), and reduced electrophysiologic response to novel unexpected stimuli (Knight, 1984). An abnormally minimal degree of interference may be equivalent to getting stuck in the region of attentional focus and may be suggestive of dorsolateral and/or mesial frontal (anterior cingulate) involvement.

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