Preattentive Visual Information Processing in Hypothetically Psychosis Prone College Students

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Over the past fifteen years, the behavioral high-risk paradigm has become a major methodology in the study of schizophrenia. This research strategy identifies individuals considered to be at risk for schizophrenia and then examines their similarity to schizophrenics using performance based measures or observational techniques. Much of this research has involved the Chapmans' scales of psychosis proneness, a battery of self report inventories that identifies individuals with schizotypic signs. Meehl (1962) and others have hypothesized that the presence of these signs (e.g., physical anhedonia - a reduced ability to experience pleasurable sensations) is indicative of a neurophysiological predisposition to develop a schizophrenic disorder. Two advantages to studying these high-risk populations are that confounds which are often inextricably intertwined with major psychiatric illnesses (e.g., medication side effects, consequences of long term institutionalization) can be avoided, and the individuals studied (usually college students) are at or near the age of greatest risk for developing the full syndrome, thus facilitating the validation or invalidation of these procedures through follow up studies.

Past research has consistently found similarities between high scorers on the Chapmans' psychosis proneness scales and schizophrenics. These similarities have included psychophysiological abnormalities, deviant psychological test results, behavioral abnormalities, and unusual perceptual experiences (Chapman & Chapman, 1985; Edell & Chapman, 1979; Raulin, Van Slyke & Rourke, 1983; Simons & Katkin, 1985). Until recently, a curious finding from the psychosis proneness (schizotypy) literature was unexplored, namely that high scorers on the Physical Anhedonia scale (Chapman, Chapman, & Raulin, 1976) often did not show patterns of performance similar to high scorers on other schizotypy scales: Depending on the task used, anhedonics, another schizotypic group, or both might appear deviant (e.g., Simons, 1982). Out of a recognition that anhedonics might represent a distinct subgroup of psychosis prone individuals, efforts have been made to see if this schizotypic heterogeneity parallels a heterogeneity within the fully developed schizophrenic syndrome. In particular, it is thought that high scorers on the Physical Anhedonia scale may be continuous with and/or similar to a group of schizophrenics characterized by a poor premorbid history and a predominance of negative symptoms such as flat affect, anhedonia, poverty of speech, and social withdrawal.

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The two studies described here assess the extent to which high scorers on the Physical Anhedonia scale resemble schizophrenics with a poor premorbid history and a predominance of negative symptoms. Because poor premorbid schizophrenics have demonstrated a perceptual organization deficit while good premorbids have not (e.g., Knight, Elliot, & Freedman, 1985), these two studies looked at whether high scorers on the Physical Anhedonia scale would also demonstrate such a deficit while different schizotypic and control groups would not. A perceptual organization deficit refers to an impairment at an early stage in information processing where a figure-ground distinction is made and elements are formed into groups, in this way becoming more distinct units of information for later, analytic, processing (Place & Gilmore, 1980). Manifestations of a deficit at this stage among schizophrenics have included an unresponsivity to grouping of elements in a numerosity task (Place & Gilmore, 1980), a reduced ability to segregate irrelevant from relevant material in briefly presented visual displays (Cox & Leventhal, 1978), and a heightened vulnerability to patterned masks in a backward masking study (Knight, Elliot, & Freedman, 1985). Anhedonics have previously been found to be the only schizotypic group to show deficits which are theoretically consistent with a perceptual organization deficit, including deficits in orienting and other aspects of stimulus significance evaluation (e.g., Simons, 1982). Contrasting with the above findings, however, are results from a preliminary investigation from this laboratory (Silverstein, Raulin, Pomerantz & Patrey, 1988) in which anhedonics were found to have intact perceptual organization abilities. The two studies described here are further attempts, through alternative methodologies, to assess the intactness of the perceptual organization abilities of anhedonics.

STUDY 1

The procedure used was taken from Kahneman's (1973) description of the visual suffix effect. In this task, subjects view brief tachistoscopic presentations of either a six-digit series or a six-digit series followed by zeroes or some other suffix (e.g., 476392000; see Figure 1). The subject's task is to report the first six digits on each presentation.

Successful performance (in the suffix conditions) depends on the ability to isolate the suffix as a separate perceptual group. The ability to perform this initial segregation of the stimulus field is considered to involve a preattentive grouping process (Cox & Leventhal, 1978; Kahneman, 1973). By comparing error rates across the suffix conditions and in these conditions relative to the no-suffix condition, a sensitive assessment of perceptual organization abilities can be gained.

Past research with this paradigm has demonstrated that (1) normals' performance varies as a function of the ease with which relevant and irrelevant stimuli can be perceptually grouped (Kahneman, 1973) and (2) chronic nonparanoid schizophrenics (essentially a poor premorbid group) perform significantly worse than controls when the

visual suffix is present (Cox & Leventhal, 1978). Thus, the demonstration of a perceptual organization deficit among the anhedonic group would provide evidence of a continuity between this group and poor premorbid schizophrenics.

Predictions of this study were as follows: (1) For the anhedonics, there would be a direct relationship between the size of the suffix and the decrease in performance relative to the no-suffix condition. Here it was assumed that if anhedonics lack intact preattentive proceses and thus cannot isolate the six digits as a group distinct from the suffix, then as suffix size increases there would be greater interference with recall. (2) For the other groups, performance relative to the no-suffix condition would depend not on the size of the suffix, but on the ease with which it can be isolated as a distinct perceptual group (e.g., large but easily grouped suffixes should lead to levels of performance close to the no-suffix condition).

Subjects in Study 2 also completed Street's (1931) Gestalt Completion Test. This procedure consists of fifteen slides of fragmented and incomplete figures (see Figure 2). Successful performance on this task depends on the ability to achieve closure in a perceptual field, an ability that is theoretically related to the types of deficits under investigation. In addition, poor performance on this and similar tasks has been found to correlate with reduced right relative to left-hemisphere brain activity and with right-hemisphere brain damage (Hilgard, 1979; Lansdell, 1970). This is significant in light of evidence suggesting that both anhedonia and a perceptual organization deficit are linked to dysfunctional right hemispheric processes (Venables, 1984). This brief measure thus explores a theoretically relevant area.

Method

Subjects

Subjects were males and females in Introductory Psychology courses who received course credit for participation in this study. Four groups were formed comprising individuals who either: (1) scored at least 2 standard deviations above the mean on the Physical Anhedonia Scale (N=12); (2) scored at least 2 standard deviations above the mean on either the Perceptual Aberration Scale (Chapman, Chapman, & Raulin, 1978) or the Magical Ideation Scale (Eckblad & Chapman, 1983; N=16; these scales are routinely combined or interchanged for research purposes due to a high interscale correlation); (3) scored above 21 (moderate depression) on the Beck Depression Inventory (Beck, 1978; N=13); or (4) met none of the above criteria.

Stimuli

The six conditions of stimuli are as shown in Figure 1. Each condition consisted of twenty character strings, creating a total of 120 stimuli.

Each string was taken from a random number table, with the added provisions that (1): a 0 never appeared in the first six positions; (2) no number was repeated within any one character string; and (3) no character string was repeated in any one condition or in any other condition.

Stimuli were printed on a laser printer (Helvetica Type, 14 point) and enlarged 146%. The character strings were then centered and mounted on 4 x 6 inch white tachistoscope cards. The six digit strings measured 1.6 cm across and 3.5 mm high. In the condition with the smallest suffix (e.g., a single 0, Condition 2) the entire character string measured 1.8 cm across. Where the suffix was largest (3 groups of 3 zeroes, Condition 4) the string measured 2.4 cm across and 1 cm high at the suffix.

Procedure

Stimuli were presented on a Gerbrands 3-field tachistoscope (model T3-A). Each stimulus presentation consisted of a fixation point exposed for 150 msec, followed by a character string for 150 msec, and then a blank field for 150 msec. Each character string was viewed at a distance of 79 cm. Stimuli in the no-suffix condition subtended visual angles of 1.15 degrees horizontally and .23 degrees vertically. The largest stimuli (i.e., in condition 4) subtended visual angles of 1.84 degrees horizontally and .69 degrees vertically (i.e., .69 degrees vertically at the suffix, .23 degrees at the 6 digit string). The luminance of the white portion of the stimulus cards was 43.1 cd/m^2, and of the black ink was 6.8 cd/m^2.

After each presentation, subjects recorded the numbers they had seen by filling in a string of six blank spaces (e.g., _ _ _ _ _ _) on a response form. Responses were scored as correct only if both number and position matched the stimulus. Separate totals were calculated for percentage correct in the fifth position and in the sixth position. Subjects were instructed to record the first six digits they saw on each presentation and were encouraged to guess if not sure of the response. Subjects were shown examples of stimuli in the six conditions before beginning.

One random sequence of 120 card presentations was derived and was used for all subjects. Within this sequence, no more than two stimuli from any one condition ever occurred consecutively. The first 18 exposures (3 from each condition) were considered practice, and the next 102 exposures (17 from each condition) were scored.

At the completion of the visual suffix task, subjects were given Street's Gestalt Completion Test. Subjects were told that a series of slides would be shown one at a time, each for twenty seconds. They were instructed to look at each one and to try to determine the object that is depicted. Since the first few plates are quite easy, it was not expected that any subject would have trouble with these directions. At the completion of this measure, subjects were given a feedback sheet and thanked for their participation in the study.

Results

A three-way analysis of variance (group by position by condition) with repeated measures on the last two factors was performed. The main effect of group was not significant indicating that the groups did not differ on their overall percentage of correct responses. There was a significant main effect of position ($F(1,53)=54.08$, $p<.001$) as well as of condition ($F(5,265)=42.68$, $p<.001$). The

condition by position interaction effect was also significant ($F(5,265)=44.32$, $p<.001$): position 6 was associated with a higher rate of correct responses in Conditions 1, 4, 5, and 6, while position 5 was associated with a higher rate of correct responses in Conditions 2 and 3. The crucial test of the perceptual organization deficit hypothesis, that of the group by condition interaction, was not significant. The group by position interaction and the group by condition by position interaction also were not significant. These data indicate that anhedonics and the other three groups performed similarly on the visual suffix procedure. Analyses of the main effect of condition suggested that the performance of all groups was characterized by intact preattentive processing (see Figure 3).

Analyses of the intercondition differences in the fifth position revealed 5 significant pairwise differences (all beyond the .003 level set by the Bonferroni correction). Condition 2 was associated with fewer correct responses than either Condition 1, 3, 4, 5, or 6. All of these data are consistent with intact preattentive processing for all groups, since the suffix in Condition 2 was the most difficult to isolate into a perceptual group distinct from the six digit string.

Analyses of the intercondition differences in the sixth position revealed numerous statistically significant differences. Condition 1 was associated with more correct responses than Conditions 2 and 3 ($ps<.001$), and to a lesser extent, Conditions 4, 5, and 6 (ps of .024, .017, and .046 respectively; all of these are above the Bonferroni LSD corrected level of .003). Condition 2 was associated with fewer correct responses than Conditions 1 (as noted above), 3, 4, 5, and 6 (all $ps<.001$). Similarly, Condition 3 was associated with fewer correct responses than Conditions 4, 5, and 6. Given the lack of group differences previously mentioned, these data are further evidence of intact preattentive processing in this subject sample. Conditions 2 and 3, those with the least separable suffixes, were associated with the poorest performance. It should be noted that the greater number of statistically significant pairwise comparisons in the sixth position (relative to the fifth) is evidence of an increased vulnerability to interference effects in that part of the stimulus closest to the suffix. This finding is consistent with earlier work in this area (e.g., Kahneman, 1973).

A one-way analysis of variance was carried out on the number of correct responses (by group) on Street's Gestalt Completion Test. While the anhedonics achieved the lowest score on this measure, a finding consistent with a perceptual organization deficit in this group, the group differences were small and were not statistically significant (see Table 1). Intercondition difference scores yielded no significant correlations with Gestalt Completion Test scores.

There were no main effects of sex in any of the analyses, nor were there any significant interactions between sex of subject and other variables.

Overall, all groups performed similarly on both the visual suffix task and the Gestalt Completion Test. These data suggest that high scorers on the Physical Anhedonia Scale have intact perceptual organization/preattentive processing abilities.

Discussion

The results of this study support earlier findings (Silverstein, Raulin, Pomerantz, & Patrey, 1988) which point to the intactness of the early visual information processing abilities of anhedonics. On the visual suffix task, anhedonics performed like the subjects from the original Kahneman and Neisser (Kahneman, 1973) study. Similarly, their performance did not resemble that of the schizophrenics from the Cox and Leventhal study which used the same procedure. At this point, it must be assumed that, if a perceptual organization deficit exists among anhedonics, (1) it is not pervasive, and (2) it is limited to certain types of information and/or certain conditions. One condition that merits investigation is a right-left distinction in visual hemifield presentation of stimuli. As there is some evidence that the perceptual organization deficit in poor premorbid schizophrenics is associated with a right hemisphere dysfunction (Venables, 1984), it might be expected that this deficit would be most pronounced, or most easily detected, when stimuli are initially processed by this hemisphere (i.e, in a left hemifield presentation condition). This possibility will be investigated in the next study.

A final issue relevant to the visual suffix study involves the generally low scores on the Gestalt Completion Test (sample mean=6.5 out of a possible 15). Given that several of the initial items are fairly easy, these low scores suggest the possibility of a floor effect. This is especially important in this case since the anhedonic group's comparatively low score on this measure is the only evidence, albeit slight, that is suggestive of a perceptual organization deficit in this group. It is unlikely, however, that the only manifestation of a perceptual deficit would be found on a measure that is less purely perceptual than the visual suffix task and the grouping task used in the Silverstein et al. (1988) study. A partial resolution to this question is provided in Study 3, where performance on a task involving the processing of gestalts is the dependent variable.

STUDY 2

This study was a further assessment of the perceptual organization abilities of individuals with the trait of physical anhedonia. The hypothesis guiding this experiment was that anhedonics would not demonstrate the configural superiority effect (Pomerantz, 1986; Pomerantz, Pristach, & Carson, in press; Pomerantz, Sager, & Stoever, 1977) to the same extent as nonanhedonics.

The configural superiority effect has been simply and convincingly demonstrated using parentheses patterns (Pomerantz, Sager, & Stoever, 1977). In a typical experiment, subjects participate in two discrimination conditions. In one, subjects must discriminate (e.g., in a choice reaction time paradigm) between the stimuli "(" and ")". In the other, the choice is between "((" and ")(". In this second condition, only the left parenthesis is relevant for the discrimination task, the one on the right is always the same. In essence then, the discrimination required in both conditions is identical. Research has demonstrated, however, that the second

discrimination is easier than the first. This is because the addition of the extra element in Condition 2 leads to the processing of each parentheses pair as a single configuration rather than as two adjacent parentheses.

In order to achieve the pattern of performance just described, the ability to organize elements in a perceptual field into unified wholes must be intact. There is convincing evidence that among poor premorbid schizophrenics this type of processing is deficient. It has been hypothesized that this dysfunction "could create a fragmented perceptual field, where individual elements are processed separately rather than as parts of cohesive wholes and the direction of attention is not focused" (Knight, 1984, p. 121). Such a hypothesis is consistent with some schizophrenics' reports of attentional difficulties and seeing faces as collections of parts (Arieti, 1974; Chapman & Chapman, 1973). One could predict from this that with certain schizophrenics, performance on this discrimination task would not reveal a configural superiority effect. In other words, if the ability to process the parentheses pairs as single configurations is not intact, then the condition with two parentheses should be equally, if not more, difficult than the condition with single parentheses.

The predicted results with individuals with severely deficient perceptual organization abilities are clear. In this study, however, the subject sample was not composed of schizophrenics, but rather, of college students who are hypothetically psychosis prone. Thus, it was considered doubtful that such a complete reversal of the norm would occur. Instead, if a perceptual organization deficit exists to any degree among anhedonic individuals, this should be revealed in a performance difference between the single and paired parentheses conditions that is smaller than that demonstrated by control subjects.

A reaction time (RT) task was used to investigate this hypothesis. The task consisted of three conditions. The first condition involved discriminating between "(" and ")". The second condition involved discriminating between "((" and ")(". Here, the right parentheses act as a noninformative context, i.e., the right hand element is the same for both and by itself provides no information that could aid in the discrimination task. The discrimination in the third condition is between "(⌐" and ")⌐". As in condition two, the right hand element (in this case a parenthesis rotated 90 degrees) provides no useful information for the discrimination of the essential elements "(" and ")". Past research has demonstrated, however, that this discrimination is more difficult than the one with single parentheses (i.e., Condition 1; Pomerantz, 1986). While the reason for this is not clear, one hypothesis is as follows: In Condition 2, the addition of the extra element leads to the production of emergent features (configurations) that (1) conform more closely to the basic or primitive feature detectors of the visual system than do the stimuli in Condition 1, (2) are different for each element [i.e., "((" vs. ")("] and, thus, (3) subsequently produce faster discrimination times in Condition 2 than 1. In Condition 3, however, it is believed that the emergent feature that is produced is the same for both elements. In order to discriminate between the two patterns then, attention must be redirected to only the left element. The extra time it takes to do this, as opposed to being able to respond to the more salient gestalt/configural properties of the

stimuli, is what is responsible for the longer reaction times in Condition 3 with normal subjects (Pomerantz, 1986). It is also possible that in Condition 3, rotating the right parenthesis destroys the configuration (i.e., no configuration is produced) and leaves the subject with having to contend with extra "noise" in the process of responding.

As noted above, it was predicted in this study that the difference between Conditions 2 and 1 would be smaller for anhedonics than for the other three groups. An additional hypothesis was that the difference between Conditions 3 and 1 would also be smaller for the anhedonics; this is what would be expected if normals' difficulties in Condition 3 are due to an initial processing of emergent features or configural qualities, i.e., if anhedonics' showed a lessened responsivity to configural properties, this would lead to a heightened tendency to initially attend to individual elements. A final hypothesis was as follows: To the extent that the additional element in Condition 2 does not facilitate performance but merely acts as noise for the anhedonics, the difference between Conitions 2 and 3 should be smaller for this group.

In a further effort to investigate the possibility that a perceptual organization deficit is the product of a right hemisphere dysfunction, this study employed a controlled procedure for presentation of stimuli to the right and left visual hemifields. If a right hemisphere dysfunction is present, an anhedonic perceptual organization deficit should be most apparent in the left hemifield condition, i.e., when the stimuli are initially processed by the right hemisphere where preattentive processing of gestalts is thought to be localized. This paradigm also allowed for an investigation of the left-hemisphere overactivation hypothesis in schizophrenia/schizotypy in that an anhedonic superiority relative to controls for processing spatial information in the left hemisphere would be easily identifiable: This would reveal itself as larger inter-condition differences - a greater configural superiority effect - for the anhedonics in the right hemifield condition.

Subjects in this study also completed the Trailmaking Test (Reitan, 1955). This test consists of two forms. On Form A, subjects must connect circles with lines according to the numbers in the circles. On Form B, the sequence is one of alternating numbers and letters: 1-A-2-B-3-C, etc. This test is commonly used as a screening instrument for neuropsychological dysfunction, especially for frontal lobe impairment. It was included in this study to determine of anhedonics show any evidence of the "lowered processing capacity" and/or neuropsychological dysfunction that has been found among schizophrenics and that has been found to correlate with negative symptoms (Cornblatt, Lenzenweger, Dworkin, & Erlenmeyer-Kimling, 1985; Nuechterlein & Dawson, 1984).

Method

Subjects

The same selection procedures were used as in Study 1. Group composition was as follows: physical anhedonia (N=17); perceptual aberration-magical ideation (N=18); depressed (N=16); controls (N=17).

Stimuli

Stimuli are as shown in Figure 4. All stimuli were generated by an IBM XT computer and displayed on a Tektronix 5110 oscilloscope with a model 5A18N dual trace amplifier and a model 5B10 time base/amplifier.

Procedure

Before beginning the experiment, subjects were shown examples of the six stimuli and were familiarized with the three discrimination conditions. For all stimulus presentations (practice and real) subjects responded using a response box where (in each condition) each of the two buttons corresponded to one stimulus.

Each subject completed six trial blocks, with one block containing each condition once. Each condition consisted of 40 stimulus presentations, 20 of each stimulus. In addition, each stimulus was presented five times at one of four locations relative to the fixation point (upper right, lower right, lower left, upper left). This use of positional uncertainty was incorporated into the design to explore possible cerebral lateralization correlates of perceptual organization; the upper lower distinction was used to ensure that hemifield presentation (left vs. right) accounted for more of the variance than reading order (upper vs. lower).

Although this was a reaction-time experiment, each stimulus was displayed for only 150 milliseconds. This brief presentation time prevented the data from being influenced by subjects' volitional eye movements.

There was one random order of stimulus presentations that was used for each trial block (i.e., one order of 120 [3 x 40] presentations of left vs. right parentheses discriminations). The one exception to pure randomization was the provision that no stimulus could be presented more than four times in a row. Positional uncertainty was randomized within each condition (i.e., each presentation of forty stimuli). The combination of these two randomization procedures, in addition to the two stimuli (and the stimulus-button assignments) changing every forty presentations, was used to make certain that subjects would not be able to predict which of the two stimuli in any condition would appear or where it would appear. The order of trials within blocks was balanced across subjects by the use of a 3 x 3 Latin Square design.

The keying of response box buttons to stimuli was counterbalanced across subjects. This was done to equalize any stimulus-response compatibility effects which might have been present given the directional nature of the stimuli used.

The first block for each subject was treated as practice. Thus the data for each subject consisted of responses from five blocks of three conditions of 40 stimulus presentations each (total=600 responses). Furthermore, each button press was associated with five items of data: (1) the stimulus that was presented; (2) the quadrant of presentation; (3) if the response was an error; (4) the reaction time (RT) in milliseconds; and (5) the button that was pressed (left or right).

Results

Reaction time data

A four-way analysis of variance (group by sex by block by condition) with repeated measures on the last two factors was performed. There was a significant main effect of block ($F(4,240)=18.53$, $p<.001$) which reflected subjects' increased speed as they became more familiar with the task. The main effect of condition was also significant ($F(2,120)=21.08$, $p<.001$). When the data were collapsed across groups, Condition 1 (single parentheses) was associated with the fastest reaction times followed by Condition 2 (normally oriented pairs) and then Condition 3 (misoriented pairs). This result merits further comment and will be explored further in the discussion. The main effect of group was not significant, indicating that the four groups did not differ in their overall reaction times. The main effect of sex was also not significant. A four-way analysis of variance (group by sex by condition by position) with repeated measures on the last two factors revealed a significant main effect of position: $F(3,180)=4.16$, $p<.008$. Subsequent comparisons revealed that this effect was created by RTs in Position 4 (upper left) being significantly longer than RTs in Positions 1 (upper right), 2 (lower right), or 3 (lower left). No other quadrants differed significantly in their associated reaction times. No significant interactions between block and the other variables were found (see Figure 5).

The critical test of the hypothesis, that of the group by condition interaction, was not significant. The group by sex by condition interaction was also not significant, indicating that the lack of a group by condition interaction was not confounded by sex differences. The following interactions also were not significant: group by position, group by sex by position, and group by sex by condition by position. These data suggest that all groups performed similarly across conditions. The results are also consistent with the other study in that they do not support the idea of a perceptual organization deficit among anhedonics. Before this conclusion was accepted here, however, the speed-accuracy trade-off was explored. This was important since, despite the lack of RT differences among groups, there remained the possibility that anhedonics' performance might have been inferior in the sense of having an increased rate of errors across conditions.

Error rate data

Analyses of the error rate data, however, did not support this idea. An initial two-way analysis of variance (block by condition) with repeated measures on both factors revealed nonsignificant main effects of both block and condition. This indicates that, although reaction times improved over blocks and differed across conditions, error rates remained generally unchanged throughout subjects' performances. A four-way analysis of variance (group by sex by block by condition) with repeated measures on the last two factors revealed no significant main effects of group or sex. The group by sex, group by block, and group by sex by block interactions were also nonsignificant. The critical test for the differential speed-accuracy trade-off hypothesis was the group by condition interaction. This fell far short of statistical significance. Similarly, the group by sex by condition interaction and the group by sex by block by

condition interaction also were not significant. Thus, the idea that an anhedonic performance inferiority might have been revealed in a higher error rate (despite equivalent RTs) was not supported by the data.

Neuropsychological data

There were no statistically significant group differences on either form of the Trailmaking Test (see Table 2).

Discussion

The results of this study provide further evidence for the intactness of the perceptual organization abilities of high scorers on the Physical Anhedonia Scale. Across all three conditions in the reaction time task, anhedonics performed similarly to the three control groups. Moreover, subsequent analyses revealed that this finding was not confounded by sex differences, practice effects, or quadrant of stimulus presentation, i.e., these factors affected all groups equally. Given that no evidence of a cognitive deficit emerged among anhedonics, it is not surprising that the group by position interaction effect was not statistically significant. It is clear from other research, however, that anhedonics do show performance impairments on some measures of cognitive functioning. Thus, the question of cortical mapping of these functional impairments should remain open. Further investigation into this area awaits clarification of the nature of the cognitive deficits in psychosis prone individuals.

An apparently paradoxical finding from this study was that the single parentheses discrimination was easier (i.e., it was associated with faster reaction times) than that between the normally oriented parentheses pairs. This finding is in direct contrast to the findings of Pomerantz et al. (1977); in both a reaction time study similar to the one used here and an oddity task they found strong configural superiority effects. Several factors can account for the differences between these earlier results and the ones obtained here. First, in the Pomerantz et al. study, subjects responded by moving a single telephone switch either backwards or forwards, a system chosen to reduce stimulus-response compatibility effects. In the present study, a counterbalancing of stimulus-button assignments was used both across trial blocks for each subject and across subjects. It is possible, however, that since the response buttons were adjacent to each other (i.e., one on the left and one on the right), S-R compatibility effects arose in the single parentheses condition which were so strong thay they overrode a counterbalancing effect. In other words, despite the changing of stimulus-button assignments across conditions, it is possible that an "S-R compatibility template" was quickly developed for subjects in the single parentheses condition. Support for this comes from unpublished data from this laboratory where, in a previous study with normals comparing single and double parentheses patterns and using the same equipment, superiority of the single parentheses condition was found. The less robust findings of context effects in single discrimination RT procedures also supports the idea that the stronger findings obtained in oddity tasks reflect the superiority of texture perception over form perception. Specifically, it may be that for certain sets of stimuli, it is easier to detect subtle

differences in a stimulus field than it is to respond on the basis of a single form alone.

It is of additional interest that, despite the lack of a group by condition interaction, the anhedonia group was the only group for whom the normally oriented parentheses condition was associated with faster times than the single parentheses condition. There is no readily apparent explanation for this and, given that it was not statistically significant, it may have been a chance finding. Replication of this result would add further weight weight to its significance.

For all groups, the normally oriented parentheses condition was associated with faster reaction times than the misoriented condition. This supports the idea of intact perceptual organization across all groups. While the discrimination was the same in both conditions (a left vs. a right parenthesis), the addition of a normally oriented parenthesis led to the processing of these pairs as single configurations; however, in the misoriented condition, no configuration or possibly a configuration that was not useful for the discrimination was formed.

The equivalence of the anhedonics and the other groups on the Trailmaking Test suggests that there were no group differences in attention, concentration, and sequencing abilities. Scores for all groups were well within the normal range and revealed no evidence of neuropsychological dysfunction.

Overall then, the results of this study are consistent with a preliminary investigation (Silverstein et al., 1988) which suggested that anhedonics have intact perceptual organization abilities.

GENERAL DISCUSSION

When one looks at the results of these two studies in the context of other research on information processing in psychosis prone individuals, two conclusions immediately emerge. One is that anhedonics do demonstrate cognitive deficits that are found in schizophrenics and that in some cases are shared by no other diagnostic group. A second conclusion is that anhedonics do not appear to have the perceptual organization deficit that has been found among a subgroup of schizophrenics with a poor premorbid history. These conclusions raise several important questions, namely (1) What is the nature of the information processing dysfunction in these schizophrenics? and (2) What is the nature of the dysfunction among these hypothetically psychosis prone individuals? Efforts to answer these questions will help clarify the difference between being "at risk" and being schizophrenic, and in doing so, say something about the meaning of, process of, or correlates of decompensation.

The issue in need of clarification is that psychosis prone individuals share certain information processing deficits with schizophrenics but not others, i.e., not a perceptual organization deficit. What makes this even more interesting is that anhedonics and poor premorbid schizophrenics have performed similarly on several measures, such as aspects of the orienting response. These results are thought to reflect a dysfunction at an early stage of information processing which is consistent with a perceptual organization deficit. The lack of a perceptual organization deficit among anhedonics thus

suggests that a preattentive processing deficit is an aspect of either chronic psychotic disorganization or a severely impaired attentional system.

If this is the case, then the similarities that have been identified between anhedonics and poor premorbids may reflect a more general reduction in information processing capacity. For example, both the deficits in orienting, as well as the findings of reduced amplitude of evoked potentials in other paradigms (e.g., Josiassen et al., 1985) among anhedonics, could be due to a number of factors: (1) A preparatory set in which the stimuli presented are not treated as being highly significant (this is especially relevant to the orienting studies with anhedonics in which slides of human nudes were used as stimuli); (2) Less inhibition of other cognitive activity; (3) Less focused attention or (4) Less anticipatory mobilization of capacity (see Kahneman, 1973). Furthermore, deficits in eye tracking, and to a lesser extent in span of apprehension and backward masking paradigms, can be seen as a result of an impaired ability to sustain attention, a dysfunction related to numbers 2 and 3 above. Thus, while both anhedonics and schizophrenics may share a common dysfunction in attentional allocation, a perceptual organization deficit may be a later, or more severe, manifestation of this disturbance, which appears only in states where the mechanisms for controlling attention are so impaired that even basic (pre)attentional processes, such as perceptual organization, are no longer intact. This idea of a quantitative as well as a qualitative difference is supported by the data of Josiassen et al. (1985), who found reduced amplitude of somatosensory evoked potentials among both anhedonics and schizophrenics but impaired performance in the schizophrenic group only.

One danger in explaining results such as eye tracking and orienting dysfunctions as being due to reduced processing capacity or an impaired ability to sustain attention is that these concepts are somewhat vague. In addition, using several different constructs to explain different data sets is far from an ideal state of parsimony. This is important given that Knight (1984) has argued that his perceptual organization deficit hypothesis can account for schizophrenics' performance deficits in a number of paradigms in addition to those involving perceptual organization/preattentive processing, including backward masking, span of apprehension, and partial report (a measure of iconic memory). He pointed out that, in the absence of his hypothesis, different explanations must be offered to account for each set of these results. While the parsimonious nature of the perceptual organization deficit hypothesis in schizophrenia research must be recognized, such "neatness" of theoretical fit may not yet be possible or accurate as far as the schizotypy literature is concerned. Specifically, if it cannot be demonstrated that schizotypes demonstrate a perceptual organization deficit, then other explanations, such as those relating to lowered processing capacity, have to be offered for the impairments shown by this group.

What then, if anything, does this situation imply about differential brain dysfunction across the schizophrenia spectrum? It would appear that both anhedonics and poor premorbid schizophrenics share capacity and allocation limitations which are likely to reflect impairments in arousal mechanisms. This impairment in arousal is

likely mediated through either lowered tonic levels or greater fluctuations in moment-to-moment arousal, and may ultimately be a manifestation of a brain stem dysfunction. Some of the difficulties related to dysfunctional orienting, such as an impairment in the ability to updata and/or maintain templates (i.e., cortical neuronal models of the environment) would appear to reflect frontal lobe dysfunction; attention to detail, planning, sequencing, and the maintenance of attention are all thought to be mediated by frontal lobe activity. Interestingly, it may be the case that the differences between anhedonics and perceptual aberrators reflect a greater degree of frontal impairment in the former group. Support for this comes from a growing body of literature linking deficit symptoms such as anhedonia with dorsolateral prefrontal cortex dysfunction and Parkinson's disease (a condition in which hypofrontality and reduced dopaminergic activity - a condition speculated to exist in negative symptom schizophrenia - have been found; e.g., Bowen, Kamienny, Burns, & Yahr, 1975; Weinberger, 1987). In sum, although still largely within the realm of speculation, there is some reason to believe that the cognitive deficits shared by schizophrenics and schizotypes may reflect disturbed mechanisms of arousal and attention maintenance, a situation that may be the result of brain stem and frontal lobe dysfunctions. The area where the groups differ is in preattentive processing. This suggests that poor premorbid schizophrenics may be characterized by a nondominant parietal lobe dysfunction which is not shared by schizotypes (see Venables, 1984, for evidence linking a perceptual organization deficit to right parietal dysfunction).

A sequence of the effects of this dysfunction might be as follows: (1) Less figure-ground segregation or filtering of irrelevant material; (2) Attentional resources thus being allocated to a greater than normal amount of stimuli; (3) Less efficient (i.e., often incomplete) processing of most material, including the formation of unstable neuronal models or templates; (4) Shifting mental sets or attentional foci, thus further leading to interruptions in processing as well as to subjectively experienced intrusions of extraneous thoughts or other stimuli; and (5) A general vulnerability to cognitive disorganization. It can be seen how this sequence could lead to a state of reduced processing capacity, i.e., the severe disruption in cognitive integrity results in a low degree of cognitive efficiency. In sum, while both schizophrenics and schizotypes share certain attentional deficits that are consistent with brain stem and frontal lobe dysfunctions, poor premorbid schizophrenics may be further characterized by a nondominant parietal dysfunction, which creates a further disruption in cognitive integrity through the breakdown of preattentional mechanisms.

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Figure 1

Visual Suffix Study Stimuli

Condition 1: 439817

Condition 2: 8624570

Condition 3: 836924000

Condition 4: 975428000000000

Condition 5: 746819^{0}

Condition 6: 354796#

Figure 2

Street figures

(Dog)

(Knight on horseback)

Figure 3

Graphed results of visual suffix data

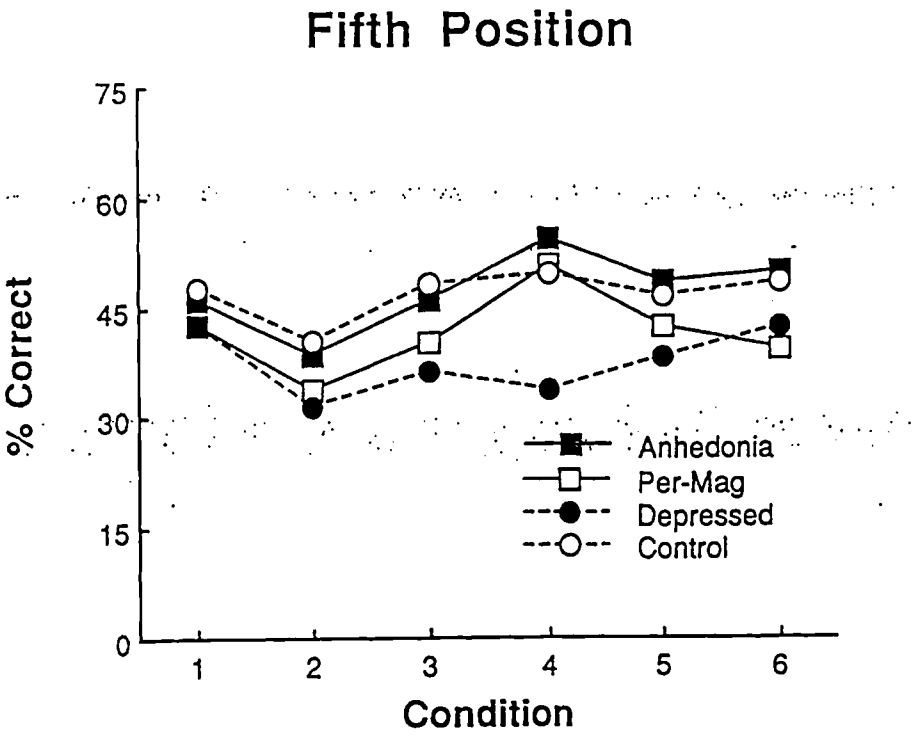

Figure 3 (contd.)

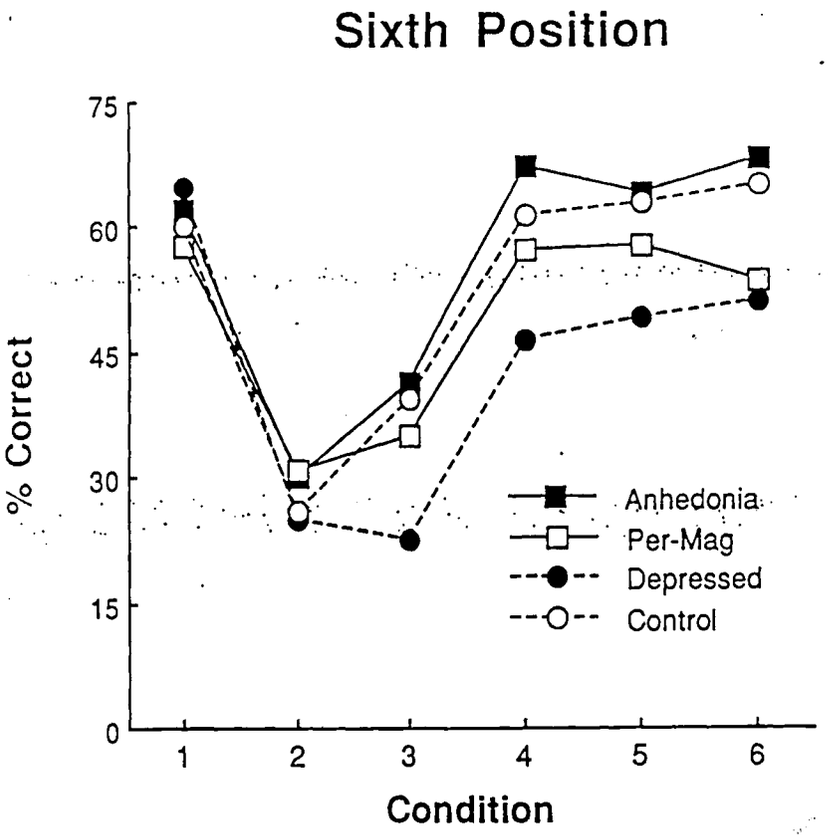

Table 1

Gestalt Completion Test results

Mean number correct by group on Street's Gestalt Completion Test

Group	Mean	Standard deviation
Anhedonia	6.08	2.11
Per-Mag	7.06	1.69
Depressed	6.46	1.33
Control	6.44	1.63

Figure 4

Parentheses discriminations

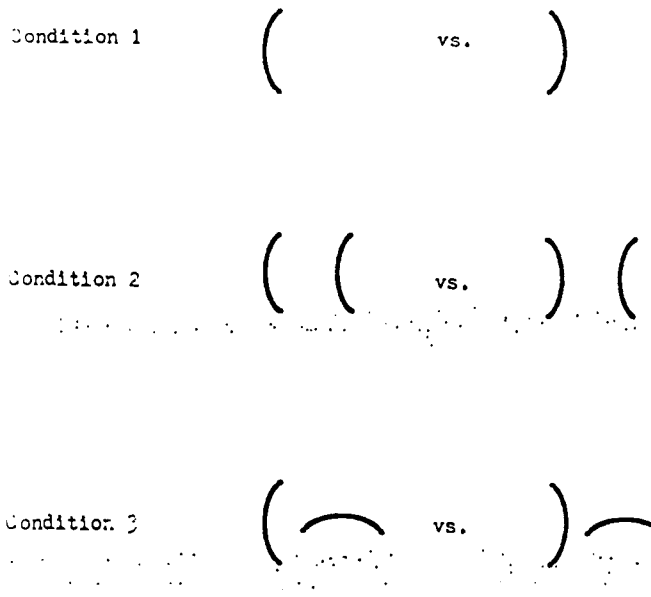

Figure 5

Condition	1 (Single)	2 (Configural)	3 (Misoriented)
Group			
Anhedonia	481.58	472.11	503.85
Per-Mag	433.56	445.16	466.61
Depressed	482.24	500.05	501.66
Control	437.07	451.52	467.96
Entire Sample	457.89	468.41	484.51

Table 2

Trailmaking Test results (in seconds) by group

	Form A	Form B
Anhedonia	20.06	46.47
Per-Mag	20.83	42.11
Depressed	19.00	49.81
Control	18.17	39.71