Perceptual Organization and Schizotypy[1]

Steven M. Silverstein, Michael L. Raulin, Edward A. Pristach, and James R. Pomerantz

State University of New York at Buffalo

The preattentive visual processing of hypothetically psychosis-prone college subjects was evaluated using three different paradigms (speeded classification, visual suffix effect, and configural superiority effect). It was hypothesized that anhedonic subjects would show the same perceptual organization deficits reported in poor premorbid schizophrenics and that Perceptual Aberration/Magical Ideation subjects and depressed subjects would perform similarly to controls. In all three studies anhedonics performed similarly to each comparison group, even though there was adequate power to detect performance differences if they existed. A framework for understanding the visual information processing deficits of schizophrenics and high risk subjects is proposed.

Over the past fifteen years, the behavioral high-risk paradigm (Chapman, Chapman, Raulin, & Edell, 1978) has become a major approach to 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, 1964) 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.

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 Slyck & 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) usually did not show patterns of performance found in 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, we speculated that high scorers on the Physical Anhedonia Scale might 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.

The three studies described here assess the extent to which high scorers on the Physical Anhedonia Scale resemble poor premorbid schizophrenics. Poor premorbid schizophrenics have demonstrated a perceptual organization deficit, while good premorbid schizophrenics have not (e.g., Knight, Elliot, & Freedman, 1985). In the three studies reported here, we looked at whether anhedonic subjects would also demonstrate such a deficit, while other schizotypic subjects and controls would not. A perceptual organization deficit refers to an impairment at an early stage in information processing, where a figure-ground distinction is

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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 et al., 1985). Anhedonics have previously been found to be the only schizotypic group to show deficits that are theoretically consistent with a perceptual organization deficit, including deficits in orienting and other attentional and psychophysiological aspects of stimulus significance evaluation (e.g., Simons, 1982). Moreover, these orienting deficits are also consistently shown by poor premorbid schizophrenics (Cohen, Sommer, & Hermanutz, 1982, Venables, 1984). The demonstration of a perceptual organization deficit among anhedonics would strengthen the evidence for a fundamental similarity between this high-risk group and poor premorbid schizophrenics.

Study 1

The perceptual organization ability of anhedonics was assessed using a speeded classification paradigm (Banks & Prinzmetal, 1976). In their study with normal college students, a target letter (T or F) was more difficult to detect if it was arranged in good form (i.e., as a part of a symmetrical pattern: see Figure 1, Study 1, Condition 1) than it was when the noise elements (hybrid T-F characters) formed their own perceptual group. This effect was found even though the display size in the good form condition (#1) contained fewer elements than in the grouped condition (#2). In the other three conditions, target detection was most difficult. Here, subjects' automatic grouping processes interfered with target detection by grouping the target with the noise elements, thus requiring the initiation of a more time consuming sequential search.

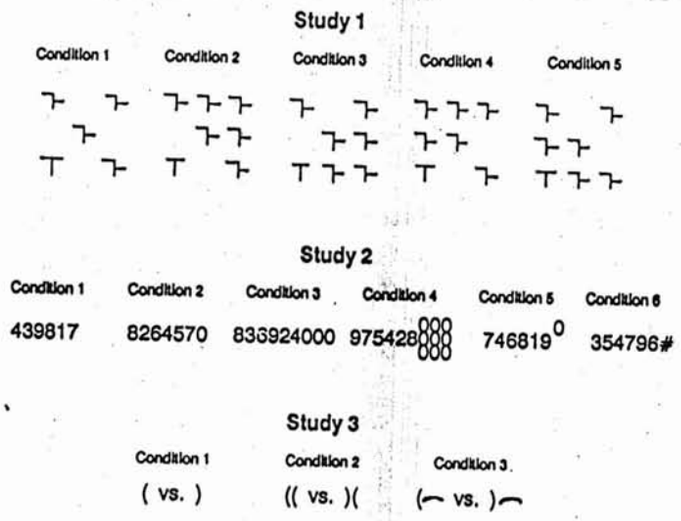

Figure 1. The stimuli used in each of the three studies of preattentive processes.

In the Banks and Prinzmetal (1976) study, organizational qualities strongly affected recognition performance, even to the point of overriding a display size effect (i.e., performance in Condition 2 was superior to that in Condition 1 and both were superior to Conditions 3-5). A similar pattern for controls was expected in this study. For the anhedonics, however, a reduced responsivity to the configural qualities of the noise elements was expected. Therefore, anhedonics' performance was expected to be characterized by a display size effect (i.e., Condition 1 faster than Condition 2) and by smaller differences between Conditions 2 through 5, where all arrays contain the same number of elements. The performance of the depressed group (a control for general psychopathology) and the perceptual aberration group (a control for psychosis-proneness) was predicted to be similar to that of the control group.

Method

Subjects. Subjects were male college students identified on the basis of their scores on a paper and pencil test containing screening versions of several schizotypy scales. Previous research has shown scores on these screening scales to be good predictors of full scale scores (Raulin, Van Slyck, & Rourke, 1983). Subjects met one of four criteria: (1) scored two or more standard deviations above the mean on the Anhedonia Scale (N = 17); (2) scored two or more standard deviations above the mean on the Perceptual Aberration Scale (Chapman, Chapman, & Raulin, 1978; N = 13); (3) scored below two standard deviations above the mean on both the Anhedonia and Perceptual Aberration Scales and above 10 on the long form of the Beck Depression Inventory (BDI, Beck, 1978; N = 13); or (4) met none of the above criteria (Controls, N = 14).

While it was anticipated that there would be no overlap between the schizotypy groups, this goal could not be achieved. One subject met the criteria for both schizotypy groups. Based on an *a priori* decision, he was assigned to the physical anhedonia group; for this study, the crucial variable was considered to be the presence/absence of anhedonia, regardless of the presence of other symptomatology. Seven out of 13 perceptual aberrators and five out of the 17 anhedonics met the criterion for the depressed group. Additionally, two perceptual aberrators had not completed the BDI and thus the overlap for this group may have actually been greater.

Stimuli. Stimulus arrays consisted of one target letter (T or F) and noise elements. Characters were created with a user defined characters program and printed on an Okidata 192 dot matrix printer. Each array was approximately 30 x 28 mm. Each character was approximately 6 x 4 mm (see Figure 1). Arrays were mounted on 4 x 6 index cards (white, unruled, SX grade, 90 lb). Each card was covered with transparent self-adhesive vinyl, and the upper right hand corner of each card was removed to insure proper alignment in the deck.

Five decks of cards were created, each containing arrays corresponding to one condition of stimulus organization. In each array, the target letter could appear in any of the four corners. Since there were two possible targets, there were eight stimulus arrays for each condition. Each array was included twice in each deck of cards, resulting in five decks of sixteen cards each.

Procedure. All subjects were tested blindly. Target detection was assessed through the use of a speeded classification procedure. Subjects were told to sort through each deck of cards as fast as they could without making errors, placing the cards with a T in one pile and the cards with an F in another. In rare instances when errors were made, subjects were told to place the incorrectly placed card in its correct pile and to continue without stopping. Relative positioning of the T and F piles (i.e., which was on the right and which was on the left) was balanced across subjects. The card-sorting procedure consisted of seven trials on each of the five decks. Presentation of conditions was randomized within each block of five trials. At the completion of the card-sorting procedure, subjects completed the Picture Completion Test of the WAIS-R. This was included as a brief measure of the ability to distinguish essential from nonessential elements in a visual display.

Results

Pilot testing indicated that sorting times in the first two trial blocks were in the early part of the learning curve and that organizational effects were largely nonexistent in these first two blocks. Thus, only the results of the last five blocks were included in the data analyses.

A three-way ANOVA (group x condition x trial), with repeated measures on the last two factors, revealed a main effect of condition ($F(4, 208) = 27.93$, $p < .001$), indicating that organizational qualities strongly affected sorting time. A main effect of trial was also obtained ($F(4, 164) = 14.26$, $p < .001$), reflecting faster sorting times with increasing task familiarity. However, there was no main effect of group or group by condition interaction. For all groups, the Condition 2 decks were sorted most rapidly (see Table 1). Analyses on the main effect of condition revealed that among the ten possible pairwise comparisons, all mean differences were in the direction consistent with intact perceptual organization across all groups. Six comparisons were significant beyond the .001 level and three others were significant beyond the .03 level (although these fall short of the .005 criterion set by the Bonferroni correction for joint alpha level).

Table 1

Mean Sorting Times by Condition in the Target Detection Task

		Conditions				
Groups		1	2	3	4	5
Anhedonics	Mean	15.96	15.84	16.09	16.28	16.69
(N = 17)	SD	2.48	2.40	2.63	2.48	2.75
Perceptual Aberrators	Mean	17.47	17.36	17.99	17.89	18.90
(N = 13)	SD	3.53	3.53	3.67	3.53	3.91
Depressed Subjects	Mean	16.85	16.55	16.92	16.79	17.37
(N = 13)	SD	2.33	2.32	2.10	2.21	2.32
Controls	Mean	16.10	15.82	16.36	16.25	16.76
(N = 14)	SD	2.15	2.01	2.10	2.10	2.55

Post hoc power analyses lend further support to the claim that the lack of a group by condition interaction indicates the intactness of anhedonics' perceptual organization processes. The crucial comparison for this study's hypothesis is between Conditions 3 and 2. It was predicted that anhedonics would demonstrate equal sorting times (thus indicating an unresponsivity to the differential organization of the stimuli and a response based solely on their equal number of elements), whereas the sorting times in Condition 2 were expected to be significantly faster than in Condition 3 for the other groups. Using the actual difference scores, the effect size, f, was .27, indicating a moderate effect. At alpha equals .05, the power of this test was .33. This low estimate of power supports the idea that there was little difference among groups, i.e., the groups' scores were so similar that many more subjects would have to have been run for this difference to have been a significant one. In recomputing the power analysis for the hypothesized results, the anhedonic difference score was set at zero (i.e., no change between Conditions 2 and 3), and the overall sample mean adjusted accordingly. This mean of zero was then compared with the actual obtained means of the other three groups. Under these conditions, the effect size is much larger, f = .45 (a large effect size), as is the power estimate (.74). These results indicate that (1) the actual performance of the groups was quite similar, and (2) the design of the study was such that there was adequate power to have detected the hypothesized results had they been obtained. The combination of this latter finding with the lack of a significant group by condition interaction effect (in which the means were not in the predicted direction) is convincing evidence for the intactness of anhedonics' perceptual organization processes.

In an effort to see if any anhedonic differences may have been normalized by the presence of "non-schizotypal" depressed anhedonics in the anhedonia group, the analyses of variance described above were repeated after removing the data of the five anhedonics who met the criteria for inclusion in the depression group (i.e., a BDI score greater than 10; this left 12 subjects in the anhedonia group). The main effect of condition remained significant. Next, the possibility was explored that this smaller anhedonia group may have had a similar pattern of performance, but smaller inter-deck differences, than the other groups, i.e., less sensitivity to the manipulation of the organizational qualities of the noise elements. An ANOVA was carried out on the differences scores between Condition 2 and Conditions 3, 4, and 5. Although the anhedonia group had the smallest difference scores for all three comparisons, the main effect of group in this analysis was not significant.

Thus, all groups were strongly affected by the organizational qualities of the stimuli. Target detection was either facilitated or impaired in the same way for all groups across conditions.

Discussion

The results of this study suggest that high scorers on the Physical Anhedonia Scale have intact perceptual organization abilities. Their performance was similar to the three control groups in this study as well as being similar to that of the normal subjects in the study of Banks and Prinzmetal (1976). These findings are somewhat curious since (1) poor premorbid schizophrenics have demonstrated a perceptual organization deficit, (2) anhedonics and poor premorbid schizophrenics have demonstrated performance similarities that suggest a common dysfunction at an early stage of information processing (e.g., the orienting response data) that would include a perceptual organization deficit, and (3) anhedonics have previously demonstrated early visual information processing deficits (Balough & Merritt, 1985). The two studies described below sought, through the use of alternative paradigms and methodological refinements, to clarify the nature of the perceptual organization processes of anhedonics.

Finally, in evaluating the extent to which the results of this study support the idea of intact perceptual organization among anhedonics, two issues must be addressed. One involves the idea that the anhedonics selected for this study differed in some way from samples in other psychosis-proneness studies. The selection measure used here included shortened screening versions of the full schizotypy scales. While this screening battery has only a 1% false positive rate in predicting full-scale identified anhedonics, the overall hit rate is only 64% (Raulin et al., 1983). This leaves open the possibility that some relevant characteristic(s) of up to 36% of the anhedonics in other studies was absent in this study. A second concern is the possibility that the arousal associated with the highly active nature of the sorting task led to a normalization of the anhedonics' preattentive processes. Miller (1986) pointed out that anhedonics do not always show evidence of physiological abnormalities in orienting paradigms and that anhedonics' responses approach those of normals as active task participation is increased, i.e., "information processing efforts normalize when the task successfully engages the anhedonic" (Miller, 1986, p. 111). The two studies to follow rule out psychometric considerations as a source of significant effect distortion. The issue of arousal and its relationship to the perceptual/attentional processes under investigation is an interesting one and will be considered more fully at the conclusion of the paper.

Study 2

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, Study 2). 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 thought to involve an automatic 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 further evidence of a similarity 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' preattentive processes 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. 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-hemisphere 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, orienting abnormalities, and a perceptual organization deficit are linked to dysfunctional right hemispheric processes (Bear, Freeman, & Greenberg, 1986, Venables, 1984). This brief measure thus explores a theoretically relevant area.

Method

Subjects. Subjects were college students, both males and females, identified on the basis of full-length versions of the psychosis-proneness scales. Subjects met one of four criteria: (1) scored two or more standard deviations above the mean on the Physical Anhedonia Scale (N = 12); (2) scored two or more 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 (Controls, N = 16).

Stimuli. The six conditions are shown in Figure 1 (Study 2). There were 20 items (number strings) per condition, making a total of 120 stimuli. Each number string was taken from a random number table with the provisions that (1) a 0 never appeared in the first six positions, (2) no number was repeated within a number string, and (3) all number strings were unique.

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 16 x 3.5 mm. In the condition with the smallest suffix (Condition 2) the entire character string measured 18 mm across. Where the suffix was largest (Condition 4) the string measured 24 x 10 mm.

Procedure. All subjects were tested blindly. 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 number string for 150 msec, and then a blank field for 150 msec. The viewing distance was 79 cm. Stimuli in the no-suffix condition subtended visual angles of 1.15 degrees horizontally and .23 degrees vertically. The largest stimuli (Condition 4) subtended visual angles of 1.84 degrees horizontally and .69 degrees vertically. 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 saw 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 the 120 stimuli 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.

Results

A three-way ANOVA (group x position x condition) with repeated measures on the last two factors was performed. There was a main effect of position ($F(1, 53) = 54.08$, $p < .001$) and condition ($F(5, 265) = 42.68$, $p < .001$), but no main effect for group. 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 Table 2).

As was done in Study 1, *post hoc* power analyses were computed to determine the extent to which the hypothesized difference would have been detected had it existed. Difference scores between Conditions 2 and 1 were calculated and compared across groups. This represented the crucial comparison between a no-suffix and a nongroupable suffix condition. For the sixth position, using the actual data, the effect size was moderate, $f = .31$, and the power was low, .42. However, using a conservative estimate of the hypothesized results (a difference score of zero for anhedonics) changes the results dramatically. Here, the effect size increases to .76, and power becomes greater than .99. The power of the tests on the fifth position data was not quite as strong. The differences between conditions at Position 5 were small; the effect size in the actual data was .1, a small effect. The power here was only .08, a further affirmation of the lack of group differences. When the anhedonic difference between Conditions 1 and 2 is set at zero, the effect size increases to .26, a moderate effect size, and power is raised to .33, still a low estimate.

In sum, the parameters of this study were such that if the hypothesized mean differences were obtained, there would have been adequate power to detect them in Position 6 but not in Position 5. Since, even in Position 6, the order of the means did not suggest a perceptual organization deficit, it is reasonable to conclude that this deficit is not present among anhedonics.

Analysis of the intercondition differences in the fifth and sixth positions revealed numerous significant pairwise differences consistent with intact preattentive processing for all groups. There were a greater number of statistically significant pairwise comparisons in the sixth position relative to the fifth position, which 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).

Table 2

Percent Accuracy in the Fifth and Sixth Positions in the Visual Suffix Task

		Position 5					
		Conditions					
Groups		1	2	3	4	5	6
Anhedonics	Mean	46.1	38.6	45.9	54.3	48.5	49.8
(N = 12)	SD	25.0	20.2	18.1	16.7	28.4	25.3
Per-Mag Subjects	Mean	42.6	33.8	40.1	50.8	42.3	39.3
(N = 16)	SD	28.0	22.4	24.1	28.3	27.1	30.3
Depressed Subjects	Mean	42.8	31.54	38.4	33.9	38.2	42.5
(N = 13)	SD	16.3	13.5	17.0	16.7	16.8	12.6
Controls	Mean	47.8	40.3	48.1	49.6	46.6	48.4
(N = 16)	SD	20.6	19.9	21.8	24.4	24.1	21.4
		Position 6					
Anhedonics	Mean	62.1	30.0	41.2	64.2	64.1	68.2
	SD	25.1	26.1	27.6	25.7	29.4	26.7
Per-Mag Subjects	Mean	57.6	30.9	34.9	57.2	57.6	53.6
	SD	28.3	26.6	28.2	30.1	28.5	25.2
Depressed Subjects	Mean	64.7	24.8	22.5	46.5	49.2	51.1
	SD	18.9	15.3	12.3	21.4	26.2	17.8
Controls	Mean	69.1	26.0	39.3	61.3	62.8	65.1
	SD	22.3	21.9	23.8	22.1	24.6	20.8

The anhedonic group showed the poorest performance on the Street's Gestalt Completion Test, a finding consistent with a perceptual organization deficit in this group However, the group differences were small and not statistically significant. 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.

Discussion

The results of this study are consistent with Study 1 in suggesting that the preattentive information processing abilities of anhedonics are intact. 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. There is

evidence that the perceptual organization deficit in poor premorbid schizophrenics is associated with a right hemisphere dysfunction (Venables, 1984). It may be that a perceptual organization deficit would be most easily detected when stimuli are initially processed by the right hemisphere. This possibility will be investigated in the next study.

Study 3

The hypothesis guiding this experiment was that anhedonics would not demonstrate the configural superiority effect (Pomerantz, 1986; Pomerantz, Pristach, & Carson, 1989; Pomerantz, Sager, & Stoever, 1977) to the same extent as nonanhedonics. The configural superiority effect has been 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). 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 demonstrated 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 (See Figure 1, Study 3). The right hand element in both Conditions 2 and 3 provides no useful information for the discrimination. Past research has demonstrated, however, that Condition 2 is the easiest discrimination, followed by Condition 1, followed by Condition 3 (Pomerantz, 1986). While the reason for this pattern of results is not completely 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 the difficulty normals experience in Condition 3 is due to an initial processing of emergent features or configural qualities. If anhedonics were less responsive to configural properties, they could attend more easily 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 Conditions 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 added the variable of which visual hemifield the stimulus was presented in. 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 intercondition differences (i.e., a greater configural superiority effect) for the anhedonics in the right hemifield condition.

Subjects in this study also completed the Trail Making Test (Reitan, 1955). 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 if 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 2. 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 1 (Study 3). 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. All subjects were tested blindly. Before beginning the experiment, subjects were shown examples of the six stimuli and were familiarized with the three discrimination conditions. Subjects responded by pressing one of two buttons depending on the stimulus presented. 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 response button assignments were made randomly for each condition. These procedures insured 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).

Results

Reaction time data. A four-way ANOVA (group x sex x block x condition) with repeated measures on the last two factors was performed. There was a main effect of block, $F(4, 240) = 18.53$, $p < .001$, which reflected subjects' increased speed as they became more familiar with the task. There was also a main effect of condition, $F(2, 120) = 21.08$, $p < .001$; as shown in Table 3, reaction times were fastest for Condition 1 (single parentheses), 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. There was no main effect of group or sex. A four-way ANOVA (group x sex x condition x position), with repeated measures on the last two factors, revealed a main effect of position, $F(3, 180) = 4.16$, $p < .008$. RTs in the upper left quadrant were longer than for the other three quadrants. No significant interactions between position and the other variables were found.

Table 3

Reaction Time and Error Data for the Parentheses Discrimination Task

		Conditions					
		RT Data			Error Data		
Group		1	2	3	1	2	3
Anhedonics	Mean	481.6	472.1	503.8	2.91	2.40	2.33
($N = 17$)	SD	78.6	63.1	78.9	1.82	1.78	2.20
Per-Mag Subjects	Mean	433.6	445.2	466.6	2.67	2.34	2.33
($N = 18$)	SD	57.8	60.7	64.0	1.68	1.55	1.44
Depressed Subjects	Mean	482.2	500.1	501.7	2.50	2.85	2.34
($N = 16$)	SD	94.9	79.4	99.7	1.98	2.15	2.00
Controls	Mean	437.1	451.5	468.0	3.07	3.07	3.15
($N = 17$)	SD	37.8	52.1	56.7	1.73	1.53	1.80

The critical test of the hypothesis, the group by condition interaction, was not significant. In fact, none of the group interactions were significant. All groups performed similarly across conditions. The results are consistent with the two previous studies in that they do not support the idea of a perceptual organization deficit among anhedonics.

Further supporting this conclusion was a *post hoc* power analysis on the difference scores between Conditions 2 (normally oriented pairs) and 3 (misoriented) across groups. Using the obtained data, there was a large effect size, $f = .54$, and a high estimate of power, .95. This occurred due to a small difference between the two conditions for the depressed group. This result indicated that (1) there was adequate power to detect a group difference, and (2) that despite this, no evidence of an anhedonic deficit emerged.

Before this conclusion was accepted in this study, 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. No group differences on the error rate data were found. No differences were found in an initial two-way ANOVA (block x condition). Although reaction times improved over blocks and differed across conditions, error rates remained generally unchanged throughout subjects' performances. In a four-way ANOVA (group x sex x block x condition) all main effects and interactions fell short of significance. 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 Trail Making Test.

Discussion

This study provide further evidence that the perceptual organization abilities of anhedonics are intact. Anhedonics performed similarly to the three control groups in all three conditions. Moreover, subsequent analyses revealed that this finding was not confounded by sex differences, practice effects, or quadrant of stimulus presentation.

An apparently paradoxical finding from this study was that the single parentheses discrimination was easier than that between the normally oriented parentheses pairs. This finding is in direct contrast to the findings of Pomerantz et al. (1977); in two studies, one very similar to the current study, 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 that 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 the Pomerantz 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 to its significance.

Overall then, the results of this study are consistent with the other two in suggesting that anhedonics have intact perceptual organization abilities.

General Discussion

When one looks at the results of these three studies in the context of other research on information processing in psychosis-prone individuals, two findings stand out. One is that

anhedonics show cognitive deficits that are found in schizophrenics (e.g., poor backward masking performance) and that, in some cases (e.g., masking deficits, reaction-time crossover), are shared by no other diagnostic group. The second is that anhedonics do not appear to have the perceptual organization deficit that has been found in poor premorbid schizophrenics. This latter finding is surprising given that anhedonics and poor premorbid schizophrenics have performed similarly on several measures (e.g., orienting response) that are thought to reflect a dysfunction at an early stage of information processing. The lack of a perceptual organization deficit among anhedonics thus suggests that the early stage deficits found in poor premorbid schizophrenics are likely the result of a severely impaired attentional system, possibly related to structural impairment and/or neurochemical abnormalities.

If this is the case, then the similarities between anhedonics and poor premorbid schizophrenics may reflect the sensitivity of paradigms like backward masking to a milder degree of the neurointegrative impairment that Patterson (1987) postulates as the source of the schizophrenics' cognitive disturbance. Patterson discussed preliminary data indicating reduced or absent N100 amplitude among schizophrenics. He interpreted this as a manifestation of inadequate integration of sensory, mnemonic, and affective information on the basis of prior evidence of the contribution of sensory and limbic, including hippocampal, factors to processing at intervals approximating 100 ms post-stimulus. An implication of such an integrative deficit is that incoming sensory data are not appropriately compared or matched to aspects of previous experience. In its most severe form, this would lead not only to significant delays in the processing or extraction of meaning from stimuli, but also to impairments in the grouping of elements based on meaningful, or high probability, contour arrangements, i.e., a perceptual organization deficit. This view is consistent with findings by Knight (1984, in press) who has systematically narrowed the conceptualization of poor premorbids' fundamental visual processing deficit to one involving inadequate perceptual organization and related impairments in the processing or extraction of meaning from stimuli.

The idea of a quantitative as well as a qualitative difference between schizophrenics and schizotypes is supported by the data of Josiassen, Shagas, Roemer, and Straumanis (1985), who found reduced amplitude of somatosensory evoked potentials among both anhedonics and schizophrenics but impaired performance (as well as greater reductions in evoked potential amplitude) in the schizophrenic group only.

A similar conceptualization was suggested in a recent review of brain research relevant to psychiatric disorders. Bear, Freeman, and Greenberg (1986) cited evidence for a "dorsal sensory-limbic processing system" which includes the parietal association cortex, the cingulate, and the dorsolateral portion of the frontal lobes. This system is involved in the monitoring of the environment for the detection and localization of drive relevant stimuli. It is known that projections from this system to the brain stem affect arousal level and the direction of attentional shifts, while projections to the frontal eye fields and motor systems are involved in visual and tactile orienting. Moreover, it is thought that this system is lateralized to the nondominant hemisphere in humans. Findings implicating dysfunctional right posterior areas are especially relevant to bridging the gap between impairments in perceptual organization and their biological underpinnings. This area is generally as yet unexplored, although there are some recent findings suggestive of right inferior anterior parietal dysfunction in schizophrenia (Cleghorn et al., 1989). These authors pointed out that this region is strongly connected to the dorsolateral prefrontal cortex, and that these two regions are connected to at least fifteen other cortical areas. Viewed in this context, models can begin to be developed that address: (1) the information processing and CNS similarities and differences between poor premorbid schizophrenics and anhedonics, including the issue of which findings are vulnerability markers and which are aspects of severe neurointegrative impairment and full syndromal states; (2) the differences between anhedonics and other schizotypic individuals; and (3) the relationship between arousal and information processing noted by Miller (1986) and Patterson (1987).

In sum, although still largely within the realm of speculation, there is some reason to believe that the sharing of certain cognitive deficits by schizophrenics and schizotypes may reflect schizotypes' having a milder version of the neurointegrative dysfunction that is characteristic of schizophrenics, and most pronounced in poor premorbids. This increased degree of impairment appears to manifest itself in an increased disruption in cognitive integrity through the breakdown of preattentional mechanisms and subsequent impediments in the processing of meaning from stimuli which go beyond those found among schizotypes.

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