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Perceptual Organization and Schizotypy

Steven M. Silverstein, Michael L. Raulin, Edward A. Pristach, and James R. Pomerantz
State University of New York at Buffalo

The preattentive visual information processing of hypothetically psychosis-prone college subjects was evaluated using three different paradigms, target detection (n = 57), visual suffix effect (n = 57), and configural superiority effect (n = 68). It was hypothesized that anhedonic subjects would show the same perceptual organization deficits reported in process schizophrenics and that perceptual aberration–magical ideation subjects and depressed subjects would perform similarly to control subjects. In each study, 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.

Past research has consistently found similarities between students who score high on psychosis-proneness scales (also called *schizotypy* 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, 1981, 1982). Interestingly, high scorers on the Physical Anhedonia Scale (Chapman, Chapman, & Raulin, 1976) have shown impairments in information processing that resemble those found among process schizophrenics, whereas high scorers on other schizotypy scales have not shown such impairments (Simons, 1981, 1982). Our studies further assess the extent to which cognitive processes in anhedonics resemble those of process schizophrenics. Specifically, these studies examine whether anhedonics demonstrate the perceptual organization deficit that has been found among process schizophrenics.

Process schizophrenics show a perceptual organization deficit in the early, preattentive stage of information processing that is not shown by other schizophrenics or by persons in other diagnostic groups (Cox & Leventhal, 1978; Knight, 1984; Place & Gilmore, 1980). At this stage a figure–ground distinction is made automatically on the basis of naturally occurring, high-frequency contour arrangements. A perceptual organization deficit in process schizophrenics is suggested by an unresponsivity to inherent grouping qualities of elements in a numerosity task (Place & Gilmore, 1980) and a reduced ability to segregate irrelevant from relevant material in briefly presented visual displays (Cox & Leventhal, 1978).

Recent data suggest that anhedonics are the only schizotypic group that shows cognitive deficits that are theoretically consistent with a perceptual organization deficit, including deficits in orienting and other psychophysiological aspects of early evaluation of stimulus significance (Miller, 1986; Simons, 1981, 1982; Simons & Russo, 1987). These same deficits are consistently shown by process schizophrenics (R. Cohen, Sommer, & Hermanutz, 1981; Venables, 1984). Assessing perceptual organization abilities in anhedonics will help clarify the extent to which these groups share a common neurointegrative deficit (Meehl, 1990).

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Correspondence concerning this article should be addressed to Steven M. Silverstein, who is now at the Department of Psychiatry, University of Rochester Medical School, 300 Crittenden Boulevard, Rochester, New York 14642.

Study 1

The perceptual organization capacity of anhedonics was assessed in a target-detection paradigm developed by Banks and Prinzmetal (1976). In their study a target letter (T or F) was more difficult for college students to detect if it was arranged in what is termed *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 (Figure 1, Study 1, Condition 2). This effect was found even though the display size in the good form condition (Condition 1) contained fewer elements than in the grouped condition (Condition 2). Target detection was most difficult in Conditions 3, 4, and 5, in which automatic grouping processes interfered with target detection by grouping the target with the noise elements and thus necessitated a time-consuming sequential search. A similar pattern for control subjects was expected in our study. If anhedonics had a perceptual organization deficit, however, they were expected to be less responsive to the configural qualities of the noise elements and thus to show a display size effect (i.e., to respond faster in Condition 1 than in Condition 2) with smaller differences between Conditions 2 through 5 (in which all arrays contain the same number of elements). The depressed group (a control for general psychopathology) and the perceptual-aberration group (a control for psychosis-proneness) were expected to perform similarly to the normal, control group.

Method

Subjects. Male college students were selected on the basis of their scores on screening versions of several schizotypy scales. These screening scales have been shown to be good predictors of full-scale scores (Raulin et al., 1983). Subjects met one of four criteria: They (a) scored two or more standard deviations above the mean on the Physical Anhedonia Scale (n = 17); (b) scored two or more standard deviations above the mean on the Perceptual Aberration Scale (Chapman, Chapman, & Raulin, 1978; n = 13); (c) scored below two standard deviations above the mean on both the Physical Anhedonia and Perceptual Aberration Scales and above 10 on the long form of the Beck Depression Inventory (BDI; Beck, 1978; n = 13); or (d) met none of the other criteria (control subjects; n = 14). Overlap between these two schizotypy groups is rare (Chapman et al., 1978). On the basis of an a priori decision, the one subject who qualified for both schizotypy groups was assigned to the anhedonic group; the crucial variable was considered to be the presence of anhedonia regardless of the presence of other symptomatology.

Stimuli. Stimulus arrays consisted of one target letter (T or F) and noise elements. Arrays were mounted on cards, and each character was approximately 6 × 4 mm. Five decks of 16 cards were created, one deck for each stimulus-organization condition (see Figure 1). The relative position of the target letter was balanced within each deck.

Procedure. The experimenters were unaware of subjects' group membership during testing. The subjects were told to sort each deck of cards into T and F piles as fast as possible without making errors. In rare instances when errors were made, the subject was told to place the incorrectly placed card in its correct pile and to continue without stopping. Relative positioning of the T and F piles was balanced across subjects. Each of the five decks were sorted seven times, with the order of conditions randomized within each block of five deck sorts. Pilot testing indicated that sorting times in the first two blocks of trials were in the early part of the learning curve and that organizational effects were largely nonexistent in these first two blocks. Therefore, only the data from the last five blocks were included in the analyses.

Results

Main effects were noted for condition, $F(4, 208) = 27.93$, $p < .001$, which indicates that organizational qualities strongly affected sorting time, and for trial, $F(4, 164) = 14.26$, $p < .001$, which reflects faster sorting times with increasing task familiarity. However, there was no main effect of group nor a Group × Condition interaction. The Condition 2 deck was sorted most rapidly for all groups.

Post hoc power analyses (J. Cohen, 1988) suggested that the negative findings were not due to lack of power. The crucial comparison for this study's hypothesis is between Conditions 3 and 2. It was predicted that the control groups would be faster in Condition 2 than in Condition 3 whereas anhedonics would show no difference because of their hypothesized insensitivity to organizational cues. With the actual difference scores, the effect size was .27, and the power was .33 (α = .05). This low power suggests there was little observed difference among groups. The power was recomputed for the hypothesized results (anhedonic difference score between Conditions 2 and 3 set at zero). This mean of zero was then compared with the actual obtained means of the other three groups. Under these conditions, the effect size is .45, and the power is .74. These results indicate that (a) the actual performance of the groups was quite similar and (b) there was adequate power to have detected the hypothesized results had they existed.

Discussion

These data suggest that anhedonics have intact perceptual organization abilities. Anhedonics' performance was similar to the three control groups in this study and the normal subjects in Banks and Prinzmetal's (1976) study, and the null results cannot be explained by a lack of power.

Study 2

The procedure used was taken from Kahneman's (1973) description of the visual-suffix effect. Subjects view brief presen-

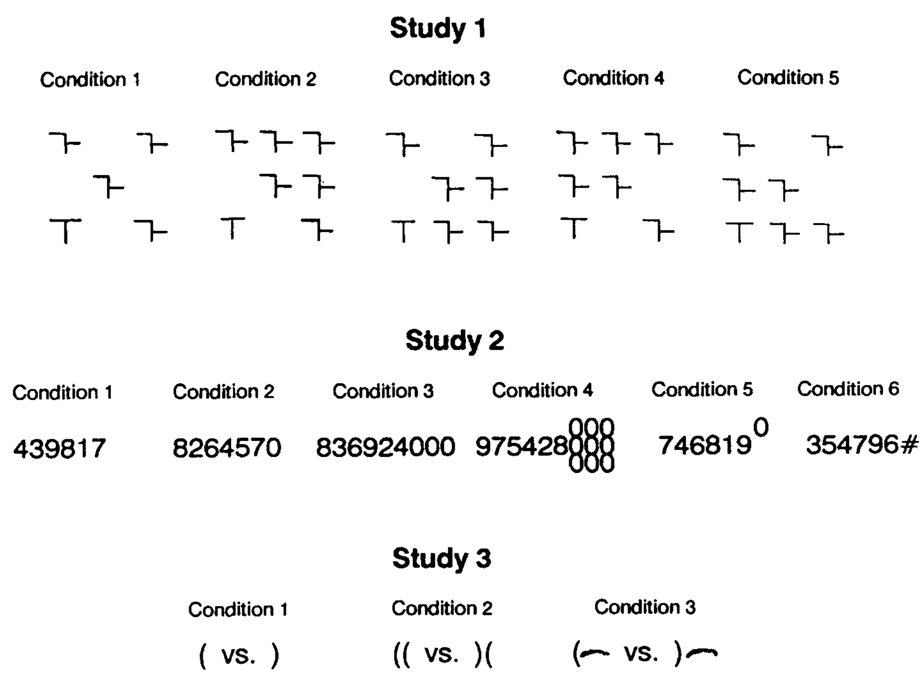

Figure 1. Examples of stimuli used in each of the three studies.

tations of either a six-digit series or a six-digit series followed by a suffix (e.g., 476392000; see Figure 1, Study 2). The task is to report the first six digits. Successful performance in the suffix conditions depends on the ability to isolate the suffix as a separate perceptual group, an ability thought to involve an automatic, preattentive organizational process (Cox & Leventhal, 1978; Kahneman, 1973). Past research with this paradigm has demonstrated that normal subjects' performance varies as a function of the ease with which the six-digit string and the suffix can be perceptually grouped (Kahneman, 1973) and that chronic nonparanoid schizophrenics (essentially a process-schizophrenic group) perform worse than do control subjects when the visual suffix is present (Cox & Leventhal, 1978). To the extent that anhedonics resemble process schizophrenics, their performance ought to reveal a reduced sensitivity to the grouping qualities of the suffixes (in relation to other groups) and poorer performance overall in the suffix conditions.

Method

Subjects. College students were selected on the basis of full-length scales. The subjects met one of four criteria: They (a) scored two or more standard deviations above the mean on the Physical Anhedonia Scale ($n = 12$); (b) scored two or more standard deviations above the mean on either the Perceptual Aberration Scale or the Magical Ideation Scale (Eckblad & Chapman, 1983; $n = 16$; these scales are routinely combined for research purposes because of a high interscale correlation); (c) scored above 21 (moderate depression) on the BDI ($n = 13$); or (d) met none of the above criteria (control subjects; $n = 16$).

Procedure. The experimenters were unaware of the subjects' group membership during testing. Stimuli were presented on a Gerbrands (Arlington, MA) Model T3-A three-field tachistoscope. Each stimulus presentation consisted of a fixation point exposed for 150 ms, followed by a number string for 150 ms, and then a blank field for 150 ms. The viewing distance was 79 cm. The six conditions are shown in Figure 1 (Study 2). There were 20 items (number strings) per condition. Number strings were random except for the provisions that (a) a 0 never appeared in the first six positions, (b) no number was repeated within a number string, and (c) all number strings were unique. Stimuli in the no-suffix condition subtended visual angles of 1.15° horizontally and 0.23° vertically. The largest stimuli (Condition 4) subtended visual angles of 1.84° horizontally and 0.69° 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. One random sequence of the 120 stimuli was derived and 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.

After each presentation, the subjects recorded the numbers they saw by filling in a string of six blank spaces (e.g., _ _ _ _ _ _) on a response form. The subjects were encouraged to guess if they were not sure of the response. Responses were scored as correct only if both number and position matched the stimulus. Only the data from the fifth and sixth positions were analyzed because interference effects are not usually found in the initial items in the list. Subjects had been shown examples of stimuli in the six conditions before they began testing.

Results

There were main effects of position, $F(1, 53) = 54.08$, $p < .001$, and of condition, $F(5, 265) = 42.68$, $p < .001$, but no main effect for group. The Condition × Position interaction was 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, whereas Position 5 was associated with a higher rate of correct responses in Conditions 2 and 3. The crucial test of the hypothesis for a perceptual organization deficit, that of the Group × Condition interaction, was not significant. In fact, no group interaction was significant. There were also no main effects or interactions for sex. These data indicate that anhedonics and the other three groups performed similarly on the visual-suffix procedure and that the preattentive processing of each group was intact (see Table 1).

Post hoc power analyses of the crucial difference between Conditions 2 (nongroupable suffix) and 4 (highly groupable suffix) were performed. For the sixth position, with the actual data, the effect size was moderate (.25), and the power was low (.32). With a conservative estimate of the hypothesized results (i.e., a difference score of zero for anhedonics), the effect size increased to .51, and power was .88. For the fifth position, the effect size in the actual data was moderate to large (.39), and power was .65. When the anhedonic difference between Conditions 4 and 2 is set at zero, the effect size increases to .45, and power is .77. In sum, if the hypothesized mean differences were present, there would have been adequate power to detect them in both Positions 5 and 6.

Discussion

The findings of this study are consistent with Study 1 in suggesting that anhedonics' preattentive processing is intact. On the visual-suffix task, anhedonics performed like Kahneman's (1973) normal subjects and not like Cox and Leventhal's (1978) schizophrenics.

Study 3

This study assessed anhedonics' performance on a configural superiority task (Pomerantz, 1986; Pomerantz, Pristach, & Carson, 1989). In a typical experiment with parentheses patterns (Pomerantz, Sager, & Stoever, 1977), subjects responded to two discrimination conditions. In one, subjects must discriminate in a choice reaction time paradigm between the stimuli) and (. In the other the discrimination is between)(and ((. In this second condition, only the left parenthesis is relevant for the discrimination task; the parenthesis on the right is always in the same orientation. In essence then, the discrimination required in both conditions is identical. Research has demonstrated, however, that the second discrimination is easier than the first, possibly because the extra element in Condition 2 leads to the production of emergent features (e.g., closure, parallelism) and thus to the processing of each parenthesis pair as a single configuration.

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. This type of processing is deficient in process schizophrenics (Knight, 1984). If a perceptual organization deficit exists in anhedonics, they ought to show a smaller performance difference between the single and paired parentheses conditions than do control subjects. This would reflect anhedonics' reduced ability to make use of the emergent feature to facilitate performance.

A reaction-time task with three conditions (see Figure 1,

Table 1
Percentage of Accuracy in the Fifth and Sixth Positions in the Visual Suffix Task

	Condition											
	1		2		3		4		5		6	
Subject group	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Position 5												
Anhedonia	46.1	25.0	38.6	20.2	45.9	18.1	54.3	16.7	48.5	28.4	49.8	25.3
Perceptual aberration–magical ideation	42.6	28.0	33.8	22.4	40.1	24.1	50.8	28.3	42.3	27.1	39.3	30.3
Depression	42.8	16.3	31.5	13.5	38.4	17.0	33.9	16.7	38.2	16.8	42.5	12.6
Control	47.8	20.6	40.3	19.9	48.1	21.8	49.6	24.4	46.6	24.1	48.4	21.4
Position 6												
Anhedonia	62.1	25.1	30.0	26.1	41.2	27.6	64.2	25.7	64.1	29.4	68.2	26.7
Perceptual aberration–magical ideation	57.6	28.3	30.9	26.6	34.9	28.2	57.2	30.1	57.6	28.5	53.6	25.2
Depression	64.7	18.9	24.8	15.3	22.5	12.3	46.5	21.4	49.2	26.2	51.1	17.8
Control	69.1	22.3	26.0	21.9	39.3	23.8	61.3	22.1	62.8	24.6	65.1	20.8

Note. For anhedonia, $n = 12$; for perceptual aberration–magical ideation, $n = 16$; for depression, $n = 13$; and for control, $n = 16$.

Study 3) was used to investigate this hypothesis. The right-hand element in both Conditions 2 and 3 provides no useful information for the discrimination. However, past research shows that Condition 2 is the easiest discrimination, followed by Condition 1, followed by Condition 3 (Pomerantz, 1986). In Condition 3, an emergent feature that is not useful for the task is produced and subjects must redirect their attention to the left parenthesis before they can make a successful discrimination. If anhedonics show a perceptual organization deficit, they will not automatically respond to the configuration in Condition 3 and therefore ought to show more similar reaction times in Conditions 1 and 3 than shown by the other groups.

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 ($n = 16$); and control subjects ($n = 17$). Several of these subjects had also participated in Study 2 (11, 14, 10, and 6 subjects in the four groups, respectively).

Stimuli. Stimuli (shown in Figure 1, Study 3) were computer generated and displayed on a Tektronix (Beaverton, OR) Model 5110 oscilloscope with a Model 5A18N dual trace amplifier and a Model 5B10 time base–amplifier.

Procedure. The experimenters were unaware of the subjects' group membership during testing. The subjects were instructed on the discrimination task and told to respond by pressing one of two buttons corresponding to the stimulus presented. Each subject completed six blocks, in which each block contained one 40-trial subblock of each condition. The position of the stimulus was randomized between four locations relative to the fixation point (upper right, lower right, lower left, and upper left). Stimuli were displayed for 150 ms to prevent volitional eye movement effects.

There was one random order of stimulus presentations that was used for each block (i.e., one order of 120 [3 × 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. With positional uncertainty also randomized, subjects could not predict which stimulus would appear or where. The order of the subblocks within blocks was balanced across subjects in a Latin square design. Response button assignments were made randomly for each condition. The keying of response buttons to stimuli was counterbalanced across subjects in order to equalize stimulus–response compatibility effects that might exist given the directional nature of the stimuli. The first block for each subject was treated as practice.

Results

Reaction-time data. There was a main effect of block, $F(4, 240) = 18.53$, $p < .001$, and condition, $F(2, 120) = 21.08$, $p < .001$. Subjects' speed increased across blocks, and mean reaction times were fastest for Condition 1 (single parentheses), followed by those for Condition 2 (normally oriented pairs), and then those for Condition 3 (misoriented pairs; see Table 2). There was no main effect of group or of sex. A second analysis of variance, which included stimulus position as a variable, found a main effect of position, $F(3, 180) = 4.16$, $p < .008$, with reaction times longer for stimuli in the upper left quadrant, but no significant interactions between position and the other variables. The critical test of the hypothesis, the Group × 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.

A post hoc power analysis on the difference scores in Condition 2 (normally oriented pairs) and Condition 3 (misoriented) across groups found an effect size of .54 and a power of .95. This occurred because of a small difference between the two conditions for the depressed group. Thus there was adequate power to detect a group difference, but despite this, no evidence of an anhedonic deficit emerged. Before a null conclusion was accepted, the speed–accuracy trade-off was explored. This was important because, despite the lack of reaction-time differences, there remained the possibility that anhedonics' perfor-

Table 2
Reaction Time and Error Data for the Parentheses Discrimination Task

	Condition					
	1		2		3	
Subject group	*M*	*SD*	*M*	*SD*	*M*	*SD*
	Reaction time (in seconds)					
Anhedonia	481.6	78.6	472.1	63.1	503.8	78.9
Perceptual aberration–magical ideation	433.6	57.8	445.2	60.7	466.6	64.0
Depression	482.2	94.9	500.1	79.4	501.7	99.7
Control	437.1	37.8	451.5	52.1	468.0	56.7
	Errors					
Anhedonia	2.91	1.82	2.40	1.78	2.33	2.20
Perceptual aberration–magical ideation	2.67	1.68	2.34	1.55	2.33	1.44
Depression	2.50	1.98	2.85	2.15	2.34	2.00
Control	3.07	1.73	3.07	1.53	3.15	1.80

Note. For anhedonia, $n = 17$; for perceptual aberration–magical ideation, $n = 18$; for depression, $n = 16$; and for control, $n = 17$.

mance might be 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. Although reaction times improved over blocks and differed across conditions, error rates remained generally constant. Thus, the idea that an anhedonic performance inferiority might show up as a higher error rate (despite equivalent reaction times) was not supported.

Discussion

This study provides further evidence that the perceptual organization abilities of anhedonics are intact. The performance of anhedonics revealed a configural superiority effect similar to that of the other groups. The paradoxical finding that, overall, the single parentheses condition was easier than the normally oriented paired condition appears to reflect the weakness of context effects in single-discrimination, reaction-time procedures in relation to oddity tasks (i.e., paradigms in which subjects must detect the presence of a single aberrant element in an array of otherwise identical noise elements.)

General Discussion

When one looks at the current results in the context of other research on information processing in psychosis-prone persons, a puzzle emerges. Even though anhedonics show evidence of cognitive deficits found in schizophrenics (e.g., poor backward-masking performance; Balough & Merritt, 1985), they do not show the perceptual organization deficit that has been found in process schizophrenics. This is especially interesting in that both anhedonics and schizophrenics show poor performance and psychophysiological abnormalities in orienting tasks, which suggests a common impairment in early stimulus significance evaluation. The lack of a perceptual organization deficit among anhedonics thus suggests that their information-processing dysfunction is much less pronounced than is the case among process schizophrenics and that whereas subtle cognitive abnormalities may exist in anhedonics, these are usually not sufficiently severe to interfere with task performance in a significant way. This idea is supported by the data of Josiassen, Shagass, Roemer, and Straumanis (1985), who found reduced amplitude of somatosensory evoked potentials among both anhedonics and schizophrenics but impaired task performance (as well as greater reductions in evoked potential amplitude) in the schizophrenic group only. Similar findings were obtained by Simons and Russo (1987), who found no differences between anhedonics, perceptual aberrators, and control subjects on three versions of the continuous performance test, even though anhedonics had reduced P300 amplitude while performing the tasks, and Simons and Chapman (L. J. Chapman, personal communication, December 2, 1990), who found no difference between schizotypes and controls on a forced-choice, span-of-apprehension task. Schizophrenics do worse than control subjects on both of these tasks.

Even though we have demonstrated that inadequate power could not account for the consistently negative results, one still may be concerned about the reliability of the cognitive processing measures used in this study. To our knowledge, the reliability of these procedures has never been reported in the literature. However, these paradigms are well known within the field of cognitive psychology and are considered to be quite robust. Moreover, they have been replicated numerous times. For example, Pomerantz and his students conducted well over 100 studies with parentheses and similar stimuli in order to demonstrate aspects of emergent-feature processing (Carson, Pomerantz, Pristach, & Schwartz-Kenney, 1988). The visual-suffix procedure described by Kahneman (1973; used in our Study 2) is generally considered to be a classic demonstration of perceptual organization principles and is often used as a demonstration in the teaching of undergraduates. Across studies with any one of the paradigms, the results among nonschizophrenics are virtually identical (e.g., Kahneman's, 1973, original data; Cox and Leventhal's, 1978, control groups) and are similar to the results we obtained with all of our groups. Banks and Prinzmetal's (1976) procedure (used in our first study) is less well known but is still considered to be highly robust. In Banks and Prinzmetal's (1976) study, they obtained identical results in two versions of their basic experiment. Moreover, these studies replicated the organizational findings from an earlier study (Banks, Bodinger, & Illige, 1974) and were supported in a study of perceived organization reported as the final experiment in the 1976 article. Thus, although we cannot cite reliability data, the number of times these procedures have produced predictable results speaks to their robustness. Moreover, it is unlikely that our results would so closely resemble those of past reports with nonpatients if the paradigms were of low reliability.

Taken together, the previous findings we discuss and our own from these studies suggest that the information-processing deficits of anhedonics and other psychosis-prone subjects are somewhat mild. Moreover, these findings suggest that the subtlety of these abnormalities may not be adequately or meaningfully assessed when one uses performance-based measures that are used to study schizophrenics. Because backward masking, the only paradigm that has consistently demonstrated cognitive deficits among schizotypes, is theoretically unclear, and because masking deficits have been found to be reversible even among many schizophrenics (Sacuzzo & Braff, 1981), a rethinking of how the cognitive processing of psychosis-prone persons is conceptualized and investigated appears to be in order. Future research will also need to clarify the extent to which these cognitive processing abnormalities are in fact predictive of later psychosis, rather than correlates of traits (e.g., anhedonia) or symptoms with minimal predictive utility.

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