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Authors
Bunney, WE
Hetrick, WP
Bunney, BG
et al.

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Structured Interview for Assessing Perceptual Anomalies (SIAPA)

by William E. Bunney, Jr., William P. Hetrick, Blynn G. Bunney, Julie V. Patterson, Yi Jin, Steven G. Potkin, and Curt A. Sandman

Abstract

Clinical descriptions of perceptual and attentional anomalies in schizophrenia emphasize phenomena such as flooding, or inundation, by sensory stimuli. A failure of sensory "gating" mechanisms in the brain is hypothesized to account for these symptoms, and this hypothesis has led to a marked interest in their putative psychophysiological substrates. However, there are no systematic analyses of the phenomenology of these perceptual experiences, nor has the hypothesized connection between the clinical phenomena and their reported psychophysiological substrates been tested. In this investigation, a structured interview instrument was developed to measure perceptual anomalies as distinct from hallucinations and to determine their prevalence across sensory modalities in schizophrenia in 67 schizophrenia subjects and 98 normal controls. The instrument includes Likert ratings of hypersensitivity, inundation, and selective attention to external sensory stimuli. Good interrater agreement, determined from interviews, was obtained. Schizophrenia subjects had significantly higher auditory, visual, and combined scores (i.e., across all modalities) than normal controls did, indicating significantly more perceptual anomalies. For the schizophrenia group, the prevalence of auditory and visual anomalies was significantly greater than the other sensory modalities. The data indicate that the putative phenomenological correlates of sensory gating may be reliably measured and tested with the Structured Interview for Assessing Perceptual Anomalies.

Key Words: Perceptual abnormalities, sensory gating, structured interview scale, psychosis, schizophrenia.

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Anomalies in the perception and processing of sensory stimuli have been consistently documented in schizophrenia patients (Venables 1964; Shagass 1977; Shagass et al. 1978; Braff and Geyer 1990). Sensory gating hypotheses assert that these perceptual anomalies arise from defects in gating or filtering of external sensory stimuli (Freedman et al. 1987; Braff and Geyer 1990). It has been speculated that the inability to gate or filter sensory stimuli underlies the abnormalities of perception and attention observed in schizophrenia, such as hyper-alertness and poor selective attention, and might contribute to a psychotic state in which patients are flooded by an overabundance of stimulation (Venables 1964; Maher 1974). Furthermore, it has been postulated that "gating and inhibitory deficits are a crucial fulcrum from which we can understand the neurobiological basis of the group of schizophrenias" (Braff et al. 1995, p. 136).

In their classic seminal paper, McGhie and Chapman (1961) proposed that symptoms of schizophrenia reflect a primary deficit in "the selective and inhibitory functions of attention" (p. 114). Their conclusions were based on extensive clinical interviews (2–12 hours) with 26 recent-onset schizophrenia patients. In these interviews, patients reported anomalies in attention and perception, including difficulty in concentrating and focusing on exteroceptive stimuli, including striking increases in awareness of background noises and a perceived increase in the intensity of color and light. Clinical anecdotal observations include "I just cannot shut things out"; "Everything seems to grip my attention although I am not particularly interested in anything"; "I am attending to everything at once and as a result I do not really attend to anything"; and "... noises all seem to be louder.... It is as if someone has turned up the volume.... I notice it with background noises." McGhie and Chapman (1961) concluded that schizophrenia subjects have a heightened sense of sensory vividness, particularly in the auditory and visual modalities. They further hypothesized a breakdown in selective inhibitory

Reprint requests should be sent to Dr. W.E. Bunney, Jr., Department of Psychiatry and Human Behavior, Medical Science 1-D440, University of California, Irvine, CA 92717; e-mail: webunney@uci.edu.

function resulting in "flooding" by "an undifferentiated mass of incoming sensory data" (p. 112). They proposed that organisms need to integrate sensory data and to control and reduce the otherwise chaotic flow of information reaching consciousness. They reasoned that an internal mechanism must exist for organisms to select and inhibit stimuli, and that this mechanism was disturbed in schizophrenia. Similarly, Venables (1964) concluded that the observed sensory processing anomalies pointed to a fundamental "input dysfunction" in schizophrenia. As Geyer and Braff (1987) note, the observations of McGhie and Chapman, in particular, "set the stage for sensory or sensorimotor gating studies of schizophrenia" (p. 644).

Research on perceptual and attentional dysfunction in schizophrenia has focused largely on putative neurophysiologic and behavioral deficits hypothesized to be associated with the clinical phenomena described by McGhie and Chapman (1961). The data are consistent with the clinical phenomenology insofar as they indicate that schizophrenia subjects perform poorly on tests of selective attention, such as the continuous performance task (Kornetsky and Orzack 1978); show increased distractibility (Grillon et al. 1990); are hyperattentive (Mar et al., in press); and demonstrate sensory gating deficits or abnormal regulation of responsiveness to repeated sensory stimuli (Adler et al. 1982; Braff et al. 1982).

In recent years, particular attention has been paid to the psychophysiological characterization of sensory gating abnormalities, although their direct link with phenomenology remains largely untested. Broad interest in the two primary methods of assessing sensory gating, P50 and acoustic startle suppression, arises from the general assumption that they reflect central gating mechanisms necessary for normal perception and, when impaired, lead to perceptual anomalies (Perlstein et al. 1993) that may underlie the symptoms of schizophrenia (Braff and Geyer 1990). In a dual click (conditioning-test) paradigm, the relative decrease of the amplitude of the auditory P50 evoked potential to repeated stimulation has been widely accepted as a measure of auditory gating (Freedman et al. 1987). Similarly, suppression of the ocular startle reflex to acoustic stimuli preceded by weak prepulses has been used as an additional measure of sensorimotor gating (Geyer and Braff 1987; Braff and Geyer 1990). Both P50 and acoustic startle suppression deficits in schizophrenia subjects have been interpreted as evidence of abnormal sensory processing that may contribute to clinical symptoms.

The vast majority of sensory gating studies cite the McGhie and Chapman (1961) paper describing the clinical phenomenology (Adler et al. 1982, 1990, 1994; Franks et al. 1983; Freedman et al. 1983, 1987; Schneider 1984; Siegel et al. 1984; Baker et al. 1987; Geyer and Braff 1987; Nagamoto et al. 1989, 1991; Braff and Geyer 1990; Naber et al. 1992; Simons and Giardina 1992; Smith et al. 1994). Typically, these citations serve to explicitly link the clinical phenomenology observed by McGhie and Chapman to the respective physiological deficits under investigation (i.e., P50 or acoustic startle abnormalities). Remarkably, despite the widespread citation of McGhie and Chapman's (1961) clinical descriptions and the centrality of these phenomena to the prevalent sensory-gating information-processing approach to the study of schizophrenia, the link between the clinical phenomenology and the physiological deficits remains untested. Nevertheless, the citation of McGhie and Chapman's (1961) and Venables' (1964) observations in the sensory gating literature strongly implies that the described phenomena provide the observational, clinical basis for the physiological investigations of P50 and acoustic startle inhibition, and that P50 and acoustic startle suppression may relate to and, by implication, provide an index of the defective processing of sensory input observed clinically.

We believe that a primary reason for the neglect of the relationship between physiological and clinical gating is the lack of appropriate instrumentation in the phenomenological domain. Except for a small cluster of items on one of the Chapmans' Psychosis-Proneness Scales (Chapman et al. 1976), there are no systematic or established measures of perceptual anomalies. Chapman et al. (1978) developed the Body-Image Aberration Scale to measure the psychotic experience of body-image aberration in schizophrenia. They were interested in measuring delusions and aberrant perceptions of body size and shape as well as surreal body feelings such as the merging of the body with external objects or of the body not being one's own. Interestingly, in pilot testing they also included seven items tapping perceptual aberrations other than of body image. These items sampled external sensory-perceptual experiences such as the modulation of external stimuli that parallel the sensory gating phenomenon of present interest (e.g., "My hearing is sometimes so sensitive that ordinary sounds become uncomfortable"; "For several days at a time I have had such heightened awareness of sights and sounds that I cannot shut them out"). Taken together, these seven sensory-perception items correlated highly with the Body-Image Aberration Scale in the schizophrenia group. Therefore, Chapman et al. (1978) retained these items on the Perceptual Aberration Scale, noting that the primary advantage of doing so was broader coverage of the range of perceptual pathology. They interpreted their findings to indicate that "body-image aberration is an *aspect* of a broader perceptual dysfunction" (p. 405, italics added), a conclusion consistent with other body-image data (Traub et al. 1967). Thus, even though classic and contemporary conceptualizations

of the "input dysfunction" in schizophrenia incorporate perceptual aberrations reported by patients and existing measures of related phenomena (i.e., body-image aberration) are placed under the rubric of broad perceptual dysfunction, no systematic method of assessing these particular phenomena presently exists.

Empirical study of perceptual anomalies that are widely assumed to be related to defective gating or filtering in schizophrenia patients requires a well-characterized and psychometrically sound instrument. The purpose of this article is to describe the development and evaluation of a structured interview for assessing perceptual anomalies.

Methods

Participants. Structured interviews were conducted with 67 patients and 98 healthy control participants (see table 1 for a summary of sample characteristics). Patients were recruited from the inpatient psychiatric facility at the University of California, Irvine, Medical Center. Patient diagnoses were made with structured clinical interviews according to *DSM–III–R* (American Psychiatric Association 1987) criteria. Fluency in English was required of all participants. Control participants were recruited from an undergraduate research pool and received course credit for their involvement. Exclusionary criteria for the controls included a reported personal history of psychiatric illness or a first-degree relative with a psychotic disorder.

Table 1. Participant characteristics

	Schizophrenia patients (n = 67)	Healthy controls (n = 98)
Age, yrs. ± SD	33.1 ± 10.1	21.9 ± 9.3
Gender, % male	74.6	44.9
Race, *n* (%)		
African-American	4 (6)	2 (2)
Asian	8 (12)	36 (37)
Hispanic	13 (19)	9 (9)
Caucasian	42 (63)	51 (52)
Primary *DSM–III–R* diagnosis, *n* (%)		
Schizophrenia: Paranoid type	45 (67)	
Schizophrenia: Undifferentiated type	20 (30)	
Schizophrenia: Disorganized	2 (3)	
Age at first hospitalization, yrs. ± SD	23.1 ± 4.4	
Lifetime hospitalizations, *n* ± SD	5.2 ± 2.9	
Years since onset of illness, mean ± SD	10.9 ± 6.2	
Taking psychotropic medications, *n* (%)	57 (85)	
Unmedicated (mean washout, 3 days), *n* (%)	10 (15)	

Note.—SD = standard deviation.

Procedures. The item composition of the Structured Interview for Assessing Perceptual Anomalies (SIAPA) evolved during 2 years of interviews of 50 schizophrenia patients not included in the study group. Particular attention was given to generating items to assess, in McGhie and Chapman's (1961) terminology, sensory disturbances in perception and attention, as opposed to apparently more cognitive, higher-order disturbances such as those associated with bodily awareness, motility, thinking, and affect.

Fifteen items tapping anomalies of external sensory perception and attention were generated according to the following algorithm. For each of the five sensory modalities, Likert items that assessed (1) hypersensitivity, (2) inundation or flooding, and (3) selective attention to external sensory stimuli were included. Items assessing these phenomena were selected because of their prevalence in the pilot interviews conducted with schizophrenia subjects. To uniformly probe these phenomena and allow comparisons between sensory modalities, similar item stems were used across the various modalities. The SIAPA is presented in the Appendix.

Ratings of perceptual anomalies were based on the interviewee's reported experiences and symptoms during the preceding week, including the day of the interview. This interval was selected because pilot interviews indicated that inquiring about a 1-week, versus a 24-hour, period elicited more broadly characterized descriptions of experiences and was well tolerated by the patient group. Also, limiting the data collection to 1 week would likely increase the accuracy of recall and interrater agreement. The frequency of reported perceptual anomalies, as judged by the examiner's appraisal of the self-report, was rated on a 5-point Likert scale, ranging from never to always. In the development of this scale, we were concerned about using the Likert format for measuring reliable and valid schizophrenic sensory experience. We explored several strategies with different rating systems, including three- and nine-point scales, and we found a five-point rating scale was effective in eliciting responses from schizophrenia subjects and, as reported, resulted in excellent rater reliability.

Response exemplars were included on the interview response sheet for each item to assist the interviewer in identifying the type of perceptual phenomenon of interest

and to quantify its frequency (see Appendix). Individual interviews with schizophrenia subjects were conducted in their rooms or in a conference room adjoining the inpatient facility. The control participants were interviewed for 10 to 20 minutes in a conference room; they were not informed that their responses were to be compared with those of "mentally ill" patients.

Interview Instructions. Rapport was established with interviewees. The structured portion of the interview then began with the statement, "I'd like to talk to you about your sense of hearing, vision, touch, and so on. Let's start with your sense of hearing. Tell me about your hearing...." This open-ended inquiry elicited the subject's initial perceptions and provided the opportunity for interviewees to characterize features that they perceived to be relevant. Some participants immediately reported phenomena related to difficulties modulating sensory stimuli. Other participants remarked about common perceptual experiences, stating, for example, "I don't particularly like the loudness of nearby ambulance sirens" or "Sometimes when I go out into the sunlight, it seems bright at first, but my eyes adjust to it like you'd expect." Similarly, some participants felt that their hearing was not as keen as it used to be. As necessary, the initial responses were clarified by asking, for example, "Is your hearing particularly good or sensitive, or particularly poor?" Clarifications such as these were helpful for patients who responded with descriptions of psychotic experiences, especially hallucinations, rather than perceptual experiences. Analogous open-ended inquiries were made for each sensory modality, serving to elicit unbiased self-observations regarding the respective perceptual systems. Since subsequent questions probed for specific and recent perceptual anomalies, the initial responses provided by the participants were used by the interviewer to resolve misunderstandings and ensure that participants did not respond indiscriminately. Although the initial interview question was not specifically scored or rated, patient responses were used to guide subsequent inquiry, including helping the interviewer to phrase questions in the interviewee's lexicon when possible.

Within each modality, the initial open-ended inquiry was followed by structured questions about (1) hypersensitivity to stimuli, (2) the feeling of inundation or flooding by sensory stimuli, and (3) difficulty selectively attending to external sensory stimuli. To assess hypersensitivity to auditory stimuli, for example, interviewees were asked, "Have you ever had the feeling or sensation that sounds were particularly loud? Or louder than usual? Or that your sense of hearing was particularly keen or sensitive? Or that your ears were picking up the slightest detail of sounds?" To assess flooding or inundation, they were asked, "Have you ever had the experience or felt like you were being flooded or inundated by sounds? Or that you couldn't block out sounds? Or that it seemed as if your ears were picking up everything going on around you?" And, to assess selective attention to sensory stimuli, interviewees were asked, "Have you ever had the experience or felt like you couldn't pay attention to one sound, or a conversation, because of interference from other sounds, like background noise? Do you find that your attention is captured by irrelevant sounds, like traffic noises, even though they are of no interest to you?" The interviewer might state, "Some people report that [it seems like they hear all sounds at once and they are overwhelming]; have you had any experiences like this?" When participants reported a perceptual anomaly, they were asked to describe instances of its occurrence. Ratings of the frequency of the perceptual anomalies were based on the examples given by the interviewee of the anomaly or the duration within the last week of the perceptual aberration or both.

Our interview method was consistent with Overall and Gorham's Brief Psychiatric Rating Scale (BPRS; 1962) observation that an expedient way to conduct the interview was to ask, "Have you ever ...?" and, as necessary, follow up with "Has this occurred in the ... [past week]?" Another recommended approach for eliciting information was to use the subject's previously reported content and terminology to elicit information in another modality. For example, "You have told me that.... Does anything like this, or analogous to this, happen with your hearing? Or sight? Or sense of touch?" The interviewer used probes such as these to elicit and confirm perceptual anomalies.

Rating instructions emphasized that the purpose of the instrument was to document the frequency of occurrence of perceptual anomalies to external, environmental, sensory stimuli. A distinction was carefully made between responses to "real," external stimuli versus imagined, internally derived stimuli (i.e., hallucinations). An expanded response form was used to record the subject's verbatim statements before the numerical ratings were made. This expanded form also prompted recording of the interviewer's global clinical impression about the presence of sensory perceptual anomalies on a scale of 0 (absent) to 4 (pervasive) in order to compare the psychometric properties of global clinical impressions with the structured ratings that comprise the interview instrument.

Reliability and Validity. Interrater agreement was determined from interviews with a subset of 51 of the 67 schizophrenia patients. Simultaneous and independent ratings were made by two raters. Face validity was gauged by comparing the content of the verbal reports elicited by

the present interview with those reported by McGhie and Chapman (1961). The known-groups validity of the structured interview was established by comparing the responses of the 67 schizophrenia patients with those of the 98 controls. Discriminant validity was assessed in a subgroup of the patient sample by evaluating the intercorrelations between this instrument and the BPRS, $n = 25$ and the Positive and Negative Syndrome Scale, $n = 31$ (PANSS; Kay et al. 1987). To facilitate the examination of discriminant validity, items on the BPRS and PANSS were organized into the symptom constructs: positive symptoms, negative symptoms, and general psychopathology (Kane et al. 1988; Bell et al. 1992). The BPRS and PANSS ratings were made by independent staff psychiatrists within 1 week of the perceptual anomalies assessment.

Statistical Analyses. Interrater agreement for individual items was calculated using the weighted kappa coefficient (Cohen 1968). The assigned weights were as follows: complete categorical agreements were weighted 1; when the pair of raters disagreed by one, two, three, and four categories, the weights were 0.67, 0.33, 0.08, and zero, respectively. The interrater reliabilities of the mean sensory modality ratings (e.g., auditory, visual) were calculated by the intraclass correlation coefficient (Winer 1971, p. 287, formulae 9 and 10). Because the ratings were significantly skewed, interrelationships among scales were assessed using the Spearman correlation coefficient. The internal reliability of items grouped by sensory modality, perceptual phenomenon (i.e., hypersensitivity, inundation, and selective attention), and the overall rating was determined by Cronbach's coefficient alpha. Group differences between ratings of schizophrenia and control participants were examined with the Mann-Whitney U test, using normal two-tail approximations. Within-group comparisons (with Bonferroni adjustments) between sensory modalities were made with Wilcoxon's matched-pairs signed-ranks test.

Results

Verbatim quotes illustrating the type of perceptual anomalies reported by patients during interviews are presented in table 2. The anomalies are consistent with the perceptual anomalies commonly reported in schizophrenia (McGhie and Chapman 1961).

Reliability. Table 3 shows an item-by-item analysis of interrater agreement in the subgroup ($n = 51$) of jointly interviewed schizophrenia patients. The absolute agreement (i.e., exact categorical agreement) between the two raters was 79 percent or greater for all interview items, with a mean of 90 percent (SD = 6.5) and median of 91 percent. Weighted kappa coefficients varied widely, but were higher and more consistent as the item response variance increased. In the auditory, visual, and tactile modalities, all items showed good to excellent interrater agreement (kappas: 0.67 to 1.0), whereas olfactory and gustatory items, which were predominantly rated "never," showed inconsistent and generally poorer agreement (0.28 to 0.72; see table 3). Excellent agreement (kappa: 0.75) was achieved for two of three items in each of the auditory, visual, and tactile modalities. Kappa coefficients for items in the olfactory and gustatory modalities were appreciably lower because of the lack of variability due to the infrequent report of anomalies, but even in these sensory modalities absolute agreements were high (86.7 to 97.8%).

The interrater agreement of the mean sensory modality scores (the average of the three items in each modality) was indexed with the intraclass correlation coefficients (ICCs) of the two raters' mean scores (see table 4). The ICCs were classified as excellent (ranging from 0.89 to 0.96) for the auditory, visual, tactile, and olfactory modalities. Mean ratings of gustatory anomalies achieved fair interrater reliability (ICC = 0.48) because of the lack of response variability.

The global clinical impressions were less reliable than the scores derived from the interview supporting the value of a structured interview. For example, the kappa coefficient for the global clinical judgment of auditory anomalies was 0.52 (fair) versus 0.70 (good) for the structured interview score. The global clinical impressions of visual anomalies yielded a weighted kappa value of 0.62 (good agreement) versus the structured interview weighted kappa value of 0.76 (excellent agreement).

The internal reliability (or consistency) of the 15 items comprising the rating instrument was good as indicated by the Cronbach alpha coefficient of 0.80. The internal consistency of each modality was as follows: auditory, 0.84; visual, 0.73; tactile, 0.66; olfactory, 0.46; and gustatory, 0.68. The internal consistency of the five hypersensitivity items (i.e., one from each sensory modality) was 0.55, but increased to 0.67 when the olfactory item was removed. The internal consistency of the "inundation or flooding" items was 0.60, but improved to 0.70 when the olfactory items was removed. The internal consistency of selective attention items was 0.37 and improved slightly to 0.43 with the deletion of the olfactory items.

Prevalence of Perceptual Anomalies. The prevalence of perceptual anomalies for schizophrenia subjects and normals is presented in figure 1. Most of the perceptual abnormalities were reported in the auditory and visual

Table 2. Samples of quotes from patients interviewed with the Structured Interview for the Assessment of Perceptual Anomalies (SIAPA)

Subject	Auditory (A) and visual (V) quotes
Female 32 yrs.	A: "I try to get away, but I'm sensitive to sounds. Doors clink, people talk loud." A: "I'm easily distracted, I can't focus on one conversation; it's overwhelming." V: "Things in the corner of my eyes often catch my attention. I feel like I see everything at once." V: "Things are too bright: like the brightness has been turned-up."
Male 35 yrs.	A: "Slight noises often startle me, so I'm more jumpy than most people. It annoys me." A: "I can't concentrate on one thing because I can't shut out other sounds happening at the same time. It makes me feel flooded." V: "I'm distractible; things in my peripheral vision catch my eye."
Male 26 yrs.	A: "My hearing is very sensitive ... It's like bionic hearing. I do whatever I can to keep away from noises, even normal conversations." A: "I have a hard time listening because I'm easily distracted by things happening around me ... like people talking, ringing phones, and the intercom." V: Colors seem "very intense, piercing ... they are like techni-colored." V: "I cannot focus on one image or sight because there are so many things that catch my eye. It's like my peripheral vision takes priority."
Male 21 yrs.	A: "All sounds come to me at once and I have trouble focusing on one conversation when other sounds are happening." A: "Things are louder than normal: the TV is louder; other peoples' conversations seem louder." V: "When I am watching a cartoon sometimes the intensity of colors bother me."
Male 42 yrs.	A: "I am really distracted by the TV and noises around me. It's hard to concentrate because these things disrupt my thoughts." A: "I can hear you and the people around me, all at once." V: "It was hard to work on the construction site. I couldn't pay attention to my work because of visual distractibility. Everything seemed to catch my eye."
Male 33 yrs.	A: "When my illness is worse, regular noises like the TV, radio, and traffic seem much more intense. They are distracting and annoying...." A: "Sometimes it feels like everything is coming in, like my brain is a radar for sounds."
Male 42 yrs.	A: "It feels like the sound of the TV and keys rattling are going right through me." A: "I cannot tune out environmental sounds."
Male 28 yrs.	A: "I am more distractible than other people. I just want to tell everybody to shut off the noise and the TV." V: "Light sometimes gets on my nerves; it's just bright and bothers me."

Note.—Quotes such as these formed the basis for ratings on the SIAPA.

modalities, particularly among schizophrenia patients. The percentage of participants reporting any perceptual anomaly (that is, a rating of at least "rarely" on one of the 15 items) was 52.2 percent among schizophrenia subjects and 25.5 percent in controls. Inspection of the content of the self-reported anomalies indicated that the schizophrenia patients consistently described more elaborate, impairing accounts of perceptual anomalies compared with controls. The anomalies reported by the controls were much less severe and less impairing and, with one exception, were always reported to be associated with fatigue or stress, such as academic examinations or severe lack of sleep. One person in the control group reported persistent and frequent perceptual auditory and visual abnormalities similar in intensity and content to those reported in schizophrenia but unrelated to fatigue or stress.

For the schizophrenia group, the prevalence of anomalies in the auditory compared with the visual modality did not differ as tested by the Wilcoxon's matched-pairs signed-ranks test. Auditory *and* visual anomalies were significantly more prevalent than tactile and gustatory anomalies, and significantly more auditory, but not visual, anomalies were reported compared with olfactory anomalies. There were no other modality differences for schizophrenia subjects. Among the controls, the only between-modality differences indicated significantly more auditory anomalies compared with olfactory and gustatory anomalies. There was no correlation between chronological age and perceptual anomalies.

Group Differences (Known-Groups Validity). The mean Likert ratings for the schizophrenia subjects and

Table 3. Item-by-item interrater agreement and reliability for a subgroup of 51 jointly interviewed schizophrenia patients

Modality and interview items	Percentage of absolute agreement[1]	Weighted kappa value[2]
Auditory		
Stimuli seem unusually intense	80.0	0.78
Sensory flooding	81.6	0.79
Cannot focus attention on single stimulus to exclusion of others	79.2	0.73
Visual		
Stimuli seem unusually intense	85.1	0.76
Sensory flooding	91.1	0.88
Cannot focus attention on single stimulus to exclusion of others	86.4	0.67
Tactile		
Stimuli seem unusually intense	91.1	0.67
Sensory flooding	95.7	0.81
Cannot focus attention on single stimulus to exclusion of others	100.0	1.00
Olfactory		
Stimuli seem unusually intense	86.7	0.71
Sensory flooding	88.9	0.38
Cannot focus attention on single stimulus to exclusion of others	95.7	0.72
Gustatory		
Stimuli seem unusually intense	91.0	0.28
Sensory flooding	95.5	0.64
Cannot focus attention on single stimulus to exclusion of others	97.8	0.39

Note.—The absolute agreement between the two raters was near 80 percent or greater for all interview items. In the auditory, visual, and tactile modalities, all items showed good or strong interrater reliability; olfactory and gustatory items were less consistent and showed poorer reliability.

[1] The percentage of agreement between raters is higher than the corresponding kappas because of (1) the inflated agreements caused by the absence of behavior, (2) the fact that the kappa coefficient controls for chance agreements, and (3) because the kappa statistic results in low coefficients when variances are small.

[2] Qualitative descriptors of the clinical or practical meaning of the weighted kappa coefficients are as follows (Cicchetti and Sparrow 1981): 0.75, excellent; 0.60–0.74, good; 0.40–0.59, fair/moderate; 0.40, poor.

controls, separated according to modality, are presented in figure 2. Nonparametric analyses demonstrated that schizophrenia subjects reported significantly more perceptual anomalies than controls did (n = 98) in the auditory (Mann-Whitney test, W_s = 2175, $p < 0.0001$), visual (W_s = 2251, $p < 0.0001$), and olfactory (W_s = 2684, p = 0.0003) sensory modalities as well as in the overall ratings (W_s = 1681, $p < 0.0001$). These differences support the known-groups validity of the instrument. Schizophrenia subjects and controls did not differ significantly in the tactile (W_s = 3045, p = 0.11) and gustatory (W_s = 3056, p = 0.07) modalities. The number of participants reporting anomalies in these modalities was extremely small.

There were no differences in the frequency of perceptual anomalies between men and women in the schizophrenia or control group. Neither were there significant differences between ratings of unmedicated (n = 10) and

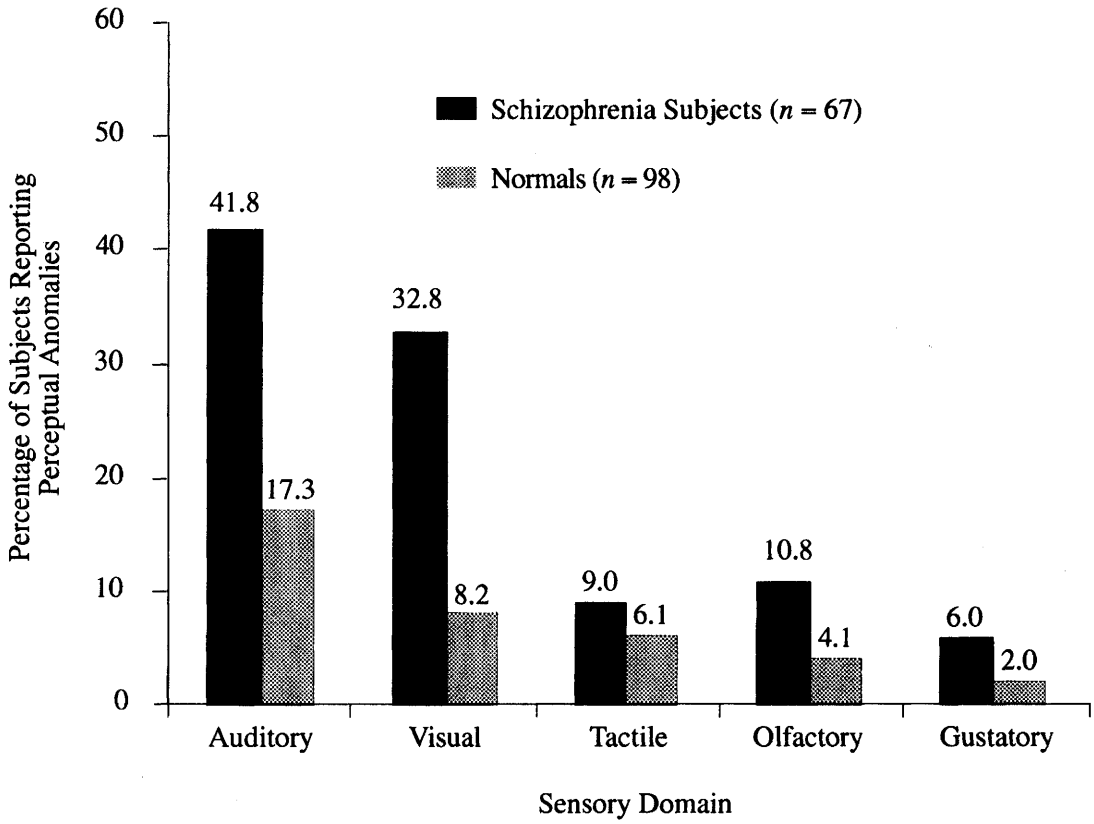
Table 4. Interrater agreement and reliability of the mean sensory modality ratings (average of the three items in each modality)

Sensory modality	Percentage of agreement	Intraclass correlation coefficient[1]
Auditory mean	74.0	0.96
Visual mean	87.2	0.95
Tactile mean	95.7	0.96
Olfactory mean	84.8	0.89
Gustatory mean	93.5	0.48
Mean scale rating	86.0	0.93

Note.—Auditory, visual, tactile, and olfactory anomalies were reliably assessed; gustatory anomalies were not.

[1]Qualitative descriptors of the clinical or practical meaning of the intraclass correlation coefficients are as follows (Cicchetti and Sparrow 1981): 0.75, excellent; 0.60–0.74, good; 0.40–0.59, fair/moderate; 0.40, poor.

Figure 1. Percentage of schizophrenia patients and controls reporting at least one perceptual anomaly (i.e., endorsing at least "rare" occurrence of one anomaly) based on the SIAPA



Note.—Schizophrenia patients consistently reported more perceptual anomalies than controls did, particularly in the auditory and visual modalities.

medicated (n = 57) patients, paranoid (n = 45) and undifferentiated (n = 20) types, or between those with (n = 43) and without (n = 24) a history of substance use. Statistical tests of correlations between ratings of perceptual anomalies with the total number of lifetime hospitalizations and correlations between perceptual anomalies with duration of illness were not significant.

Discriminant and Structural Validity. Table 5 shows the intercorrelations between the PANSS, BPRS, and SIAPA. Full-scale and subscale scores on the PANSS and the BPRS, representing positive and negative symptoms and a general index of psychopathology, were highly correlated and similar to the correlations reported by Bell et al. (1992). In our study the SIAPA did not correlate significantly with the PANSS or BPRS.

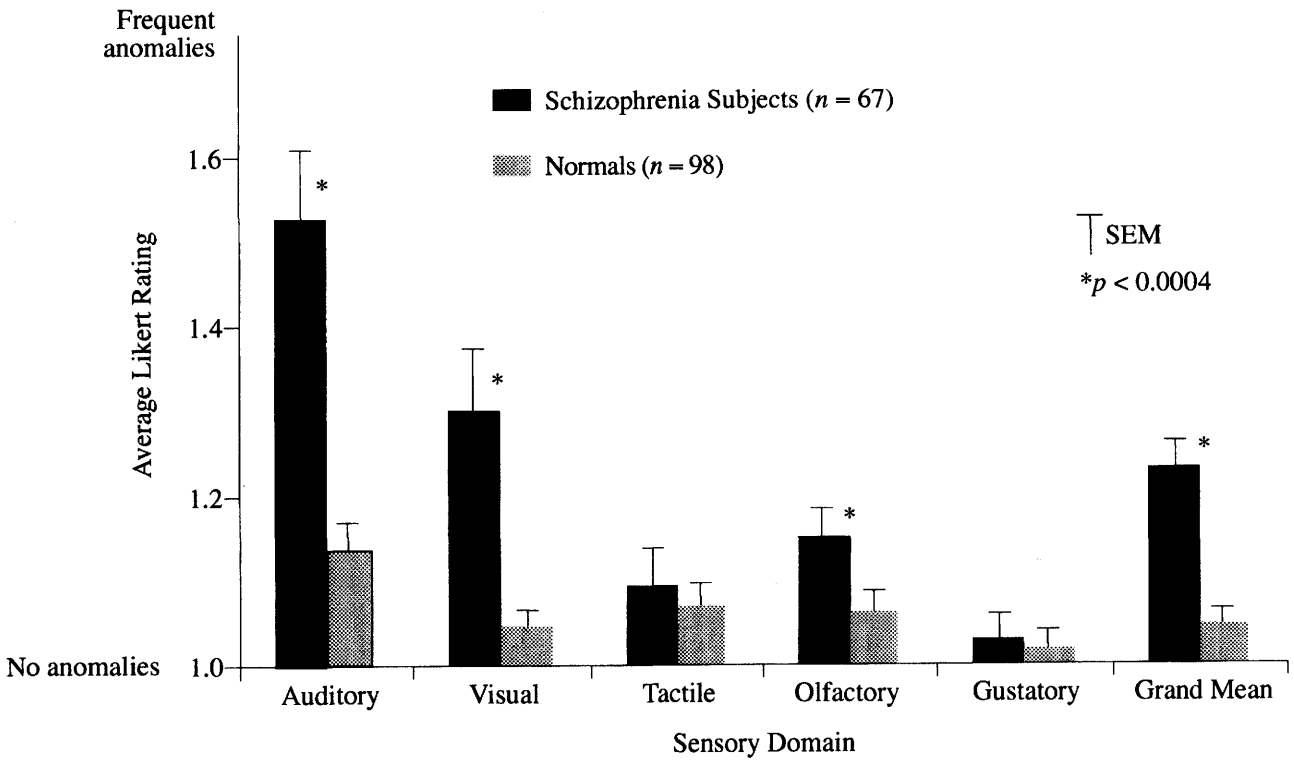
To test whether perceptual gating anomalies correlate with and relate to hallucinations, correlations between ratings of hallucinations as assessed on the BPRS and PANSS and the scores on the SIAPA were calculated. The correlations between hallucinatory behavior (positive symptoms), as rated in items on the PANSS and BPRS, and items from the SIAPA (see table 6) are positive but not statistically significant and contributed only 1 to 16 percent of the shared variance.

With respect to structural validity, the total score on the SIAPA (shown at the bottom of table 5) correlated with specific sensory modalities and indicated that the auditory, visual, and, to some extent, tactile domains contributed most significantly to the total score of the interview: auditory 0.90; visual 0.77; tactile 0.69.

Discussion

The primary contribution of this investigation is the development and testing of a 15-item structured clinical interview instrument for assessing and quantifying perceptual anomalies across the five sensory modalities. An instrument for assessing perceptual anomalies is particularly important because of the importance of these phe-

Figure 2. Mean Likert ratings of the frequency of auditory and visual anomalies



Note.—Ratings were significantly higher for schizophrenia patients compared with controls. Also, the total scale score was significantly greater for schizophrenia patients.

nomena in schizophrenia and because such an instrument provides a tool for comparing these putative phenomenological manifestations of sensory gating deficits with psychophysiological indices of sensory gating, such as P50 and acoustic startle suppression.

This is the first investigation to publish estimates of the proportion of schizophrenia patients and healthy controls reporting perceptual anomalies such as those described in McGhie and Chapman's (1961) classic paper. The major findings of this study were that perceptual anomalies can be measured reliably and were significantly more prevalent in the self-reports of schizophrenia patients compared with those of healthy controls, particularly in the auditory and visual modalities where anomalies were most often reported. Significantly more auditory and visual perceptual anomalies were reported by schizophrenia patients compared with controls, consistent with the hypothesized role of psychophysiological (e.g., P50 and acoustic startle) gating deficits in schizophrenia. Olfactory anomalies were significantly more prevalent among schizophrenia patients than among controls. However, they were rarely reported in both groups. Similarly, tactile and gustatory abnormalities were rarely reported.

Despite the fact that tactile, olfactory, and gustatory abnormalities were very rarely reported and thus gave lower kappa values, retaining these items in the scale may be important because some patients report dramatic symptoms in these modalities, such as "I am so sensitive to touch ... I feel like I am wearing a hair shirt" or "It feels as painful as having tacks stuck into my skin." In terms of olfactory abnormalities, one new patient stated: "When I just walk by a restroom I get almost sick ... the smell is so strong and powerful even many feet away." Another patient stated: "The taste of raisins is just overwhelming." Future studies in larger samples will determine if these items contribute meaningfully to the study of clinical gating. All the data available concerning the psychometric properties of our scale are included, so investigators can decide whether they wish to exclude items based on an evaluation of the frequency of reporting, reliability of the item, or theoretical importance of a given sensory modal-

Table 5. Intercorrelations between the PANSS, BPRS, and SIAPA

	PANSS				BPRS				SIAPA					
	Pos	Neg	Gen	Total	Pos	Neg	Gen	Total	Aud	Vis	Tac	Olf	Gus	Total
PANSS														
Positive														
Negative	0.34 (34)													
Gen Psych	0.57 (34)	0.64 (34)												
Total	0.73 (34)	0.80 (34)	0.93 (34)											
BPRS														
Positive	0.92 (27)													
Negative	0.47 (27)	0.84 (27)			0.40 (28)									
Gen Psych	0.13 (27)	0.06 (27)	0.59 (27)		0.19 (28)	0.27 (28)								
Total	0.77 (27)	0.55 (27)	0.86 (27)	0.90 (27)	0.79 (28)	0.76 (28)	0.62 (28)							
SIAPA														
Auditory	0.13 (31)	0.06 (31)	0.16 (31)	0.14 (31)	0.17 (25)	0.24 (25)	0.31 (25)	0.31 (25)						
Visual	0.02 (30)	–0.6 (30)	0.04 (30)	0.02 (30)	0.32 (24)	0.16 (24)	0.16 (24)	0.30 (24)	0.62 (67)					
Tactile	0.39 (30)	0.31 (30)	0.49 (30)	0.49 (30)	0.26 (24)	0.59 (24)	0.36 (24)	0.55 (24)	0.62 (67)	0.40 (67)				
Olfactory	0.14 (30)	0.14 (30)	–0.14 (30)	0.02 (30)	0.17 (24)	0.03 (24)	–0.11 (24)	0.05 (24)	0.15 (67)	–0.01 (67)	0.05 (67)			
Gustatory	0.37 (30)	0.08 (30)	0.22 (30)	0.25 (30)	0.34 (24)	0.27 (24)	0.26 (24)	0.40 (24)	0.39 (67)	0.23 (67)	0.31 (67)	0.27 (67)		
Total	0.27 (31)	0.17 (31)	0.23 (31)	0.26 (31)	0.39 (25)	0.40 (25)	0.34 (25)	0.51 (25)	0.90 (67)	0.77 (67)	0.69 (67)	0.34 (67)	0.50 (67)	

Note.— Full and subscale scores on the PANSS and BPRS were highly correlated. The discriminant of the SIAPA was supported by the lack of significant correlations with PANSS and BPRS scores. PANSS = Positive and Negative Syndrome Scale; BPRS = Brief Psychiatric Rating Scale; SIAPA = Structured Interview for Assessing Perceptual Anomalies; Pos = positive symptoms; Neg = negative symptoms; Gen = general psychopathology. The numbers in parentheses represent the number of patients tested with PANSS, BPRS, and SIAPA.

Table 6. Intercorrelations between ratings of hallucinations on the BPRS and PANSS and sensory modality mean ratings from the SIAPA

	Ratings of hallucinatory behavior	
SIAPA sensory modalities	**BPRS (n = 25)**	**PANSS (n = 31)**
Auditory	0.10	0.02
Visual	0.11	0.01
Tactile	0.00	0.09
Olfactory	0.06	0.13
Gustatory	–0.10	–0.03
Overall, mean	0.11	0.07

Note.—Perceptual anomalies were not related to ratings of hallucinations derived from the BPRS and PANSS. BPRS = Brief Psychiatric Rating Scale; PANSS = Positive and Negative Syndrome Scale; SIAPA = Structured Interview for Assessing Perceptual Anomalies.

ity to their research. Nevertheless, users should clearly note the low reliability of two gustatory items and one of three items in the olfactory mode. It should also be noted, however, with the scale as it is, that the overall alpha coefficient is a very high 0.80. Finally, although we had a significant sample of representative schizophrenia inpatients, use and analysis of the scale will continue to inform us about the usefulness of the various items. Thus, on the basis of our data, investigators can make an informed decision to use the entire scale or select those items most useful for their research goals.

In designing the scale we felt it was important to clearly differentiate external sensory stimuli from internal sensory hallucinations. Supporting this, we reported no significant correlations between the SIAPA scale and those items assessing hallucination on the BPRS and PANSS.

Interrater agreement on the occurrence of perceptual anomalies was considerably better when ratings were made with the SIAPA compared with global clinical *impressions* of the frequency of anomalies formed by the raters, indicating an important benefit of the structured scale.

The face validity of the SIAPA was evidenced by the fact that the verbatim quotes recorded during the interviews described perceptual and attentional anomalies that were strikingly similar to those recorded by McGhie and Chapman (1961). Sampling perceptual anomalies from three areas of perceptual experience (hypersensitivity, flooding, and selective attention) and across the five sensory modalities supports the content validity of the instrument insofar as these domains were consistent with the phenomenological descriptions offered by McGhie and Chapman (1961). The known-groups validity of the SIAPA was established by the finding of significantly more perceptual anomalies among schizophrenia patients than among controls.

The development of the SIAPA and our findings have implications for future investigations. First, the SIAPA provides a systematic and reliable method for surveying the prevalence of perceptual anomalies in clinical populations. Second, the cluster of items assessing auditory anomalies and the cluster measuring visual anomalies each possess psychometric properties that make them suitable as dependent variables in studies of the clinical manifestations of the sensory gating deficits. These properties include adequate frequency of occurrence, excellent interrater agreement, adequate internal consistency, and known-groups validity. Third, analyses of the internal consistency of items assessing the phenomenological construct of hypersensitivity and flooding demonstrated adequate reliability when the olfactory items were removed, supporting these phenomenological conceptualizations. Although the failed selective attention construct item may not reflect group differences, it is useful in identifying an important characteristic of perceptual anomalies in schizophrenia patients. Examples from patients include the following comments: "It's so hard to focus my attention on what is happening around me"; "The TV will be too loud or people will talk too loud and it ruins my power to hear. I can't focus on what I was trying to do or hear. It is very irritating beyond belief. I lose track of what I was thinking about"; "I am easily distracted by anything, like the noise coming from that room out there. I can't tune out background noises"; and "Cars and noises distract my thoughts. They take my concentration away from the TV or reading or whatever I am doing."

The SIAPA offers investigators the opportunity to directly test the relationship between the often cited and classic perceptual and attentional aberrations in schizophrenia (McGhie and Chapman 1961) and the psychophysiological deficits reported in P50 suppression and acoustic startle prepulse inhibition paradigms. Given that nearly one-half of the schizophrenia patients in the present sample did not report any perceptual anomalies, a challenge for subsequent investigations is to characterize the profiles of individuals who report perceptual anomalies and those who do not.

The observation that nearly one-half of schizophrenia patients in our sample did not report perceptual anomalies could be explained by several factors. First, a disproportionate number of the schizophrenia patients in our sample were of the paranoid type (67%). Recent findings suggest that the preattentive phases of information processing, such as measured by P50 amplitude and gating, are more aberrant in nonparanoid (i.e., undifferenti-

ated) than in paranoid subgroups of schizophrenia patients (Boutros et al. 1991, 1993). Although in our investigation there was no evidence that perceptual anomalies differed between paranoid and undifferentiated type schizophrenia, additional research is warranted to specifically study perceptual anomalies across the spectrum of diagnostic subtypes. A second possibility is that McGhie and Chapman (1961) and Venables (1964) observed that perceptual and attentional anomalies, such as those of interest here, were more pronounced in the early, acute phase of schizophrenia. The sample of schizophrenia patients in the present study comprises many chronic patients: the mean number of years since the onset of their illness was 10.9 years (SD = 6.2). In the present study, however, there was no correlation between perceptual anomalies and the number of years since the onset of the illness. Further investigation is necessary to elucidate the relationships between perceptual anomalies and the time-course of illness. Longitudinal studies, for example, could determine if the incidence of perceptual anomalies increases during the initial onset of schizophrenia (first episode) or at the onset of a recurrent exacerbation of the illness. Also, longitudinal or cross-sectional studies may clarify the relationship between perceptual anomalies and a variety of clinical symptoms, including hallucinations and cognitive fragmentation. In the future it will be important to evaluate perceptual anomalies in other diagnostic categories, including bipolar and unipolar affective illness, obsessive-compulsive disorder, and post-traumatic stress disorder.

In this study, the incidence of normal controls reporting a perceptual anomaly rated as "rarely occurring" was 25.5 percent. This is consistent with Chapman and Chapman (1989) in their Perceptual Aberration Scale, which measures primarily body-image distortions but includes items assessing "nonbody image," anomalies of external sensory processing. The similarity of the findings from these independent reports of healthy subjects suggests good convergent validity for the SIAPA. In future investigations, exploring linkages between these two scales would be useful, for one might expect low if any correlation between these two instruments, one of which measures primary perceptual anomalies and the other sensory experience anomalies.

The verbatim quotes recorded during the interviews make it clear that the perceptual anomalies reported by the schizophrenia patients were qualitatively much more severe than those reported by the controls. Anchoring our ratings according to the frequency of perceptual anomalies, rather than on the severity of impairment may have reduced the magnitude of the group differences. Inspection of the content of the verbatim quotes supports this possibility because the schizophrenia patients consistently described more elaborate accounts of impairing perceptual anomalies compared with controls, whose anomalies were, with only one exception, associated with fatigue and stress. Although taking severity and frequency into account may have resulted in quantitatively more pronounced anomalies among schizophrenia patients compared with controls, the decision not to measure severity was based on the difficulty of assessing the extent to which anomalies impair an individual's functioning.

After reviewing the literature, and with the intent of stimulating testable hypotheses, Braff and Geyer (1990) concluded that the sensory-gating information-processing approach to the study of schizophrenia "relies on several critical but tacit assumptions, [including that] primary attentional or cognitive impairment may lead to the dramatic symptoms of schizophrenia such as paranoia and delusion formation" (p. 187). Further, Karper et al. (1996) have shown decreased gating, measured by prepulse inhibition, correlates with increased levels of distractibility. Perry and Braff (1994) have reported that poor prepulse inhibition correlates with thought disorder, as measured by a Rorschach-derived Ego Impairment Index. These studies provide some evidence for linking abnormal sensory gating with clinically important measures.

The SIAPA could be useful for testing the relationship between the phenomenology described by McGhie and Chapman (1961) and the widely reported P50 suppression and acoustic startle prepulse inhibition deficits as well as latent inhibition, the degraded form of the continuous performance tasks, and other information-processing measures. Investigations of these relationships will result in direct tests of important assumptions in the sensory gating literature.

Appendix. Structured Interview for Assessing Perceptual Anomalies

INSTRUCTIONS:

The purpose of this instrument is to document patient responses to environmental stimuli. A distinction between responses to "real," external stimuli **versus** imagined, internally derived stimuli (i.e., hallucinations) must be carefully made for each item. This instrument is intended for the recording of responses to "real," external stimuli.

Below are statements describing sensory perception. Carefully rate how frequently each statement characterized the patient's experience during the past week.

Auditory Anomalies						
1.	**Real sounds seem more intense or loud**	Never	Rarely	Half the time	Often	Always
	Normal noises (i.e., auto & air traffic, motorized appliances, speech) are perceived with increased intensity. Sounds are perceived as painfully loud.					
2.	**Feelings of being flooded/inundated by real sounds**	Never	Rarely	Half the time	Often	Always
	All sounds seem to come in at once. Irritated by complex auditory environments (i.e., multiple, simultaneous sounds).					
3.	**Cannot focus attention on one real sound or voice to the exclusion of others**	Never	Rarely	Half the time	Often	Always
	Unable to focus on only one sound and ignore others. Difficulty attending to one voice when in a group of people. Cannot "tune out" environmental sounds.					
Visual Anomalies						
4.	**Real sights or colors seem unusually intense**	Never	Rarely	Half the time	Often	Always
	Lights seem much brighter. The intensity of colors is greater (i.e., more vivid).					
5.	**Feelings of being flooded/inundated by sights or colors**	Never	Rarely	Half the time	Often	Always
	Complex visual environments are bothersome. Feelings of being overwhelmed by multiple visual stimuli.					
6.	**Cannot focus attention on one visual perception to the exclusion of others**	Never	Rarely	Half the time	Often	Always
	Cannot attend to one of many simultaneous visual inputs.					
Tactile Anomalies						
7.	**Real touch seems more intense**	Never	Rarely	Half the time	Often	Always
	Skin sensitivity is increased to the extent that clothing/fabric is described as particularly abrasive or uncomfortable.					

8.	**Feelings of being flooded/inundated by real tactile experiences**	Never	Rarely	Half the time	Often	Always
	Tactile experiences seem overwhelming (i.e., dominate sensory experience and attention).					
9.	**Cannot focus attention on one real tactile sensation to the exclusion of others**	Never	Rarely	Half the time	Often	Always
	Difficulty discriminating between multiple sources of tactile sensation. Difficulty localizing tactile sensation.					
Olfactory Anomalies						
10.	**Real smells are perceived with increased intensity**	Never	Rarely	Half the time	Often	Always
	Increased sensitivity to and/or perceptual awareness of perfumes and/or body odor.					
11.	**Feelings of being flooded/inundated by real smells**	Never	Rarely	Half the time	Often	Always
	Smells everything at once. Feels "permeated" by real olfactory stimuli.					
12.	**Cannot focus on one real smell to the exclusion of others**	Never	Rarely	Half the time	Often	Always
	Cannot clearly discriminate between various olfactory sensations.					
	Gustatory Anomalies					
13.	**Real tastes are perceived with increased intensity**	Never	Rarely	Half the time	Often	Always
	Tastes are perceived with increased intensity. Increased sensitivity to tastes.					
14.	**Feelings of being flooded/inundated by gustatory sensations**	Never	Rarely	Half the time	Often	Always
	Tactile experiences seem overwhelming (i.e., dominate sensory experience and attention).					
15.	**Cannot focus on one real taste to the exclusion of others**	Never	Rarely	Half the time	Often	Always
	Cannot distinguish clearly between taste sensations.					

References

Adler, L.E.; Hoffer, L.; Nagamoto, H.T.; Waldo, M.C.; Kisley, MA.; and Griffith, J.M. Yohimbine impairs P50 auditory sensory gating in normals. *Neuropsychopharmacology,* 10:249–257, 1994.

Adler, L.E.; Pachtman, E.; Franks, R.D.; Pecevich, M.; Waldo, M.C.; and Freedman, R. Neurophysiological evidence for a defect in neural mechanisms involved in sensory gating in schizophrenia. *Biological Psychiatry,* 17:639–654, 1982.

Adler, L.E.; Waldo, M.C.; Tatcher, A.; Cawthra, E.; Baker, N.; and Freedman, R. Lack of relationship of auditory gating deficits to negative symptoms in schizophrenia. *Schizophrenia Research,* 3:131–138, 1990.

American Psychiatric Association. *DSM–III–R: Diagnostic and Statistical Manual of Mental Disorders.* 3rd ed., revised. Washington, DC: The Association, 1987.

Baker, N.J.; Adler, L.E.; Franks, R.D.; Waldo, M.C.; Berry, S.; Nagamoto, T.H.; Muckle, A.; and Freedman, R. Neurophysiological assessment of sensory gating in psychiatric inpatients: Comparison between schizophrenia and other diagnoses. *Biological Psychiatry,* 22:603–617, 1987.

Bell, M.; Milstein, R.; Beam-Goulet, J.; Lysaker, P; and Cicchetti, D. The Positive and Negative Syndrome Scale and the Brief Psychiatric Rating Scale: Reliability, comparability, and predictive validity. *Journal of Nervous and Mental Disease,* 180:723–728, 1992.

Boutrous, N.N.; Zouridakis, G.; and Overall, J. Replication and extension of P50 findings in schizophrenia. *Clinical Electroencephalography,* 22:40–45, 1991.

Boutros, N.N; Zouridakis, G.; Rustin, T.; Peabody, C.; and Warner, D. The P50 component of the auditory evoked potential and subtypes of schizophrenia. *Psychiatry Research,* 47:243–254, 1993.

Braff, D.; Callaway, E.; Geyer, M.; Glick, I.; and Bali, L. Prestimulus effects on human startle reflex in normals and schizophrenics. *Psychophysiology,* 15:339–343, 1982.

Braff, B.L., and Geyer, M.A. Sensorimotor gating and schizophrenia. *Archives of General Psychiatry,* 47:181–188, 1990.

Braff, D.L.; Swerdlow, N.R.; and Geyer, M.A. Gating and habituation deficits in the schizophrenia disorders. *Clinical Neuroscience,* 3:131–139, 1995.

Chapman, J.P., and Chapman, L.J. "Norms on Psychosis-Proneness Scales for University of Wisconsin Undergraduate Students From the Introductory Psychology Course." Unpublished raw data, 1989.

Chapman, L.J.; Chapman, J.P.; and Raulin, M.L. Body image aberration in schizophrenia. *Journal of Abnormal Psychology,* 87:399–407, 1976.

Chapman, L.J.; Chapman, J.P.; and Raulin, M.L. Scales for physical and social anhedonia. *Journal of Abnormal Psychology,* 85:374–382, 1978.

Cicchetti, D.V., and Sparrow, S.S. Developing criteria for establishing interrater reliability on specific items. *American Journal of Mental Deficiency,* 86:127–137, 1981.

Cohen, J. Weighted kappa: Nominal scale agreement with provision for scaled disagreement or partial credit. *Psychological Bulletin,* 70:213–220, 1968.

Franks, D.R.; Adler, L.E.; Waldo, M.C.; Alpert, J.; and Freedman, R. Neurophysiological studies of sensory gating in mania: Comparison with schizophrenia. *Biological Psychiatry,* 18:989–1005, 1983.

Freedman, R.; Adler, L.E.; Gerhardt, G.A.; Waldo, M.; Baker, N.; Rose, G.; Drebing, C.; Nagamoto, H.; Bickford-Wimer, P.; and Franks, R. Neurobiological studies of sensory gating in schizophrenia. *Schizophrenia Bulletin,* 13:669–678, 1987.

Freedman, R.; Adler, L.E.; Waldo, M.C.; Pachtman, E.; and Franks, R. Neurophysiological evidence for a defect in inhibitory pathways in schizophrenia: Comparison of medicated and drug-free patients. *Biological Psychiatry,* 18:537–551, 1983.

Geyer, M.A., and Braff, D.L. Startle habituation and sensorimotor gating in schizophrenia and related animal models. *Schizophrenia Bulletin,* 13:643–668, 1987.

Grillon, C.; Courchesne, E.; Ameli, R.; Geyer, MA.; and Braff, D.L. Increased distractibility in schizophrenia patients: Electrophysiologic and behavioral evidence. *Archives of General Psychiatry,* 47:171–179, 1990.

Kane, J.; Honigfeld, G.; Singer, J.; and Meltzer, H. Clozapine for the treatment-resistant schizophrenic. *Archives of General Psychiatry,* 45:789–796, 1988.

Karper, L.P.; Freeman, G.K.; Grillon, C.; Morgan, C.A. III; Charney, D.S.; and Krystal, J.H. Preliminary evidence of an association between sensorimotor gating and distractibility in psychosis. *Journal of Neuropsychiatry and Clinical Neurosciences,* 8:60–66, 1996.

Kay, S.R.; Fiszbein, A.; and Opler, L.A. The Positive and Negative Syndrome Scale (PANSS) for schizophrenia. *Schizophrenia Bulletin,* 13:261–276, 1987.

Kornetsky, C., and Orzack, M.H. Physiological and behavioral correlates of attention dysfunction in schizophrenic patients. *Journal of Psychiatric Research,* 14:69–79, 1978.

Maher, B. Delusional thinking and perceptual disorder. *Journal of Individual Psychology,* 30:98–113, 1974.

Mar, C.M.; Smith, D.A.; and Sarter, M. Behavioural vigilance in schizophrenia: Evidence for hyperattentional processing. *British Journal of Psychiatry,* 6:781–789, 1996.

McGhie, A., and Chapman, J. Disorders of attention and perception in early schizophrenia. *British Journal of Medical Psychology,* 34:103–116, 1961.

Naber, G.; Kathmann, N.; and Engel, R.R. P50 suppression in normal subjects: Influence of stimulus intensity, test repetition, and presentation mode. *Journal of Pscyhophysiology,* 6:47–53, 1992.

Nagamoto, H.T.; Adler, L.E.; Waldo, M.C.; Griffin, J.; and Freedman, R. Sensory gating in schizophrenics and normal controls: Effects of changing stimulation interval. *Biological Psychiatry,* 25:549–561, 1989.

Nagamoto, H.T.; Adler, L.E.; Waldo, M.C.; Griffith, J.; and Freedman, R. Gating of auditory response in schizophrenics and normal controls. *Schizophrenia Research,* 4:31–40, 1991.

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

Perlstein, W.M.; Fiorito, E.; Simons, R.T.; and Graham, F.K. Lead stimulation effects on reflex blink, exogenous brain potentials, and loudness judgments. *Psychophysiology,* 30:347–358, 1993.

Perry, W., and Braff, D.L. Information-processing deficits and thought disorder in schizophrenia. *American Journal of Psychiatry,* 151:363–367, 1994.

Schneider, J.S. Basal ganglia role in behavior: Importance of sensory gating and its relevance to psychiatry. *Biological Psychiatry,* 19:1693–1710, 1984.

Shagass, C. Early evoked potentials. *Schizophrenia Bulletin,* 3:80–92, 1977.

Shagass, C.; Straumanis, J.J.; Roemer, R.A.; and Amadeo, M. Evoked potentials of schizophrenics in several sensory modalities. *Biological Psychiatry,* 12:211–235, 1978.

Siegel, C.; Waldo, M.C.; Minzer, G.; Adler, LE.; and Freedman, R. Deficits in sensory gating in schizophrenia patients and their relatives. *Archives of General Psychiatry,* 41:607–612, 1984.

Simons, R.F., and Giardina, B.D. Reflex modification in psychosis-prone young adults. *Psychophysiology,* 29:8–16. 1992.

Smith, D.A.; Boutros, N.N.; and Schwarzkopf; S.B. Reliability of P50 auditory event-related potential indices of sensory gating. *Psychophysiology,* 31:495–502, 1994.

Traub, A.C.; Olson, R.; Orbach, J.; and Cardone, S.C. Psychophysical studies of body image: III. Initial studies of disturbance in a chronic schizophrenic group. *Archives of General Psychiatry,* 17:664–670, 1967.

Venables, P. Input dysfunction in schizophrenia. In: Maher, B.A., ed. *Progress in Experimental Personality Research.* New York, NY: Academic Press, 1964. pp. 1–47.

Winer, B.J. *Statistical Principles in Experimental Design.* 2nd ed. New York, NY: McGraw-Hill, 1971.

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The Authors

William E. Bunney, Jr., M.D., is Distinguished Professor and Della Martin Chair of Psychiatry, Department of Psychiatry and Human Behavior, University of California, Irvine (UCI). William P. Hetrick, M.A., was Research Associate, Department of Psychiatry and Human Behavior, UCI, during data collection and is currently a doctoral student in the Department of Psychology, The Ohio State University, Columbus. Blynn Garland-Bunney, Ph.D., is Assistant Professor, Department of Psychiatry and Human Behavior; Julie V. Patterson, Ph.D., is Assistant Professor, Department of Neurology; Yi Jin, M.D., is Assistant Professor; and Steven G. Potkin, M.D., is Professor, Department of Psychiatry and Human Behavior, UCI. Curt A. Sandman, Ph.D., is Professor and Vice Chairman, Department of Psychiatry and Human Behavior, UCI, and Director of Research, Fairview Developmental Center, Costa Mesa, CA.