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AUDITORY PROCESSING, DIAGNOSIS AND SYMPTOMATOLOGY IN PSYCHIATRIC PATIENTS

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AUDITORY PROCESSING, DIAGNOSIS AND SYMPTOMATOLOGY IN PSYCHIATRIC PATIENTS

By

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Abstract

AUDITORY PROCESSING, DIAGNOSIS AND SYMPTOMATOLOGY IN PSYCHIATRIC PATIENTS

By

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In an investigation of auditory temporal integration, right and left ear thresholds to brief and long (2 and 500 ms) 1000 Hz pure tone or white noise stimuli were obtained for 19 psychiatric patients and 10 matched non-patient controls. Clinical evaluations were made with the aid of tape recorded Combined Instrument Schedule/ Multiple Diagnostic Strategy Schedule (CIS/MDSS) interviews. The patients were given project diagnoses of schizophrenic or affective psychotic disorder, based on agreement by several well-trained diagnosticians. Symptom profiles based on Cross-National Study norms were also scored by three well-trained raters.

The reliability and validity of psychiatric diagnoses vs. symptom profiles were contrasted for utility in a research setting. Relationships between drug dosage, symptomatology and auditory threshold measures were evaluated. Relationships between within-session auditory threshold variability, symptomatology, and threshold level were also examined. In addition, piloting was performed on two non-patient subjects, to determine the characteristics of auditory temporal integration functions at the parameters used in the present study.

The brief and long auditory stimuli were used to assess the relative efficiency of brief and long time constant auditory processing. A duration effect measure of auditory processing (the difference in thresholds to brief and long stimuli) was used to reflect auditory temporal integration.

Affective patients were found to have higher 2 ms click thresholds and steeper-sloped temporal integration functions than those of the control subjects. This replicated earlier work by Bruder and his colleagues (1979; 1976; 1980). These higher thresholds were found to be highly correlated with the presence of speech retardation, flat affect, and bizarre behavior in this group. Higher click threshold (steeper-sloped temporal integration) was also found to be related to the presence of auditory hallucinations in the affective patients. Auditory hallucinations were not found to be correlated with the speech retardation, flat affect, and bizarre behavior symptom cluster in any of the subject groups; however all of these symptom factors do have a high language loading.

These findings, which suggest a deficit in short time constant auditory processing in affective patients with linguistically loaded symptomatology, stand in contrast to those of Bazhin, Wasserman, and Tonkonogii (1975) and Babkoff, Sutton, Zubin & Har-Even (in press). It was the hallucinating affective, and not the schizophrenic group, that showed significantly higher brief thresholds and steeper-sloped temporal integration in the present study.

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CHAPTER 1

INTRODUCTION

The hypotheses investigated in the present study are that a deficit in sensory processing in psychiatric patients, specifically in auditory thresholds or in the temporal integration of auditory stimuli, may be related to diagnostic category or to specific aspects of clinical symptomatology. In addition, processing abnormalities which involve only one cerebral hemisphere may be associated with characteristic patterns of symptomatology related to the differential functions of the dominant and nondominant hemispheres.

This study contrasts right and left ear thresholds in psychiatric patients for brief and long (2 and 500 msec) 1000 Hz tones and white noise bursts. These psychophysical measures are examined in relation to the patients' diagnoses (affective vs. schizophrenic psychotic disorders) as well as their correlations with different aspects of psychiatric symptomatology, using symptom profiles derived from a semistructured interview. A matched non-patient control sample was also tested.

Methodological Notes

Zubin, Salzinger, Fleiss, Gurland, Spitzer, Endicott and Sutton (1975) have noted the importance of a multidisciplinary approach to the study of psychopathology, involving an iterative strategy to define diagnostic groupings, along with methodologically refined psychophysical research. Such investigations should involve culture-fair tasks which are simple enough to ensure adequate patient performance, own-control designs, and the use of experimental

designs which allow for the possibility of producing better performance in the patient population, compared to that of non-patients, as well as the use of procedures which control for the response criterion variable.

The present study uses several techniques which allow for the incorporation of the considerations suggested by Zubin et al.

A Multidisciplinary Approach

Why should one be interested in the sensory/perceptual performance of psychiatric patients? Patients are not, as Cromwell (1978) has noted, likely to be referred for treatment due to their sensory or perceptual abnormalities; it is their higher-level behavior, i.e., their deviation from social norms, that brings them to notice. Yet, if this behavior is to be analyzed and reduced to its lowest common denominator in what Savodnick (1978) has called an objective-descriptive, neo-Kraepelinian manner, a scientific, reductionistic approach needs to be taken. As Freud (1895/1966) noted in his Project for a Scientific Psychology, one of the ultimate goals of investigations in the field of psychopathology is the explanation of behavioral dysfunctions and of psychic constructs in terms of underlying physiological mechanisms. The demonstration of correlations between sensory processing deficits and higher-level symptomatology is an important preliminary step in such an endeavor. The present study relates psychophysical measures of sensory/perceptual function to clinical assessments, and also examines relationships between various aspects of auditory processing and symptomatology within and between diagnostic groups.

An Iterative Approach

The iterative approach can be used to improve both our diagnostic classification schema and our knowledge of the physiological substrates of behavior, especially of the organic dysfunctions underlying psychopathology (Sutton, 1973). An iterative approach involves "raising oneself by one's bootstraps" in diagnostic precision and the definition of psychophysical tasks by alternately using these measures as dependent and independent variables, repeatedly refining them until reliable relationships can be found between well-specified sensory/perceptual processing markers and well-defined clinical entities. In the present study, diagnostic and psychophysical variables used in prior research by Bruder, Sutton, Babkoff, Gurland, Yozawitz and Fleiss (1975), by Babkoff, Sutton, Zubin and Har-Even (Note 1), and by Bazhin, Wasserman and Tonkonogii (1975) are combined and extended.

Culture-fair Tasks

There exists a need for the specification of indicators, markers, or correlates of psychopathology which can be measured in a culture-free or culture-fair manner (Zubin & Kietzman, 1966). Psychophysical techniques provide an excellent tool for the assessment of the sensory processing aspects of abnormal behavior (Bruder et al., 1975; Sutton, 1973). Zubin & Kietzman (1966) have noted that measures of temporal processing, which are dependent upon reactions taking place within milliseconds of stimulus onset, are likely to provide precise and reliable culture-fair indicators of central nervous system functioning.

No test can ever be totally free from cultural influences, as all tests presume some past learning of a cultural nature on the part of the subject. Culture-fair tests are those that presume only experiences that are highly common to many different cultures. These tests are constructed in a way likely to minimize contributions of cultural differences (Anastasi, 1968). In psychophysical testing, the greatest sources of cultural confounding are ones like differences in familiarity with machinery, emotional and motivational factors such as the desire to do well or to excell, intrinsic interest of the test to the subject, response criterion, and rapport with the examiner. However, even on these factors, psychophysical testing is much less prone to confounding than are more complicated and verbally-loaded measures.

Simple Tasks

Zubin et al. (1975) have suggested that simple tasks should be used so that one could be assured of adequate patient performance. More complex tasks are more likely to be confounded by attentional or cognitive variables, and will prohibit the testing of the more severely ill patients.

Another advantage of the use of simple tasks has been suggested by Venables (1965). Venables has noted the need for experiments in psychopathology dealing with simple, well-known aspects of mental functioning, and has suggested that patient-normal differences should be examined and explained in the context of a detailed analysis of such procedures. A good "processing" analysis of behavior depends upon a clear understanding of the various manners in which stimuli are likely to be processed. The

more cognitively complex the subject's task, the more open it is to alternate modes of processing. The three-interval forced-choice auditory threshold task used here to assess temporal integration capacity in this study provides an extremely simple processing situation. This task falls into the class of measures called "Class A" by Brindley (1960), since it deals with an observation of the identity or non-identity of sensations. (Brindley's "Class B" measures, which are not as powerful a research tool, deal with the quality or intensity of sensations.) "Class A" observations, according to Brindley, can be interpreted most directly in terms of underlying neural processing phenomena.

Own-control Design

In this study, subjects serve as their own controls for many aspects of the data analysis, allowing comparisons of their thresholds measured across ears, stimulus spectral characteristics, and stimulus durations. This helps control for effects such as those of motivation and attention, which tend to differ across patient and non-patient subject groups. Any deficits in patient performance seen here can be evaluated in the light of patient performance on other comparable tasks. For instance, elevated brief stimulus thresholds seen in only one ear, or which are not accompanied by elevated thresholds to longer stimuli, are indicative of a specific deficit in patient performance. Patients' elevated thresholds to all stimuli might be more parsimoniously interpreted as the results of motivational or attentional factors.

The Possibility of "Patients Doing Better"

An additional advantage inherent in the use of an own-control design is the enhanced possibility of encountering situations in which patients may, in some way, perform "better" than do non-patients. As Sutton (1973) has noted, better patient performance can not easily be interpreted as being due to poorer attention or motivation on the part of these subjects.

Even if patients do not perform better than do non-patients on an absolute level, if patients can be shown to improve in performance relative to their own-control baselines (as demonstrated by Bruder et al., 1975), a relatively convincing argument can be made that these differences are real, and not attentional artifacts. In addition, if patients can be shown to alter their performance in response to stimulus manipulations to which non-patients are insensitive (as demonstrated by Collins, 1972, and Collins, Kietzman, Sutton & Shapiro, 1978), it is also difficult to interpret such sensitivity as due to poorer performance on the part of these patients.

Criterion Control

Clark, Brown and Rutschman (1967) have shown that differences in sensory processing observed in psychiatric patients may be due to non-sensory factors such as response criterion. In the present study, the use of a forced-choice psychophysical task help free threshold measures from confounding by criterion-related factors. Criterion level is not directly measured in such a procedure; rather it is held constant, as the subject must pick one of three

response intervals on each trial, no matter how sure or unsure he is as to whether any, or all, or as to which of the response intervals contained the stimulus.

Calfee (1970) has noted that problems can arise in forced-choice testing if subjects develop a position preference (e.g., a tendency to choose the middle stimulus when they are not sure of the correct response). One way of correcting for such a response bias is to examine the hit rate separately for each interval, and then to correct for the bias, should it be demonstrated to exist.

Perceptual Deficits in Psychiatric Patients

Several theories have been suggested and examined (Broen, 1968; Kietzman, Spring & Zubin, 1980, Yates, 1966; and Zubin & Kietzman, 1966) that deal with the possibility that psychopathology involves a disturbance in the temporal processing of sensory and perceptual information.

Demonstrations of sensory deficit in individuals suffering from well-documented cerebral damage have often proved an elusive task. It has been noted by Neff (1961; 1968) that even extensive bilateral auditory cortex ablation in animals may not greatly increase detection thresholds for stationary acoustic stimuli, or impair frequency and intensity discrimination. Baru and Karaseva (1972) have provided an extensive review of this literature. It has been generally found that tests using patterned stimuli (Neff, 1968) or stimuli of short duration (Baru & Karaseva, 1972) have been the most successful in reflecting the sequellae of central nervous system lesions. This is true not only in research with

brain-damaged subjects, but also in investigations dealing with psychiatric patients (Katz, 1978). Although Venables (1963) has suggested that the auditory modality is the one in which psychiatric patients are most likely to show a processing deficit, as this system has a finely-tuned resolving power, Bull and Venables (1974) found no difference in pure tone thresholds of schizophrenics when they were compared to thresholds of non-patient control subjects. However, they did find evidence of impaired speech discrimination in patients. Although much of the contemporary focus in the diagnosis of central auditory nervous system deficits has been on the use of patterned stimuli (e.g., speech discrimination ability), there are many problems inherent in such procedures (Katz, 1978). Differing linguistic backgrounds, subcultural variations, educational level, IQ, and motivational state can all act as confounding variables. Thus, for both neurological and psychiatric patients, there is a need for a more objective and culture-fair diagnostic tool to assess cerebral damage or malfunction involving the auditory system. The measurement of temporal integration capacity, using brief tone audiometry, may provide such an instrument. Temporal integration, or temporal summation, refers to the reciprocal relationship between stimulus duration and stimulus intensity in the production of a subjectively equal sensation-level or threshold measurement. Factors influencing auditory temporal integration will be discussed later.

Brief Tone Audiometry

Brief tone audiometry involves the generation of a temporal integration function by measurement of thresholds to stimuli of

different durations. Specifically, comparisons are made between thresholds to extremely brief stimuli of only a few milliseconds duration and thresholds to longer duration stimuli (500 or 1000 milliseconds).

Pioneering work using brief tone audiometry to assess central nervous system dysfunction has been done in the Soviet Union by Gersuni, Baru, Karaseva and Tonkonogii (Gersuni, 1971), while at the same time, the lack of and need for this sort of inquiry in the United States was noted (Katz, 1972). The use of brief tone audiometry in the United States has until recently been limited almost exclusively to the differential diagnosis of conductive and sensory (cochlear) hearing loss (Berlin & Lowe, 1972).

Factors Influencing Auditory Temporal Integration

Intensity-time reciprocity was originally investigated in the visual modality (Bloch, 1885), and is described by Bloch's Law in vision, which relates intensity and duration ($I \times T = C$), and which can usually be described by a linear function with a slope of -1.0 on log-log coordinates (Stevens, 1975). The first systematic description of auditory temporal integration in normal listeners was performed by Hughes (1946). Other early investigations of the relationship between auditory stimulus duration were performed by de Vries (1948), Garner (1947b), Garner and Miller (1945; 1947), and Olsen and Cahart (1966). Zwislocki (1960) and Algom (1978) have reviewed various theories of auditory temporal integration.

Complete intensity-time reciprocity would involve an alteration in intensity of 10 dB for each tenfold change in duration; complete reciprocity is often not found to hold for

auditory stimuli (Garner & Miller, 1947). When perfect integration is observed, it is most likely to occur when pure tone stimuli are employed (Garner, 1947b; Garner & Miller, 1945)

Although auditory temporal integration is often described as a linear function on log-log coordinates, there are probably more instances of nonlinear temporal summation in audition than in other modalities (Békésy, 1960; Goldstein, 1967).

Several parameters interact to affect the auditory temporal integration function, including stimulus frequency and bandwidth, mode of stimulation, and phasic characteristics of the stimuli and level of summation (i.e., threshold vs. suprathreshold levels). Especially important are interactions between duration and bandwidth of stimuli and between stimulus frequency and the time constant of integration.

The bandwidth of the frequencies composing the stimulus is one of the factors influencing temporal integration. As Garner (1947b) noted, "The rate of temporal integration of energy in the ear is dependent on the width of the frequency band of the energy to be integrated. Duration is exactly equivalent to intensity only when all energy to be integrated is in a narrow band of frequencies. When the energy is in a wider band of frequencies, integration will occur, but the change in threshold will be less than the change in duration" (p. 810).

Garner (1947b), Miskolczy-Fodor (1959) and Jeffress (1964) have reported that as a tone becomes briefer it loses its tonal quality and becomes more like a noise burst; its energy is spread into frequency regions at which auditory sensitivity may be

different, thus altering the shape of the temporal integration function. Temporal integration functions for pure tones in the region of 1000 Hz tend to have slopes of about -10, when plotted on the axes dB SPL and log stimulus duration. Wideband noise burst (white noise) stimuli produce temporal integration functions with slopes of about -7.0.

The slope of the temporal integration function has been found to differ for stimuli of different pure tone frequencies (Watson & Gengel, 1969). The slope difference is most pronounced for low frequency stimuli and at the shortest stimulus durations (Plomp & Bouman, 1959; Sheeley & Bilger, 1964). At frequencies of under 250 Hz, both very steep and very shallow slopes have been reported (Garner, 1947b; Green, Birdsall & Tanner, 1957). This is probably due to interactions between frequency spread effects and the characteristics of the individual subjects' audiograms. For stimulus frequencies to which the subject is less sensitive, the introduction of noise characteristics as the stimulus becomes briefer may aid in its detection. On the other hand, if the frequency is one to which the subject is more sensitive, the replacement of pure tone with noise cues as the stimulus becomes briefer may impair performance.

Watson and Gengel (1969) observed that one of the time constants of the temporal integration function (the duration at which stimulus amplitude needed to reach threshold is 63.2% of its long-duration amplitude) tends to decrease as the frequency of the stimulus is increased; similarly, S.D.G. Stephens (1974) noted that critical duration, the upper limit at which full intensity-duration

reciprocity is found, decreases as stimulus frequency increases.

Stimulus rise and decay times (the form of the stimulus envelope) have been reported to affect temporal integration slopes (Miller, 1948). This is especially true for shorter stimuli (Dallos & Olsen, 1964; Olsen & Cahart, 1966). Extremely brief rise and decay times give the stimulus a clicklike character, which could result in its being detected at a frequency different than that of the fundamental tone. Also, if the total effective stimulus duration is not properly specified with some correction made for the contribution of the rise and decay time (such as including the half-energy points of the rise and decay times in total stimulus duration), confounding of rise/decay time and stimulus duration will occur. According to Olsen and Cahart (1966), differences in rise and decay time will not appreciably alter the character of a temporal integration function, if total stimulus durations are accurately computed (as the time between the half-energy points of stimulus onset and offset).

The slope of the temporal integration function differs with the perceived intensity of the stimulus. J.C. Stevens and Hall (1966) reported shallower-sloped functions at threshold than at suprathreshold levels.

The duration at which intensity-time reciprocity is complete (critical duration), as well as the duration at which growth of loudness is complete (utilization time) differ with stimuli of different amplitudes. In the early literature, Miller (1948) suggested that at threshold, temporal integration was evidenced for up to 1 second; at suprathreshold values, 65 ms was felt to

be the limit. Zwislocki (1969) suggested that critical duration is about 100 ms for suprathreshold stimuli, and 200 ms for threshold-level stimuli. Stevens and Hall (1966) found these values to be 150 and 230 ms, respectively. Not only is there an upper duration limit to temporal integration; Sheeley and Bilger (1964) have suggested that a lower duration limit may exist, as well.

Furthermore, it has been suggested that the psychophysical task employed, the instructions given to the subject, the method of stimulus presentation and the group of subjects used (Stephens, 1974) all may influence auditory intensity-time reciprocity, even at absolute threshold level (Chamberlain & Zwislocki, 1970; Gengel & Watson, 1971). Algom and Babkoff (1978) found that critical duration differs for different response measures and procedural variations (i.e., for detection vs. identification tasks). Studies employing forced-choice procedures have been found to produce shorter estimates of critical duration than do those employing more traditional methodologies (Green, Birdsall & Tanner, 1957; Pollack, 1973).

Measures of Intensity-time Reciprocity

Kietzman (1979) has noted that one can distinguish at least seven major characteristics of temporal summation: two "critical" times (critical duration and utilization time) and five "regions" of summation which display different slopes (supersummation, complete summation, partial summation, no summation and subsummation). Supersummation (superintegration) refers to a situation in which the slope of the temporal integration function exceeds (in absolute value) -1, and can be due to a subject showing

normal brief stimulus thresholds and lower than normal long stimulus thresholds. Complete summation or complete integration describes the range of situations in which intensity and time (I and T) are interchangeable; the slope of the temporal integration here is -1. Critical duration refers to the particular stimulus duration at which complete summation ceases, and partial summation begins. With partial summation, increased stimulus duration can only partially compensate for decreased intensity; the slope of the temporal integration function is less than -1 in absolute value. Utilization time refers to the point at which the temporal summation seen in the period of partial summation ceases and no further summation can be demonstrated. Beyond utilization time, no summation occurs; the slope of the temporal integration function is zero, which is to say stimulus intensity is constant. Subsummation refers to situations in which increased stimulus duration would actually require increased intensity to produce an equivalent sensation. A visual temporal integration function of this sort has been reported (the Broca-Sulzer brightness phenomenon; M.S. Katz, 1964). At high intensity levels, fatigue may produce this sort of effect.

Kietzman (1969) notes that in his usage, these distinctions refer to the stimulus parameters associated with a particular response measured at a specified level, and are not meant to refer directly to inferred theoretical internal physiological processes. In his view, temporal integration refers to relationships between characteristics of the independent variable only (with the dependent variable, threshold or sensation level, held constant) and not to inferred processes.

This sort of metatheoretical perspective puts one on a much sounder footing when attempting to deal with data in an iterative approach. Temporal integration can be treated as an independent or dependent variable, rather than as an intervening variable or hypothetical construct.

However, the use of certain terms to describe the characteristics of temporal integration carries implications as to the underlying nature of the function, as different terms have had their derivation in different mathematical and physiological models. Some of these terms are reviewed here, and the rationale for their use or exclusion from consideration in the present study is given.

Critical Duration

Critical duration is used with reference to linear models of temporal integration, and refers to the longest stimulus duration demonstrating complete intensity-time reciprocity. This limit of complete I x T reciprocity usually refers to the stimulus duration corresponding to the intersection of two linear functions, $I \times T = C$, (intensity x duration = a constant value), with a slope of -1; and $I = C$, with a slope of 0. However, if a period of partial integration is also found to exist, then critical duration refers to the point at which the first deviation from complete integration occurs. What, then, is the critical duration of the linear I x T function if it always has a slope of under -1 (e.g., what is the "critical duration" for a broadband noise signal)? Or, how does one specify critical duration if the obtained data are not linear in form, or are being interpreted using nonlinear models (e.g., Plomp & Bouman, 1959)? In these instances, the concept of critical duration is inadequate,

and the time constant of the curve is used to define its rate of decline (rate of integration of the stimulus over time). In linear models, the slope of the temporal integration function can serve a function similar to that of the time constant of a curvilinear function.

Algom (1978) has suggested that critical duration is rarely used as a summary statistic in audition due to: (1) its variation with stimulus frequency, (2) the gradual nature of the transition from complete integration to no integration, (3) the long period of partial summation. and (4) its variation with the methodology employed.

Since auditory data, which often show incomplete I x T reciprocity, do not adequately fit the assumptions which underlie the critical duration measure (derived for use in vision), the critical duration concept was not employed in the present study.

Utilization Time

Utilization time is, in traditional temporal integration parlance, the point in time at which particl integration ceases, and beyond which no further temporal integration occurs (e.g., no change in intensity needed to reach threshold). When there is no duration region for which integration is complete, the term "utilization time" is often used interchangeably with "critical duration". Garner and Miller (1947) and Watson and Gengel (1969) placed this point at about 2 seconds. Utilization time may be thought of as the time measure of partial integration that parallels the concept of critical duration for complete integration; it is the longest stimulus duration at which a characteristic

form of processing is performed. Green, Birdsall and Tanner (1957) have noted that characteristics of partial integration (such as slope and degree of linearity) tend to be less well-defined than they are for complete integration. Utilization time tends to vary with stimulus frequency; it is difficult to measure when the transition from partial to no integration is a gradual one, and may vary with the methodology employed. In addition, when dealing with nonlinear data, or nonlinear theoretical models, the concept of utilization time is an inappropriate one.

Slope

The slope of the temporal integration function is often used as a descriptive statistic. Algom (1978) has noted, with reference to work by Green, Birdsall and Tanner (1957) and Watson and Gengel (1969), that for pure-tone, threshold-level stimuli the auditory temporal integration function is most properly represented by three lines rather than one. The linear function for the briefest durations may be described as $I \times T^{3/2} = C$. This involves a threshold decrease of 4.5 dB per doubling in time on log-log coordinates. At these brief durations, the bandwidth of the stimulus produces what appears to be greater than complete integration.

For intermediate durations (i.e., up to critical duration), $I \times T = C$; a threshold decrease of -3 dB per doubling in time is found when data are plotted on log-log coordinates.

At longer durations (beyond critical duration), partial integration is seen. Here, $I \times T^{1/2} = C$, with a threshold decrease of 1.5 dB per doubling of stimulus duration.

If the slope of a line of best fit to temporal integration data is used to describe the function, it will be influenced by the durations at which the data are collected, as well as by the other parameters previously discussed (frequency, intensity, rise and decay time, etc.).

Pilot data were collected in the present study to provide assurance that auditory temporal integration within the parameters employed in data collection in the main body of the present study could be well-described by a single linear function (see Appendix I).

Time Constants

Time constant, the duration at which threshold amplitude reaches 63.2% of its steady state (intensity asymptote at long duration) value is used with reference to non-linear temporal integration models. An example of such a model would be Plomp and Bouman's (1959) description of temporal integration in terms of a curvilinear, negative exponential function. Algom (1978) has noted that time constants tend to provide briefer estimates of the limits of temporal integration than do comparable measures of critical duration. This is an important point to note when comparing across studies which have used different models to estimate temporal integration.

Duration Effect

Duration effect is a concept first used by Kishonas (1966), which has become well established in the Soviet temporal integration literature (Baru & Karaseva, 1972). Duration effect was operationally defined by these researchers as the difference in threshold between 1 or 2 ms stimuli, and 1200 ms stimuli.

In the present study, the term "duration effect" is used to refer to the difference in threshold between 2 and 500 ms duration stimuli.

Since the threshold to the 500 ms stimulus serves as a baseline against which the 2 ms threshold is compared, thresholds to the brief 2 ms stimuli can be assessed after correcting for 500 ms threshold level by use of the duration effect measure. Thus, duration effect values can be compared across stimulus frequencies, across ears, and across subjects and subject groups. Threshold levels for the 2 and 500 ms stimulus conditions can also be analyzed separately.

Although the concept of duration effect can be used in the context of both linear and non-linear models of temporal integration, as well as with models implying probability summation, signal detectability, or neural power integration, it is of special value when dealing with data related to nonsummation models, such as those of Miller (1948), Gersuni (1965), and Watson and Gengel (1969). This is because these models are based on the view that it is the differential latencies of neural pathways which underlies temporal integration phenomena. Both Gersuni and Watson and Gengel have suggested that two partially independent auditory processing systems exist, with less sensitive receptor systems having shorter (10 ms) time constants, and more sensitive receptors having longer (100 ms) time constants. Duration effect measures are especially useful in the collection of data for use within this theoretical context, as they are in parallel form with the existing literature, employing thresholds to stimuli at the extreme upper and lower limits of

temporal integration, tapping the comparative efficiency of functioning of these hypothesized long and short time constant systems.

Effects of Organic Damage on Temporal Integration

Alterations in the slope of the temporal integration function have been related to the presence of pathology in the auditory system. Figure 1 shows duration effects for healthy subjects and patients with lesions of the auditory system at different levels. This figure is adapted from Baru and Karaseva (1972). As has been previously noted, steeper-sloped temporal integration functions are the same as larger duration effects.

Cochlear lesions result in a shallower slope (i.e., lower thresholds to shorter stimuli than would be expected, based on the subject's elevated long-stimulus thresholds). This has been reported by Gengel and Watson (1971), Harris, Haines and Myers (1958), Miskolczy-Fodor (1953), Pederson and Elberling (1973), and Sanders and Honig (1967). Temporary inhibition of enzymatic systems in the cochlea by salicylate also produces a shallower-sloped function (Pederson, 1974). Baru (1967) found that caffeine decreases the slope of the temporal integration function by lowering thresholds to brief (under 16 ms) stimuli, whereas administration of l-amphetamine produces a steeper-sloped function with normal brief tone thresholds, but with increased sensitivity to longer duration stimuli (longer critical duration).

Neuritis of the auditory nerve produces a shallower slope, as do brainstem lesions involving the collicular nuclei or cortical lesions outside of the temporal lobe, which occasionally produce elevated thresholds or longer reaction times to stimuli; their effect

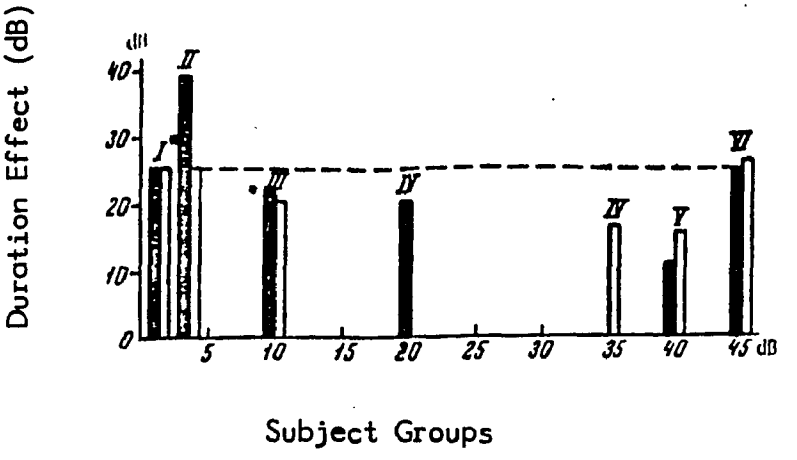


Fig. 1 . Effect of duration of series of tones at 1000 Hz, 1200 and 1,2 msec in duration, in healthy subjects and patients with lesions of the auditory system at various levels, in relation to degree of impairment of hearing in dB, obtained from the results of audiometric tests: I) healthy subjects; II) patients with lesions of the auditory cortex; III) patient with lesion of the inferior colliculi and lateral lemniscus; IV) patient with lesion of the cochlear nuclei; V) patient with lesion of the receptor system of the cochlea; VI) patient with disturbance of sound conduction. Abscissa, degree of impairment of hearing, in dB; ordinate, difference between threshold intensities, in dB. Unshaded column represents results of measurement on the side of the lesion, shaded column — on the side contralateral to the lesion.

Figure 1. Duration effects for healthy subjects and patients with lesions of the auditory system at different levels.

Note. Adapted from A.V. Baru and T.A. Karaseva, The Brain and Hearing, New York: Consultants Bureau, 1972, page 99.

on temporal integration is seen in decreased sensitivity to longer duration stimuli (Baru & Karaseva, 1972).

Patients with damage to the area surrounding Heschel's gyrus or the auditory projection pathways due to vascular lesions (Baru, Gersuni & Tonkonogii, 1974) or tumors, pre- and postoperatively (Gersuni, Baru & Karaseva, 1967) show normal thresholds to stimuli of over 120 ms in duration (Hodgson, 1967; Karaseva, 1972), but their thresholds and reaction times to brief stimuli, especially to those under 16 ms, are elevated (Blinkov & Karaseva, 1967; Gersuni, Baru, Karaseva & Tonkonogii, 1967; 1971), with the degree of elevation correlated with the extent of the lesion. These findings imply a processing deficit in the short time constant system in patients with central nervous system lesions.

Jerger and his colleagues (Jerger, Lovering & Wertz, 1972; Jerger, Weikers, Sharbrough & Jerger, 1969) have reported that bilateral temporal lobe lesions in man produce elevations in absolute thresholds to tones under 200 ms in duration. However, seemingly contradictory results have been reported by Cranford and Igarshi (1977), who did not find elevated thresholds in cats with bilateral auditory cortex lesions; thresholds were found to be normal for 1 KHz and 16 KHz tones of 16 ms or less. Cranford (1979) found that cats with bilateral auditory cortex lesions could detect brief tones of 2, 8, and 100 ms duration at a normal level, but were impaired in their ability to discriminate (difference limen) between tones. Wright (1978) has suggested that temporal lobe lesioned patients may show elevated brief tone thresholds only at some frequencies, and Cullen (as reported by Cranford, 1979) found no evidence of

alterations in brief tone thresholds in temporal lobe patients. This seeming paradox will be examined further in Appendix II, in a discussion of data collected on temporal lobe lesioned subjects.

A General Rationale for the Use of Auditory Measures of Brain Dysfunction in Psychiatric Patients

Many recent studies have pointed to relationships between brain damage or dysfunction and symptoms commonly observed in the functional psychoses. These studies have included discussions of factors such as neurochemical imbalances in various systems, and the sequellae of diffuse, lateralized or focal brain injuries, such as anoxia, strokes, surgically-produced lesions, or epilepsy (especially the psychomotor variety), and of the relationships between brain damage and auditory dysfunction.

Although the multiplicity of theories and findings to be reviewed here may present a picture that seems, at worst, contradictory and, at best, complimentary but somewhat unrelated, it is important to remember that psychiatric patients are not a homogeneous population. Several different but coherent patterns of etiology, symptomatology, and sensory deficit may exist within one major diagnostic class. Elucidation of possible meaningful relationships between central nervous system deficit and specific aspects of psychiatric symptomatology is one of the goals of the present study.

Theoretical and Empirical Relationships Between Brain Damage and Psychopathology

Anoxia

Anoxia has been implicated in the etiology of minimal brain dysfunction, including conditions such as learning disabilities,

developmental dysphasia and hyperactivity. Mednick and Schulsinger (1973) performed an extensive longitudinal study in which it was noted that birth complications involving anoxia increase an individual's risk for psychiatric disorders. Windle (1969) reported that monkeys asphyxiated at birth had damage to the auditory centers of the brain. Cerebellar, cortical and collicular damage of the sort attributed by Windle to perinatal anoxia, and the limbic irregularities found to be associated with serious perinatal difficulties have been related by Emmerich and Levine (1970) to the presence of sensory dysfunction: "If the development of schizophrenia is related to anoxia at birth, schizophrenic patients could be expected to exhibit a hearing loss."

Temporal Lobe Epilepsy

Temporal lobe epilepsy has been reported to be related to the functional psychoses by Flor-Henry (1969; 1974; 1976), Slater and Beard (1963), and Blumer (1975). Falconer (1971) has noted that a circular relationship exists between epilepsy and brain damage; seizures are both produced by,and can produce, brain damage. Davison and Bagley (1969) have reported, in their review of the literature, that interictal psychoses resembling schizophrenia occur more often than would be expected on the basis of pure chance in patients with epileptogenic temporal lobe foci.

According to Flor-Henry, left hemisphere epileptic involvement is correlated with schizophrenia, and right hemisphere involvement with the affective psychoses. Personality patterns have also been found to vary with the hemisphere involved in interictal and subictal temporal lobe electrical abnormalities (Bear & Fedio, 1977).

Patients who have experienced actual temporal lobe (psychomotor) seizures have been found to have differing symptomatology, depending on the side of involvement. Right temporal lobe epileptics tend to display externally demonstrated emotional tendencies (e.g., elation, depression) in contrast to more ideational traits (e.g., humorlessness, a tendency to be overly conscientious, paranoia, dependency, anger, or an exaggerated sense of personal destiny) which are seen in left temporal epileptics. In addition, Bear and Fedio report that "right temporal epileptics tended to exhibit 'denial', while left temporal epileptics demonstrated a 'catastrophic' overemphasis of dyssocial behavior".

Bear and Fedio have suggested that their findings can be related to our present knowledge about specialization of the left hemisphere for linguistic and analytic processing, and of the right hemisphere for spatial, synthetic operations (Milner, 1971a; b; 1974; Sperry, 1974).

Lateralized Brain Damage and Disorders of Communication

Hughlings Jackson (1915) noted that the affective components of speech were retained in subjects with motor aphasia who had difficulties with propositional speech; and that the "minor" hemisphere contained the neuroanatomical substrates of emotional speech.

Although the left hemisphere is the one traditionally associated with language, recent evidence supports the existence of a right hemisphere contribution to speech. It is well known that left hemisphere disorders tend to influence the cognitive aspects of communication; a supra-sylvan left hemisphere lesion

results in Broca's aphasia, an impairment in the production of propositional speech. Right hemisphere disorders have been found to be more closely related to the affective components of language (Mohr, 1976).

Heilman, Scholes and Watson (1975) have noted that right-handed patients with right temporoparietal lesions show impairment in identifying the affective components of language, but not the propositional components, and Tucker, Watson and Heilman (1977) have found that patients with right parietal lesions have great difficulty imparting affective tone to repetitions of statements read to them in a bland voice.

Thus, it is suggested that the right posterior Sylvian region plays a role in the comprehension of affective speech similar to that played by the analogous left area (Wernicke's area) in the understanding of propositional speech.

Zurif (1974) and Blumstein and Copper (1974) have found the left ear and therefore the right hemisphere superior in detecting the prosodic[1] elements of speech in a dichotic listening task. According to Monrad-Krohn (1963) three types of prosodic disturbances

[1] Monrad-Krohn (1947) has described speech as made up of several components: vocabulary (individual spoken words and their articulation), grammar (the rules for the ordering, conjugation, and declination of words) and prosody (the melodic line produced by the variation of pitch, rhythm, and stress of pronounciation that bestows certain semantic and emotional meaning to speech). Prosody itself is subdivided into four categories: intrinsic prosody (the melodic patterns of spoken language which have specific and standard semantic connotations, such as pitch, which is lowered or raised to imply an affirmation or a question), intellectual prosody (complicated stresses to indicate subtle sarcasm or skepticism), emotional prosody (conveying of emotions by vocal tone) and inarticulate prosody (nonlinguistic sounds which communicate information).

have been found to occur. Hyperprosody is an exaggeration of the sort seen in mania and in some cases of motor (Broca's) aphasia when vocabulary is reduced, and the patient relies on an exaggerated prosody for communication. Dysprosody consists of distorted or "ataxic" prosody with altered cadence and melodic patterns. Aprosody involves an absence of normal prosodic variation, and can occur following a right hemisphere lesion (Ross & Mesulam, 1979), or in Parkinson's disease. The involvement of the basal ganglia and other subcortical structures in speech have been suggested by several authors, according to Ojemann (1976).

Dordain, Degos and Dordain (1971) reported that right hemisphere lesions altered the pitch and volume of right-handed patients' vocalizations. Speech was uncontrollable in pitch and volume in some of the patients studied, and extremely monotonous in others. A "painful, groaning, plaintive voice" was the most commonly observed symptom. Thus, right hemisphere lesions could produce symptomatology which might be misinterpreted as signs of affective disorder.

Ross and Mesulam (1979) have reported that supra-sylvian right hemisphere lesions (corresponding to Broca's area in the right hemisphere) can disrupt the modulation of the affective qualities of speech, making the subjects appear to express little affect, or to express unnatural, stilted-seeming affect. "Personality changes", apparent dysphoria, depression, paranoia, and "nasty temperament" were reported to exist in these patients by close relatives who served as informants, and initial diagnoses of flattened affect were given by hospital staff to these subjects,

although the patients' own subjective experiences of emotion were reported to be unimpaired. They indicated that they felt emotions normally, but simply could not impart their affective quality to their expressed speech.

The effects of lateralized lesions are also reflected in non-verbal aspects of communication. Although Hughlings Jackson (1915) and Critchley (1939) had reported that emotional gesturing is generally intact in aphasics, Gainotti and Lemmo (1976) state that disorders in kinesics, especially of the semantic, symbolic sort have been linked to the aphasias since the late 1880's. Goodglass and Kaplan (1963) have related this pantomime disturbance to the presence of idiomotor apraxia. Disturbances in kinesics (nonverbal movements used as communication) may be either emotional (gestural or prosodic) or propositional (semiotic or semantic) in nature. Ross and Mesulam (1979) suggest that these are related to right and left hemisphere dysfunction, respectively, and noted impairments in the gestural movements of their right-hemisphere stroke subjects.

Relationships Between Auditory Temporal Integration, Developmental Dysphasia and Psychiatric Disorders

In a longitudinal study of children with behavior problems referred for detailed neuropsychological evaluation, B. and J. Wilson (Note 2) have reported that disturbances in social adjustment and behavior disorders commonly accompany the sequellae of minimal brain damage. It is their hypothesis that many individuals receiving psychiatric treatment should receive a primary diagnosis indicative of brain injury.

Auditory findings indicative of brain damage have been observed in both aphasics and developmentally dysphasic children. Aphasia appears to involve both increased auditory time constants and deficits in order perception. Ax and Colley (1955) have found that both frankly brain-damaged subjects and aphasic subjects have elevated auditory fusion thresholds, and Efron (1963) reported deficits in aphasic subjects' temporal order discrimination for short tonal signals. Children with developmental aphasia have been found to display increased time constants for the perception of successiveness and temporal order of tones (Lowe & Campbell, 1965), and for temporal order of speech and non-speech sounds (W.S. Rosenthal, Note 3). Needham and Black (1970) found aphasics had difficulty judging the relative duration and intensity of pure tones and Liberman, Harris, Hoffman and Griffith (1957) have emphasized the importance of the parameter of duration for the discrimination of speech sounds, and have noted that discrimination deficits are seen in aphasics only at brief stimulus durations.

Tallal and Piercy (1975) have found that individuals with developmental dysphasia have difficulty discriminating brief vowel-vowel and consonant-vowel syllables that were under 43 ms in length, but were unimpaired then these components were 95 ms or longer. These same authors (1974) had previously noted that developmental dysphasics had difficulty processing consonants, as opposed to vowels (shorter vs. longer sounds) and that (1973) this speed constraint in processing exists in the auditory but not in the visual modality.

Studies which link the research just reviewed to the investigations of the present study were done by W.S. Rosenthal (Notes 4 and 5). He reported, having used signal detection procedures and brief tone audiometry, to have found abnormally high brief (1 and 10 ms) tone thresholds for 1000 Hz stimuli in individuals with developmental aphasia. Differences were not found at 4000 Hz or longer (20, 40 or 100 ms) stimulus durations.

Efron (1963) has noted a relationship between aphasia, disorders in the temporal perception of brief stimuli, and déjà vu phenomena. Sequencing deficits in patients with lesions of the dominant hemisphere can, according to Efron, produce feelings of déjà vu when dealing with afferent events, and language disorders of the aphasic sort (jargon, neologisms, "word salad") in the efferent mode. It should be noted that both these speech and subjective symptoms (déjà vu can be related to other symptoms such as disorientation, delusional mood and delusions of control) are often associated with schizophrenia. Although Efron has emphasized the role of the left hemisphere, the non-dominant hemisphere may also be involved. Efron himself has noted that "certain information (relative to the time of occurrence) is transferred from non-dominant to dominant hemisphere before temporal discrimination if simultaneity and order can be performed".

Symptoms commonly thought of as associated with depression (speech retardation, including poverty of content and increased pauses between words) are also signs associated with aphasia. The pressure of speech and disorganization associated with mania are also symptoms of aphasia, seen when the subject attempts to

compensate for semantic difficulties by exaggeration of prosody.

Bruder et al. (1975) have found significantly higher (6 dB) right ear thresholds to a transient (click) stimulus in affective patients when they were compared to schizophrenic subjects and non-patients. These higher thresholds were associated with a higher symptom profile score ($r = .56$) on the factor of speech retardation. These findings were recently replicated in new patient samples (Bruder et al., 1980), which included some of the same subjects tested in the present study.

The flat or inappropriate affect associated with schizophrenia, as well as general disorientation may also be viewed as symptomatic of aphasia. Flor-Henry (1976) has reviewed the evidence implicating impaired speech perception in schizophrenia, and Bull and Venables (1974) have noted poorer word discrimination in schizophrenic vs. control subjects. Maloney, Sloane, Whipple, Razani and Eaton (1976) and Polidoro (1970) have found the word discrimination deficit to be greater in process than in reactive schizophrenics. It should be noted here that perception of brief sounds is crucial for speech perception.

The possibility may be entertained that many individuals diagnosed as endogenous or "process" psychotics and who show disorders in linguistic behavior may actually be suffering from minimal brain damage involving the auditory system.

Not only are the social/emotional stressors resulting from communication disorders likely to add to the stresses which may precipitate other behavioral disorders in these individuals, but

other sequellae of brain damage (i.e., shorter attention span, low frustration tolerance, memory impairments) may also provide added handicaps to adjustment for these individuals.

Therefore, it is suggested that abnormal auditory integration performance may serve as a "marker" of possible brain damage and vulnerability to psychiatric disorders.

Cortical Excitability

Cortical excitability may be implicated in psychopathology, in that a disturbance in neural excitation or inhibition in patients has frequently been suggested in both the Soviet and western literature. In the Soviet literature, Pavlov's (1941) cortical excitability hypothesis has been a major focus of interest. It has been suggested that schizophrenics have a "weak nervous system" (Gray, 1964; Neblytsin, 1972) and show "transmarginal inhibition", an increase in sensitivity to low-intensity stimulation, with a concomitant blocking of high-intensity stimuli. Venables (1969) and Gruzelier and Hammond (1976) have entertained a similar possibility. Neblytsin (1972) found an inverse relationship between indices of "strength of nervous system" and auditory sensitivity. Gruzelier and Venables (1975) suggested that Gray's and Neblytsin's views in strength of nervous system could be interpreted as variations in general levels of cortical arousal and ability to amplify stimulation.

However, the implications of the "strength of nervous system" view are not supported by Levine and Whitney's (1970) findings; using a modification of the method of average error, chronic schizophrenic patients were found to have a higher absolute

threshold, but a lower threshold for the unpleasantness of auditory stimuli. Patients with a "weak nervous system" would be expected to show the opposite effect; low absolute threshold and high "unpleasantness" threshold.

Buchsbaum's research group (Buchsbaum, 1975; Landau, Buchsbaum, Carpenter, Strauss, & Sacks, 1975) has proposed the existence of a variety of patterns of reactivity to stimuli (as demonstrated by evoked potential responses) in psychiatric patients. In general, affective patients were seen as tending to be "augmenters" and acute schizophrenics were viewed as "reducers". Paranoid schizophrenics would be "augmenters", vigilantly scanning the environment, whereas bipolar depressives have been suggested to be extreme augmenters. However, Gershon and Buchsbaum (1977) have recently encountered difficulty in finding additional support for this formulation.

Venables (1963) has postulated that altered cortical excitability in psychiatric patients could account for differences in two-flash and two-click measures of temporal resolution obtained when these subjects are compared to non-patient controls. Gruzelier and Venables (1975) viewed psychiatric patients as falling into two homogeneous groups, each showing different response patterns. Venables has noted (1964; 1967) that temporal resolution differences in psychiatric patients are most pronounced in the auditory modality; if differences in central functioning are to be observed, the finely-tuned resolving power of this system provides an excellent opportunity for sensitive measurement.

Baru (1967) has found that the administration of pharmacological agents (e.g. caffeine and phenamine) with a selective action on the nuclei of the posterior hypothalamus and reticular formation or on cortical neurons and thalamic structures lowers auditory thresholds to brief stimuli. Caffeine has been found to lower thresholds to stimuli under 16 ms in duration; phenamine has not been found to alter thresholds to stimuli under 10 ms in duration, but does lower thresholds to 10 - 1,000 ms stimuli. Baru has postulated that this is the result of enhancement of cortical activity due to an activating effect of these agents on nonspecific systems in auditory projection areas.

Auditory Research in Schizophrenia

Much of the early literature, in which classical psychophysical techniques were employed, reported no difference in the auditory thresholds of schizophrenic patients and non-patient controls (Bartlett, 1935; Bull & Venables, 1974; Ludwig, Wood & Downs, 1962; Maher, 1966; Rappaport & Hopkins, 1969). However, L.E. Travis (1924), and R.C. Travis (1926), using the method of limits, had found higher thresholds in schizophrenics during "reverie". Higher absolute thresholds (a 5.6 dB difference) to a 400 Hz tone were reported for schizophrenic patients vs. non-patients by Levine and Whitney (1970), using the method of average error with both ascending and descending trials. These authors suggested that many of the earlier studies might have suffered from the use of poor patient classification procedures. Emmerich and Levine (1970), using 400 Hz, 2 ms stimuli, and Rappaport, Hopkins, Silverman, and Hall (1972) reported similar findings; higher auditory thresholds

in schizophrenic vs. non-patient subjects. Both of these studies used signal detection procedures to control for the effects of response bias or criterion. However, Emmerich and Levine's schizophrenic group was, on the average, over 20 years older than their non-patient controls. The 8 dB higher thresholds found in this study might be more parsimoniously interpreted as a result of this age difference. Bruder, Sutton, Babkoff, Gurland, Yozawitz and Fleiss (1975), using a forced-choice procedure, found that affective patients had higher right ear thresholds to a click stimulus, and that the thresholds of age-matched schizophrenics were equivalent to those of non-patients. These patients were diagnosed using a structured interview technique, which decreased the likelihood that the schizophrenic group included some misdiagnosed affective patients.

Bruder, Spring, Yozawitz and Sutton (1980) have performed research which employed, as part of the patient sample, the same patients and the same project diagnoses that were used in the present study. No statistically significant differences were found in click thresholds of the patients diagnosed as schizophrenic and the non-patient controls. Testing these same patients, and employing the same diagnoses, Yozawitz (1977) found no difference between schizophrenic subjects and non-patients on dichotic listening tasks which used both speech and non-speech stimuli.

Gruzelier and Hammond (1976; 1979), examining audiograms obtained using an ascending method of limits, found schizophrenic patients to be more sensitive than controls at low frequencies, but the schizophrenic patients were less sensitive than controls

at higher frequencies. Better right than left ear functioning was seen in repeated testing of a group of 19 psychiatric patients diagnosed as schizophrenic. This effect was most pronounced at high frequencies. A variation over time was also noted, in that the ear difference tended to diminish with repeated testing. This had been related to the possibility of greater fatigue of the right ear (left hemisphere) in the schizophrenic subjects. Gruzelier and Hammond (1979) have discussed these results with respect to the "strength of nervous system" hypothesis, suggesting greater left hemisphere fatigue effects in patients diagnosed as schizophrenic.

Measures of within-session threshold variability were examined in the present study in an attempt to see whether Gruzelier and Hammond's findings of greater variability in schizophrenics could be observed over a short time course.

Auditory Processing in Affective Patients

Auditory processing in affective patients will be discussed in more detail in the next section in the context of the Babkoff et al. (Note 1) findings of shallower-sloped temporal integration functions seen in right ear data for affective patients. The performance of affective subjects considered in this section includes a more comprehensive examination of Bruder et al.'s (1975) findings of higher right ear thresholds to click stimuli for affective patients, which were recently replicated (Bruder et al., 1980).

It has been previously noted that a relationship has been recognized between the presence of temporal lobe lesions (especially

in temporal lobe epilepsy) and affective disorder (Horowitz & Cohen, 1968; Slater & Beard, 1963). Flor-Henry (1969; 1974) has suggested that affective psychosis is related to temporal lobe dysfunctions of the right hemisphere. Flor-Henry has further suggested that affectives should show psychophysical performance similar to that of patients with right temporal lobe lesions. If there is temporal lobe involvement in affective patients, they would be expected to show higher contralateral thresholds to brief auditory stimuli, but would be likely to have a more "normal" performance in long tone threshold tasks.

In addition, if affective patients have a lower cortical excitability, due to disturbed hypothalamic functioning, to reticular or other brainstem involvement, or to hormonal and neurotransmitter imbalances, or to any combination of these factors, alterations in auditory thresholds could be expected.

Malone and Hemsley (1977) reported reduced sensitivity to 1 second "pure tones" presented against a noise background to depressed patients. These patients improved in sensitivity when placed on antidepressant medication. Similarly, Babkoff et al. (Note 1) reported affective patients to have reduced sensitivity to white noise bursts of 4, 32 and 128 ms durations, when their performance is compared to that of non-patient controls.

Bruder et al. (1975) found that hospitalized schizophrenics did not differ from non-hospitalized control subjects in either their auditory sensitivity to a single click stimulus or in their reaction time facilitation to suprathreshold double click stimuli at interclick intervals of two to fifteen ms. Affective patients,

however, were found to have a 6 dB higher threshold to the click stimulus than the schizophrenic or non-patient subjects. In addition, the patients diagnosed as affective benefitted more from the presence of a second click in the two-click reaction time facilitation paradigm. Thus, these affective subjects showed what may be interpreted as higher thresholds and steeper-sloped temporal integration functions compared to the other subjects' performance. This study had several important methodological advantages. The subjects were diagnosed by a psychiatrist based on interview data. The use of forced-choice procedures allowed for the measurement of threshold sensitivity independent of the subjects' criterion levels. The performance of the affective subjects in the two-click paradigm, when compared to their one-click performance may be interpreted as an instance of "better patient performance", which reduced the chance of artifactual findings (Sutton, 1973). However, in Bruder et al.'s (1975) study, only right ear data were obtained, which did not permit an analysis of lateralized effects. "Better patient performance" by the affective subjects was, in fact, only relatively less inferior performance on the two-click condition, when compared to the one-click performance. Yet, it it important to note that when overall reaction time level is ignored, reaction time facilitation is seen in these affective patients, i.e., they benefitted more from the presence of a second click than did the other subject groups.

Using a procedure similar to that employed in the present study, Bruder, Spring, Yozawitz and Sutton (1980) found that patients diagnosed as affective using the Combined Instrument

Schedule/Multiple Diagnostic Strategy Schedule, and especially those with high speech retardation scores on the U.S.-U.K. Cross National Study Interview Schedule, had reduced right ear vs. left ear sensitivity to a click stimulus. Reduced right ear sensitivity was also seen in Bruder et al.'s (1975) study. This was not seen in patients diagnosed as schizophrenic. Such abnormal asymmetries in affective subjects have been well-documented by dichotic listening measures (Yozawitz, Bruder, Sutton, Sharpe, Gurland, Fleiss & Costa, 1979).

Bruder et al. (1980) have suggested several mechanisms which may underlie these findings. The first possibility is the presence of a disturbance in sensory information processing, as hypothesized by Johnson (1975), with less efficient temporal integration evidenced by these subjects (i.e., a loss of energy over the range within which integration occurs). A second possibility involves selective attention effects of the type suggested by Malone and Hemsley (1977). The third possibility is that of a hypersecretion of cortisol, which is reported to decrease sensory acuity (Henkin, 1970). This has been noted to exist in many depressive patients (Gibbons, 1964; Sachar, Hellman, Fukushima & Gallagher, 1970). Sachar (1975) and Carrol, Curtis, Davies, Mendels and Sugerman (1976) have suggested that depressive patients may have defective neuroendocrine regulation similar to that shown by patients with Cushing's syndrome. Kiev (1975) has reported that corticosteroid administration often results in depressive symptomatology.

Relationships Between Symptomatology and Auditory Measures in Psychiatric Patients

Bazhin, Wasserman and Tonkonogii (1974) have found steeper sloped auditory temporal integration functions in the right ears of hallucinating schizophrenics. Elevated thresholds to brief (vs. long) stimuli were not evidenced in the left ear, nor in schizophrenics who did not suffer from "true" (vs. "pseudo") auditory hallucinations.

Babkoff, Sutton, Zubin and Har-Even (Note 1) have re-analyzed some visual reaction time data presented by Collins (1972) and Collins, Kietzman, Sutton and Shapiro (1978) in which hallucinating schizophrenics were found to show greater reaction time difference scores (suggestive of temporal integration functions with significantly steeper slopes) than those of non-hallucinating schizophrenic or hallucinating affective patients, or of non-patients. The affective patients were found to have a significantly smaller reaction time difference than the non-patient group. Non-hallucinating schizophrenics did not show significant differences from normals.

Similar and somewhat parallel findings are reported in the auditory modality by Babkoff, Sutton, Zubin and Har-Even (Note 1), who used threshold and interview procedures similar to those employed in the present study. (These were a three-interval temporal forced-choice adaptation of the Block Up and Down Two-interval Forced-choice procedure and a Hebrew translation of the U.S.-U.K. Mental State Interview Schedule.) Psychiatric

patients were found to have temporal integration functions which were elevated about 5 dB in comparison to those of non-patients, but these functions were equivalent in slope. However, when the data from the patients with affective symptomatology were examined separately (particularly those patients with a high factor loading on depression), flatter-sloped temporal integration functions were observed.

Subsequent data analysis, using a combination of cluster analysis (Guttman Q-Sort Smallest Space Analysis) and discriminant function analysis, grouped the patients into three clusters: affective, non-hallucinating psychotic, and hallucinating psychotic groups. The affective patients exhibited symptoms of (in rank order from highest to lowest): somatic dysfunction, tension, lack of interest, depression, lack of concentration, lack of insight, social discomfort, physical health problems, worry and obsessions. The non-hallucinating psychotic (a possibly schizophrenic) group was characterized by: depersonalization, situational anxiety, delusions of persecution, general anxiety, worry, obsessions, self deprecation, irritability, social discomfort and slowness. The hallucinating psychotic (possibly hallucinating schizophrenic) group suffered from: hallucinations, lack of insight, self deprecation, perceptual distortions, situational anxiety, thinking difficulties and depersonalization. The ratio of subjects to variables entering into Babkoff et al.'s Q-Sort was too small to permit an evaluation of the statistical significance of these clusters.

Based on this patiert clustering, Babkoff et al. found that the affectives had an average reduction in threshold of 5.07 dB per decade increase in stimulus duration; non-hallucinating psychotics had a change of 7.92 dB per decade duration increase; this is slightly greater than the normal value (6.68 dB). Hallucinating psychotic patients had the steepest sloped functions (12.4 dB/decade increase in duration).

The Babkoff et al. study employs temporal integration functions generated to noise stimuli of 4, 32 and 128 ms in duration, with 1 ms rise and decay times; only right ear data were collected. The present study extends these investigations through the use of both 1000 Hz and noise data, and through the testing of both ears. The present investigation is limited, however, in that only two stimulus durations are used.

Visual Analogies

Visual analogies to the auditory research that has been discussed here can provide more indirect support for the likelihood of finding impaired temporal processing in subjects with cortical damage. Wilson (1967) measured temporal summation in impaired areas of visual fields, and noted that pre-geniculate lesions resulted in elevated functions (higher thresholds, overall, but with a normal slope). In subjects with post-geniculate lesions (i.e., optic radiations or cortex) the temporal integration function was both elevated and of an abnormally steep slope. He also noted parallel findings for spatial summation, which he explained by suggesting that "any factor which reduces the number of nerve fibers which can be activated by a given stimulus will necessarily

increase the incremental luminance threshold for that stimulus, and also make spatial summation more nearly complete". This could be accomplished either by moving the stimulus more peripherally or by damaging the visual pathways, thereby reducing the number of fibers able to respond to the given stimulus. Wilson felt that no known mechanism could account for the observed temporal summation effects (although a temporal analogue of the spatial situation seems tempting).

In studies dealing with abnormal visual temporal integration, it is important to note that many factors causing damage to the optic radiations will also involve the temporal lobe, and that central nervous system damage is often rather diffuse in nature.

In 1970, Beck (Note 6) reported that schizophrenic subjects displayed a greater range of spatial and temporal summation than did non-schizophrenics. Reduced thresholds seen in schizophrenic subjects were interpreted as the result of a domination of excitatory spread, with a deficit in retinal neural inhibitory processes. Although this effect was presumed to be primarily retinal in locus, it was suggested that this could act centrally, as well.

A parallel deficit in auditory inhibitory processes could result from lesions of the higher auditory system; the lack of descending inhibitory impulses (i.e., in the tract of Rasmussen) could have much the same effect as a lack of local peripheral inhibition.

Braff, Callaway and Naylor (1977) have implicated abnormalities in short time constant information processing in schizophrenia. A dysfunctionally greater sensitivity and overactivity of fast neurons has been postulated by these authors, based on visual evoked potential work. Babkoff et al. (Note 1) have suggested that a dysfunction similar to that discussed by Braff et al. may be the substrate for the steeper temporal integration functions they found in hallucinating schizophrenics.

Visual Temporal Integration and Psychiatric Symptomatology

Collins (1972) and Collins, Kietzman, Sutton and Shapiro (1978) reported that a visual reaction time measure of temporal integration showed patients diagnosed as schizophrenic and who displayed symptoms of speech disorganization to have a shorter critical duration than did control subjects or patients diagnosed as schizophrenic who did not display speech disorganization. The re-analysis of these data by Babkoff, et al. (Note 1) found hallucinating psychotics (possibly schizophrenics) to have greater reaction time difference scores (which were suggestive of significantly steeper-sloped temporal integration functions) than did non-hallucinating psychotics (possibly schizophrenics) or non-patients. The affective patients were found to have a significantly shallower-sloped temporal integration function, when compared to that of non-patients. Non-hallucinating patients did not show significant differences from the normal data.

Problems in Research-oriented Diagnosis

This section provides a discussion of some commonly encountered problems in psychiatric diagnosis, and how these problems can be (at least partially) solved through the use of semistructured interviews. Information is also provided on the development of the Combined Instrument Schedule/Multiple Diagnostic Strategy Schedule (Mannuzza, Spring & Yozawitz, Note 7), the semistructured interview used in the present study.

If research-oriented patient classification schema are to be successfully employed, it is necessary for them to possess satisfactory degrees of both reliability and validity. The current state of the art of patient classification is far from perfected; psychiatric diagnoses raise formidable but not insoluble problems for researchers (Gurland, 1973; Sutton, 1973). Zubin (1967) has noted that at least 50 types of psychiatric classification schema exist. At present, we are attempting to raise ourselves by our own bootstraps, so to speak, using iterative procedures to refine our knowledge of both behavioral syndromes and accompanying phychophysiological dysfunctions in psychiatric populations. Many of the problems inherent in the use of loosely defined (i.e., clinical or unstructured interview-based) classification strategies are lessened by the use of semistructured interview techniques in conjunction with highly operationalized diagnostic strategies. Semistructured interviews also possess several advantages over highly structured interviews and self-rating scales.

Disadvantages of Hospital Diagnoses

Clinical diagnoses as provided by hospitals tend to lack validity, and show low reliability with other diagnostic measures (Spitzer & Fleiss, 1974; Zubin, 1967). Even highly qualified diagnosticians may not always produce diagnoses which are optimally suited for research purposes when they are operating in a clinical setting.

Swets, Pickett, Whitehead, Getty, Schnur, Swets, and Freeman (1979) have discussed the use of signal detection analyses in the assessment of diagnostic efficiency, applying their model to computerized tomography measurement data. It is of use to note that the "payoffs" associated with different diagnostic decisions vary in research and clinical settings, and this factor may influence the criterion level of the observer (Zubin et al., 1975). Thus, a clinician attempts to maximize the probability of his decisions having beneficial effects, weighing the costs of false positives and incorrect rejections of diagnostic categories when making decisions.

Hospital diagnoses may serve several purposes; expedient agreement among experts may be required in order to qualify the patient for placement in the best available treatment program. In addition, programs must often meet quotas for the treatment of a certain number of a certain type of patient within a certain time period. It may be vital to the interests of both the institution and the patient that a diagnosis be provided which will ensure adequate third-party payments. Such "administrative diagnoses" may be highly pragmatic, but are of little value for the researcher.

It is also well recognized that some hospital diagnoses are more "acceptable", i.e., less likely to be challenged than are others. Categories such as undifferentiated schizophrenia are widely used and have vague and diverse prognostic and etiological implications; the use of "undifferentiated schizophrenia" as a preliminary diagnosis, which may or may not be revised at a later date is encouraged by administrators (Williams, Note 8). Williams has also noted that the recent increase in use of the schizoaffective categorization partially reflects a desire to "cover all bets" when a patient shows mixed symptomatology. A discussion of the utility of the schizoaffective categorization is given by Procci (1976).

Variability of Diagnostic Criteria

A great deal of the difficulty experienced in the generation of reliable and valid research diagnoses lies in the variable and idiosyncratic nature of diagnostic criteria. These tend to vary over time, space, over individual diagnosticians, and over interviewing context (Mannuzza, Note 9). Such variations make interpretation of the literature and replication of prior findings a difficult task. Gurland (1973) has reported that subjective judgments, differences in interviewing style and training, the use of poorly defined labels, which are often drawn from several different classification systems, and the use of variable diagnostic criteria all contribute to the unreliability of clinical diagnoses, and that the use of structured or semistructured interviews can help to reduce these problems.

For example, in the U.S.A., schizophrenia was defined more narrowly in the 1930's than in the post-World War II era (Kuriansky, Deming & Gurland, 1974). Sharpe, Gurland, Fisher & Fleiss (Note 10) have reported that the vocabulary used to describe patient behavior differs with locale, and is especially variable cross-culturally. As the U.S.-U.K. Cross-National Project demonstrated, American psychiatrists tend to use and define the term "schizophrenia" more broadly (Kendell, 1971), whereas British diagnosticians will define "schizophrenia" more narrowly and will tend to employ the category of "depression" more frequently (Sharpe, Gurland, Fleiss, Kendell, Cooper & Copeland, 1974). American psychiatrists see delusions and hallucinations as virtually pathognomonic of schizophrenia, but this view is not shared by British clinicians (Edwards, 1972).

Even the most widely used and best standardized diagnostic schema have changed greatly over time. The Diagnostic and Statistical Manual of Mental Disorders (DSM) of the American Psychiatric Association, first adopted in 1952, has undergone several revisions. DSM II was developed in 1968, in collaboration with the World Health Organization, to provide a diagnostic schema which could be employed cross-culturally. The most recent version, published in 1980, DSM III, is more behaviorally oriented, and is more logical and internally consistent, with etiological and therapeutic considerations employed to produce more homogeneous diagnostic groups with less overlap and of approximately equal width. DSM III is more closely related to actual clinical observations rather than to infrequently seen textbook cases, and provides specific criteria for each disorder.

DSM III diagnoses can now be provided with several dimensions through the use of multiaxial classification. These include: (1) present symptomatology (2) history of past personality and developmental disorders (3) assessment of non-psychiatric (medical) disorders (4) severity of psychosocial stressors and (5) a measure of the degree and severity of impairment; the highest level of functioning in the past year.

In the present study, the use of an interview which permitted the use of Research Diagnostic Criteria (RDC), which were developed by Spitzer, Endicott and Robins (1977), provides diagnoses which are congruent with DSM III classifications.

Confounding Due to Social Interaction Factors

Individual factors, the style of interaction and social stimulus value of both the patient and clinician, as well as the interview environment tend to interact to produce a diagnostic impression (Salzinger, Note 11). Some of these factors are lessened by the objectivity introduced by semistructured interviewing techniques. In hospital diagnoses, socioeconomic and racial factors have been found to be powerful confounding factors. Black patients were more likely to be diagnosed as schizophrenic in hospital settings, but for the U.S.-U.K. project staff who used semistructured interviewing techniques the race of the patient and his diagnosis were unrelated (Simon, Fleiss, Gurland, Stiller & Sharpe, 1973); however, depressed blacks were found to differ from depressed white patients in that they reported more worry, muscular tension, autonomic symptoms with anxiety, somatic complaints, and irritability.

An increased tendency for black patients to somaticize has often been reported (Frank, 1947; Miller, Knapp & Daniels, 1968; Olatawura, 1973; Simon, 1965; St. Clair, 1951).

De Hoyos and De Hoyos (1965) have suggested that the tendency for black schizophrenic patients to report fewer symptoms than do white schizophrenic patients is largely due to problems in motivation and rapport when dealing with white middle-class interviewers. However, Parker & Kleiner (1966) posit that urban black families may also be less tolerant of psychiatric symptomatology than are comparable white families,and may have a better rapport with the agencies mediating admission into treatment facilities. They noted that black depressives sought treatment sooner than did white depressives (the means were 6.0 months vs. 9.7 months).

Tonks, Paykel and Klerman (1970) reported that when semi-structured interview data for depressed black vs. white patients were corrected for social class differences, the only symptomatic differences found were that the white patients were more subjectively helpless than were the blacks, and that the blacks were less severely depressed and had sought treatment sooner. Liss, Welner, Robins and Richardson (1973) and Welner, Liss and Robins (1973) found that with the use of semistructured interviews, black patients, when compared with white patients, had more delusions (of reference, body change and grandeur) and reported more hallucinations (both auditory and visual).

It has been suggested that much of the variation in expressed symptomatology of minority group patients may be due to social class more than to ethnicity differences (Fabrega, Swartz, &

Wallace, 1968). Lehmann (1971) found that lower socioeconomic group subjects are more likely to be diagnosed as having schizophrenia than affective disorders. Social class differences (Jacobs, Charles, Jacobs, Weinstein & Mann, 1972) tend to confound diagnosis and referral for treatment; lower-class patients tend to request and receive direct and active somatic intervention rather than long-term insight-oriented therapy, and they tend to be given diagnoses which would support such a therapeutic strategy.

Redlich, Hollingshead and Bellis (1955) have discussed the problem of incongruity of perceptions in interactions of lower socioeconomic group patients with middle-class therapists. These researchers suggested that there tends to be apprehension of speaking freely on the part of the patient, coupled with a lack of understanding as to why certain questions (particularly historical ones) are asked. Immediate relief is demanded, and the patient is disillusioned and disappointed when no such relief is provided. The therapist, on the other hand, sees the patient as lacking both insight and motivation, and as being uncooperative; this often results in the denial of or termination of therapy. Research-oriented interviews which are separated from the therapeutic context help eliminate this problem, and semistructured interviews used in conjunction with psychophysical measures may help to answer important epidemiological questions such as the degree to which black vs. white depressives actually might differ in the psychological substrates of depression; and the extent to which reported differences are the product of a complex social matrix.

Semistructured Interviews in a Research Setting

The proficiency and experience of the diagnostician are also relevant factors in semistructured interviewing. New raters tend to rate patient symptomatology as more severe than do experienced raters (Wing, Cooper & Sartorius, 1974). The rater's expectations can also influence ratings. Kendell (1968) has noted that if a clinician believes that certain symptom factors tend to cohere, this "halo effect" is likely to produce an observation bias towards finding such symptom clusters in certain patient groups. Costello (1970) and Eysenck (1970) have discussed this interaction between the diagnostician's theoretical framework and the perception of depressive syndromes. This bias can help perpetuate certain diagnostic myths, even in the face of the sort of clustering and typological research which Lorr (1966) has noted is designed to refine previously unrecognized syndromes.

Stereotypes formed early in an interview, especially in the less structured ones, are hard to break. Kendell (1973) reported that preliminary diagnoses made within three minutes generally remained congruent with those made at the end of a full unstructured interview. Use of semistructured interviews helps assure that all requisite questions will be asked and all relevant areas are probed so as to assure a more well-rounded interview. In the CIS/MDSS, ratings are made on individual, clearly-defined symptoms, and the rater is required to provide examples of each; a procedure which reduces confounding due to "clinical intuition"-produced halo effects.

Interview context factors, such as the circumstances of the interview, and the rater's knowledge of prior diagnoses given to the subject can also influence ratings (Mannuzza, Note 9). To deal with this in the present study, all the raters except one were kept blind to the patients' hospital diagnoses, and no raters were aware of the other raters' conclusions. Patients were informed that information given in the interview was confidential, and would not affect their treatment.

Semistructured interviews provide a compromise between the rigidity of structured interviews and self-rating scales and the openness of a clinical interview. Pre-determined questions are asked, usually in a pre-determined order; many of these semi-structured interviews function like branching programs, allowing for the deletion of questions beyond negative responses at cutoffs, and providing detailed probes for items answered positively. The CIS/MDSS is structured in this manner. The interviewer is given leeway to question the subject on unclear points or to rephrase questions and restate the subject's responses in such a way as to establish better rapport and provide feedback to assure that both parties understand what has been communicated.

Operationalized Scoring. Semistructured interviews can be scored both by the use of operationalized diagnostic criteria and by computer programs. For instance, the Present State Examination can be scored by CATEGO (Wing et al., 1974), and the Current and Past Psychopathology Scales (Endicott & Spitzer, 1972) can be scored

by DIAGNO (Spitzer & Endicott, 1968; 1969) programs. The resulting diagnoses are comparable to those of well-trained clinicians (Spitzer & Endicott, 1973). The Schedule for Affective and Schizophrenic Disorders (Spitzer & Endicott, 1975) can be used to generate Research Diagnostic Criteria (Spitzer, Endicott & Robins, 1975) evaluations.

Extent of Use of Semistructured Techniques. Semistructured interview techniques have gained in popularity in recent years; the Schedule for Affective Disorders and Schizophrenia (Spitzer & Endicott, 1975) is currently used in over 100 research units (Endicott, Note 12). The Present State Examination (Wing et al., 1974) has been translated into 12 languages, and the Cross-National Project's Combined Mental State Schedule (Gurland, Fleiss, Goldberg, Sharpe, Copeland, Kelleher, Kellett & Gourlay, 1976) has been translated into 3 languages.

Advantages of Semistructured Interviews over More Structured Techniques. Semistructured interviews, unlike both self-report scales and more highly structured instruments, allow for the clarification of communications beyond the printed interchange set down in the protocol.

This is of importance both in the development of good rapport and to promote honest answering at the highest level of insight possible. Unclear or unconventional responses can be probed in a suitable manner, and questioning can continue until a satisfactory resolution of the item is obtained.

In structured interviews and in self-report scales, both clarity and rapport are often lost by the inflexibility produced by the standardized nature of the questions asked. In structured interviews, only certain probe questions are allowed, and these questions are not to be rephrased or the order of questions rearranged.

Semistructured interviews have several advantages over self-report scales (Mannuzza, Note 9). These include the ability to deal with more severely disturbed patients and with those who may not be literate in English. Both speech and behavior samples are recorded; this allows for the rating of items like thought disorder (i.e., neologisms, incoherence, loose associations) and bizarre behavior and psychomotor retardation or agitation. These are not always within the subjective awareness of the patient when they are present to an objective observer. Spitzer and Endicott (1973) have noted that appropriateness of affect and behavior are extremely difficult to assess using self-report interviews, as the patient often lacks insight in these areas. The same is true for impaired reality testing and impaired interpersonal relations. Semistructured interviews have the advantage of being able to tap both the subjective and objective components of factors like memory impairment, psychomotor retardation, and belligerence. Both chronicity and severity of symptomatology can be assessed independently with greater ease in semistructured interviews than in self-report questionnaires, which often confound these two. Clarifications

can also be made on other factors which patients tend not to differentiate. Halo effects exist for both the patients' and doctors' perceptions of patient symptomatology. For instance, Pinard and Tetreault (1974) reported that patients tend not to distinguish between sadness, fatigue, and anxiety if detailed questions are not asked on these matters, since the patients tend to experience these simultaneously. Forthermore, these patients often tend to express anxiety in terms connotative of aggression. Simon et al. (1973) have noted that black patients tend to express anxiety symptoms in somatic terms.

Advantages of Semistructured Interviews over Less Structured Techniques. Semistructured scales are better than unstructured clinical interviews in that they assure that all relevant questions will be asked, and the interviewer will not be easily sidetracked.

The social stimulus value of the interviewer is standardized within certain limits, which may help reduce confounding due to social interactions, yet enough flexibility is allowed to assure development of adequate rapport with the interviewee. Yet, scoring of semistructured interviews is highly standardized, and is in most cases done on an item-by-item basis. This helps reduce halo effects by breaking the syndrome in question down into objective components which are rated as present or absent.

Semistructured interviews have been found to possess high reliability and validity when used by experienced clinicians (Gurland et al., 1976; Spitzer, Endicott & Cohen, 1967; Wing et al., 1974).

The Combined Instrument Schedule/Multiple Diagnostic Strategy Schedule

The Combined Instrument Schedule/Multiple Diagnostic Strategy Schedule, also known as the CIS/MDSS, (Mannuzza, Spring & Yozawitz, Note 7) was developed by members of the Psychophysiology Section of Biometrics Research, New York State Psychiatric Institute (now the Department of Psychophysiology of New York State Psychiatric Institute) to provide a semistructured research interview suitable for diagnosis of large numbers of subjects to be tested in several psychophysical labs. This interview combined the advantages inherent in several diagnostic measures which have shown their utility in a research setting.

The CIS/MDSS is composed of items taken from three other scales, with the elimination of overlapping items. It includes all 140 items from the Present State Examination's Ninth Edition (Wing et al., 1974), 185 items from the Combined Mental State Schedule used in the U.S.-U.K. Cross-National Study (Cooper, Kendell, Gurland, Sartorius & Farkas, 1969), and 50 items from the Schedule for Affective Disorders and Schizophrenia (or SADS, developed by Spitzer, Endicott & Robins, 1975).

The PSE items can be used to derive a CATEGO computer diagnosis and Syndrome Check List classifications. The PSE has the advantage of a glossary of definitions and clarifications in the manual, The Measurement and Classification of Psychiatric Symptoms (Wing et al., 1974) which provides rating instructions, reliability information, and a detailed description of the CATEGO items.

The Combined Mental State Schedule, also known as the U.S.-U.K. Interview Schedule, can be rated for symptom factor scores (Cooper et al., 1969; Fleiss, Gurland & Cooper, 1971) to derive a symptom

profile based on a factor analysis of data from 500 patients from London and from the New York hospital in which this present study was conducted.

The Schedule for Affective Disorders and Schizophrenia was especially designed to provide the information necessary to derive diagnoses according to the Research Diagnostic Criteria (Spitzer, Endicott & Robins, 1975), a research-oriented diagnostic tool using terms and criteria more or less congruent with those proposed for use in the American Psychiatric Association's new DSM III (1980). The RDC was found to have a higher reliability than DSM II for all diagnostic categories in a study with 120 psychiatric patients (Spitzer, Endicott, Robins, Kuriansky & Gurland, 1975).

In order to successfully combine these items into a scale which would flow smoothly and not be of excessive length, several changes were made in the three constituent schedules.

Items from the U.S.-U.K. Interview Schedule (which is also known as the Combined Mental State Schedule) not necessary for the derivation of the 20 symptom factors were deleted. SADS questions not essential to RDC diagnoses were also deleted, and redundant questions from the scales were combined, which sometimes required a slight re-wording of the questions. However, if these items were scored differently in some way in the different interviews, both of the items were retained in their original form. In addition, U.S.-U.K. (CMS) items that would have been placed after PSE cutoffs were moved forward, so their content would not be lost if the PSE cutoff section was not employed. PSE "depressed mood" items were moved

forward, so that the information crucial for differential diagnosis of depression would not be lost if the interview were terminated prematurely. It should be noted, however, that since this is a semi-structured interview, individual interviewers are allowed leeway as to the order in which the sections and questions within sections in the interview are asked.

The greatest change was in the alteration of the time cutoffs for rating presence of symptomatology. U.S.-U.K. Interview Schedule (Combined Mental State Schedule) items and PSE items traditionally employ a one month cutoff, while SADS items are scored from the beginning of the current episode or the past week. An item was included which allowed for the specification of an adjustable time cutoff. Possible cutoffs were: (1) the past week or two, (2) during the current episode ("when...at their worst"), (3) during the past year (when symptoms were "at their worst during the past year"), or for the non-patients, "how you have been feeling during the past year". To enhance reliability and validity in the present study, the time cutoffs appropriate to each individual instrument were retained in the scoring of its constituent questions.

A more detailed account of the development of the CIS/MDSS is given by Mannuzza (Note 13).

Drug Dosage

Since medications could not be controlled in the present study, a concern existed that they might act as a confounding factor. This could occur through any combination of several mechanisms.

Medication could alter overall threshold levels or affect the slope of the temporal integration function by selectively altering

processing efficiency at some durations. Medication could also produce interactions with symptomatology in any of several ways. For instance, the drugs could simply alter the symptomatology presented by the patients, but such drug-induced changes in symptomatology could then alter the diagnoses given to some patients. Drug-symptom interactions might be group-specific (i.e. phenothiazines may cause a clinical improvement in schizophrenic patients, but have a different effect on depressed patients). In addition, patient symptomatology could influence the type or quantity of medications given. This could produce further confounding if medication were to have an effect on the patients' auditory functioning.

Effects of Medication on Auditory Measures

Baru (1967) had found that caffeine decreased the slope of temporal integration functions by lowering thresholds to brief (under 16 ms) stimuli, and that l-amphetamine (which inhibits catecholamine uptake) produced steeper sloped functions which had normal level brief tone thresholds, but which showed increased sensitivity to longer duration stimuli (producing a longer critical duration).

If drugs with excitatory effects can alter temporal integration functions, it is also possible that the major tranquilizers, especially those with dopaminergic effects, might have similar properties. Both phenothiazines and butyrophenones are known to block dopamine receptors and to increase the turnover of dopamine to homovanillic acid (Barbeau, 1972). The presence of dopaminergic synapses in the temporal lobe has been suggested by Moore and Bloom (1978).

Malone and Hemsley (1977) have reported that auditory sensitivity in depressive patients was worse prior to four to six weeks of antidepressant treatment. Bruder et al. (1980) report finding a correlation ($r = .45$; $p < .05$) between antipsychotic medication dosage (in chlorpromazine equivalents) and right ear click thresholds for schizophrenic patients. No significant correlations were found between affective patients' click thresholds and their medication level in the present study, however.

No evidence has been found by Emmerich and Levine (1973), Gruzelier and Hammond (1976), Ludwig et al. (1962), Rappaport and Hopkins (1969), and Rappaport et al. (1972) of an appreciable alteration in the auditory sensitivity of schizophrenic patients due to phenothiazine administration. Babkoff et al. (Note 1) studied the relationship between phenothiazine dosage level and auditory threshold vs. duration functions for a group of patients who were classified as having affective symptomatology, or as being either hallucinating or non-hallucinating psychotics (probably schizophrenics). Although no analysis was done of the relationship between drug dosage and temporal integration for each of these groups separately, an analysis of variance found that there was no effect of drug dosage level on auditory threshold level or on temporal integration slopes.

St. Jean, Lidsky, Ban and Lehman (1964) found that butyrophenones tended to lower schizophrenics' critical flicker fusion thresholds measured in cycles per second. However, they did not control for criterion, and merely requested subjects to indicate the point at which fusion was perceived. As Clark, Brown, and

Rutschmann (1967) have noted, control of response criterion through the use of signal detection procedures is an important methodological consideration in such studies.

In the present study, relationships between medication level and auditory thresholds, temporal integration measures, measures of lateralization of dysfunction, and of variability in threshold level within a session are examined.

Interactions of Medication with Symptomatology

Alterations in Symptomatology. Klein (1976) has suggested that affective and schizophrenic patients, and even patients in subgroups within categories, tend to react to psychotropic drugs in a qualitatively and quantitatively different manner.

Endicott (Note 14) has noted that phenothiazines tend to blunt the symptomatology seen in bipolar depressives, producing a schizomimetic symptomatology which frequently confounds attempts at diagnosis. For instance, when manic speech is slowed down by psychomotor retardation due to phenothiazines, it is deprived of some of its prosodic emphasis. As a result, it sounds less logical, to the point of appearing thought-disordered. Thus, flight of ideas, (which, by itself, is symptomatic of mania, and does not indicate the formal thought disorder pathognomonic of schizophrenia) when slowed down, may seem like loose associations, or even incoherence (which are both considered to be formal thought disorder, per se., according to RDC). Agitated depressives given phenothiazines tend to resemble "burnt-out" old schizophrenics and are often diagnosed as having residual schizophrenia.

Rifkin et al., (1975) and Van Putten and May (1978) have reported that anti-psychotic drugs produce "akinetic depression" in both schizophrenic and affective patients. This syndrome consists of psychomotor retardation, diminished speech, and depressed mood. Rifkin et al. have suggested that much of the behavior commonly considered to be part of the schizophrenic process (little show of affect and lack of initiative) may be iatrogenic in nature, i.e., part of the akinetic syndrome of tardive dyskinesia.

Although it is impossible to determine, post hoc, whether medications have altered symptomatology, correlations of symptomatology with medication were determined. Relationships between project diagnosis and medication were also examined.

Influences of Symptomatology or Diagnosis on Type or Quality of Medication. Since phenothiazines are traditionally used in the treatment of schizophrenia and are not strongly indicated for the treatment of affective disorders, there is the possibility that, although all of the patients were given hospital diagnoses of "schizophrenia", patients with stronger schizophrenic symptomatology might have received a higher dose. If affective patients were less likely to receive high phenothiazine doses than were schizophrenics, a relationship between project diagnosis and/or symptom profiles might be observed.

Poorer auditory sensitivity has been observed in depressed patients (vs. nonpatients or schizophrenic subjects) by Bruder et al. (1975), Bruder, Spring, Yozawitz and Sutton (1980), Malone and Hemsley (1977) and Yozawitz et al. (1970); and temporal integration

functions with different slopes have been observed for affectives vs. different classes of schizophrenics (hallucinating vs. non-hallucinating psychotics) by Babkoff et al. (Note 1), as well as between hallucinating vs. non-hallucinating schizophrenics (Bazhin, Wasserman & Tonkonogii, 1975). Therefore, there is a concern that an interaction between symptomatology or diagnosis, medication, and threshold levels might exist in the present study. For this reason, in addition to the aforementioned examination of relationships between medication and the auditory measures, data were examined for relationships between project diagnosis and medication level, as well as for relationships between each of the 19 symptom factors measured in this study and medication level.

CHAPTER II

METHODS

Apparatus

General Description

The apparatus used in these experiments was part of the Audition Laboratory of the Department of Psychophysiology, New York State Psychiatric Institute. It is outlined in a functional block diagram in Figure 2, and is described in greater detail by Babkoff and Sutton (1968) and Yozawitz (1977).

The apparatus allowed for the production and attenuation of sinusoidal stimuli of different frequencies and of white noise bursts. Stimuli could be presented at different durations and at different rise and decay times to either ear of the subject. The timing of stimulus events for a three-interval forced-choice task and the intertrial intervals were automatically controlled.

The subjects' response console and events within the forced-choice task were as follows: A red light flashed for 500 ms to indicate that a 7 sec response interval had ended, and that the next trial could begin. When the subject initiated the next trial by depressing a telegraph key mounted on the right side of the subjects' response console, the red light flashed again to provide feedback that the trial had begun. After 3.6 sec, a sequence of three 500 ms red lights flashed; each adjacent light pair was separated by 700 ms. The target stimulus (a tone or noise burst) was presented to the subject 100 ms after the onset of one of these three flashes. The subject was required to press one of three

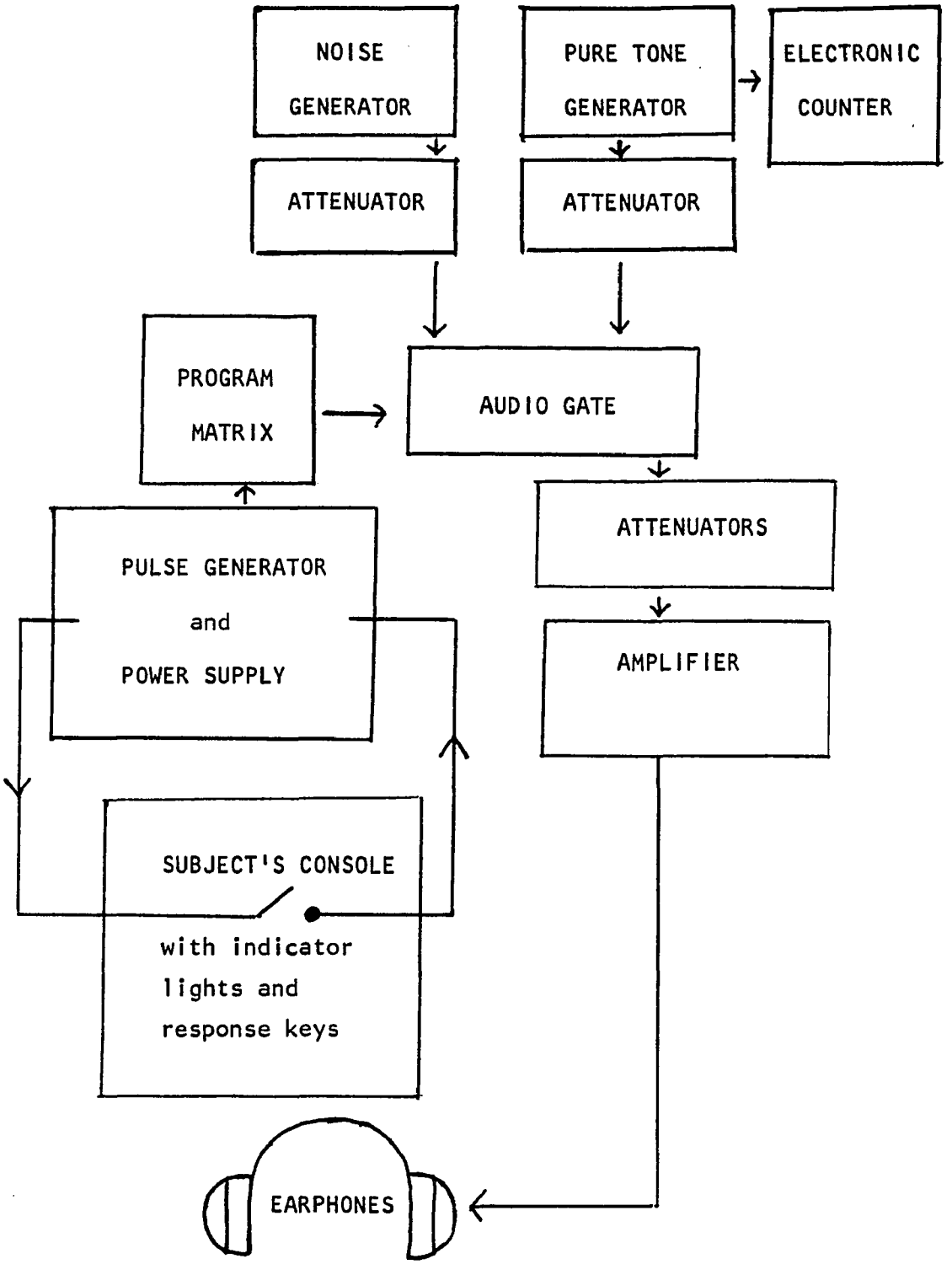


Figure 2. A schematic diagram of the apparatus used to generate auditory stimuli.

response buttons on the console, to indicate his assessment of which interval contained the stimulus. If the subject pressed the button which corresponded to the correct choice during the 7 sec response interval, a blue feedback light was illuminated.

A digital time generator with a power supply (Analog and Digital Instrument Company Type TG-700) and a General Radio Pulse Generator (Type 1217-B) with a Power Supply (Type 1203-B) were used to control the duration and separation of the light flashes and the timing of the response interval.

A Program Matrix (local design) permitted the programming of stimulus events and response intervals for each trial. An Audio Gate (local design) shaped the sinusoidal output of the Hewlett-Packard Audio Oscillator (Model 200 CD) or the output of a General Radio Random Noise Generator (# 1390 B) into trapezoidal stimulus pulses with controllable rise and decay time and duration. The Random Noise Generator's range setting was 20 KHz for this study. The frequency output of the Audio Oscillator was constantly monitored by a Hewlett-Packard 522B Electronic Counter.

The output signal of the Audio Gate was attenuated by a Hewlett-Packard 5W, 600Ω attenuator which was adjustable in 1 dB steps over a 110 dB range. The signal was amplified by locally designed amplifiers, and fed into either the right or left phone of a set of Sharpe HA 10 (MK-II) circumaural earphones.

The subject was tested in a sound-attenuating booth. There was a low level ambient noise produced by a pair of Rotron MK4 Whisper Fans. Communication with the subject during testing was effected by means of an intercom.

Calibrations

In order to monitor and control the characteristics of the stimuli, calibrations of the peak to peak amplitude and shape of the input to the earphones were performed before the subjects were tested on each day.

Also, prior to the beginning of the study, once during the course of testing, and at the completion of data collection, calibrations were performed on the duration of the input to the earphones, the frequency response of the earphones, the peak to peak amplitude and shape of the output of the earphones, and the sound pressure level (in dB) of the stimuli produced by the earphones. Calibrations were done for both sinusoidal and white noise stimuli. A brief description of the calibration procedures follows. For a more detailed account, see Yozawitz (1977).

Daily Calibration of the Shape and Peak to Peak Amplitude of the Input to the Earphones. Peak to peak input voltage to the earphones was checked each day before testing. It was measured using an oscilloscope (Tektronix Type 561 with a Type 67 Time Base and a Type 3A72 Dual Trace Amplifier). The RMS level was measured using a True RMS Meter (Ballantine, Model 320A). With an attenuator setting of 0 dB and a pulse repetition rate of 7.75/sec, the oscilloscope indicated a 10 mv peak to peak voltage and the RMS voltage was 3.1 mv.

Monitoring of the Duration and Rise/Decay Time of the Input to the Earphones. Pulse durations and rise and decay times were monitored on the oscilloscope using both the voltage input to the earphones and the voltage output of the phones measured using a Brüel and Kjaer microphone system.

Figure 3 shows a photograph of an oscilloscope tracing of the 1000 Hz pulse with a duration of 500 ms and a 1 ms rise and decay time. This photograph was taken using a Tektronix Oscilloscope Camera (Type C-27 with a Type C-27 Camera Bezel). The oscilloscope time sweep was set at 100 mv/cm and a trace amplitude of 10 ms/cm The sinusoidal character and trapezoidal shape of the pulses can be more clearly seen in Figure 4, which shows an oscilloscope tracing of a 2000 Hz pulse with a duration of 10 ms and a 1 ms rise and decay time. Time sweep was set at 2 ms/cm and trace amplitude was 10 mv/cm.

Calibration of the Frequency Response of the Earphones. The frequency response of the right and left channels of the Sharpe MK-II circumaural earphones was calibrated using a procedure described by Yozawitz (1977). The output of a Hewlett-Packard Function Generator (Model 3310A) was set at frequencies ranging from 100 to 10,000 Hz, using a Hewlett-Packard Electronic Counter (Model 3310A). This sinusoidal voltage was attenuated by a Hewlett-Packard 350D attenuator, amplified using a locally designed amplifier, and transduced into a pure tone output by either the right or left phone of the Sharpe MK-II earphones. A constant input of 100 mv peak to peak and 34 mv rms was maintained at all frequencies used.

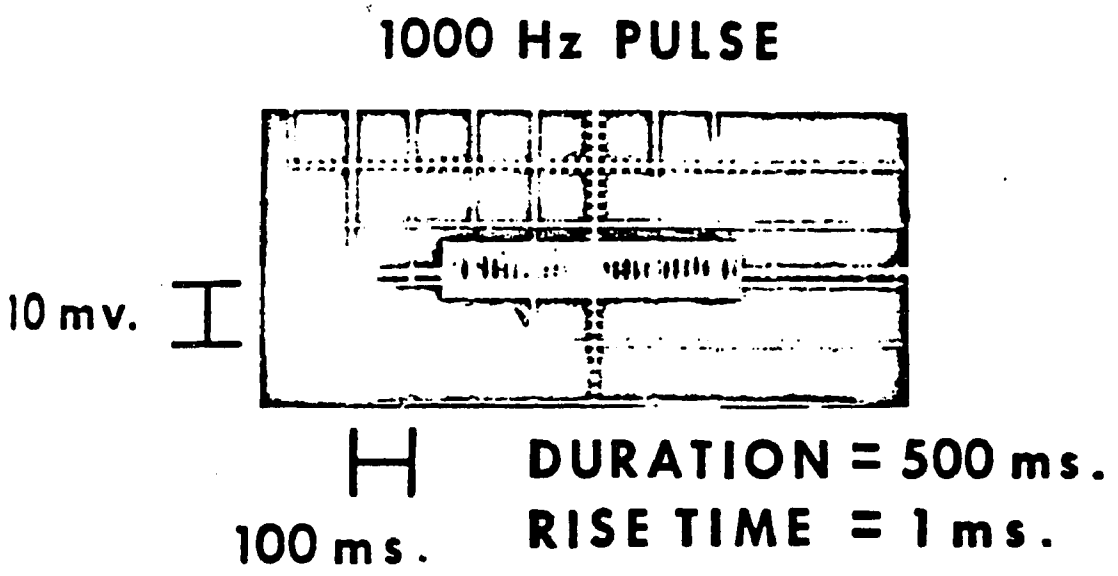


Figure 3. An oscilloscope photograph of a 1000 Hz pulse.

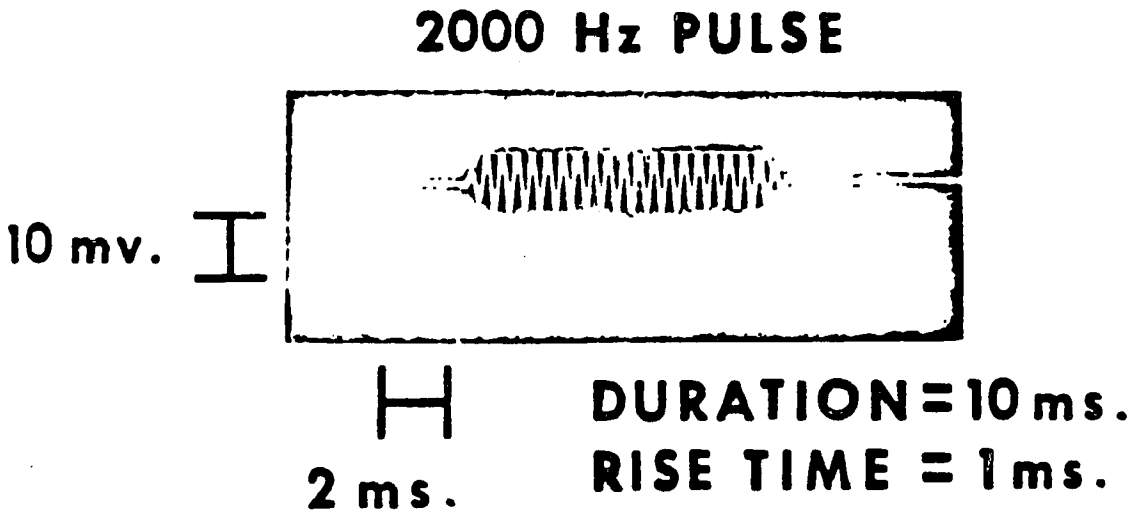


Figure 4. An oscilloscope photograph of a 2000 Hz pulse of abbreviated duration.

A half inch BrÜel and Kjaer condenser microphone (Type 4134) connected to a BrÜel and Kjaer Type 2615 cathode follower and to a BrÜel and Kjaer Type 2801 power supply was mounted in the central opening of a flat plate lucite coupler, positioned flush with the coupler surface. The diaphragm of the earphone was aligned over the center of the microphone on the coupler plate, and the voltage output of the BrÜel and Kjaer system was monitored on the oscilloscope and read in rms voltage on the True RMS meter for each response of each earphone. Corrections in the conversion of rms voltage readings into dB SPL were made using specifications for errors based on in-factory calibrations made by BrÜel and Kjaer.

The obtained frequency response of the right and left phones in dB SPL is plotted in Figure 5. The frequency response was stable throughout the data collection. From 250 - 4000 Hz, the mean difference in frequency response between the right and left phones was 0.003 dB (SD = .68). The greatest right-left difference (1.19 dB) occurred at 3000 Hz.

Monitoring Peak to Peak Amplitude and Shape of the Output of the Earphones. Oscilloscope photos of the voltage output of the BrÜel and Kjaer system for the right and left earphones, using the 1000 Hz pulse, showed it to be sinusoidal in composition and trapezoidal in shape; identical to the pulse observed at the input to the earphones (shown in Figure 3). The earphone output proved stable in its trapezoidal shape, sinusoidal character, rise time, and peak to peak amplitude when measured at different times throughout the study.

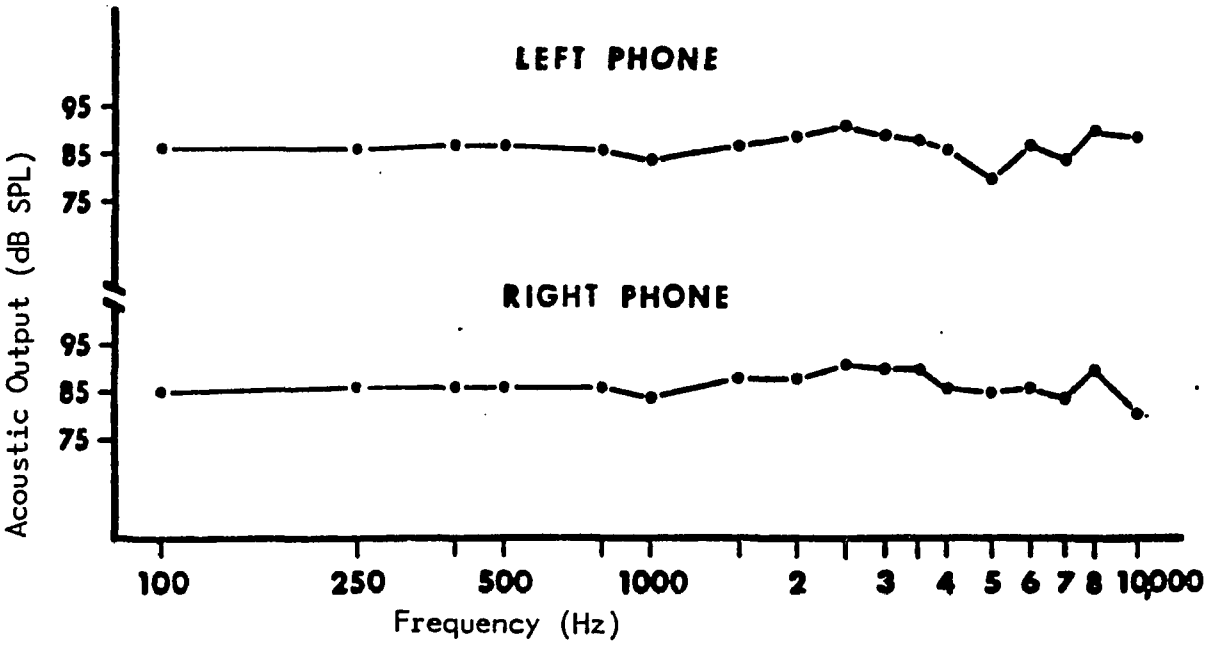


Figure 5. Frequency response of the Sharpe MK-II-S circumaural earphones.

Note. Input voltage to the phones was 34 mv. rms.

Calibration of the Sound Pressure Level of the Stimuli Produced by the Earphones in dB.

Pure Tone Stimuli. Intensity of the output of the earphones in dB SPL was determined with the earphones mounted in the BrÜel and Kjaer system described above.

The voltage of the 1000 Hz pulse measured at the input to the earphones was 10 mv peak to peak and 3.1 mv RMS at 0 dB attenuation. This voltage input was matched by a continuous 1000 Hz sinusoidal voltage output of a Hewlett-Packard Function Generator (Model 3310A) attenuated using a Hewlett-Packard 350D attenuator and amplified by a locally designed amplifier. This input of the phones was increased by 21 dB to permit accurate readings of the RMS output of the phones. At a constant voltage input of 100 mv peak to peak and 34 mv RMS, the frequency response of the right and left earphones was obtained for discrete frequencies over the audiometric range from 250 - 4000 Hz. The voltage output of the BrÜel and Kjaer system was read in RMS voltage for each frequency and converted to dB SPL. The dB SPL level at 0 dB attenuation was 21 dB less than the obtained calibrations.

White Noise Stimuli. The voltage of white noise pulses (500 ms duration and rise and decay time of 5 ms) at 0 dB attenuation was measured at the input to the earphones as 10 mv peak to peak and 3.1 mv RMS (pulse repetition rate of 77.5/sec). To calibrate the SPL in dB, this voltage input was matched using a continuous noise output from the noise generator. In order to read the output from the earphones, this attenuation was reduced by 21 dB. This altered the input to the earphones to 100 mv, and 34 rms. Correcting

for the 21 dB alteration in attenuation needed for calibration, the sound pressure level of the white noise stimulus produced by the earphones for 0 attenuation was 63.02 dB (1.27 mv rms) for the right earphone and 63.36 mv rms) for the left earphone.

Subjects

Psychiatric Patients

Nineteen right-handed male psychiatric patients from the wards of Kingsboro Psychiatric Center were tested. They ranged in age from 18 - 33 years ($\bar{X}$ = 25.89; SD = 4.76). Their ethnic identification was: 15 Negro, 3 Hispanic, and 1 Caucasian. Length of current hospitalization ranged from 12 - 147 days. For 13 patients, this was either their first or second psychiatric hispitalization. One patient was hospitalized for the 10th time, and the other 5 patients had 2 to 4 prior hospitalizations.

These subjects were obtained by screening male admissions to Kingsboro Psychiatric Center, after consultation with ward personnel. Those aged 18 to 35 years, without histories of neurological disease, drug or alcohol abuse, penal incarceration, or mental retardation were briefly interviewed on the wards.

The brief screening interview consisted of a handedness inventory and a few questions from the Combined Instrument Schedule/Multiple Diagnostic Strategy Schedule (CIS/MDSS). Patients who were left handed, lacking fluency in English, incoherent or uncooperative (refusing to communicate or denying symptomatology present in their records and observed by ward personnel) were excluded.

An explanation of the testing and interview procedure was given, and informed consent obtained.

Data from patients who were unable to perform the three-interval forced-choice task at a high level of accuracy at supra-threshold levels or who had thresholds 20 dB or more above the normal level or a greater than 10 dB threshold difference across ears were excluded.

Patients who refused to complete the full audio- and video-taped Combined Instrument Schedule/Multiple Diagnostic Strategy Schedule (CIS/MDSS) interview or who were otherwise uncooperative were allowed to withdraw from the study.

Patients were paid at an hourly rate and given a bonus of 1¢ for each correct response in the threshold task plus an additional bonus upon completion of testing.

Medications. All psychiatric patients were receiving anti-psychotic medication at the time of testing. None received mood-active medications. Medication was prescribed by the staff of Kingsboro Psychiatric Center, and neither qualitative nor quantitative aspects of medication were manipulated in the present study.

Fifteen of the patients received only phenothiazines. Dosage ranged from 2.92 - 25.56 mg/kg ($\bar{X}$ = 11.27; SD = 5.49) estimated equivalent daily dosage of chlorpromazine (see Prien & Caffey, 1975; Davis, 1976). Eleven received only thorazine, one received thorazine and prolixin, and one patient received prolixin and cogentin. Prolixin only, and stellazine only were received by one patient each.

Three patients received haloperidol (a butyrophenone). Dosages ranged from 16.21 - 41.86 mg/kg ($\bar{X}$ = 28.06; SD = 12.93) estimated equivalent daily dosage of chlorpromazine. The patient who received the lowest dose of haloperidol also received 0.06 mg/kg of benztropine mesylate (Cogentin), an antiparkinsonian agent.

One patient received thiothixene (Navane) at 8.18 mg/kg estimated equivalent daily dosage of chlorpromazine.

For a summary of patient medications at the time of testing, see Table 1.

Since Baru (1967) had found that caffeine decreases the slope of temporal integration functions, the subjects in the present study were not allowed to have coffee before or during testing.

Non-patient Controls

Ten right-handed males were recruited through the New York State Employment Service. These subjects were demographically matched to the psychiatric patients that were tested. The control subjects ranged in age from 18 - 33 years ($\bar{X}$ = 25.3; SD = 4.47); their ethnic identification was : 8 Negro, 1 Hispanic and 1 Caucasian.

Screening for psychopathology was performed by a psychologist (AY) using the Combined Instrument Schedule/Multiple Diagnostic Strategy Schedule (CIS/MDSS) interview. Subjects with evidence of psychopathology or records of neurological disease, criminal incarceration or psychiatric hospitalization were excluded from the study. Subjects with auditory thresholds 20 dB above average or with a 10 dB threshold difference across ears, and those who could not learn to perform consistently at suprathreshold stimulus levels were also excluded.

Table 1

Summary of Patients' Medications

Patient Number	Dosage in mg/kg (daily, unless specified)	Average Daily Dosage in mg/kg chlorpromazine calculated equivalent
01	9.19 and 12.25 thorazine*	10.72
02	12.42 thorazine	12.42
03	25.56 thorazine	25.56
04	0.52 haloperidol	26.12
05	6.78 thorazine	6.78
06	14.38 thorazine	14.38
07	0.22 stellazine	5.48
08	10.37 thorazine	10.37
09	10.02 thorazine	10.02
10	0.84 haloperidol	41.86
11	15.15 thorazine	15.15
12	0.33 thiothixene (Navane)	8.18
13	12.48 and 8.32 thorazine*	10.40
14	8.76 and 6.57 thorazine*	7.66
15	17.84 thorazine	17.84
16	4.24 and 2.12 thorazine* & 0.71 prolixin/week	8.23
17	0.32 haloperidol & 0.06 cogentin	16.21
18	0.06 proloxin	2.92
19	1.56 prolixin/week & 0.08 cogentin daily	11.14

Note. Mean phenothiazine dose was 11.27 mg/kg (SD = 5.49); the mean equivalent haloperidol dose was 28.06 mg/kg (SD = 12.93).

Interview data for control subjects were not tape recorded or analyzed, since the CIS/MDSS interview was designed for validity in assessment of psychosis, and does not effectively quantify neurotic-range symptomatology.

Nonpatient subjects were paid an hourly wage plus bonuses of 1¢ per correct response during testing, and an additional bonus for the completion of the testing sequence.

Right Temporal Lobe Lesioned Subjects

Three-interval forced-choice thresholds were obtained at stimulus durations of 2 and 500 ms for 250, 500, 1000, 2000, 4000 Hz and white noise stimuli for two neurological patients.

One subject, S.G., a 56 year old Caucasian male, was referred by Dr. Sidney Diamond of Mt. Sinai Medical Center. Computerized transaxial tomography scans (CTT scans) showed a right temporal-parietal infarct. The patient presented difficulty in recent memory, word finding and comprehension of speech in the presence of background noise or cross conversation. These symptoms dated from a heart attack nine months prior to testing.

The other subject, U.J., was a 32 year old Negro male who was an outpatient at Kings County Hospital. Testing was performed one month after a right temporal craniectomy and removal of a 30 cc right subdural hematoma and a 20 cc right intracerebral hematoma.

Due to the difficulty in obtaining subjects with temporal lobe lesions, the exclusion criteria (i.e., age, a balanced normal-level audiogram) were not strictly applied to this group.

The data for these subjects are presented and discussed in Appendix II.

Informed Consent

The testing and interview procedure was explained to all subjects and informed consent was obtained prior to data collection. For some psychiatric patients, informed consent of their next-of-kin was also elicited.

All subjects were assured of the confidentiality of their testing and interview data, and were told that the testing involved no physical or psychological risk, and that they could withdraw from the study at any time, and would be paid for their participation up to that point.

Psychiatric patient subjects signed informed consent forms which had been approved by review committees at both New York State Psychiatric Institute and Kingsboro Psychiatric Center. Patients were promised that the results of the interview and testing would not adversely affect their length of hospitalization, drug dosages or other therapies, and that the results of the interview and/or testing would be shared with ward personnel only upon the patient's own request.

Initial Piloting

Before the main investigation was started, three pilot studies were performed to resolve some preliminary questions. The results of these studies are presented in Appendix I.

Pilot Study I was performed to determine the optimum length for the brief staircase procedure, i.e., the number of revisitations at a given intensity level required to determine "threshold". This piloting also helped determine that the brief staircase provided threshold measures which would be stable upon replication and

equivalent in accuracy to those provided by a slightly longer version of this procedure which was concurrently in use in the Audition Laboratory.

Pilot Study 2 employed frequency as a parameter, and demonstrated the extent to which the frequency of the stimulus affected the slope of the temporal integration function.

Pilot Study 3, which employed the rise and decay time of the stimulus as a parameter provided information on the extent to which the slope of the temporal integration functions for the 1000 Hz and white noise stimuli were affected by stimulus rise and decay times.

A combination of Pilot Studies 2 and 3 allowed for the choice of stimulus frequencies and rise and decay times for use in the main investigation, and provided indications that the temporal integration functions for these stimuli showed sufficient linearity on log-log coordinates to allow adequate determination by use of thresholds to stimuli of only two durations.

This piloting also provided as estimate of the amount of time needed to determine brief staircase thresholds, and provided replications of earlier work done in the area of temporal integration.

Methodological Comments

The technique used for determining the subjects' auditory thresholds employed several suggestions made by Zubin et al. (1975) for experimental design in research with psychiatric patients:

(1) Use of a simple task. The three-interval forced-choice procedure is a straightforward task, which gives accuracy indicators not provided by techniques such as reaction time (Sutton, 1973).

It does not involve complex memory, judgmental or response factors; in this way it is superior to two-interval forced-choice or yes-no procedures. A staircase technique was used which provided rapid estimates of threshold minimally affected by fatigue or other motivational factors (Campbell & Lasky, 1968; Levitt, 1971; Taylor & Creelman, 1967; Wetherill & Levitt, 1965).

(2) Use of an own-control design. Since measurements were obtained for the subjects' right and left ears, for noise and tone stimuli of brief and long durations, it was possible to make many own-control within-subjects comparisons across groups, minimizing possible confounding due to motivational effects or task difficulty.

(3) Control of criterion variables. As Clark, Brown and Rutschmann (1967) have noted, differences which have previously been observed in patient vs. non-patient performance may be attributed to non-sensory factors, such as willingness to respond in a yes-no task. The use of a forced-choice measure provides an indicator of sensory performance which is not confounded by criterion factors (Bruder et al., 1975; Emmerich & Levine, 1970; Green & Swets, 1966; Malone & Hemsley, 1977). Although measures of criterion can not be obtained using a forced-choice procedure, a sensory measure which is criterion-free (except for possible position bias, as discussed by Calfee, 1970; and Sutton, 1973) is obtained.

This experiment was also designed in such a way as to provide for:

(4) The possibility of a demonstration of better patient performance, either on an absolute level, or in one condition, relative to performance in other parallel conditions. Better patient

performance is desirable since it cannot be interpreted as being due simply to poorer motivation, comprehension, or a global generalized deficit across all tasks so ubiquitously seen in patient research.

(5) Results which can be used within the framework of a multidisciplinary iterative approach (Sutton, 1973) to the definition of clinical and psychophysiological characteristics of the patient population, allowing for further refinement of categories in which some groups of psychiatric patients perform in a distinctive and characteristic manner.

Brief Staircase Procedure

The subjects' auditory thresholds were determined using a brief staircase procedure, developed in the Audition Laboratory of the Department of Psychophysiology, New York State Psychiatric Institute (Bruder et al., 1980). This procedure is an adaptation of Campbell's Block Up and Down Two-Interval Forced-Choice procedure (Campbell, 1963; Campbell & Lasky, 1968). It uses a three-interval forced-choice task to determine the stimulus intensity needed to produce 67% correct response performance (a 50% correct response threshold adjusted for chance guessing in a three-interval forced-choice task), employing successively finer steps in order to quickly arrive at the threshold level. A sample brief staircase is shown in Figure 6.

Each trial was initiated by the subject's pressing a telegraph key. After 3.6 sec, a red light flashed for 500 ms, three times, each flash pair separated by 700 ms. During one of the three observation intervals, the stimulus was presented; the other two

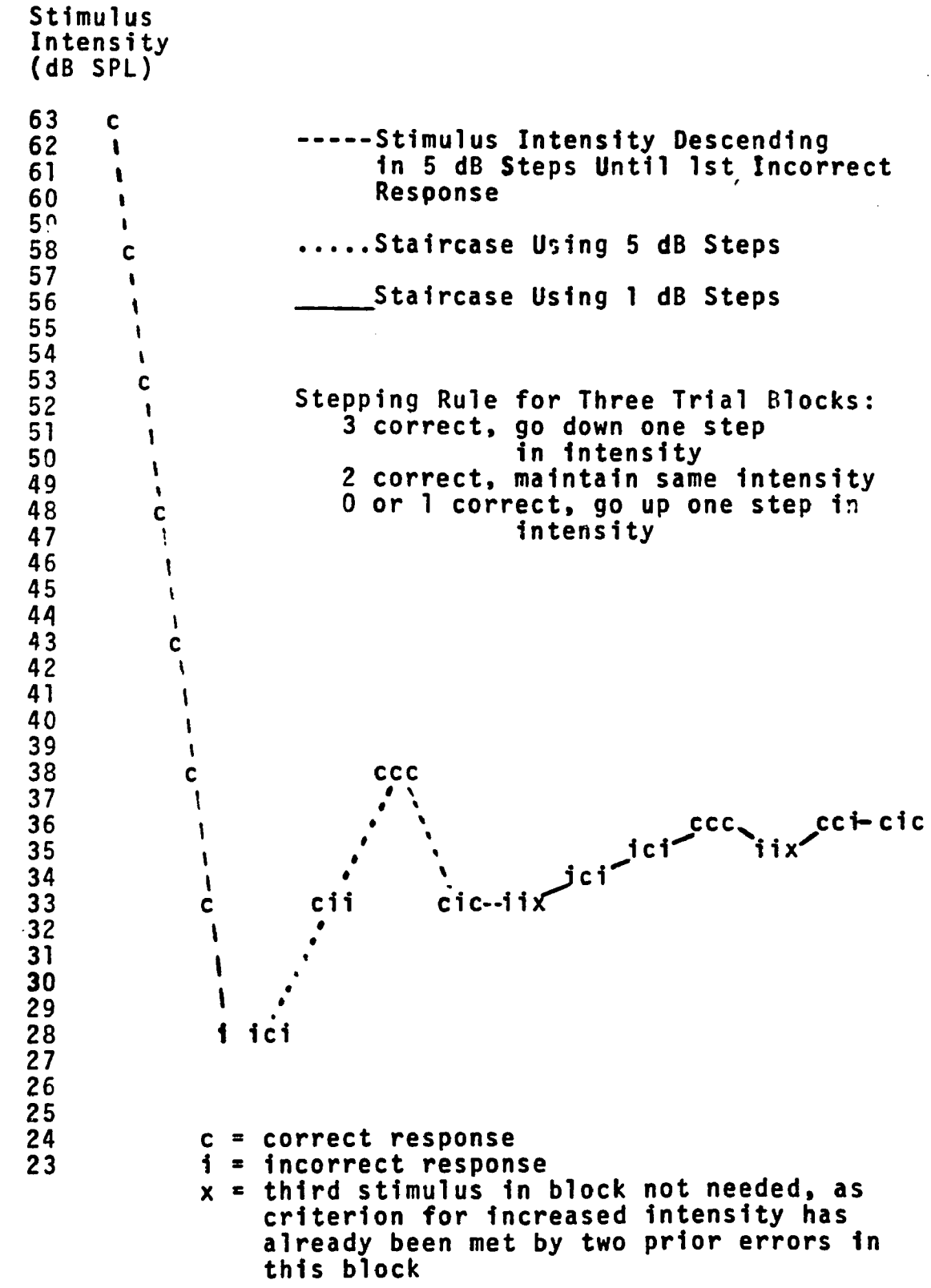


Figure 5. A sample brief staircase procedure using the criterion of three revisitations at the 5 dB and 1 dB step levels.

observation intervals were unfilled. The interval containing the stimulus was pre-determined by computer, randomly, with the constraint that the stimulus could not occur in the same position in more than four consecutive trials. The subject was required to press one of three buttons, corresponding to the 1st, 2nd, or 3rd observation interval, to indicate his judgment of which interval contained the stimulus.

The staircase began at a stimulus level sufficiently above threshold (about 60 dB SL) for the subjects to be able to perform with 100% accuracy. This provided assurance that the subjects understood the task and were suffienently motivated to perform adequately.

At the start of each staircase, stimulus intensity was decreased in 5 dB steps after each correct response, until the subject made his first error. Stimuli were then presented in blocks of three trials at a constant intensity level. The signal level to be used in each subsequent block was determined by the following stepping rule:

3 correct: decrease intensity by one step (5 dB)

2 correct: no change in stimulus

0 or 1 correct: increase intensity by one step (5 dB)

After three blocks at one stimulus level had been observed (not necessarily consecutively), the step size was reduced to 1 dB. This modified the stepping rule to:

3 correct: decrease intensity by one step (1 dB)

2 correct: no change in stimulus

0 or 1 correct: increase intensity by one step (1 dB)

When three blocks at one stimulus level had been observed (not necessarily consecutively) using the 1 dB steps, testing for that threshold stopped. The intensity level at which the three revisitations at the 1 dB-step level had occurred was considered to be the subject's threshold.

The choice of three revisitations at a given stimulus intensity as the criterion for threshold was made based on piloting performed before the main study was conducted, and the appropriateness of this measure was supported by data concurrently collected in the laboratory (see Appendix I).

This staircase procedure yielded an estimate of threshold in about 10 - 15 minutes.

Thresholds were collected using a stimulus rise and decay time of 1 ms, which was chosen on the basis of piloting (see Appendix I). Only one stimulus frequency was tested in each session. The order in which the ears, stimulus durations, and stimulus frequencies were tested was counterbalanced across subjects, separately for patients and non-patients.

Right and left ear thresholds were collected for the psychiatric patients and non-patient control subjects at stimulus durations of 2 and 500 ms, for 1000 Hz and white noise stimuli.

Since the subjects had previously been tested on audiograms at 250, 500, 1000, 2000 and 4000 Hz at a 500 ms duration with a 5 ms rise and decay time for both ears, and had been extensively tested on a dichotic listening task in the same laboratory, they were already well practiced in the brief staircase procedure, and had provided assurance of their ability to perform adequately.

The two right temporal lobe lesioned subjects were tested on full-scale audiograms and on the dichotic listening procedure in the same manner as were the other subjects who participated in this study. However, in this study per se, additional data were obtained from these subjects; thresholds were obtained for both ears at stimulus frequencies of 250, 1000 and 4000 Hz, as well at the white noise condition. Durations of 2 and 500 ms were employed, at a rise and decay time of 1 ms.

Semistructured Interview

The interview used to provide patient diagnoses was the newly constructed Combined Instrument Schedule/Multiple Diagnostic Strategy Schedule (CIS/MDSS) (Mannuzza, Spring & Yozawitz, Note 7), which consisted of items culled from three sources:

(1) The Cross National Study Project's U.S.-U.K. Interview Schedule used by Cooper et al. (1969), known as the Combined Mental State Schedule.

(2) The Present State Examination (PSE; 9th Edition), constructed by Wing et al. (1974).

(3) The Schedule for Affective Disorders and Schizophrenia (SADS), developed by Spitzer and Endicott (1975).

Interviews of each psychiatric patient were performed by A.Y., a psychologist who was one of the compilers of the CIS/MDSS. Interviewing was completed before the auditory testing was performed. Audio recordings were made using Electrovoice lavalier microphones worn by both the patient and the interviewer, and mixed by a Shure Audio Mixer and recorded on a Uher 500 tape recorder. Videotapes of the patients were made during the interviews using an Ampex 7500

Videorecorder and a General Electric Closed Circuit TV Camera.

Based on the CIS/MDSS interview, clinical diagnoses for the 19 psychiatric patients were initially made by the interviewer, A.Y. All subsequent diagnoses were made using tape recordings of these interviews. All of the raters who used taped interviews were kept blind to the subjects' psychophysical test performance, and to the diagnoses and symptom factor ratings provided by the other raters. This was accomplished by replacing all subjects' names with code numbers on the tapes.

A second rater, L.S., provided two sets of diagnoses for the 19 subjects, one set of strict RDC diagnoses, and one set of clinical assessments.

A third rater, B.J.G., provided clinical diagnoses for the 9 patients for whom diagnostic agreement had not been reached by the first two raters. A fourth rater, S.M., subsequently provided RDC diagnoses for all 19 patients.

Both L.S. and B.J.G. are psychiatrists who were members of the Cross-National Study of Diagnosis of the Mental Disorders Project Team. Their diagnostic ratings have been repeatedly assessed for satisfactory reliability (Cooper, Kendell, Gurland, Sharpe, Copeland & Simon, 1972; Gurland, Fleiss, Cooper, Sharpe, Kendell & Roberts, 1970). Raters A.Y. and S.M. were advanced graduate students in psychology,and were experienced diagnostic raters.

All RDC diagnoses were made according to Spitzer et al.'s (1977) RDC guidelines; guidelines for the clinical diagnoses were taken from the British Registrar General's Office's

(General Register Office, 1968) Glossary of Terms to Accompany the 8th Edition of the International Classification of Diseases.

Details of some of the diagnostic procedures used in this study can be found in Yozawitz et al. (1979). Further information on the reliability of these diagnoses will be presented in the Results section of this manuscript.

The items from the U.S.-U.K. Project's Combined Mental State Schedule used in the CIS/MDSS interview were used to derive symptom profiles for twenty factors of psychopathology. These are expressed in standard scores derived through a factor analysis of ratings given to 500 hospitalized psychiatric patients in New York and London (Fleiss et al., 1971). The New York hospital from which these patients were drawn was the same one from which the patients tested in the present study were obtained.

Symptom factor ratings in the present study were made by the interviewer, A.Y., and by S.M., both of whom were compilers of the CIS/MDSS, and by the present author, B.K.G. These ratings were made based on the audiotaped interviews and interview transcripts. Raters S.M. and B.K.G. were blind as to the identity, hospital diagnoses, and psychophysical test performance of the subjects being rated. All raters were kept blind to their co-raters' judgments.

CHAPTER III

RESULTS

Preliminary Diagnoses

Preliminary diagnoses for the 19 psychiatric patients were provided by three raters (A.Y., L.S. and S.M.). An additional rater (B.J.G.) provided diagnoses for the 9 patients for whom diagnostic agreement had not been reached by A.Y. and L.S.; S.M.'s diagnoses were made as a post hoc reliability check after the Project diagnoses were derived. The training and qualifications of these raters have been discussed in the Methods section.

A summary of L.S.'s RDC diagnoses and his own clinical assessment of these patients is given in Table 2.

Diagnoses by A.Y. and B.J.G. for these patients are given in Table 3.

S.M.'s diagnoses are shown in Table 4.

A comparison of the patient diagnoses by A.Y. and L.S. (see Tables 2 and 3, or Table 6) shows that these two raters agreed as to whether 10 of the 19 patients had affective vs. schizophrenic disorders; 5 were judged affective, and 5 schizophrenic by both raters. Project diagnoses were assigned to these 10 patients on the basis of this agreement.

It should be noted that by "agreement", what is meant is not completely concordant diagnoses by subtypes of disorder, but merely an agreement as to whether the patients were basically schizophrenic, affective, or in neither of these two categories. For instance, all types of schizophrenia (i.e., paranoid, chronic undifferentiated, and schizoaffective) were included under the "schizophrenic" category;

Table 2

Rater L.S.'s Clinical and R.D.C. Diagnoses

Patient Number	CLINICAL ASSESSMENT	R.D.C. DIAGNOSIS
01	-Paranoid Schizophrenia, acute (Atypical Depressive Psychosis)	-Schizophrenia, paranoid, acute
02	-Manic Disorder	-Manic Disorder
03	-Paranoid Schizophrenia	-Chronic Paranoid Schizophrenia (Chronic Undifferent. Schiz.)
04	-Unspecified Psychosis	-Schizophrenia, Paranoid, probable (Other Psychotic Disorder)
05	-Manic-depressive, Manic	-Bipolar Depression with Mania (Manic Disorder)
06	-Manic Psychosis	-Manic Disorder, probable
07	-Manic, recurrent, bipolar	-Manic Disorder
08	-Paranoid Schizophrenia	-Schizophrenia, paranoid, subacute
09	-Manic-depressive, Depressed	-Major Depr. Disorder with Hypomania, primary, psychotic, incapacitating, retarded, endogenous (Bipolar #2)
10	-Paranoid Schizophrenia, chronic	-Schizophrenia, paranoid, chronic
11	-Schizoaffective, manic	-Schizoaffective, manic (subacute)
12	-Hysterical Psychosis (Mental Retardation) (Chronic Undifferentiated Schiz)	-Schizophrenia, disorganized, chronic
13	-Depressive Psychosis	-Major Depressive Disorder, sychotic
14	-DEFER DIAGNOSIS (Atypical Psychosis or Severe Schizoid Personality Disorder)	-Schizophrenia, disorganized, probable (subacute)
15	-Mixed Manic-depressive Psychosis, Alcohol & Marihuana Aguse	-Manic-Minor Depressive (Bipolar #1) & Alcohol & Marihuana Abuse
16	-Chronic Paranoid Schizophrenia	-Schizophrenia, paranoid, chronic
17	-Depressive Disorder (Schizoaffective, Depressed)	-Schizoaffective, Depression, acute
18	-Paranoid Schizophrenia, chronic (Schizoaffective with depression, bipolar)	-Schizophrenia, paranoid, chronic
19	-Schizoaffective, manic	-Schizoaffective, manic (subtype uncertain)

Note. Alternative diagnoses are given in parentheses.

Table 3

Clinical Diagnoses by Raters A.Y. and B.J.G.

Patient Number	Rater A.Y.	Rater B.J.G.
01	Major depressive disorder	Affective disorder, depressive-agitated
02	Manic disorder	(not diagnosed)
03	Manic disorder	Paranoid schizophrenia
04	Major depressive disorder	Paranoid Schizophrenia
05	Schizoaffective, manic	Manic-depressive, manic
06	Schizophrenia, undifferentiated	Schizoaffective
07	Schizoaffective, manic	Manic-depressive, manic
08	Schizoaffective, depressed	(not diagnosed)
09	Major depressive disorder	(not diagnosed)
10	Schizoaffective, depressed or Paranoid schizophrenia	(not diagnosed)
11	Schizoaffective, manic	(not diagnosed)
12	Schizoaffective, depressed	Schizoaffective
13	Major depressive disorder	(not diagnosed)
14	Schizoaffective, manic	Paranoid Schizophrenia
15	Manic disorder	(not diagnosed)
16	Schizophrenia, undifferentiated	(not diagnosed)
17	Major depressive disorder	(not diagnosed)
18	Schizoaffective, depressed	(not diagnosed)
19	Manic disorder	Schizoaffective, excited type

Table 4

R.D.C. Diagnoses by Rater S.M.

Patient Number	DIAGNOSIS
01	-Unspecified Functional Psychosis, probable (or Other Psychiatric Disorder)
02	-Hypomanic Disorder (or Unspecified Functional Psychosis or Other Psychiatric Disorder)
03	-Schizophrenia, Undifferentiated (paranoid or disorganized)
04	-Unspecified Functional Psychosis (or Probable Schizophrenia)
05	-Other Psychiatric Disorder (or Unspecified Functional Psychosis, Manic Disorder,probable, or Schizoaffective, manic, probable)
06	-Schizophrenia, probable
07	-Manic Disorder, definite (or Schizoaffective, manic)
08	-Minor Depressive Disorder, definite (Major Depressive Disorder, probable)
09	-Major Depressive Disorder. (Psychotic Major Depressive Disorder)
10	-Schizophrenia (Paranoid or Undifferentiated)
11	-Manic Disorder, probable (or Schizoaffective, manic type)
12	-Schizophrenia, disorganized
13	-Major Depressive Disorder
14	-Unspecified Functional Psychosis (or Schizophrenia, disorganized, probable)
15	-Major Depressive Disorder, probable
16	-Schizophrenia, Undifferentiated, definite
17	-Schizoaffective Disorder, depressed type
18	-Major Depressive Disorder, probable
19	-Unspecified Functional Psychosis probable (or Other Psychiatric Disorder)

Note.
Alternative diagnoses are in parentheses.

and all types of affective disorder (manic, depressed, and bipolar) were placed under the "affective" rubric. Patients who could not be diagnosed, or who had other diagnoses (i.e., unspecified psychosis, hysterical psychosis, or other psychotic disorder) were grouped as "unclassified/other".

The 9 patients for whom agreement was not reached by L.S. and A.Y. for the schizophrenic/affective dichotomy were diagnosed by B.J.G. He agreed with L.S. in 6 of these cases, and agreed with A.Y. in the other 3 instances.

Project Diagnoses

Based on the agreement of two of three raters, a Project diagnosis of either schizophrenic, affective, or unclassified was assigned to these patients (see Yozawitz et al., 1979). Ten of the patients were judged schizophrenic, eight classed as affective, and one patient remained unclassified.

Diagnoses were provided by the fourth rater (S.M.) subsequent to this classification, so his ratings did not provide input to this triage. Of eight patients given a Project diagnosis of affective, S.M.'s diagnosis agreed with this assessment in five cases, and disagreed in three. Of the ten patients given Project diagnoses of schizophrenic, S.M. agreed for five and disagreed for five. S.M. agreed that the patient who was termed unclassified/other was neither schizophrenic nor affective.

It was decided that no alterations in Project diagnoses would be made based on S.M.'s additional input, in the interest of maintaining comparability across studies, since these Project diagnoses for these patients had already been used in published

research and in ongoing data analysis (Bruder, Spring, Yozawitz & Sutton, 1980; Yozawitz, 1977).

Table 5 provides a summary of the Project diagnoses given to these patients.

Hospital Diagnoses

All 19 of the psychiatric patients had received hospital diagnoses of schizophrenia (see Table 5).

Of the 8 patients classified as affective by Project diagnoses, 6 received hospital diagnoses of schizophrenia, paranoid type (one, chronic subtype); one was diagnosed as having chronic, undifferentiated schizophrenia, and one was diagnosed as having an acute schizophrenic episode and habitual, excessive drinking.

The prevalence of diagnoses of schizophrenia provides support for findings (Cooper et al., 1969; 1972; Gurland et al., 1970; Kendell & Gourlay, 1970; Pope & Lipinski, 1978, Sicignano & Lichtenstein, 1978) that psychiatrists in the United States, especially those in large service-oriented hospitals, tend to overdiagnose schizophrenia and underdiagnose the affective disorders. This is found to be especially true in the diagnosis of minority populations (Lehmann, 1971; Simon, 1965; Simon et al., 1973; Zubin et al., 1975).

Reliability of Diagnostic Measures

An examination of Tables 2, 3 and 4 reveals that a wide variety of diagnoses were given to these patients. Even after these categories were collapsed (Table 7), substantial disagreement existed.

Table 5

Hospital Diagnoses and Project Diagnoses for 19 Patients

Patient Number	PROJECT DIAGNOSIS	HOSPITAL DIAGNOSIS (I.C.D. Number)
01	affective	- Schizophrenia, paranoid type (295.3)
02	affective	- Schizophrenia, paranoid type (295.3)
03	schizophrenic	- Schizophrenia, paranoid type (295.3)
04	unclassified	- Acute Schizophrenic Episode (295.4)
05	affective	- Schizophrenia, paranoid type (295.3)
06	schizophrenic	- Schizophrenia, chronic, paranoid type (295.3 x2)
07	affective	- Schizophrenia, paranoid type (295.3)
08	schizophrenic	- Schizophrenia, paranoid type (295.3)
09	affective	- Acute Schizophrenic Episode(295.4) & Habitual Excessive Drinking(303.1)
10	schizophrenic	- Schizophrenia, paranoid type (295.3)
11	schizophrenic	- Schizophrenia, paranoid type (295.3)
12	schizophrenic	- Schizophrenia, chronic undifferentiated type (295.90)
13	affective	- Schizophrenia, paranoid type (295.3)
14	schizophrenic	- Schizophrenia, paranoid type (295.3)
15	affective	- Schizophrenia, chronic paranoid type (295.3)
16	schizophrenic	- Schizophrenia, paranoid type (295.3)
17	affective	- Schizophrenia, chronic undifferentiated type (295.90)
18	schizophrenic	- Schizophrenia, chronic undifferentiated type (295.90)
19	schizophrenic	- Schizophrenia, catatonic, withdrawn (295.24)

For the ten patients who were diagnosed by three raters, agreement as to diagnostic categorization was reached for six patients; two "schizophrenics" and four "affectives" (one manic and three depressed).

Nine patients were diagnosed by all four raters; B.J.G. had been asked to contribute his diagnoses for these patients because of disagreement in diagnoses by L.S. and A.Y. For these patients, agreement by three of four raters was reached for three "schizophrenics" and one "affective".

Percent Agreement

Percent agreement in diagnoses for the four raters was calculated. Although this is the simplest and most commonly used measure of agreement (Janes, 1979) it contains no correction for chance agreement, and is therefore usually considered in inadequate index. The highest percent agreement was obtained for L.S.'s agreements with A.Y. and with S.M. (52.63% each). Agreement of B.J.G. with all other raters was slightly lower (44.44%). The lowest percent agreement was between A.Y. and S.M. (42.10%). Table 6 shows percent agreement for these raters, with a breakdown by diagnostic category.

Using percent agreement as a measure of reliability, L.S., an experienced psychiatrist, had the greatest agreement with the other raters. This was not surprising, as he is considered to be an expert diagnostician. The two graduate students, A.Y. and S.M., were next in reliability; although they were well-trained, they did not have L.S. and B.J.G.'s extensive experience. B.J.G., a

Table 6

Percent Agreement Between Raters

for Preliminary Diagnoses

Raters	Overall Agreement	Breakdown by Diagnostic Category		
		Schizophrenic	Affective	Other
L.S. - A.Y.	52.63%	26.31%	26.31%	0.0
L.S. - S.M.	52.63%	15.79%	26.31%	10.53%
A.Y. - S.M.	42.10%	21.05%	21.05%	0.0
A.Y. - B.J.G	44.44%	33.33%	11.11%	0.0
L.S. - B.J.G.	44.44%	11.11%	33.33%	0.0
S.M. - B.J.G.	44.44%	33.33%	11.11%	0.0
Mean Agreement	46.78%	23.49%	21.54%	1.75%

Mean Inter-rater Percent Agreement for Each Rater

L.S.	49.90%
A.Y.	46.39%
S.M.	46.39%
B.J.G.	44.44%

highly-qualified psychiatrist, had the lowest reliability. This could be explained by the fact that he was asked to rate only those patients for whom L.S. and A.Y. could not reach agreement; these patients are assumed to constitute a sample of the more ambiguous cases. In addition, since two of the raters had already disagreed on these patients' classifications, any diagnosis he might make would, a priori, disagree with one rater's assessment.

Kappa

In order to provide a better evaluation of the degree of agreement in diagnosis obtained by these four raters, kappa, an interclass correlation coefficient which involves corrections for chance agreement, proposed by Cohen (1960) was used. An unweighted kappa measure (Spitzer & Fleiss, 1974; Spitzer, Encicott, Cohen & Fleiss, 1974; Helzer, Robins, Taibleson, Woodruff, Reich & Wish, 1977) was calculated, using a program developed locally by John Nee based on Fleiss and Cuzick's (Note 15) derivation.

In general formulation, kappa consists of the difference between percent observed agreement and percent agreement expected by chance divided by 1 - the percent agreement expected by chance.

$$\text{kappa} = \frac{P_o - P_c}{1 - P_c}$$

Kappa may range from negative values, which indicate below-chance agreement, through zero, which indicates chance agreement, to + 1.0; perfect agreement.

Two classes of kappa exist; weighted and unweighted. Unweighted kappa is employed for the assessment of reliability of judgments of particular diagnostic categories as nominal entities. Weighted kappa deals with the question of the degree of diagnostic agreement, taking into account the magnitude of the "distance" between the diagnoses, i.e., how similar they were.

Although for theoretical reasons, weighted kappa might hypothetically provide more meaningful results in an investigation like this one, it has not come into general use, because no universally acceptable rule has been developed for the assignment of weights to the diagnostic categories (Helzer et al., 1977).

Spitzer et al. (1974) have indicated that kappas among expert raters tend to be .50 to .60 when audiotaped interviews are used. The kappa values obtained in this study (.15 for schizophrenia; .24 for affective disorder; and .001 for unclassified/other) are unacceptably low. For this reason, RDC diagnoses were not exclusively employed in subsequent data analyses. Symptom profiles, which proved more reliable, and which provided quantitative data (rather than nominal categorization) on several scales, were derived from the CIS interview.

Both percent agreement and kappa values for the "schizophrenic", "affective", and "unclassified/other" categories are shown in Table 7, along with a summary of the preliminary diagnoses given to the 19 patients by the four raters and the Project diagnoses assigned to these subjects.

Table 7

Triage of Patients by Primary Project Diagnosis as "Schizophrenic", "Affective", or "Unclassified/Other"

Patnent Number	Project Diagnosis	PRELIMINARY DIAGNOSES				Agreement Summary as Percentage		
		L.S. (clinical)	A.Y.	S.M.	B.J.G.	Schizophrenic	Affective	Other
01	Affective	S	A	U	A	25%	50%	25%
02	Affective	A	A	A	-		100%	
03	Schizophrenic	S	A	S	S	75%	25%	
04	Unclassified	U	A	U	S	25%	25%	50%
05	Affective	A	S	U	A	25%	50%	25%
06	Schizophrenic	A	S	S	S	75%	25%	
07	Affective	A	S	A	A	25%	75%	
08	Schizophrenic	S	S	A	-	67%	33%	
09	Affective	A	A	A	-		100%	
10	Schizophrenic	S	S	S	-	100%		
11	Schizophrenic	S	S	A	-	67%	33%	
12	Schizophrenic	U	S	S	S	75%		25%
13	Affective	A	A	A	-		100%	
14	Schizophrenic	U	S	U	S	50%		50%
15	Affective	A	A	A	-		100%	
16	Schizophrenic	S	S	S	-	100%		
17	Affective	A	A	S	-	33%	67%	
18	Schizophrenic	S	S	A	-	67%	33%	
19	Schizophrenic	S	A	U	S	50%	25%	25%
					Mean Percent Agreement =	57.27%	56.07%	33.33%
					Standard Deviation =	26.37%	31.32%	12.90%
$\text{kappa} = \frac{P_o - P_c}{1 - P_c}$					Kappa Values =	0.15	0.24	0.001

Symptom Factor Ratings

Items from the Combined Instrument Schedule were used to rate the 19 psychiatric patients on 19 different psychopathological scales, using Combined Mental State (Cross-National Study) factors (Gurland et al., 1970; Fleiss et al., 1971). These scales were: Depression, Speech Retardation, Anxiety, and Somatic Concern (the Depressive Mood factors); Hypomania and Grandiose Delusions (the Manic Mood factors); Lack of Insight, Paranoid Delusions, Control Delusions, Bizarre Behavior, Flat Affect, Incomprehensibility, Visual Hallucinations, and Auditory Hallucinations (the Disorganization factors); and Observed Belligerence, Reported Belligerence, Obsessions, Depersonalization/Derealization, and Disorientation (the Non-specific factors).

The use of these factor profile scores was of special interest in the present study because:

(1) Standard scores were obtainable on 19 independent symptom factors derived from a factor analysis of data from 500 psychiatric in-patients in New York and London hospitals (Fleiss et al., 1971).

(2) The hospital in which the present study was conducted (Brooklyn Psychiatric Center/Brooklyn State Hospital) was the same New York hospital which contributed to the standardization of these scales. Therefore, data could be compared to norms derived from a similar population from the same ecological niche.

(3) Scoring of these factors from a semi-structured interview could be operationalized more specifically than could the production of RDC diagnoses. It was hoped that a more fine-grained

and reliable symptom picture of these patients could be obtained from this measure.

Symptom factor ratings were made by A.Y., S.M., and B.K.G. based on tapes of the CIS/MDSS interviews conducted by A.Y. The training and qualifications of these raters have been discussed previously.

A.Y.'s ratings were not performed blind to either the patients' hospital diagnoses or to their psychophysical test results.

S.M. and B.K.G. were kept blind to the hospital diagnoses of these patients. B.K.G., who had participated in the collection of the auditory test data for these patients, was kept blind to their identity on the tapes by means of numeric coding and deletion of the subjects' names on tapes and transcripts.

Although two of the raters (AY and SM) had also provided RDC diagnoses for these patients, they were kept blind to the diagnoses given to the patients by the other diagnosticians.

The symptom factor ratings in standard scores based on a factor analysis (Fleiss et al., 1971), which were given to each of the 19 psychiatric patients by each of the 3 raters, are listed in Appendix III, along with the average symptom factor ratings for each patient, using the mean of the 3 raters' factor scores.

The mean ratings given by each rater and the standard deviations of these ratings across all patients for each of these factors and mean standard score for each of the 19 symptom profile factors over all patients, based on the mean of the three raters,

are shown in Table 8. The mean standard deviations for the three raters on these factors averaged over all 19 patients are also given. The average symptom profile generated across all patients for each of these three raters can be seen graphically presented in Figure 7, and in Figure 8 for all raters.

Comparisons of Symptom Factor and Diagnostic Ratings

Symptom factor profiles in standard scores based on the norms of the Cross-National Study (Fleiss et al., 1971) were calculated for the 8 patients judged to be affective and for the 10 patients judged schizophrenic by the Project diagnoses (which had been used in the Yozawitz, 1979 study).

These scores for the affective group given by the three raters for the 19 symptom factors are shown in Table 9. Table 10 gives the symptom factor scores by the three raters for the Project-diagnosed schizophrenic group. Means and standard deviations across patients are given.

The mean ratings given to the Project-diagnosed schizophrenic and affective groups by the three raters are contrasted in Table 11. The average of the standard deviations of the three raters on these factors are also provided. These same data are depicted graphically in Figure 9.

An examination of the symptom factor scores of these Project-diagnosed affectives and schizophrenics with reference to the norms derived by Fleiss et al. (1971) shows the patients to be significantly different from the standardization sample on only one factor. Both affectives and schizophrenics scored

Table 8

Symptom Profiles for All 19 Psychiatric Patients by Three Raters

Symptom Factor	A.Y.		B.K.G.		S.M.		Mean of 3 Raters	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Mood: Depressive								
Depression	47.26	7.38	47.47	7.53	45.12	6.39	46.62	7.12
Speech Retardation	50.88	6.67	57.52	16.66	52.49	13.62	53.66	13.00
Anxiety	45.40	3.62	47.06	6.83	45.57	5.61	46.01	5.51
Somatic Concern	49.38	9.71	50.89	12.54	53.41	13.03	51.23	11.85
Mood: Manic								
Hypomania	59.09	13.51	54.59	10.15	55.23	9.16	56.30	11.10
Grandiose Delus.	74.32	20.14	78.59	25.50	59.39	14.87	70.77	20.63
Disorganization								
Lack of Insight	50.09	9.50	57.26	13.90	53.68	11.81	53.68	11.87
Paranoid Delusions	62.86	14.75	65.83	15.99	58.90	17.46	62.53	16.10
Control Delusions	48.83	5.57	55.82	12.99	49.24	5.10	51.30	8.63
Bizarre Behavior	49,90	5.62	48.96	4.09	48.02	0.00	48.96	4.01
Flat Affect	53.87	15.46	51.84	10.24	48.80	7.20	51.49	11.48
Incomprehens.	49.82	7.04	52.92	8.68	54.86	14.13	52.53	10.40
Visual Halluc.	55.92	17.37	58.81	20.18	57.37	16.67	57.37	18.14
Auditory Halluc.	60.30	14.65	60.43	14.66	56.81	15.42	59.18	14.75
Non-Specific								
Observed Bellig.	48.95	7.96	49.55	10.70	49.14	9.35	48.74	9.40
Reported Bellig.	52.80	10.86	54.17	11.71	49.20	9.90	52.05	10.85
Obsessions	49.19	8.39	52.80	16.32	48.59	8.16	50.19	11.59
Depers./Dereal.	46.89	2.82	50.06	5.22	46.89	2.82	47.95	3.79
Disorientation	46.40	0.00	48.06	4.12	46.40	0.00	47.39	2.38

Note.

Average standard deviation for three raters (Guilford, 1956) $= \sqrt{\frac{(SD_{r1})^2+(SD_{r2})^2+(SD_{r3})^2}{3}}$

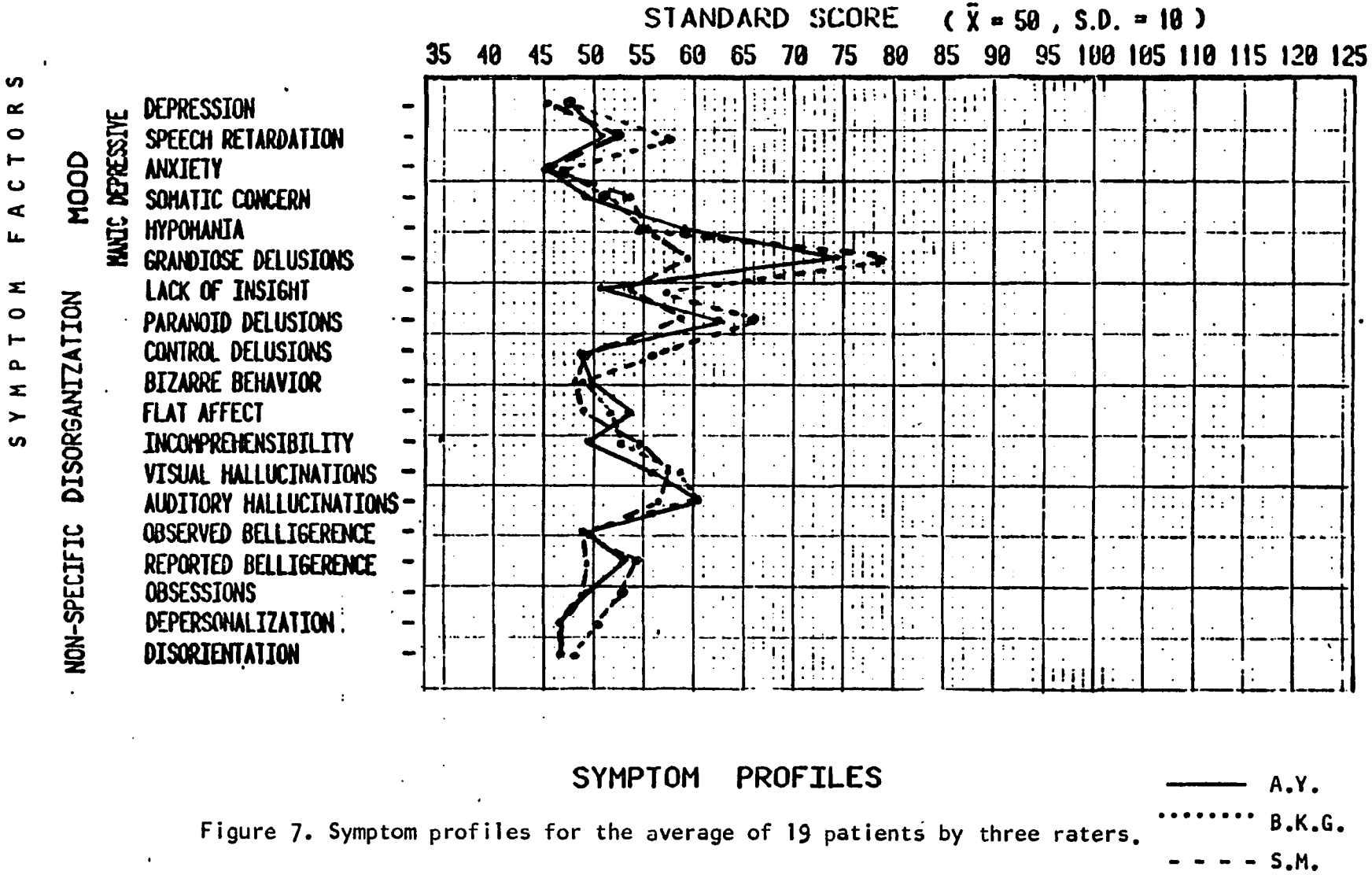
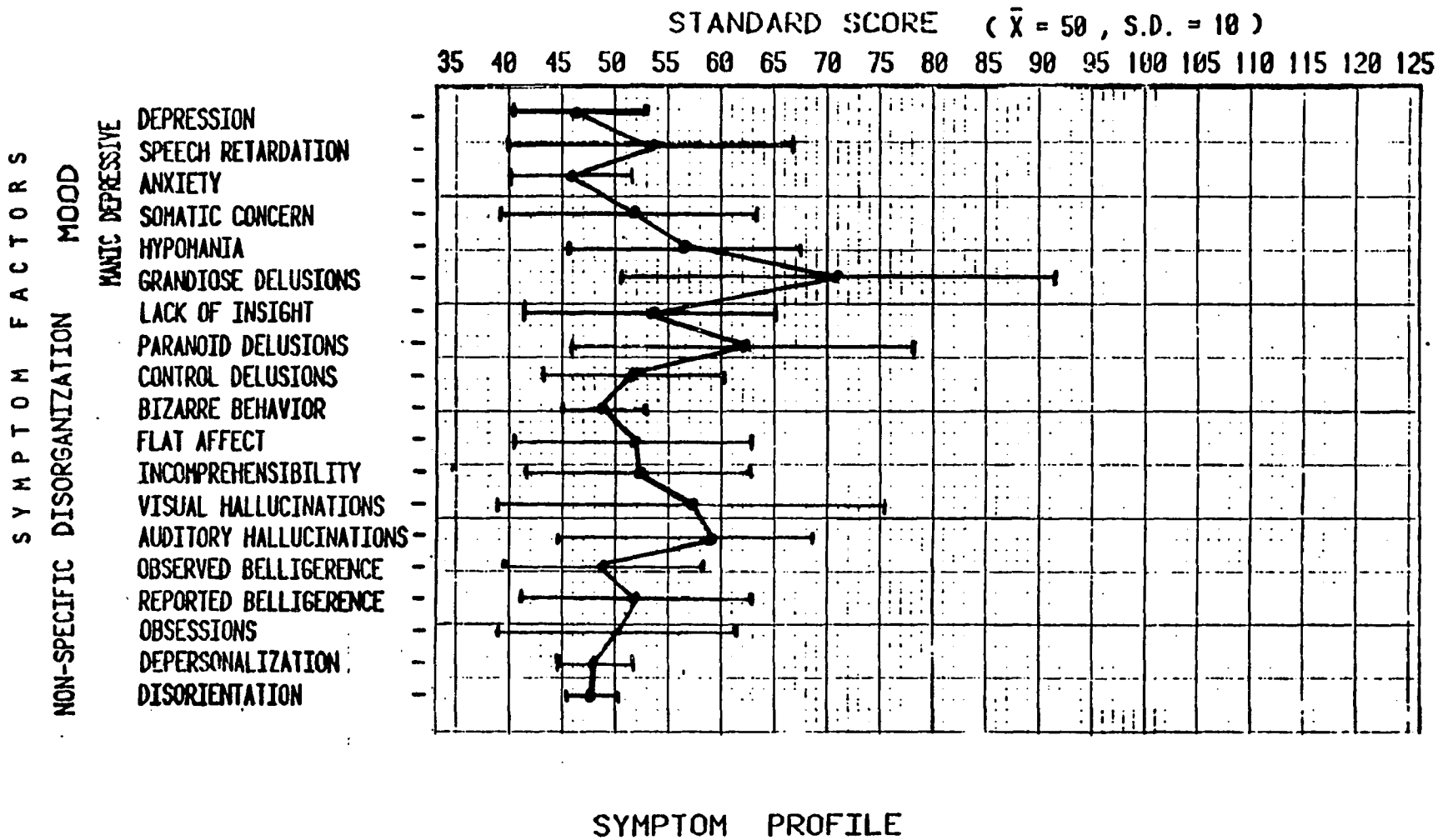


Figure 7. Symptom profiles for the average of 19 patients by three raters.



SYMPTOM PROFILE

Figure 8. Average symptom profile for all patients (n = 19); Average of three raters.

Table 9

Symptom Profiles by Three Raters for the 8 Patients

Given a Project Diagnosis of Affective Disorder

Symptom Factor	A.Y. Mean	A.Y. S.D.	B.K.G. Mean	B.K.G. S.D.	S.M. Mean	S.M. S.D.
Mood: Depressive						
Depression	48.22	7.78	49.40	8.42	47.04	7.77
Speech Retardation	50.03	7.12	52.42	13.48	52.42	16.92
Anxiety	46.92	3.74	49.67	8.87	47.31	6.52
Somatic Concern	45.84	0.00	50.64	10.26	53.04	9.94
Mood: Manic						
Hypomania	62.14	16.97	56.03	10.83	56.03	8.64
Grandiose Delusions	79.39	20.35	82.77	21.59	57.43	11.97
Disorganization						
Lack of Insight	47.27	9.01	59.44	14.48	53.36	12.13
Paranoid Delusions	64.51	15.35	73.13	13.78	59.03	17.55
Control Delusions	50.12	8.28	55.00	16.17	49.14	5.52
Bizarre Behavior	50.25	6.31	48.02	0.00	48.02	0.00
Flat Affect	50.58	10.28	46.97	3.40	48.17	6.80
Incomprehensibility	47.00	5.21	49.77	5.49	53.45	15.48
Visual Hallucinations	52.98	16.17	52.98	16.17	52.98	12.87
Auditory Hallucin.	54.71	11.90	55.57	11.34	49.55	7.54
Non-Specific						
Observed Belligerence	49.19	8.18	52.09	16.37	51.12	13.64
Reported Belligerence	53.82	11.79	57.75	13.99	52.51	11.54
Obsessions	53.33	12.13	60.48	23.48	51.90	12.22
Depersonalization/ Derealization	45.70	0.00	48.53	3.90	46.64	2.66
Disorientation	46.40	0.00	49.55	5.84	49.55	3.37

Note: Standard Scores from Fleiss, et al., 1971.

Table 10

Symptom Profiles by Three Raters for the 10 Patients

Given a Project Diagnosis of Schizophrenic Disorder

Symptom Factor	A.Y. Mean	A.Y. S.D.	B.K.G. Mean	B.K.G. S.D.	S.M. Mean	S.M. S.D.
Mood: Depressive						
Depression	46.73	7.75	46.46	7.11	44.03	5.29
Speech Retardation	50.27	4.95	59.84	18.72	53.14	11.98
Anxiety	44.47	3.39	45.52	4.57	44.47	4.97
Somatic Concern	52.56	12.84	51.60	15.14	54.48	15.97
Mood: Manic						
Hypomania	57.87	10.70	54.20	10.30	55.42	10.06
Grandiose Delusions	72.97	19.58	78.38	28.52	62.16	17.39
Disorganization						
Lack of Insight	51.17	9.67	55.06	14.54	53.11	12.52
Paranoid Delusions	62.00	15.69	62.00	15.69	60.12	18.69
Control Delusions	47.97	2.47	56.56	11.53	49.53	5.27
Bizarre Behavior	49.80	5.64	49.80	5.64	48.02	0.00
Flat Affect	57.31	19.12	54.42	12.37	49.62	8.11
Incomprehensibility	52.53	7.77	56.22	9.98	56.96	13.99
Visual Hallucinations	59.15	19.30	64.64	22.99	61.89	19.38
Auditory Hallucin.	66.23	15.24	64.16	17.12	62.33	18.71
Non-Specific						
Observed Belligerence	46.30	0.00	47.07	2.44	46.30	0.00
Reported Belligerence	52.51	11.04	52.51	9.56	47.28	8.55
Obsessions	46.18	0.00	47.32	3.61	46.18	0.00
Depersonalization/ Derealization	47.96	3.64	51.73	5.95	47.21	3.18
Disorientation	46.40	0.00	47.03	1.99	46.40	0.00

Note: Standard Scores from Fleiss, et al., 1971.

Table 11

Average Symptom Profiles of Patients Given Project Diagnoses of Affective and Schizophrenic Disorder

Symptom Factor	AFFECTIVES (= 8) Mean	Standard Deviation	SCHIZOPHRENICS (n=10) Mean	Standard Deviation	Aff-Schiz Difference in Scores
Mood: Depressive					
Depression	48.23	8.00	45.74	6.80	2.49
Speech Retardation	51.63	13.15	54.42	13.15	-2.74
Anxiety	47.97	6.71	44.79	4.36	3.18
Somatic Concern	49.84	8.25	52.88	14.71	-3.04
Mood: Manic					
Hypomania	58.07	12.65	55.83	10.35	2.24
Grandiose Delus.	73.20	18.47	71.17	22.35	2.03
Disorganization					
Lack of Insight	53.36	12.08	53.11	12.41	0.25
Paranoid Delus.	65.55	15.69	61.38	16.83	4.17
Control Delusions	51.42	10.95	51.35	7.46	0.07
Bizarre Behavior	48.76	3.64	49.21	4.60	-0.45
Flat Affect	48,53	7,38	53,78	13.96	-5.25
Incomprehensibility	50.07	9.95	55.24	10.89	-5.17
Visual Halluc.	52.97	15.15	61.89	20.63	-8.92
Auditory Halluc.	53.28	10.44	64.24	17.03	-10.96
Non-Specific					
Observed Bellig.	50.80	13.18	46.56	1.41	4.24
Reported Bellig.	54.69	12.49	50.77	9.77	3.92
Obsessions	55.23	16.81	46.56	2.08	8.67
Depers./Dereal.	46.96	2.73	48.97	4.43	-2.01
Disorientation	48.50	3.89	46.61	1.15	1.89

Notes. Symptom Factor Standard Scores are from Fleiss et al., 1971.

Average Standard Deviation for Three Raters (Guilford, 1956) $= \sqrt{\frac{(SD_{r1})^2+(SD_{r2})^2+(SD_{r3})^2}{3}}$

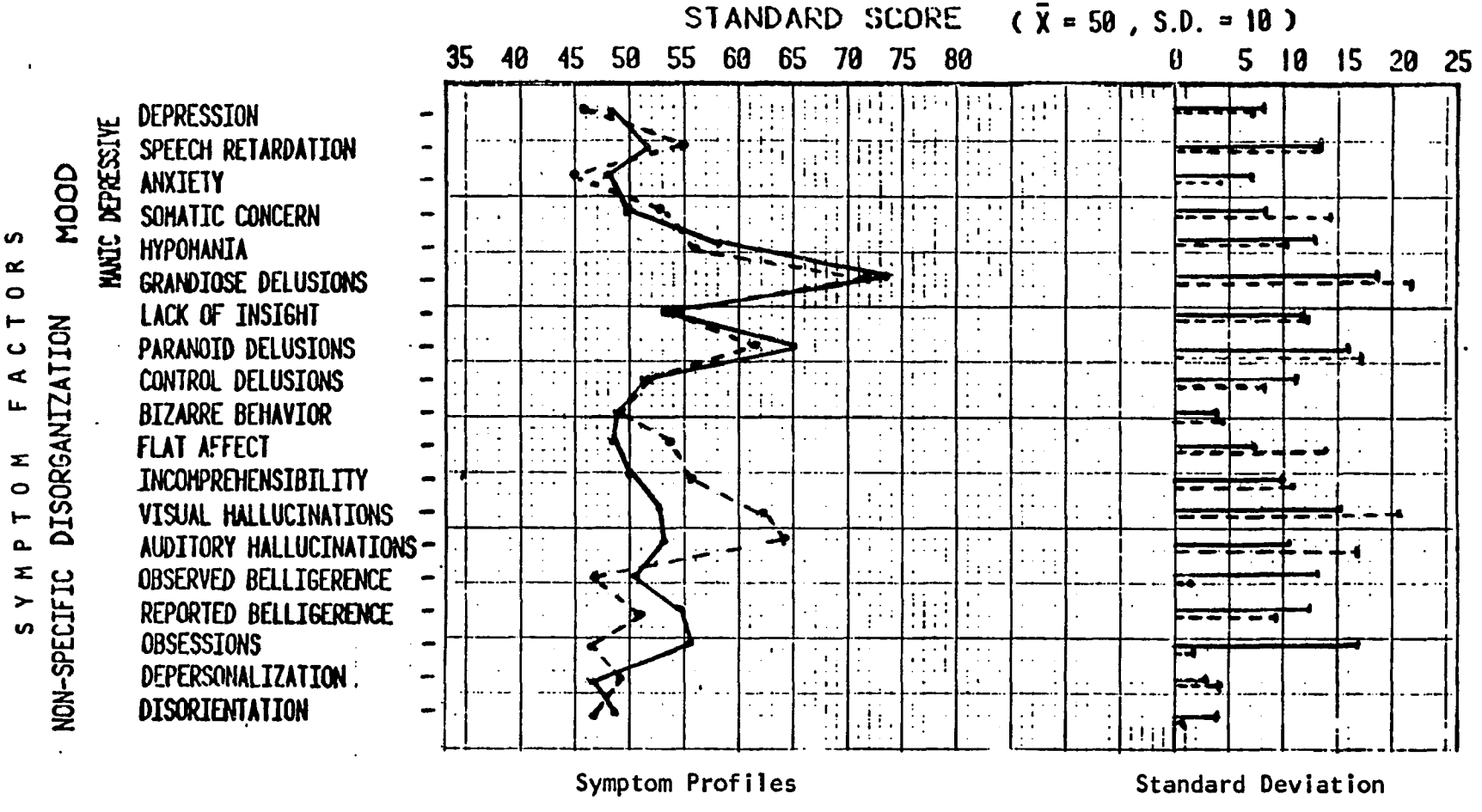


Figure 9. Average symptom profiles for Project-diagnosed affectives and schizophrenics; Average of three raters.

Affectives ——— n = 8
Schizophrenics---- n = 10

more than 1.96 standard deviations (a standard score of $\geq$ 69.6, significantly different at the p = .05 level) above the mean of the standardization sample on the factor of Grandiose Delusions.

The samples of schizophrenics and affectives differed from each other by at least 5 standard score points on five factors. The schizophrenics scored at least 5 standard score points higher than the affectives on Flat Affect and Incomprehensibility, and were 8 standard score points higher on Visual Hallucinations, and were 10 standard score units higher on Auditory Hallucinations. The affectives had a mean score elevated above that of the schizophrenics by over 8 standard score units for the Obsessions factor.

The higher symptom profile scores of the schizophrenics on the Flat Affect, Incomprehensibility, Visual and Auditory Hallucinations factors are consonant with the RDC characterization of schizophrenia (Spitzer et al., 1977) as involving "definite instances of marked formal thought disorder, accompanied by either blunted or inappropriate affect, delusions or hallucinations of any type, or grossly disorganized behavior".

However, when the variability and small number of subjects within these groups was taken into account, no statistically significant differences in the symptom factors was found between the groups of patients given Project diagnoses of affective vs. schizophrenic disorders.

Characteristics of the Distribution of Symptom Factor Scores

Mean values obtained on the symptom factor scales by these subjects were compared to the mean values for Fleiss et al.'s (1971) standardization sample of 500 psychiatric patients. Since ratings were given in standard scores derived from this population of patients from the Cross-National Study, if the means for the present sample were significantly different ($\pm$ 1.960 SD for $p = .05$; or $\pm$ 2.576 SD for $p = .01$), and the null hypothesis rejected, mean values would be obtained below 30.40 or above 69.60 for $p < .05$, or below 24.24 or above 75.56 for $p < .01$.

Mean values on each of the 19 symptom scales were examined for: (1) all subjects, using the average of the three raters (see Table 8), (2) all subjects, for each of the three raters individually, and (3) the affectives and schizophrenics separately, using the average score of three raters (see Table 11).

The only factor that had a mean significantly different from that of the standardization sample was Grandiose Delusions. It was significantly different at $p < .05$ for ratings of all raters across all patients, for both affectives and schizophrenics for all raters, and for all patients using ratings of A.Y. and B.K.G. It was not significantly different only for S.M.'s ratings of all subjects. All other means for these factors were not found to be significantly different from the mean of the standardization sample from the Cross-National Study.

Reliability of Symptom Factor Ratings

The reliability of the three raters on the 19 symptom factors was assessed for their ratings of the 19 psychiatric patients using the Statistical Program for the Social Sciences (SPSS) Reliability Program (Specht & Bubolz, 1977).

Standardized item alphas were used to provide a parametric measure of reliability in which observations on each item were standardized by dividing them by the standard deviation of the item. This is analogous to a Spearman-Brown split-half coefficient, but it is calculated for three, rather than two items in this case.

$$\alpha = \frac{k \times F}{(1 + (k-1) \times F)} = \frac{3\,\bar{r}}{1 + 2\,\bar{r}}$$

where k = number of raters

F = average correlation between items

These are listed in Table 12 along with standardized item alphas based on analogous nonparametric correlations (Kendall's tau, rather than Pearson r) for the three raters. The nonparametric correlations were obtained using the SPSS subprogram Nonpar Corr (Nie, Hull, Jenkins, Steinbrenner & Bent, 1975).

Table 12 also includes the squared multiple correlations (Nunnally, 1967) for each of the three raters for the 19 symptom factors. The squared multiple correlation is computed by regressing one rater's evaluation upon the other two raters' evaluations for that factor (Lord & Novick, 1968; Nunnally, 1967). These values were computed using the SPSS Reliability program (Specht & Bubolz, 1977).

Table 12

Reliability Measures for Symptom Factor Ratings of Three Raters

SYMPTOM	Standardized Item Alpha		Squared Multiple Correlation		
	Nonparametric	Parametric	A.Y.	S.M.	B.K.G.
Depression	.9247	.9623	.8838	.7917	.9025
Anxiety	.8483	.8304	.5400	.3875	.5513
Speech Retardation	.8524	.8850	.5186	.6628	.7232
Hypomania	.8206	.8583	.5677	.7829	.6352
Somatic Concern	.8522	.9300	.7020	.7959	.7349
Observed Bellig.	.8801	.9840	.9500	.9244	.9729
Reported Bellig.	.7764	.8623	.6090	.6188	.7913
Obsessions	.7944	.9372	.9774	.9562	.8790
Disorientation	.6765 [a]	.7487 [a]	(--)	(.3581)	(.3581)
Lack of Insight	.8136	.8420	.4550	.5100	.5560
Depers./Dereal.	.5577	.4997	.0929	.0929	.1211
Paranoid Delusions	.7659	.8342	.5310	.4658	.4658
Grandiose Delusions	.7486	.7757	.7586	.1457	.7570
Control Delusions	.6281	.5478	.0036	.7103	.7105
Visual Hallucinations	.9391	.9695	.8707	.9752	.9575
Auditory Halluc,	.7829	.8564	.5283	.5028	.6450
Bizarre Behavior	.8146 [a]	.8146 [a]	(.4722)	(--)	(.4722)
Flat Affect	.6922	.6909	.3779	.2581	.2367
Incomprehensibility	.7805	.8259	.4986	.4719	.4349
	Mean for 19 Factors	.5743	.5784	.6266	
	Standard Deviation	.2627	.2685	.2739	
	Mean for 17 Factors	.5803	.5913	.6515	
	Standard Deviation	.2695	.2709	.2388	

$$\text{alpha} = \frac{3\,\bar{r}}{1 + 2\,\bar{r}}$$

Note . [a] These correlations were computed based on only two raters, since the third rater had zero variance on that item.

Average squared multiple correlations for each rater are shown at the bottom of Table 12.

A single-factor repeated measures Analysis of Variance (ANOVAR) was performed contrasting the three raters on each of the 19 symptom factors. Significant between measures F values were obtained for Depression ($F = 5.758$; $p < .01$), Speech Retardation ($F = 3.588$; $p < .05$), Reported Belligerence ($F = 3.301$; $p < .05$), Lack of Insight ($F = 4.604$; $p < .02$), Depersonalization/Derealization ($F = 5.703$; $p < .01$), Grandiose Delusions ($F = 9.976$; $p < .0005$) and Control Delusions ($F = 5.211$; $p < .02$). These measures were calculated using the SPSS Reliability program (Specht & Bubolz, 1977), and are summarized in Table 13.

Significant interaction effects of subjects and raters were seen for 10 of the symptom factors. These were: Anxiety ($F = 6.358$; $p < .02$), Speech Retardation ($F = 19.599$; $p < .0001$), Observed Belligerence ($F = 94.075$; $p = .0000$), Obsession, ($F = 30.305$; $p = .0000$), Disorientation ($F = 5.609$; $p < .05$), Lack of Insight ($F = 4.348$; $p < .05$), Depersonalization/ Derealization ($F = 10.017$; $p < .005$), Grandiose Delusions ($F = 13.901$; $p < .001$), Control Delusions ($F = 36.637$; $p = .0000$), and Incomprehensibility ($F = 10.005$; $p < .005$). These are also reported in Table 13. Significant nonadditivity here suggests that raters reacted to different subjects differently. This would suggest that the F values for treatment effects for these factors would be negatively biased, providing overly conservative estimates.

Table 13

Analysis of Variance of Symptom Factors by Three Raters

Symptom	BETWEEN RATERS		RESIDUAL NONADDITIVITY	
	F	probability	F	probability
Depression	5.758	.006	3.523	.068
Anxiety	1.194	.037	6.357	.016
Speech Retardation	3.588	.037	19.598	.000
Hypomania	2.433	.101	2.957	.094
Somatic Concern	2.826	.072	4.070	.051
Observed Belligerence	2.010	.148	94.075	.000
Reported Belligerence	3.300	.048	1.708	.199
Obsessions	2.296	.115	30.305	.000
Disorientation	0.192	.666	5.609	.029
Lack of Insight	4.604	.016	4.347	.044
Depersonalization/ Derealization	5.702	.007	10.016	.003
Paranoid Delusions	2.328	.111	0.248	.621
Grandiose Delusions	9.976	.000	13.901	.000
Control Delusions	5.210	.010	36.636	.000
Visual Hallucinations	1.242	.300	3.030	.090
Auditory Hallucinations	1.073	.352	0.013	.909
Bizarre Behavior	1.000	.330	3.368	.084
Flat Affect	1.531	.229	11.149	.246
Incomprehensibility	2.433	.102	10.004	.003

Notes. For Between Raters, dF = 2, except for Disorientation & Bizarre Behavior, for which df = 1. For Residual Nonadditivity, df = 1.

Thus, the presence of nonadditivity may act to mask relationships between variables in an ANOVAR, and reduces experimental precision by inflating the estimated error variance. The greater the main effect, the greater is the loss of precision (Nie & Hull, 1977). In order to reduce inter-rater effects and in order to maximize reliability of symptom factor ratings to be used in subsequent data analyses, the mean score for the three raters was used for each factor for each patient. Table 14 shows Cronbach's alpha if all raters are used for each factor, contrasted with alpha values which would have been obtained were one of the raters deleted.

An examination of the mean values for Cronbach's alpha in each case shows that the exclusion of rater B.K.G. results in the lowest overall reliability. The exclusion of S.M. results in the next lowest reliability, and the exclusion of rater A.Y. in a higher reliability. Not surprisingly, the inclusion of all raters gives the highest reliability, .805.

It should be noted that the probability that reliability will increase with more raters being employed is inherent in the definition of reliability; it is assumed that errors of measurement are normally distributed, and that additional raters will decrease the proportion of error variance vs. true variance in the observed scores (Magnusson, 1966; Nunnally, 1967). This assumption, that reliability will increase with the number of measurements taken, is incorporated in the Spearman-Brown prediction formula, which estimates the increase in reliability to be gained by increasing test length (Winer, 1971); as reliability is increased by the incorporation of additional measures, validity should increase as well.

Table 14

Reliability for the Average of Three Raters

and Reliability if Each Rater Were to be Deleted

Symptom Factor	Cronbach's Alpha	Alpha With One Rater Deleted A.Y.	B.K.G.	S.M.
Depression	.961	.932	.920	.968
Anxiety	.795	.727	.683	.740
Speech Retardation	.837	.885	.668	.660
Hypomania	.833	.877	.813	.635
Somatic Concern	.923	.918	.885	.854
Observed Bellig.	.948	.975	.886	.873
Reported Bellig.	.864	.864	.658	.865
Obsessions	.865	.713	.974	.820
Disorientation	(.704)	-----	-----	-----
Lack of Insight	.833	.808	.733	.748
Depers/Dereal.	.463	.369	.345	.369
Paranoid Delus.	.830	.735	.780	.785
Grandiose Delus.	.782	.482	.525	.916
Control Delus.	.507	.729	-.013	.038
Visual Halluc.	.965	.977	.956	.914
Auditory Halluc.	.856	.825	.727	.838
Bizarre Behavior	(.791)	-----	-----	-----
Flat Affect	.657	.432	.558	.616
Incomprehensibility	.774	.684	.679	.748
Mean	.805	.761	.694	.729
Standard Deviation	.143	.184	.241	.229

Correlations of Reliability and Scale Length

The number of items contributing to the scales ranged from 28 items for Depression, to 3 items for Lack of Insight. The mean symptom factor scale length was 9.5 items. No significant correlation was found (Pearson r = .190; not significant using a two-tailed test) between the number of items contributing to a scale and the reliability of that scale, using Cronbach's alpha as the reliability measure.

Correlations Between Symptom Factors

Using the mean of the three raters' evaluations, Pearson correlations with two-tailed tests of significance were calculated between the symptoms. These are shown in Appendix V, along with a hodological/topographical depiction of these relationships. Excluding the diagonal cells of the matrix, 7% of these correlations were statistically significant at the 0.05 level. Five percent of the correlations would have been expected to be significant on the basis of chance alone. Since 160 correlations are tested here, the corrected level of statistical significance corresponds to 0.05/160, or .0003. Only Flat Affect and Speech Retardation approached a significant correlation, using these criteria. Their correlation had reached significance at $p < .001$.

Inspection of the statistically significant correlations, uncorrected for number of correlations tested, indicates a clustering of Speech Retardation and Flat affect, correlated (r = .9) with each other, and both negatively correlated (r = -.5) with Grandiose Delusions. Grandiose Delusions was correlated (r = .6) with Auditory Hallucinations, which was correlated (r = .6) with

Visual Hallucinations. Auditory Hallucinations was positively (r = .5) correlated with Somatic Concern, which was correlated (r = .5) with Incomprehensibility. Incomprehensibility was correlated (r = .5) with Depersonalization.

Visual Hallucinations was negatively correlated (r = -.5) with Reported Belligerence, which was correlated (r = .5) with Obsessions. Disorientation was positively correlated with Anxiety (r = .6) and negatively correlated with Hypomania (r = - .5). A correlation which was not statistically significant (r = .4) was found between Hypomania and Reported Belligerence.

Since the number of subjects contributing data was small, it was not possible to analyze these data quantitatively using factor analyses or clustering techniques.

Correlations Between Symptom Factors for the Patients Diagnosed as Having Affective Disorder

For the eight patients given Project diagnoses of affective disorder, a strong pattern of symptom factor correlations emerged.

Using Pearson correlations and two-tailed tests of statistical significance, 15 statistically significant ($p < .05$) correlations were observed. Depersonalization/Derealization was correlated (r = .8) with Incomprehensibility and with Somatic Concern (r = .8). Incomprehensibility was also correlated (r = .8) with Obsessions. Disorientation was negatively correlated with Hypomania (r = -.8) and with Grandiose Delusions (r = -.72). Grandiose Delusions was correlated (r = .7) with Observed Belligerence. Disorientation was also positively correlated with Anxiety (r = .8) and with

Flat Affect (r = .7). Anxiety and Flat Affect were both correlated with Control Delusions (r = .7 and .9, respectively). Control Delusions and Flat Affect were both (r = .9 and .99) correlated with Bizarre Behavior. Speech Retardation was also highly correlated with these symptoms: Control Delusions (r = .9), Bizarre Behavior (r = .99), and Flat Affect (r = .97). These correlations are illustrated in Appendix V.

Correlations Between Symptom Factors for the Patients Diagnosed as Having Schizophrenic Disorder

For the ten subjects given a Project diagnosis of schizophrenic disorder, the symptom picture was not as tightly-knit as for the affective group. Seven statistically significant correlations were observed.

These are shown in Appendix V. Flat Affect and Speech Retardation were positively correlated (r = .9). Somatic Concern and Observed Belligerence were also highly correlated (r = .9), and a correlation of 1.0 was found between Bizarre Behavior and Obsessions. Auditory Hallucinations was correlated (r = .8) with Grandiose Delusions. Visual Hallucinations was negatively correlated with Control Delusions (r = -.6) and with Reported Belligerence (r = -.6). Control Delusions and Reported Belligerence were positively correlated with each other (r = .7).

It should be noted that, for the symptom-symptom correlations for the affective and schizophrenic groups, as for the total patient group, the number of correlations tested (160 each) alters the significance levels that would be required by a correction for chance correlations to .0003 each. These tests are not wholly independent, however, since the affective and schizophrenic groups are not really independent samples, but subsets of the larger group of all patients.

Auditory Threshold Data

Original Auditory Threshold Measures

For the 19 psychiatric patients and 10 non-patients, eight auditory threshold measures were obtained. These were for the right and left ears at durations of 2 and 500 ms, for white noise and 1000 Hz stimuli.

Additional Derived Auditory Threshold Measures

These 33 additional scores were derived by taking differences or combining data across ears, frequencies and durations.

(1) Duration effect was calculated as a measure of the amount of temporal integration (intensity-time reciprocity) evidenced by the subjects. For the purposes of this study, duration effect was defined as the difference in thresholds to the 500 ms and 2 ms stimuli for comparable conditions; however it should be noted that the difference in thresholds to 1 and 1200 ms stimuli have often been used as duration effect measures by other researchers (i.e., Baru & Karaseva, 1972). Duration effects were calculated for each ear at each frequency, for left-right ear differences at each frequency, for right and left ears at all frequencies, and for overall duration effect for all conditions.

(2) Left-right ear differences in threshold were calculated for white noise and 1000 Hz tones at each duration, and were also averaged across durations. As was previously noted above, left-right ear differences were also calculated for duration effects at each frequency and across all frequencies.

(3) Data averaging across both ears were compiled for each white noise, 1000 Hz tone and duration combination, and for duration effects.

(4) Data averaging across the noise and tone conditions were calculated for each duration and ear combination, and for duration effects.

Table 15 lists all of the original and derived auditory measures which are used in subsequent data analyses. Table 16 lists mean values and standard deviations for the non-patient controls (n = 10), for all psychiatric patients (n = 19), for the Project-diagnoses affectives (n = 8) and schizophrenics (n = 10) for each of these 41 measures. Since one affective patient did not complete the noise testing, data for the affective patients and total patient group are based on n - 1 subjects for all conditions employing noise data.

Appendix V shows a matrix of Pearson correlations between auditory threshold measures for all 19 psychiatric patients, for the 8 original threshold measures, and for some ear differences and duration effects.

Auditory Threshold Measures and Project Diagnosis

A four-way Analysis of Variance of the auditory data, using repeated measures (BMD-P2V; ANOVA, Jennrich & Sampson, 1979) was performed to assess the effects of ear tested, stimulus frequency composition, stimulus duration, and group for the patients and the non-patient controls. This ANOVAR is shown in Table 17.

Significant effects can be seen for groups ($F = 6.60$; $p = .016$), for ears ($F = 7.42$; $p = .011$), for stimulus frequency ($F = 61.10$; $p = .00$), for stimulus duration ($F = 542.24$; $p = .00$) and for frequency x duration interactions ($F = 19.60$; $p = .00$). Higher

Table 15

A Summary of the Auditory Measures used in Data Analysis

	Ear	Stimulus Frequency	Stimulus Duration
1.[a]	Left	1000 Hz	2 ms
2.[a]	Left	1000 Hz	500 ms
3.	Left	1000 Hz	2-500 ms dura. eff.
4.[a]	Left	white noise	2 ms
5.[a]	Left	white noise	500 ms
6.	Left	white noise	2-500 ms dura. eff.
7.[a]	Right	1000 Hz	2 ms
8.[a]	Right	1000 Hz	500 ms
9.	Right	1000 Hz	2-500 ms dura. eff.
10.[a]	Right	white noise	2 ms
11.[a]	Right	white noise	500 ms
12.	Right	white noise	2-500 ms dura. eff.
13.	Left-Right	1000 Hz	2 ms
14.	Left-Right	1000 Hz	500 ms
15.	Left-Right	white noise	2 ms
16.	Left-Right	white noise	500 ms
17.	Left-Right	1000 Hz	2-500 ms dura. eff.
18.	Left-Right	white noise	2-500 ms dura. eff.
19.	Average Both	1000 Hz	2 ms
20.	Average Both	1000 Hz	500 ms
21.	Average Both	white noise	2 ms
22.	Average Both	white noise	500 ms
23.	Average Both	1000 Hz	2-500 ms dura. eff.
24.	Average Both	white noise	2-500 ms dura. eff.
25.	Average Both	average noise & 1000 Hz	2 ms
26.	Average Both	average noise & 1000 Hz	500 ms
27.	Average Both	average noise & 1000 Hz	2-500 ms dura. eff.
28.	Left	1000 Hz	average 2 & 500 ms
29.	Left	white noise	average 2 & 500 ms
30.	Left	average noise & 1000 Hz	2 ms
31.	Left	average noise & 1000 Hz	500 ms
32.	Left	average noise & 1000 Hz	2-500 ms dura. eff.
33.	Right	1000 Hz	average 2 & 500 ms
34.	Right	white noise	average 2 & 500 ms
35.	Right	average noise & 1000 Hz	2 ms
36.	Right	average noise & 1000 Hz	500 ms
37.	Right	average noise & 1000 Hz	2-500 ms dura. eff.
38.	Left	average tone-noise difference	all
39.	Right	average tone-noise difference	all
40.	Left-Right	average 1000 Hz difference	all
41.	Left-Right	average noise difference	all

[a] original auditory threshold measures.
dura. eff. = duration effect; difference (dB) in threshold to 2 and 500 ms stimuli.

Table 16

Auditory Thresholds for Non-patients, all Patients, and Affective and Schizophrenic Patients on 41 Measures

Auditory Measure	Non-Patient (n = 10)		Total of All Patients (n = 19)		Project Affectives (n =8)		Project Schizophrenics (n = 10)	
	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.
1.	29.7	6.0	34.8	7.8	34.7	8.9	34.0	7.3
2.	9.5	6.9	13.0	7.3	11.7	6.4	13.6	8.4
3.	20.2	3.1	21.8	5.0	23.0	6.2	20.4	3.9
4.	35.2	3.7	39.9	7.2	42.6	9.8	37.7	4.7
5.	17.8	4.3	22.2	4.2	22.0	4.2	22.1	4.6
6.	17.4	2.1	17.7	5.6	20.6	7.1	15.6	3.7
7.	27.0	5.4	33.8	7.4	36.4	9.1	31.7	5.9
8.	8.3	5.7	12.2	6.0	12.0	5.7	12.2	6.9
9.	18.7	2.7	21.6	7.5	24.4	10.5	19.5	3.8
10.	33.0	4.1	37.9	7.0	40.3	7.3	35.9	6.9
11.	15.5	5.0	21.4	4.5	22.0	4.5	21.2	4.9
12.	17.5	3.7	16.5	5.7	18.3	7.2	14.7	4.3
13.	2.7	5.5	1.0	5.5	-1.7	5.3	2.3	4.8
14.	1.2	7.5	0.8	4.7	-0.3	4.5	1.4	5.2
15.	2.2	2.8	2.0	4.8	2.3	5.6	1.8	4.7
16.	2.3	3.9	0.8	2.8	0.0	1.8	0.9	3.2
17.	1.5	3.9	0.2	6.1	-1.4	5.9	0.9	6.5
18.	-0.1	4.4	1.2	5.5	2.3	5.8	0.9	5.5
19.	28.3	5.0	34.3	7.1	35.5	8.6	32.8	6.2
20.	8.9	5.1	12.6	6.2	11.8	5.6	12.9	7.2
21.	34.1	3.7	38.9	6.7	41.4	8.2	36.8	5.4
22.	16.7	4.2	21.8	4.1	22.0	4.3	21.6	4.5
23.	19.4	2.2	21.7	5.6	23.7	8.1	19.9	2.0
24.	17.4	2.1	17.1	5.0	19.4	6.5	15.1	2.9
25.	30.1	4.9	36.5	6.3	38.3	7.9	34.8	5.1
26.	12.8	4.3	17.1	5.0	16.8	4.8	17.3	5.5
27.	18.4	1.6	19.3	5.0	21.5	7.1	17.6	2.1
28.	19.6	6.3	23.9	7.1	23.2	7.1	23.8	7.6
29.	26.5	3.9	31.0	5.2	32.3	6.7	29.9	4.3
30.	32.6	4.6	37.3	6.7	38.7	8.8	35.8	5.2
31.	13.6	4.9	17.5	5.4	16.7	5.3	17.8	6.0
32.	18.8	1.5	19.8	4.6	22.0	6.1	18.0	2.5
33.	17.6	5.3	23.0	5.6	24.2	5.5	21.9	6.1
34.	24.2	4.1	29.6	5.1	31.1	4.9	28.5	5.6
35.	30.0	3.9	35.6	6.5	37.9	7.7	33.8	5.7
36.	11.9	4.7	16.7	4.8	16.9	4.7	16.7	5.4
37.	18.1	2.7	18.9	6.0	21.1	8.5	17.1	3.4
38.	-6.9	4.8	-7.2	5.7	-9.2	5.8	-5.9	6.1
39.	-6.6	4.9	-5.6	6.5	-7.5	4.9	-6.0	4.9
40.	1.9	6.3	0.9	4.1	-1.0	3.9	2.0	4.0
41.	2.2	2.5	1.3	2.8	1.0	2.8	1.9	2.4

Table 17

Four-Way ANOVAR with Repeated Measures on 3 Factors

for Patient (n = 18) and Non-patient (n = 10) Subjects

Source	Sum of Squares	Degrees of Freedom	Mean Squares	F	Prob. F Exceeded
Group	1186.95	1	1186.95	6.60741	0.016
Error	4670.60	26	179.64		
Ear	146.45	1	146.45	7.42229	0.011
Ear x Group	8.75	1	8.75	0.44351	0.511
Error	513.01	26	19.73		
Frequency	2447.52	1	2447.52	61.10101	0.000
Frequency x Group	1.14	1	1.14	0.02835	0.868
Error	1041.48	26	40.06		
Ear x Frequency	0.82	1	0.82	0.06911	0.795
Ear X Freq. x Group	0.03	1	0.03	0.00240	0.961
Error	308.98	26	11.88		
Duration	18367.98	1	18367.98	542.23926	0.000
Duration x Group	10.35	1	10.35	0.30551	0.585
Error	880.73	26	33.87		
Ear X Duration	8.40	1	8.40	1.26906	0.270
Ear x Dura. x Group	0.15	1	0.15	0.02279	0.881
Error	172.11	26	6.62		
Frequency x Duration	134.64	1	134.64	19.59915	0.000
Freq. x Dura. x Group	19.64	1	19.64	2.85956	0.103
Error	178.62	26	6.87		
Ear x Freq. x Dura.	0.79	1	0.79	0.11314	0.739
Ear x Freq. x Dura. x Group	3.93	1	3.93	0.56564	0.459
Error	180.58	26	6.95		

thresholds for the patients vs. the nonpatient subjects were shown in this analysis.

To assess whether this significant group effect was due to patient-non-patient status, or the different performance of the patient sub-groups, two additional ANOVARS were performed. Table 18 shows a four-way ANOVAR with repeated measures using the ear, frequency, and duration variables and a Project-diagnosed affective, schizophrenic, and non-patient grouping. In this, and in all subsequent ANOVARS, data for the patient (#1) who did not complete testing, and the patient who could not be given a conclusive Project diagnosis (#4) are excluded. Thus, there were 10 nonpatient, 10 schizophrenic, and 7 affective subjects contributing data to this analysis. The results of this ANOVAR are shown in Table 18.

Significant effects were found for ear ($F = 4.77$; $p = .039$), for frequency ($F = 64.41$; $p = .000$), for duration ($F = 630.53$; $p = .000$), and for frequency x duration interactions ($F = 24.02$; $p = .000$). The group effect approached significance, but did not meet the .05 level ($F = 3.09$; $p = .064$).

Table 19 shows a similar four-way Analysis of Variance (using ear, frequency, duration and group) for the psychiatric patient subjects. The groups in this analysis were Project diagnosed schizophrenic ($n = 10$) and affective ($n = 7$) subjects.

Significant effects were found for stimulus frequency ($F = 35.15$; $p = .000$), for stimulus duration ($F = 272.88$; $p = .000$) and for frequency x duration ($F = 18.42$; $p = .001$). No statistically significant main groups effect existed for the Project diagnosed schizophrenics and affectives. However, there was an interaction of

Table 18

Four-Way ANOVAR with Repeated Measures on 3 Factors for Project-Diagnosed Schizophrenic (n = 10), Affective (n = 7) Patients, and Non-patient (n = 10) Subjects

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	Prob. F Exceeded
Group	1173.59	2	586.79	3.09	0.064
Error	4552.09	24	189.67		
Ear	94.67	1	94.67	4.78	0.039
Ear x Group	26.50	2	13.25	0.67	0.522
Error	475.58	24	19.82		
Frequency	2682.14	1	2682.14	64.41	0.000
Frequency x Group	34.93	2	17.47	0.42	0.662
Error	999.46	24	41.64		
Ear x Frequency	3.22	1	3.22	0.26	0.613
Ear x Frequency x Group	9.87	2	4.93	0.40	0.672
Error	293.36	24	12.22		
Duration	19310.22	1	19310.22	630.53	0.000
Duration x Group	137.74	2	68.87	2.25	0.127
Error	735.00	24	30.63		
Ear x Duration	9.32	1	9.32	1.30	0.265
Ear x Duration x Group	0.14	2	0.07	0.01	0.990
Error	172.11	24	7.17		
Frequency X Duration	176.92	1	176.92	24.02	0.000
Freq. x Dura. x Group	21.32	2	10.66	1.45	0.255
Error	176.76	24	7.37		
Ear x Freq. x Dura.	0.45	1	0.45	0.06	0.801
Ear x Frequency x Dura. x Group	9.60	2	4.80	0.69	0.511
Error	166.98	24	6.96		

Table 19

Four-Way ANOVAR with Repeated Measures for Project-diagnosed Schizophrenic (n = 10) and Affective (n = 7) Patients

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	Prob. F. Exceeded
Group	74.82	1	74.82	0.330	0.574
Error	3404.06	15	228.94		
Ear	30.63	1	30.63	1.890	0.189
Ear x Group	13.31	1	13.31	0.821	0.379
Error	243.13	15	16.20		
Frequency	1777.83	1	1777.83	5.146	0.000
Frequency x Group	32.71	1	32.71	0.647	0.434
Error	758.76	15	50.58		
Ear x Frequency	2.89	1	2.89	0.385	0.544
Ear x Freq. x Group	9.84	1	9.84	1.310	0.270
Error	122.66	15	7.51		
Druation	12580.89	1	2580.89	272.883	0.000
Duration x Group	130.82	1	130.82	2.838	0.113
Error	691.56	15	46.10		
Ear x Duration	6.88	1	6.88	0.800	0.385
Ear x Duration x Group	0.00	1	0.00	0.000	0.989
Error	129.06	15	8.60		
Frequancy x Duration	167.29	1	167.29	8.416	0.001
Freq. x Dura. x Group	0.71	1	0.71	0.078	0.784
Error	36.26	15	9.08		
Ear x Freq. x Dura	3.79	1	3.79	0.425	0.524
Ear x Frequency x Dura. x Group	3.79	1	3.79	0.425	0.524
Error	133.68	15	8.91		

duration and group which approached statistical significance. The duration x group interaction (F = 2.84; p = .113) prompted further analyses, using the duration effect variable, to assess temporal integration slope differences in these subjects.

Brief Tone and Noise Thresholds Trested as Click Data

Since Bruder et al. (1975) and Bruder et al. (1980) have reported elevated click thresholds in the right ears of affective patients, the present data for brief stimuli were examined and these findings replicated the prior findings of Bruder et al. for click stimuli.

Table 20 shows the 2 ms thresholds for left and right ear, as well as data for both ears averaged, for 1000 Hz tone, white noise, and averaged tone and noise values for the Project-diagnosed affective and schizophrenic subjects and for the non-patient controls. (Since the Analysis of Variance shown in Table 18, for the schizohrenic, affective, and nonpatient subjects showed no significant frequency x groups interactions,the 2 ms noise and tone data were averaged and included in this analysis.)

For all conditions, and for all subject groups, the left ear thresholds were higher than the right ear thresholds with the single exception of the 1000 Hz brief thresholds for the affective subjects. The affective subject group showed the greatest within-group variability in their thresholds.

For the average 2 ms threshold measure (an average over both ears and both stimulus spectral compositions), the affective group had click thresholds that were significantly higher than those of

Table 20

Comparison of 2 ms Thresholds for Affective, Schizophrenic, and Non-patient Subjects -- Means and Standard Deviations

Threshold Measure (dB SPL)	Affectives n = 8 for tone, n = 7 for noise		Schizophrenics n = 10		Non-patients n = 10	
	Mean	(SD)	Mean	(SD)	Mean	(SD)
Left Ear						
1000 Hz	34.7	(8.9)	34.0	(7.3)	29.7	(6.0)
Noise	42.6	(9.8)	37.7	(4.7)	35.2	(3.7)
Average	38.7	(8.8)	35.8	(5.2)	32.5	(4.6)
Right Ear						
1000 Hz	36.4	(9.1)	31.7	(5.9)	27.0	(5.4)
Noise	40.3	(7.3)	35.9	(6.9)	33.0	(4.1)
Average	37.9	(7.7)[a]	33.8	(5.7)	30.0	(3.9)[a]
Both Ears Averaged						
1000 Hz	35.3	(8.6)	32.8	(6.2)	28.3	(5.0)
Noise	41.4	(8.2)	36.8	(5.4)	34.1	(3.7)
Average 2 ms Threshold	38.3	(7.9)[b]	34.8	(5.1)	30.1	(4.9)[b]

Notes.

[a] $t = 2.50$; $p < .05$ difference between affectivs and non-patient groups.

[b] $t = 2.44$; $p < .05$ difference between affective and non-patient groups.

the non-patient group. The affectives' 2 ms thresholds, which were the highest, were found to differ from the non-patient values at the $p < .05$ level, for the average of both ears ($t = 2.44$) and for the right ear data ($t = 2.50$). This significantly poorer performance for affectives (vs. controls) in the right but not in the left ear is in accord with previously published click threshold data (Bruder et al., 1980). The average 2 ms threshold values for the affective, schizophrenic and non-patient groups were 38.3 dB SPL (SD = 7.9), 34.8 dB SPL (SD = 5.1), and 30.1 dB SPL (SD = 4.9), respectively.

When right vs. left ear 2 ms (click) thresholds are compared, the average left ear affective thresholds were found to be only .8 dB higher than the right ear values. Both the schizophrenic and non-patient subjects showed a greater right ear advantage than did the affectives. The schizophrenics' right ear advantage was 2 dB and the nonpatients' was 2.5 dB. None of these ear differences were statistically significant.

500 ms Tone and Noise Thresholds as a Measure of Threshold Level

Stimuli of 500 ms duration are commonly used in the generation of clinical audiograms, and can be used as a classical baseline measure of threshold level. Table 21 shows thresholds for left and right ear data, and both ears averaged for 1000 Hz tone, white noise, and average tone and noise data for the Project-diagnosed affective and schizophrenic subjects, and for the non-patient control subjects. Tone and noise data were averaged and included in this analysis, as the Analysis of Variance (shown in Table 18) for schizophrenic, affective and non-patient subjects showed no significant frequency x group interactions.

Table 21

Comparison of 500 ms Thresholds for Affective, Schizophrenic, and Non-patient Subjects -- Means and Standard Deviations

Threshold Measure (dB SPL)	Affectives n = 8 for tone, n = 7 for noise	Schizophrenics n = 10	Non-patients n = 10
	Mean (SD)	Mean (SD)	Mean (SD)
Left Ear			
1000 Hz	11.7 (6.4)	13.6 (8.4)	9.5 (6.9)
Noise	22.0 (4.2)	22.1 (4.6)	17.8 (4.3)
Average	16.7 (5.3)	17.8 (6.0)	13.6 (4.9)
Right Ear			
1000 Hz	12.0 (5.7)	12.2 (6.9)	8.3 (5.7)
Noise	22.0 (4.5)	21.2 (4.9)	15.5 (5.0)
Average	16.9 (4.7)	16.7 (5.4)	11.9 (4.7)
Both Ears Averaged			
1000 Hz	11.6 (5.6)	12.9 (7.2)	8.9 (5.1)
Noise	22.0 (4.8)	21.6 (4.5)	16.7 (4.2)
Average 500 ms Threshold	16.8 (4.8)[a]	7.3 (5.5)[b]	12.8 (4.3)

Notes.

[a] $t = 1.76$; $p > .05$ No significant difference between Affectives and Non-patients.

[b] $t = 2.03$; $p > .05$ No significant difference between Schizophrenics and Non-patients.

The comparisons for the average 500 ms threshold values between non-patient and affective ($t = 1.76$) and schizophrenic ($t = 2.03$) groups approached statistical significance ($p < .10$). Thresholds in both patient groups tended to be higher than those in the non-patient group.

It is of interest to note that the affective patients' data for the 500 ms stimuli did not show the greater variability seen in their 2 ms threshold performance. For the 500 ms condition, the schizophrenic subjects had, on the whole, both the highest thresholds and the greatest variability. The average 500 ms threshold for the schizophrenic subjects was 4.5 dB higher than the non-patient level, while affectives were 4 dB higher than non-patients for this condition.

A comparison of right vs. left ear 500 ms thresholds shows that the average right ear thresholds were .2 dB higher for the affectives. The schizophrenic group averaged a 1.1 dB higher left ear threshold, and the non-patients' left ear thresholds were 1.7 dB higher than their right ear thresholds. None of these ear differences are statistically significant.

Thresholds to Brief and Long Stimuli as a Measure of Temporal Integration: Duration Effect

Group differences in brief threshold level may be interpreted either as simply reflecting differences in overall threshold level, or as evidence of processing differences in the temporal integration of stimuli.

To assess the extent to which the subjects' brief stimulus differences were related to their long stimulus thresholds, the duration effect measure (the difference between 2 ms and 500 ms

thresholds) was employed.

When the subjects' click thresholds are assessed via-a-vis their long tone (500 ms) sensitivity to any particular stimulus condition by use of the duration effect, the results shown in Table 22 are obtained. Data for both ears, and for the white noise and 1000 Hz tone conditions, and a tone-noise average are presented here.

It can be seen from Table 22 that the affective subjects have slightly higher duration effects (indicative of steeper-sloped temporal integration functions) than do the schizophrenic or non-patient subjects. However, the affectives were also much more variable in their duration effects.

In order to assess whether any statistically significant differences existed in the duration effects in these groups, a three-way Analysis of Variance was performed on the duration effect data, using groups, ear, and frequency as the main effects. This analysis is shown in Table 23. Only the effect of frequency was found to be statistically significant ($F = 20.10$; $p = .00$).

The left and right ear thresholds for the Project-diagnosed schizophrenic, affective, and non-patient subjects have been plotted, and the slopes of their temporal integration functions were calculated. Figure 10 shows the 1000 Hz data for right and left ears for these three subject groups. The affectives showed the steepest-sloped temporal integration functions, with slopes of -11.71 in the left ear, and -9.95 in the right ear. The schizophrenic subjects had left ear slopes of -8.51 and right ear slopes of -8.13. The functions for these groups cross; the affectives appeared to have

Table 22

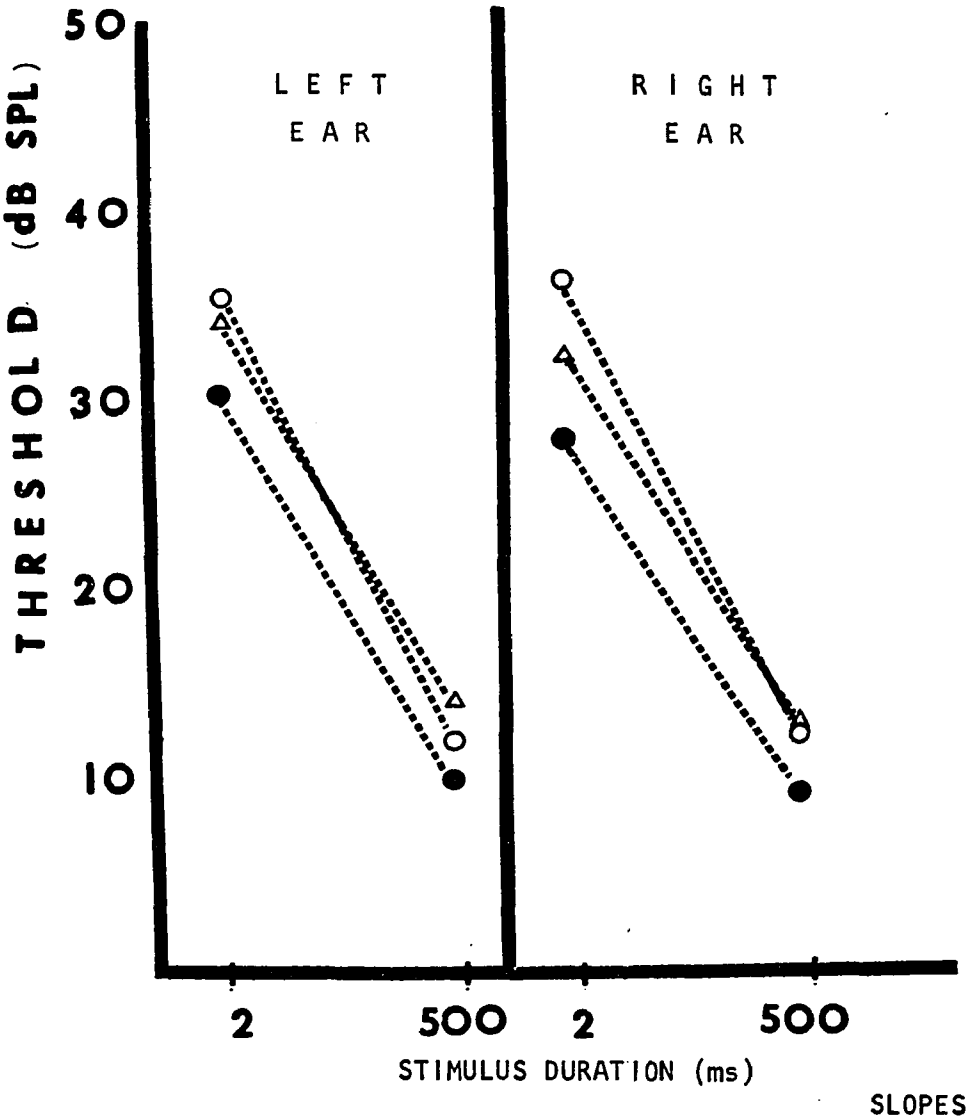
Comparison of Differences in 2 and 500 ms Thresholds by Use of the Duration Effect Measure

Threshold Difference Between 2 and 500 ms Conditions (dB) ; Duration Effect	Affectives	Schizophrenics	Non-patients
	n = 8 for tone n = 7 for noise	n = 10	n = 10
	Mean (SD)	Mean (SD)	Mean (SD)
Left Ear			
1000 Hz	23.0 (6.2)	20.4 (3.9)	20.2 (3.2)
Noise	20.6 (7.1)	15.6 (3.7)	17.4 (2.1)
Average	22.0 (6.1)	18.0 (2.5)	18.8 (1.5)
Right Ear			
1000 Hz	24.4 (10.5)	19.5(3.8)	18.7 (2.7)
Noise	18.3 (7.2)	14.7 (4.3)	17.5 (3.7)
Average	21.1 (8.5)	17.1 (3.4)	18.1 (2.7)
Both Ears Averaged			
1000 Hz	23.7 (8.1)	19.9 (2.0)	19.4 (2.4)
Noise	19.4 (6.5)	15.1 (2.9)	17.4 (2.1)
Average Duration Effect	21.5 (7.1)	17.5 (2.1)	18.4 (1.6)

Table 23

A Three-Way ANOVAR for Duration Effect Data for Project-diagnosed Affective, Schizophrenic, and Non-patient Subjects

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	Probability F Exceeded
Group	141.76	2	70.88	0.99	0.385
Error	1788.27	25	71.53		
Ear	11.25	1	11.25	0.77	0.389
Ear x Group	1.56	2	0.78	0.05	0.948
Error	365.47	25	14.62		
Frequency	559.73	1	559.73	20.10	0.000
Frequency x Group	100.96	2	50.48	1.81	0.180
Error	696.07	25	27.84		
Ear x Frequency	2.42	1	2.42	0.18	0.680
Ear x Freq. x Group	28.10	2	14.05	1.03	0.370
Error	340.07	25	13.60		



Note.

	SLOPES	
	Left Ear	Right Ear
△ = Schizophrenics (n = 10)	-8.51	-8.13
○ = Affectives (n = 7)	-11.71	-9.95
● = Non-patients (n - 10)	-8.42	-7.80

Figure 10. Right and left ear brief and long thresholds and slopes for 1000 Hz data in Project-diagnosed schizophrenic, affective and non-patient subjects.

higher brief tone thresholds than the schizophrenics, while the schizophrenics appeared to have higher long tone thresholds than the affectives. The non-patient function shows the lowest thresholds at all points, and does not overlap those of the other groups. Left ear non-patient slope was -8.42, and right ear slope was -7.80.

The white noise data for these groups, shown in Figure 11 again show the affectives to have the steepest-sloped functions; their left ear slope was -8.58 and right ear slope was -7.63. The schizophrenic subjects showed both lower thresholds and shallower slopes (left ear = -6.51; right ear = -6.13). The non-patient subjects had the lowest thresholds, with left ear slopes of -7.26 and right ear slopes of -7.30. None of the groups' functions cross for the noise condition, but the affectives and schizophrenics had the same 500 ms average threshold for the left ear data.

Figure 12 presents the schizophrenic, affective, and non-patient threshold data for the noise and tone conditions averaged. A summary of the probability values for the effects from Table 17 is also included, and the significant effects are marked with an asterisk. The affective patients had an average tone and noise left ear slope of -10.15, and a right ear slope of -8.79. The schizophrenic group had a left ear slope of -7.51 and a right ear slope of -7.13. Schizophrenic and affective functions crossed for the left ear measure, and had the same 500 ms level for the right ear. The affectives had the highest 2 ms thresholds, overall. The non-patients had a much lower level function, with a left ear slope of -7.84 and a right ear slope of -7.55.

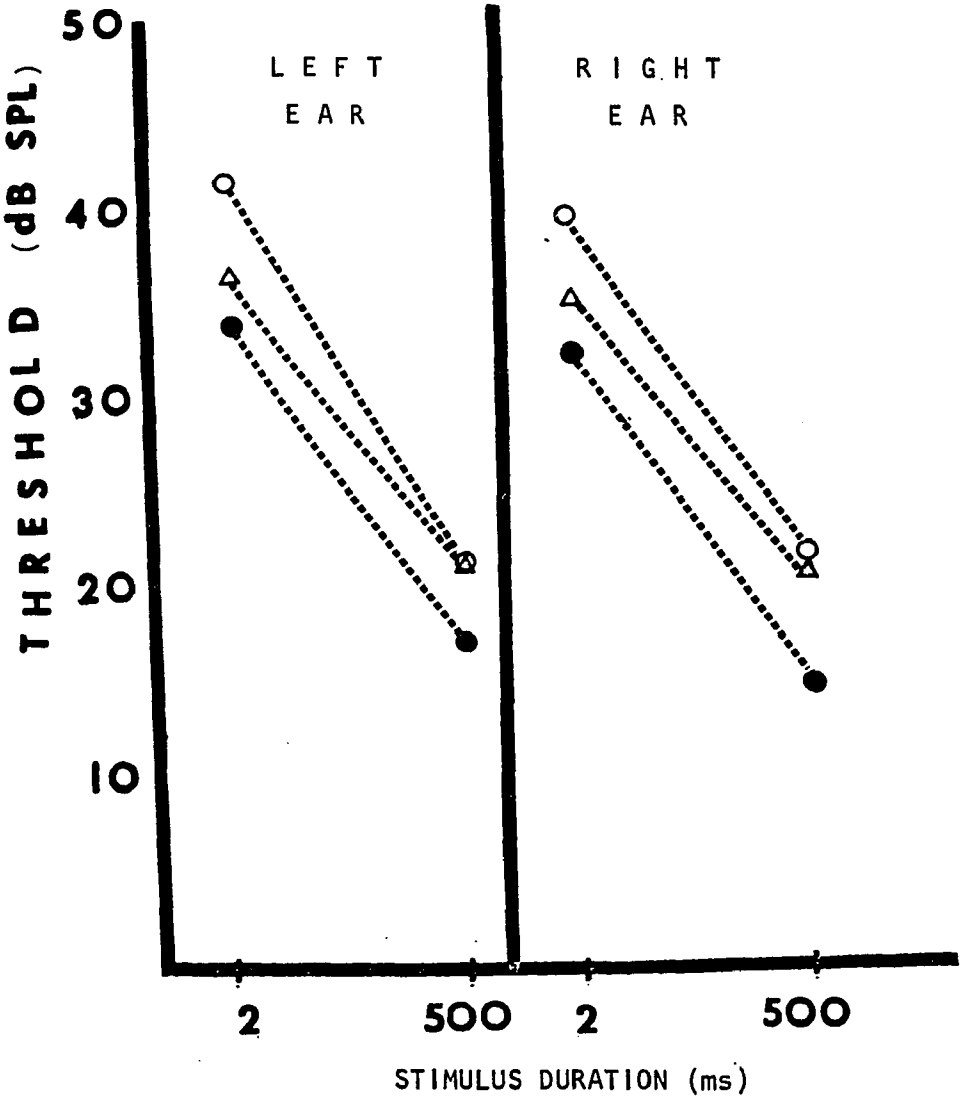
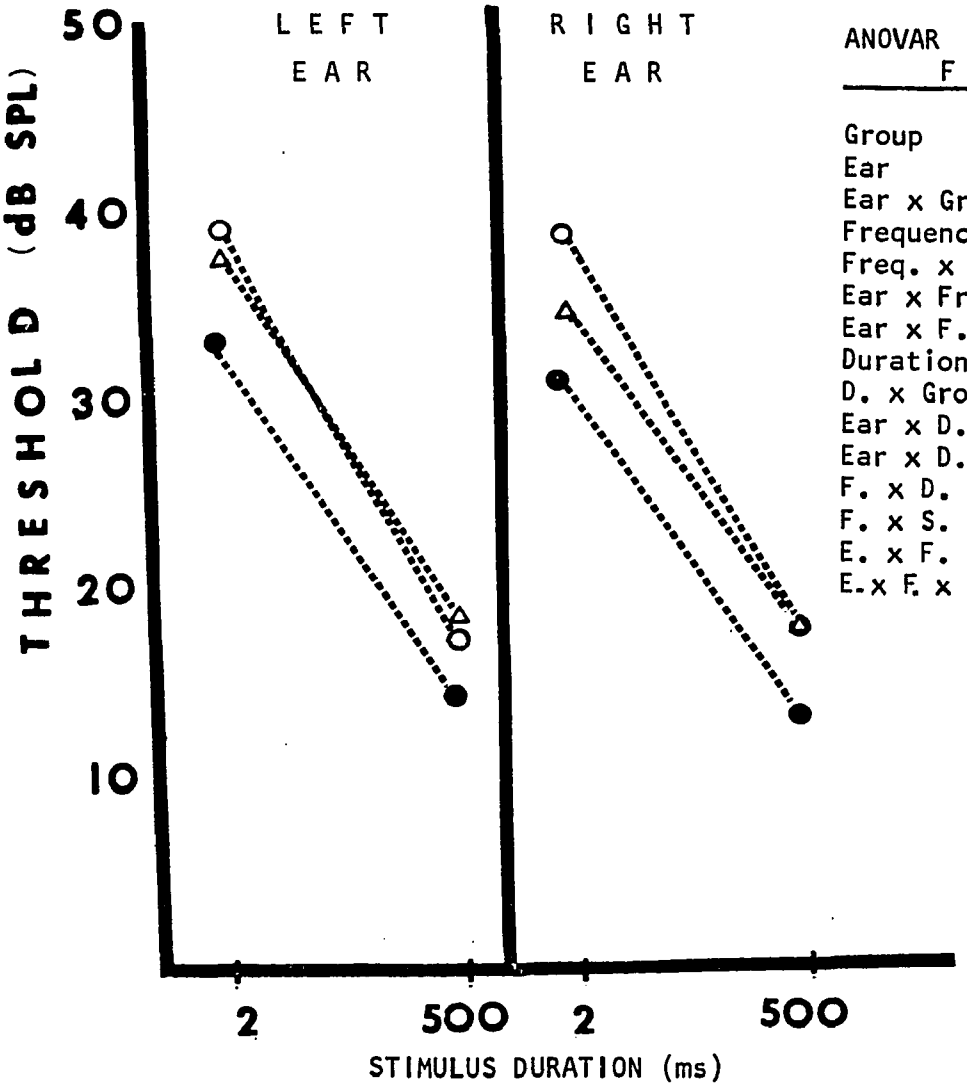


Figure 11. Right and left ear brief and long thresholds and slopes for white noise data in Project-diagnosed schizophrenic, affective and non-patient subjects.

Note.

		SLOPES	
		Left Ear	Right Ear
○	= Affectives (n = 7)	-8.58	-7.63
●	= Non-patients (n = 10)	-7.26	-7.30
△	= Schizophrenics (n = 10)	-6.51	-6.13



ANOVAR Probability F Exceeded:	
Group	.064
Ear	.039
Ear x Group	.522
Frequency	.000
Freq. x Group	.662
Ear x Freq.	.613
Ear x F. x G.	.672
Duration	.000
D. x Group	.127
Ear x D.	.265
Ear x D. x G.	.990
F. x D.	.000
F. x S. x G.	.225
E. x F. x G.	.801
E. x F. x D. x G.	.511

Figure 12. Right and left ear brief and long thresholds and slopes for average tone and noise data in schizophrenics, affectives and non-patients.

Notes.
△ = Schizophrenics (n = 10) left ear slope = -7.51, right ear slope = -7.13
○ = Affectives (n = 7) left ear slope = -10.15, right ear slope = -8.79
● = Non-patients (n = 10) left ear slope = -7.84, right ear slope = -7.55

Figure 13 presents the data from the three prior figures in terms of the duration effect measure. As the F value significance levels from Table 23, which are included in this figure indicate, the only effect not obscured by within-group variability is the frequency effect.

The reversal of ear effects shown by the affective subjects in the tone and noise conditions here can be seen to average out when tone and noise data are combined.

All groups appear to show a slightly greater left ear duration effect, and schizophrenics appear to show the smallest duration effects (below the non-patient level), and the affectives appear to show the greatest duration effects, but these differences were not statistically significant.

Relationships Between Hallucinations and Auditory Measures

Since Bazhin, Wasserman and Tonkonogii (1975) and Babkoff et al. (Note 1) had found steeper-sloped auditory temporal integration functions in patients with auditory hallucinations, the present data were closely examined with regard to this factor.

Table 24 gives a four-way Analysis of Variance with subjects grouped as hallucinating vs. non-hallucinating patients, or non-patients. All patients who displayed visual hallucinations also had auditory hallucinations. Parametric standardized item alpha, a measure of reliability for the Auditory Hallucinations factor was .86, indicating that there was good inter-rater reliability on this factor. (See Tables 12 and 14.)

The Analysis of Variance showed significant main effects for

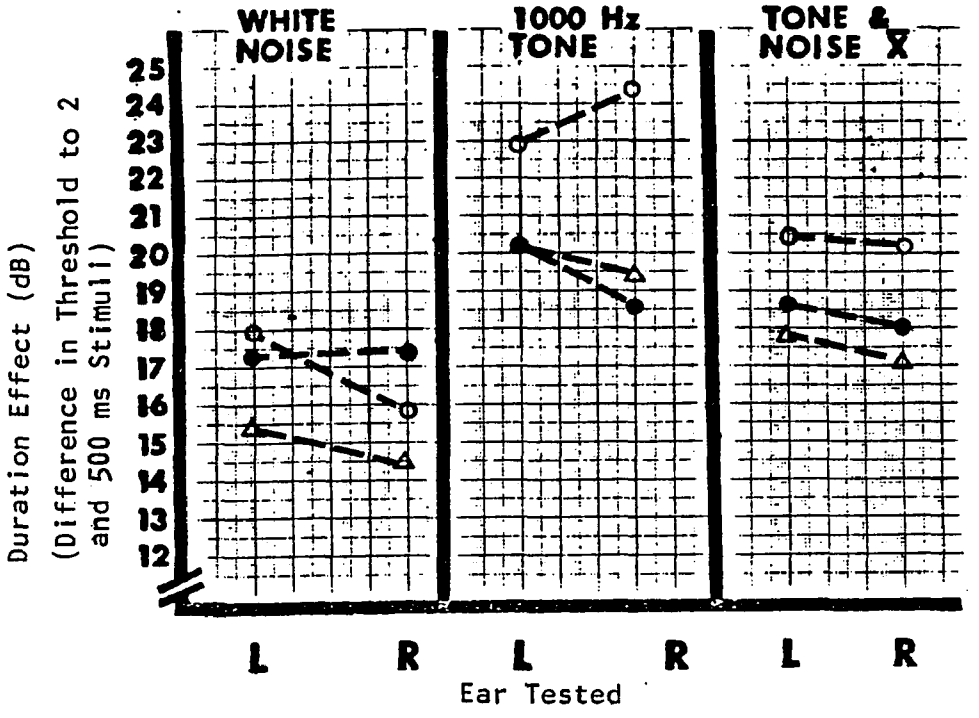


Figure 13. Ear differences in duration effect for the white noise and 1000 Hz tone conditions, and average tone and noise values.

Notes.

△ = Schizophrenics (n = 10)

○ = Affectives (n = 8)

● = Non-patients (n = 10)

Analysis of Variance : Probability F exceeded:

Group	= .385
Ear	= .389
Ear x Group	= .948
Frequency	= .000
Frequency x Group	= .184
Ear x Frequency	= .677
Ear x Frequency x Group	= .371

Table 24

A Four-way ANOVAR for Hallucinating and Non-hallucinating Patients, and Non-Patient Subjects

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	Probability F Exceeded
Group	1277.57	2	638.78	3.486	0.046
Error	4579.97	25	183.20		
Ear	75.54	1	75.54	3.895	0.060
Ear x Group	36.87	2	18.43	0.950	0.400
Error	484.89	25			
Frequency	2319.47	1	2319.47	55.685	0.000
Frequency x Group	1.28	2	0.64	0.015	0.985
Error	1041.33	25	41.65		
Ear x Frequency	3.02	1	3.02	0.249	0.622
Ear x Freq. x Group	5.83	2	2.91	0.240	0.788
Error	303.18	25	12.13		
Duration	16975.20	1	16975.20	488.746	0.000
Duration x Group	22.77	2	11.39	0.328	0.724
Error	868.30	25	34.73		
Ear x Duration	0.32	1	0.32	0.060	0.809
Ear x Dura. x Group	38.23	2	19.11	3.565	0.043
Error	134.03	25	5.36		
Frequency x Duration	164.80	1	164.80	23.115	0.000
Freq. x Dura. x Group	20.02	2	10.01	1.404	0.264
Error	178.25	25	7.13		
Ear x Freq. x Duration	0.02	1	0.02	0.002	0.961
Ear x Freq. x Duration x Group	4.77	2	2.39	0.332	0.721
Error	179.74	25	7.19		

group (F = 3.49; p = .046), frequency (F = 55.68; p = 0.00), and duration (F = 488.75; p = 0.00). The ear effect approached significance (F = 3.89; p = .060). There was a significant interaction between ear, duration, and group (F = 3.57; p = .043). A Newman-Keuls test showed that this interaction was the result of a significant ($p < .05$) difference between hallucinating and non-patient subjects at 2 ms, but not at 500 ms in both the left and right ears. This suggests that the difference between the hallucinating and non-patient groups was not merely one of overall threshold level, but instead a specific deficit in brief stimulus processing was shown by the hallucinating group. This implies a deficit in short-time-constant auditory processing in these patients.

Figure 14 shows the right and left ear functions for the hallucinating and non-hallucinating patients and the non-patients, using averaged tone and noise data. The significance levels for the different effects from an Analysis of Variance of the tone and noise data for these subjects is also presented here. The complete ANOVAR is shown in Table 25. It can be seen from Figure 14 that the hallucinating patients display the highest thresholds, followed by the non-hallucinating patients; and the non-patients have the lowest thresholds. However, the difference between the hallucinating and non-hallucinating patients is clearly not significant.

Figure 15 presents a comparison of right and left ears on the duration effect measure for noise, tone, and tone and noise average, along with the significance levels from a three-way Analysis of Variance which employed duration effects for these subjects. This ANOVAR is shown in detail in Table 25.

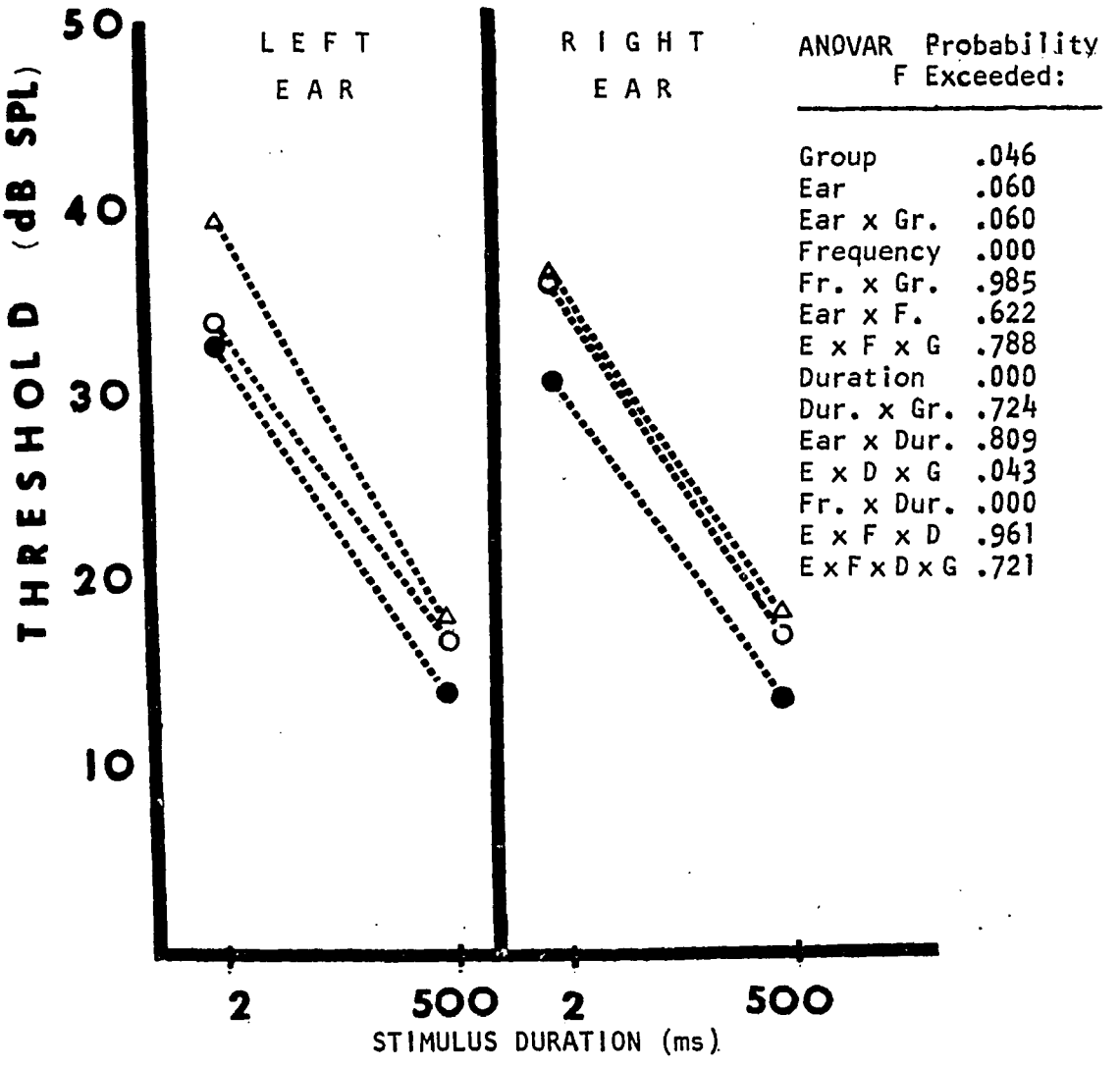


Figure 14. Right and left ear brief and long thresholds and slopes for averaged tone and noise data in hallucinating and non-hallucinating patients and non-patient subjects.

Notes.		SLOPES Left Ear	Right Ear
△	= Hallucinating Patients (n = 13)	-8.68	-7.76
O	= Non-hallucinating Patients (n = 5)	-7.18	-8.18
●	= Non-patient Subjects (n = 10)	-7.84	-7.55

Table 25

A Three-way ANOVAR using the Duration Effect Measure for Hallucinating Patients, Non-hallucinating Patients, and Non-patients

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	Probability F Exceeded
Group	99.70	2	49.85	0.690	0.510
Error	1873.16	26	72.04		
Ear	0.15	1	0.15	0.014	0.906
Ear x Group	96.93	2	48.47	4.664	0.019
Error	270.20	26	10.39		
Frequency	599.00	1	599.00	23.466	0.000
Frequency x Group	135.07	2	67.53	2.646	0.090
Error	663.69	26	25.53		
Ear x Frequency	1.22	1	1.22	0.087	0.771
Ear x Frequency x Group	17.16	2	8.58	0.606	0.553
Error	368.01	26	14.15		

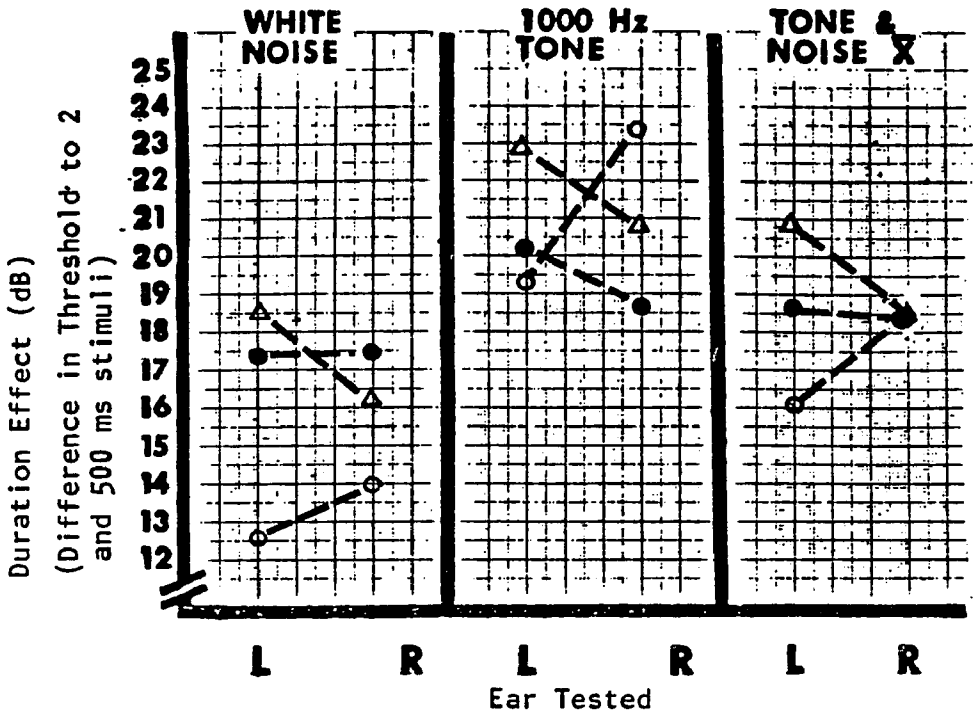


Figure 15. Ear differences in duration effect for noise, tone, and average noise and tone conditions, for subjects grouped for hallucinations.

Notes.

o = Non-hallucinating Patients

● = Non-patients

Δ = Hallucinating patients

Analysis of Variance :	Probability F exceeded:
Group	= .510
Ear	= 906
Ear x Group	= .019
Frequency	= .000
Frequency x Group	= .090
Ear x Frequency	= .771
Ear x Freq. x Group	= .553

A significant ear x group interaction (F = 4.66; p = .019) can be observed along with a frequency x group interaction (F = 2.65; p = .090), which approaches significance. As in the previous ANOVARS, the frequency main effect is highly significant (F = 23.47; p = .000).

A Newman-Keuls test on the ear x group interaction showed the hallucinating patient vs. nonpatient left ear difference to be significant at the 0.05 level. None of the components of the frequency x group interaction were found to be significant.

Hallucinating Schizophrenic, Hallucinating Affective Patients, and Non-patients

Since Babkoff et al. (Note 1) reported finding steeper-sloped temporal integration functions in hallucinating patients with schizophrenic symptomatology, both in their own auditory data and in a re-analysis of Collins' (1972) visual data, the data from the present study were analyzed using groupings of hallucinating schizophrenic vs. hallucinating affective patients, vs. non-patients. The rationale for this analysis also includes Bazhin et al's (1974) findings of steeper-sloped temporal integration functions in schizophrenic patients with "true" auditory hallucinations.

To determine whether there were any unique characteristics of the performance of hallucinating schizophrenic vs. hallucinating affective patients, vs. non-patients, threshold data for these subjects were subjected to a four-way Analysis of Variance.

This analysis incorporates a combination of two diagnostic approaches. The affective/schizophrenic distinction arose from the Project diagnoses, and the hallucinating/non-hallucinating distinction

is derived from the symptom profile scores. In this analysis, "hallucinating" patients were those who had received a positive rating on any of the items contributing to the auditory hallucinations factor, by any of the three raters. Only patients with no evidence of hallucinations were excluded.

The Analysis of Variance is presented in Table 26. A groups effect exists (F = 3.69; p = .043), which is slightly smaller than the groups effect seen in the parallel analysis performed for the hallucinating/non-hallucinating/non-patient grouping (shown in Table 19). The groups effect had not been significant in the other parallel analysis, which incorporated the schizophrenic/affective/non-patient distinction (presented in Table 18).

A significant ear effect (F = 7.36; p = .013) was observed. The ear effect for the schizophrenic/affective/non-patient ANOVAR had been significant; the ear effect for the parallel hallucinating/non-hallucinating/non-patient analysis had not reached significance.

Frequency main effects (F = 69.05; p = .000) and duration main effects (F = 480.66; p = .000) were highly significant, as they were in the other two analyses. The frequency x duration interaction (F = 23.32 p = .000) also remained highly significant. These factors were unaffected by subject grouping.

The earlier duration x group interaction, which had been significant for the Analysis of Variance which employed the hallucinating/non-hallucinating/non-patient grouping, and which had not been significant for the schizophrenic/affective/non-patient grouping, fell below a significant level in this analysis (F = 0.210; p = .812).

Table 26

A Four-way ANOVAR for Thresholds in Hallucinating Schizophrenics, Hallucinating Affectives, and Non-patients

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	Prob. F Exceeded
Group	1239.63	2	619.82	3.69	0.043
Error	3356.20	20	67.81		
Ear	129.71	1	129.71	7.36	0.013
Ear x Group	8.83	2	4.42	0.25	0.781
Error	353.35	20	17.62		
Frequency	2342.81	1	2343.81	69.05	0.000
Frequency x Group	16.02	2	8.01	0.24	0.792
Error	678.53	20	33.93		
Ear x Frequency	1.36	1	1.36	0.10	0.760
Ear x Freq. x Group	2.32	2	1.16	0.08	0.922
Error	282.74	20	14.14		
Duration	16187.23	1	16187.23	480.66	0.000
Duration x Group	149.80	2	74.90	2.22	0.134
Error	673.55	20	33.68		
Ear x Duration	16.99	1	16.99	2.14	0.159
Ear x Dura. x Group	3.34	2	1.67	0.21	0.812
Error	158.65	20	7.93		
Frequency x Duration	141.71	1	141.71	23.32	0.000
Freq. x Dura. x Group	17.86	2	8.93	1.47	0.254
Error	121.54	20	6.08		
Ear x Freq. x Dura.	2.39	1	2.39	0.32	0.577
Ear x Freq. x Dura. x Group	14.02	2	7.01	0.94	-.406
Error	148.84	20	7.44		

Table 27 shows the mean threshold values and the standard deviations for these three subject groups. T-tests showed significant differences between hallucinating affective and non-patient groups at the $p < .001$ level for the right ear 2 ms tone condition ($t = 5.33$), at the $p = .02$ level ($t = 2.62$) for the right ear 500 ms noise condition, and at the $p < .10$ level for the left ear 2 ms noise condition ($t = 1.875$), for the left ear 500 ms noise condition ($t = 2.0$), and for the right ear 2 ms noise condition ($t = 2.10$).

Because of the lack of homogeneity of variance in the thresholds of the hallucinating affectives, parametric post-hoc multiple comparison measures (i.e., Scheffe or Newman-Keuls) were deemed inappropriate here. Therefore, in evaluating the significance of these t values, we should remember that eight tests were performed, and the probability of obtaining spurious significance at the .05 level is .4.

Figure 16 gives the 1000 Hz thresholds for these subjects, along with the slopes of their temporal integration functions for both ears. Hallucinating affectives had the steepest slopes; -10.43 for both ears. The hallucinating schizophrenics had left and right ear slopes of -8.39 and -8.03, respectively. The non-patients had left and right ear slopes of -8.42 and -7.80.

A parallel plot for the tone data is shown in Figure 17. The hallucinating affectives had a much steeper slope in only their left ear data (-9.17). Their right ear slope (-7.42) was higher than the right ear slope for the other groups, but was not strikingly greater. The hallucinating schizophrenics had left and right ear slopes of -6.83 and -6.36, respectively. These values for the

Table 27

Means and Standard Deviations of Threshold Values for Hallucinating Schizophrenics, Hallucinating Affectives, and Non-patient Subjects

Threshold Measure (dB)	Hallucinating Affectives	Hallucinating Schizophrenics	Non-Patients
	Mean (SD)	Mean (SD)	Mean (SD)
Left Ear			
1000 Hz 2 ms	37.50 (9.28)	33.07 (5.88)	29.70 (6.00)
1000 Hz 500 ms	12.50 (6.87)	12.95 (5.99)	9.50 (6.91)
Noise 2 ms	44.80 (11.14)	38.35 (4.71)	35.20 (3.75)
Noise 500 ms	22.80 (4.71)	21.97 (4.14)	17.80 (4.26)
Right Ear			
1000 Hz 2 ms	36.00 (10.42)	31.37 (4.60)	27.00 (5.35)
1000 Hz 500 ms	11.00 (6.52)	12.12 (5.91)	8.30 (5.66)
Noise 2 ms	40.20 (8.84)	36.75 (7.42)	33.00 (4.08)
Noise 500 ms	22.40 (4.72)	21.50 (4.44)	15.50 (4.97)

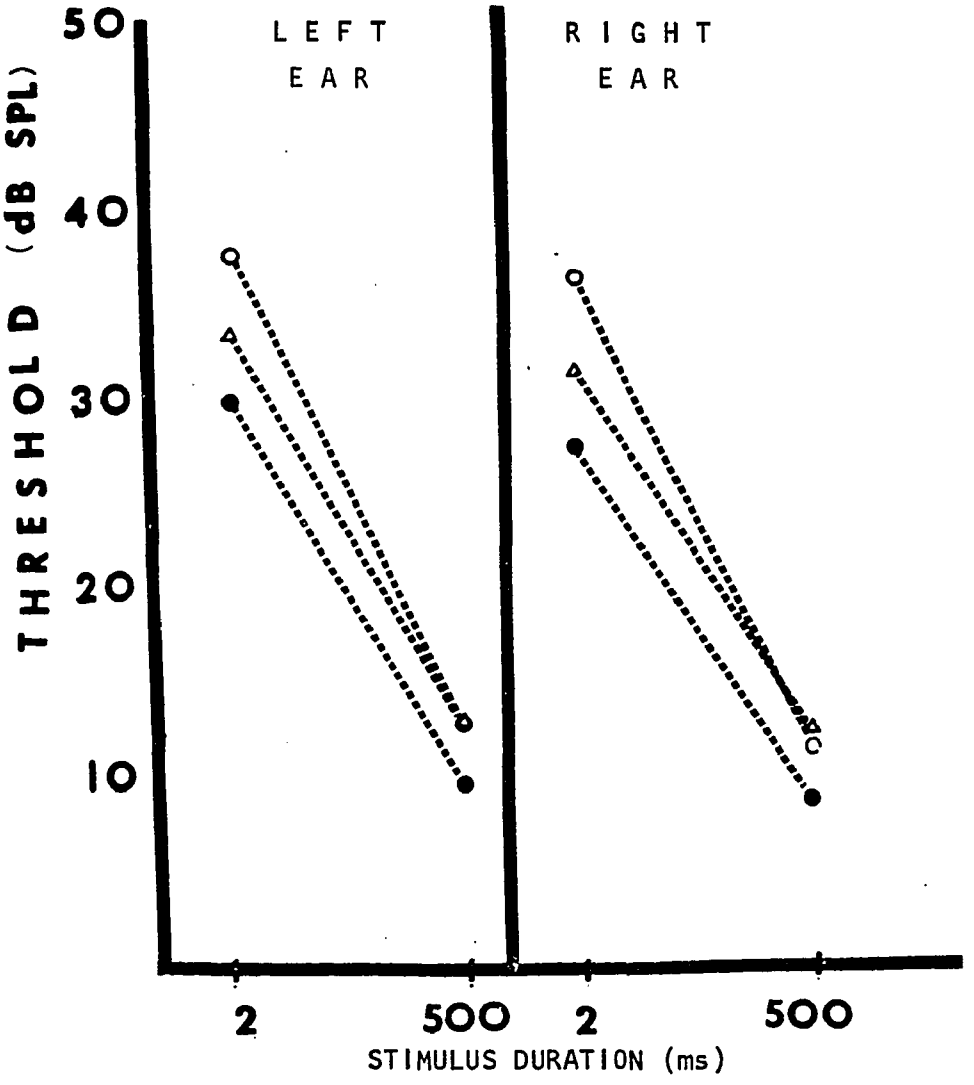


Figure 16. Right and left ear brief and long thresholds and slopes for 1000 Hz data in hallucinating schizophrenic, hallucinating affective, and non-patient subjects.

Note.

		SLOPES	
		Left Ear	Right Ear
▲	= Hallucinating Schizophrenics (n = 8)	-8.39	-8.03
o	= Hallucinating Affectives (n = 5)	-10.43	-10.43
●	= Non-patient Subjects (n = 10)	-8.42	-7.80

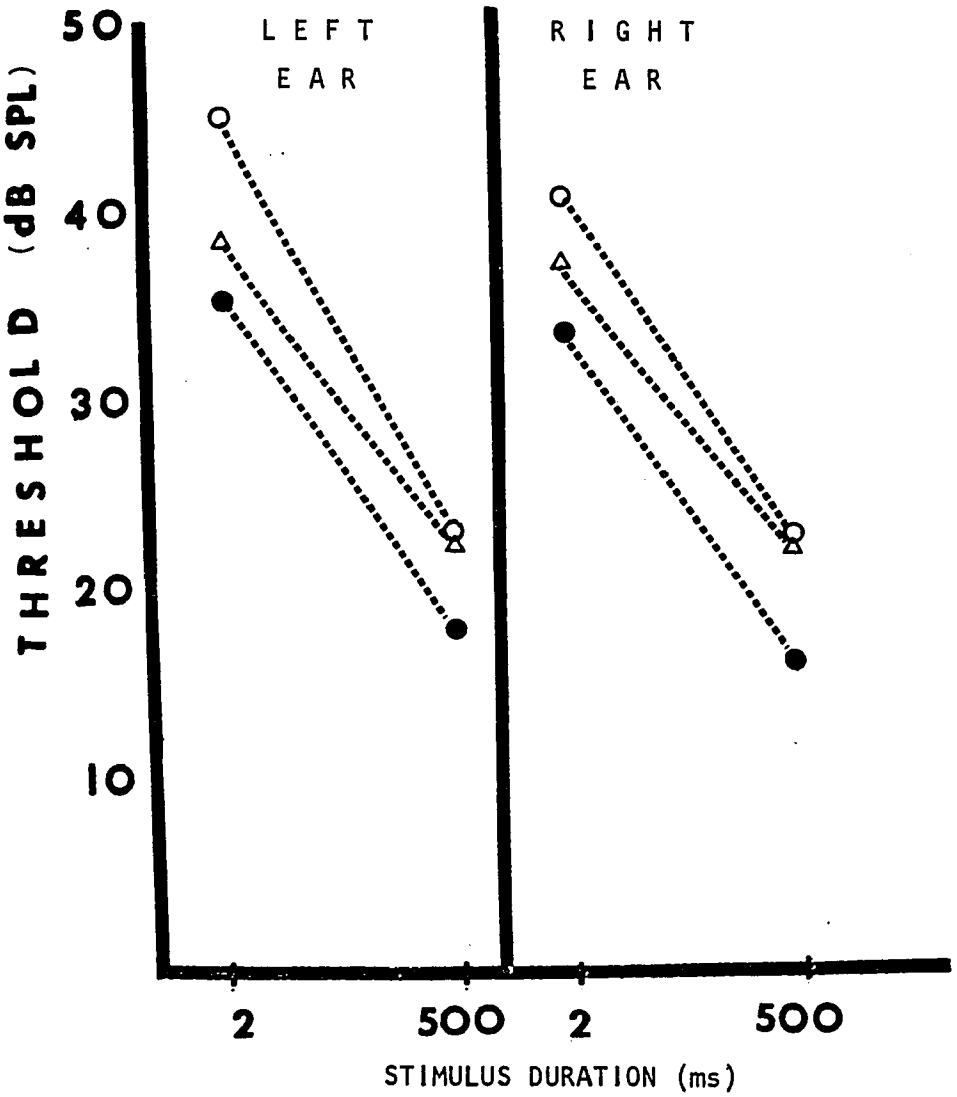


Figure 17. Right and left ear brief and long thresholds and slopes for white noise data in hallucinating schizophrenic, hallucinating affective, and non-patient subjects.

Note.		SLOPES Left Ear	Right Ear
△	= Hallucinating Schizophrenics (n = 8)	-6.83	-6.36
○	= Hallucinating Affectives (n = 5)	-9.17	-7.42
●	= Non-patient Subjects (n = 10)	-7.26	-7.30

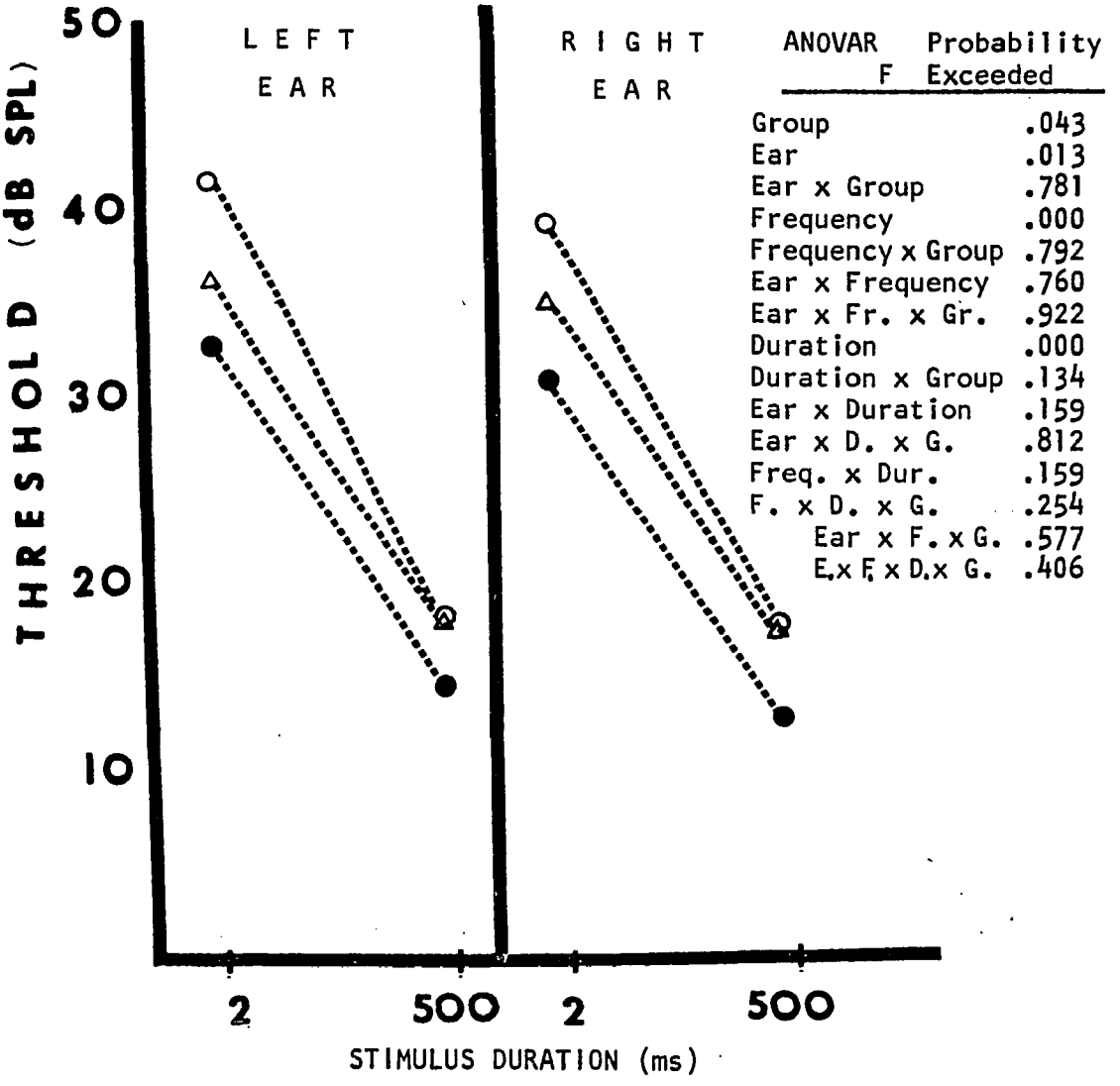
non-patients were -7.26 and -7.30.

As in the prior analyses, tone and noise data are averaged and presented in Figure 18. Steeper slopes are seen for the hallucinating affectives (left ear = -9.80; right ear = -8.93). Left and right ear slopes for the hallucinating schizophrenics were -7.61 and -7.20, respectively; the non-patient slopes were -7.84 and -7.55. Figure 18 also presents the F probability values for the different effects from the ANOVAR seen in Table 26.

Figure 19 presents the duration effects for both ears for these groups for the noise, tone, and averaged tone and noise conditions, along with the probability values from a three-way Analysis of Variance of duration effects for these subjects. This ANOVAR is shown in detail in Table 28. In this analysis, only the frequency effect was significant.

Comparison of Hallucinating and Non-hallucinating Schizophrenic and Affective Patients, and Non-patients

By using a higher cutoff score on the Auditory Hallucinations factor (a standard score of 51 or over for the affectives, and 60 or more for the schizophrenics), it was possible to divide these patient groups into subgroups that were high or low on the Auditory Hallucinations factor. (Use of the presence/absence of hallucinations dichotomy had produced too small a group of non-hallucinators for such an analysis, since there were only two schizophrenic patients and two affective patients who had no hallucinations.) By using a higher cutoff, five hallucinating schizophrenics, five non-hallucinating schizophrenics, four hallucinating affectives, three non-hallucinating affectives, and ten non-patients could be compared.



ANOVAR	Probability F Exceeded
Group	.043
Ear	.013
Ear x Group	.781
Frequency	.000
Frequency x Group	.792
Ear x Frequency	.760
Ear x Fr. x Gr.	.922
Duration	.000
Duration x Group	.134
Ear x Duration	.159
Ear x D. x G.	.812
Freq. x Dur.	.159
F. x D. x G.	.254
Ear x F. x G.	.577
E.x F. x D.x G.	.406

Figure 18. Right and left ear brief and long thresholds and slopes for average noise and tone data in hallucinating schizophrenic, hallucinating affective, and non-patient subjects.

Note.		Slopes	
		Left Ear	Right Ear
△	= Hallucinating Schizophrenics (n = 8)	-7.61	-7.20
○	= Hallucinating Affectives (n = 5)	-9.80	-8.93
●	= Non-patient Subjects (n = 10)	7.84	-7.55

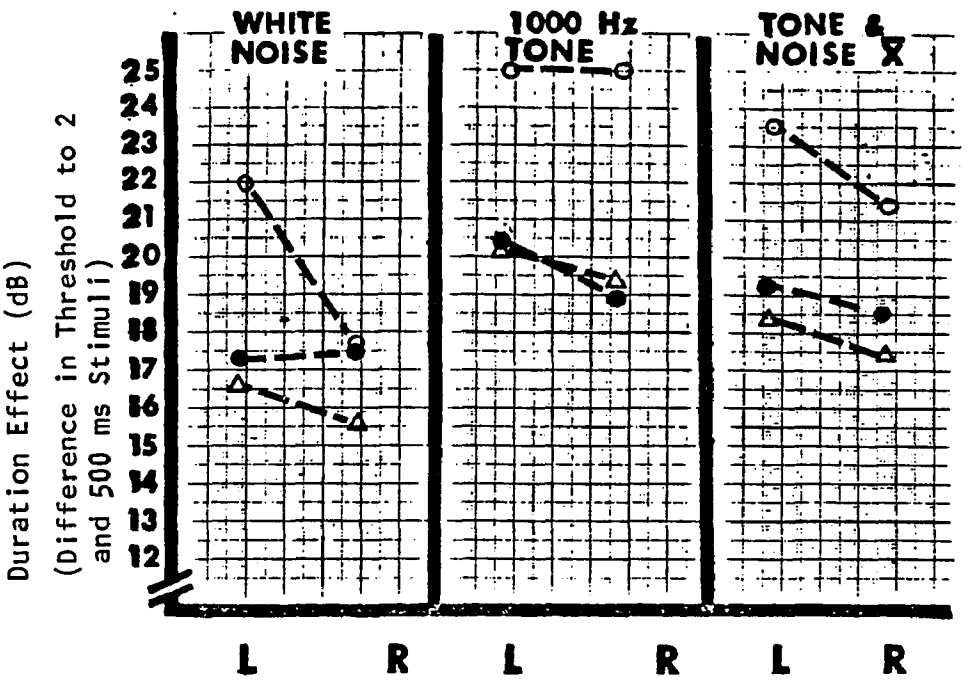


Figure 19. Ear differences in duration effect for hallucinating schizophrenics, hallucinating affectives, and non-patients.

Notes.

△ = Hallucinating Schizophrenics

○ = Hallucinating Affectives

● = Non-patients

Analysis of Variance : Probability F exceeded:

Group	= .134
Ear	= .159
Ear x Group	= .812
Frequency	= .000
Frequency x Group	= .254
Ear x Freq. x Group	= .406

Table 28

A Three-way ANOVAR of Duration Effects for Hallucinating Schizophrenic and Affective Patients and Non-patient Subjects

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	Probability Exceeded
Group	299.61	2	149.80	2.22	0.134
Error	1347.10	20	67.36		
Ear	33.98	1	33.98	2.14	0.159
Ear x Group	6.68	2	3.34	0.21	0.812
Error	317.30	20	15.86		
Frequency	283.41	1	283.41	23.32	0.000
Frequency x Group	35.73	2	17.86	1.47	0.254
Error	243.07	20	12.15		
Ear x Frequency	4.78	1	4.78	0.32	0.577
Ear x Frequency x Group	28.04	2	14.02	0.94	0.406
Error	297.67	20	14.88		

A three-way Analysis of Variance (shown in Table 29) of duration effect data for this grouping produced only a significant main effect for frequency ($F = 24.75$; $p = .000$).

Correlations Between Click Thresholds and Speech Retardation

Bruder et al. (1975) and Bruder and Yozawitz (1976) reported a significant correlation of +.56 ($p < .01$) between psychiatric patients' right ear click thresholds and the symptom factor of Speech Retardation. In Bruder et al.'s later (1980) study, click threshold correlations with Speech Retardation for the psychiatric patients were found to be significant for the right ear data ($r = .41$; $p < .01$), but not for the left ear ($r = .27$; $p > .05$). For the affective subjects, the right ear correlation with Speech Retardation was found to be statistically significant ($r = .67$; $p < .01$), but the correlation was not significant for the schizophrenic subjects ($r = .16$; $p > .05$).

Click Thresholds and Speech Retardation for All Patients

In the present study, correlations between Speech Retardation and average 1000 Hz tone and white noise 2 ms thresholds were in the expected direction, but were not statistically significant for the overall patient group, for either the right or left ear data. The right ear correlation was $r = .24$ ($p > .05$), and the left ear correlation was $r = .43$ ($p > .05$).

However, when the click threshold values were corrected for difference in long tone sensitivity by use of the duration effect measure, speech retardation was found to be significantly correlated with many of these threshold measures. Significant correlations for the patient group were found between Speech Retardation and: overall duration effect ($r = .49$; $p = .041$), overall left ear duration

Table 29

A Three-way ANOVAR for Duration Effect Data in Project-diagnosed Schizophrenic and Affective Patients with High and Low Scores on Auditory Hallucinations and Non-patient Controls

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	Prob. F Exceeded
Group	377.43	4	99.36	1.52	0.232
Error	1368.05	22	62.18		
Ear	12.69	1	12.69	0.96	0.339
Ear x Group	52.54	4	13.14	0.99	0.434
Error	291.95	22	13.27		
Frequency	374.48	1	374.48	24.75	0.000
Frequency x Group	63.31	4	15.83	1.05	0.406
Error	332.85	22	15.13		
Ear x Frequency	2.05	1	2.05	0.14	0.710
Ear x Freq. x Group	34.21	4	8.55	0.59	0.673
Error	318.95	22	14.98		

effect (r = .49; p = .040), and the 1000 Hz duration effect (r = .55; p = .014). Significant correlations were found for Speech Retardation and both the right (r = .48; p = .037) and left (r = .51; p = .025) ear duration effects for this 1000 Hz condition. Correlations with Speech Retardation were also found for the left-right ear difference in threshold for the 1000 Hz condition (r = .51; p = .037), and for the left-right ear difference for the 1000 Hz condition at 500 ms (r = .54; p = .017). Left ear 1000 Hz 2 ms thresholds were also significantly (r = .47; p = .045) correlated with Speech Retardation. Parametric standardized item alpha for the Speech Retardation factor was .885; indicating good inter-rater reliability on this factor.

Click Thresholds and Speech Retardation for Schizophrenic and Affective Subjects

The pattern of correlations changes dramatically when the data for the Project-diagnosed affective and schizophrenic subjects are considered separately. No significant correlations with the Speech Retardation factor were seen for any of the 41 auditory measures in the schizophrenic sample, and a strong pattern of currelations with the duration effect measure was seen for Speech Retardation in the affective sample.

For the affective patients, Speech Retardation was highly correlated with overall duration effect (r = .97; p = .001). (The correlation with overall left ear duration effect was .98; p = .001, and the correlation with overall right ear duration effect was .91; p = .004). Overall duration effect for the 1000 Hz condition was correlated (r = .90; p = .002) with Speech Retardation;

overall noise duration effect was also highly correlated with Speech Retardation (r = .88; p = .009).

All the duration effect measures comprising these summary statistics showed strong relationships to Speech Retardation:

Left ear 1000 Hz tone D.E.; r = .88; p = .004

white noise D.E. ; r = .87; p = .010

Right ear 1000 Hz tone D.E.; r = .87; p = .005

white noise D.E. ; r = .74; p = .059

Overall 2 ms threshold was also correlated with Speech Retardation in the affective subjects (r = .80; p = .029). The importance of this correlation lies in its demonstration that it is the brief thresholds, and not the long stimulus thresholds, that are the basis of the correlation of duration effect with Speech Retardation. Average 2 ms right ear threshold to tone and noise stimuli was also correlated with Speech Retardation (r = .80; p = .030), as was the 2 ms threshold for noise in the right ear (r = .76; p = .046). The left-right ear difference for the 1000 Hz stimuli at 500 ms was also correlated with Speech Retardation (r = .84; p = .009) in the affective group.

The present findings provide a strong replication of Bruder et al.'s findings of as association of Speech Retardation with click threshold in affectives, but not in schizophrenics. The present findings differ from those of Bruder et al. (1980) in that correlations of threshold measures with Speech Retardation are not found to be exclusively a right ear phenomenon.

Other Symptom Factors Highly Correlated with the Duration Effect in the Affective Patients

Two other symptom factors which were not found to be significantly correlated with duration effect in the total patient group were found to be highly correlated with all of the duration effect measures for the affective sub-sample. These factors were Flat Affect and Bizarre Behavior.

In the affective group, Flat Affect was positively correlated with: left ear 1000 Hz duration effect (r = .88; p = .004); right ear 1000 Hz duration effect (r = .94; p = .001); left ear noise duration effect (r = .84; p = .019), and right ear noise duration effect (r = .78; p = .038). An examination ofthe 2 ms and 500 ms data for these factors showed that the elevated duration effects were the result of higher 2 ms thresholds. The correlation between Flat Affect and the average 2 ms threshold (for noise and 1000 Hz tones) was .81 (p = .029). This is suggestive of a deficit in the short time constant processing system in these subjects. The average 1000 Hz duration effect (for the two ears) was also correlated with Flat Affect (r = .95; p = .001), as was the average noise duration effect (r = .89; p = .008). The correlation between overall duration effect (average of all conditions) and flat affect for these affective patients was .97 (p = .001).

Similar results were found for the Bizarre Behavior factor. The correlations with both left and with right ear 1000 Hz duration effect was .91 (p = .002); with left ear noise duration effect, the correlation was .84 (p = .019); with right ear noise duration effect, the correlation was .78 (p = .037). As with Flat Affect,

these correlations were the result of elevated 2 ms thresholds. The correlation of average 2 ms threshold with Bizarre Behavior was .91 (p = .028). With overall duration effect, the correlation was .99; (p = .001), and with average 1000 Hz and average noise duration effects, the correlations were .94 (p = .001) and .89 (p = .008), respectively.

No lateralized differences in correlations of Flat Affect and Bizarre Behavior with duration effect were seen. Correlations with overall right and left ear duration effect for these factors were all positive, and significant at the .001 level.

It is interesting to note that the three symptom factors which were highly correlated with duration effect in the affective sub-sample were all language-related measures; Speech Retardation, Flat Affect, and Bizarre Behavior, and that these measures were all highly correlated with each other in this affective group.

An Overview of Relationships Between Symptom Factors and Auditory Measures

This section provides a summary of correlations found between symptom profiles (using the average of three raters), and the auditory measures obtained in this study.

The rationale for the examination of these relationships included both theoretical speculations about relationships between brain damage, psychopathology, and auditory processing, and also involves a replication of Bruder et al's (1975) findings that Speech Retardation was associated with higher click thresholds, and Babkoff et al's (Note 1) findings that psychiatric symptomatology clusters can be related to characteristics of auditory temporal

integration. Findings in the Soviet literature (Bazhin, Wasserman & Tonkonogii, 1974) that hallucinating schizophrenics have steeper-sloped auditory temporal integration functions than do schizophrenics with "pseudohallucinations" (hearing voices "in the mind", not "through the ears"), can also be directly related and compared to the correlations to be examined here.

To provide a concise and yet comprehensive picture, all the psychiatric patients are grouped together in the analyses reported in this section. Separate analyses of the data for the Project-diagnosed affective and schizophrenic subjects were performed, and are presented in Appendix V, along with the full correlation matrices for all patients as a group.

An Overview of the Relationships between Symptom Factors and Auditory Measures for All Nineteen Psychiatric Patients

Symptoms Associated with Depression

Speech Retardation was significantly correlated with the duration effect (a measure of the slope of the temporal integration function obtained from the difference in the subjects' thresholds to the 2 ms and 500 ms stimuli) for the 1000 Hz condition in both the right and left ear measures. Speech Retardation was also significantly correlated with higher thresholds in the left than in the right ears of the patients for the 1000 Hz stimulus at the long 500 ms duration, and with high left ear thresholds for 1000 Hz stimuli at the brief (2 ms) duration.

Anxiety was positively correlated with the duration effect at 1000 Hz for both ears of the psychiatric patients, and for right ear duration effect for white noise stimuli.

Symptoms Associated With Mania

Hypomania, the inverse of depression, per se, was negatively correlated with left ear noise duration effect and 2 ms threshold, and with left-right threshold difference for noise at 2 ms. It was also negatively correlated with left-right ear difference in threshold for the 1000 Hz stimulus at 500 ms (a threshold measure with positive correlations with Speech Retardation, Lack of Insight, and Flat Affect).

Grandiose Delusions was negatively correlated with left-right ear difference in noise thresholds to the 500 ms stimuli.

Symptoms Associated with Disorganization

Control Delusions was significantly correlated with a right ear 1000 Hz duration effect.

Bizarre Behavior was positively correlated with a left-right ear difference in threshold to the 500 ms noise stimuli.

Visual Hallucinations was positively correlated with left-right ear difference in thresholds to brief noise stimuli as well as to left-right ear difference in duration effect for noise.

Auditory Hallucinations was positively correlated with a left-right ear difference in threshold to brief 1000 Hz stimuli and to left-right ear difference in noise duration effect. Auditory Hallucinations was negatively correlated with left-right ear difference for 500 ms noise stimuli.

Depersonalization/Derealization was negatively correlated with left-right ear difference in duration effect for white noise stimuli.

Non-specific Symptoms

Disorientation was positively correlated with duration effect for noise in both ears, and with threshold to the 2 ms stimulus for left ears in the noise condition and for right ears in the 1000 Hz condition, as well as for duration effect for right ear 1000 Hz stimuli. Disorientation was negatively correlated with left-right ear differences in duration effect for 1000 Hz.

Reported Belligerence was negatively correlated with left-right ear difference for the white noise duration effect.

Medications

Relationships Between Medication and Auditory Measures

Using Pearson correlations and two-tailed tests of significance, no statistically significant relationships ($p = .05$) were found between drug dosage (transformed to chlorpromazine equivalent) and any of the auditory threshold measures. These included all brief and long 1000 Hz and noise thresholds, duration effects, and thresholds averaged over ears, frequencies, and durations. In addition, no significant correlations were obtained between drug dosage and a measure of within-session threshold variability (the number of blocks of testing needed to meet criterion) for the brief staircase procedure.

Medication Level and Diagnosis

Patients judged schizophrenic using the Project diagnoses ($n = 10$) received an average equivalent phenothiazine dosage of 14.36 mg/kg (SD = 11.46) of chlorpromazine. The patients judged to be affective ($n = 8$) received an average of 11.2 mg/kg equivalent dosage of chlorpromazine (SD = 4.46). No significant

difference was found in the drug dosage levels of the two patient groups. The dosage administered to the schizophrenics tended to be more varied within the group.

Since all 19 patients had been given hospital diagnoses of "schizophrenic", no relationship between hospital diagnosis and medication level could be ascertained.

Relationships Between Medication and Symptomatology

Using two-tailed tests of significance of the Pearson correlations, no significant ($p = .05$) relationships were found in the present study between any of the symptom factors and medication levels for all 19 of the psychiatric patients, with the exception of one positive correlation ($r = .50$; $p < .03$) between Lack of Insight and medication level. Presumably, patients evidencing less insight might have been prescribed increased medications. An alternative hypothesis is that of iatrogenic effects (i.e., that phenothiazine medication tended to confuse patients, reducing their insight).

Interactions of Diagnostic Group, Medications, and Auditory Measures

An examination of correlations of drug dosage with symptomatology and auditory threshold measures was conducted separately for the patients given project diagnoses of schizophrenia vs. affective disorder.

For the 10 patients diagnosed as schizophrenic, none of the threshold or variability measures were significantly correlated with drug dosage. Of the symptom factors, using an average of the judgments of the three raters, only Lack of Insight was significantly correlated ($r = .71$; $p < .02$) with drug dosage.

No significant correlations were found between drug dosage and any of the threshold or symptom measures for the eight affective patients, with the exception of a barely significant correlation ($r = .76$; $p < .05$), between drug dosage and one of the measures of short-term threshold variability (within-session variability). This measure was the number of blocks in the brief staircase procedure needed to reach the criterion for threshold in the left ear, for the noise condition, at the 500 ms stimulus duration. This was true only for one of eight similar measures, which used different ear, stimulus composition, and stimulus duration parameters.

Since the assessment of relationships between medication level and the other factors in this study involved the calculation of 67 correlations for each of three groups (all patients, schizophrenics, and affectives), 201 Pearson correlations were calculated. Some are presented in Appendix V. Since about 10 of these could be expected to be statistically significant at the $p = .05$ level on the basis of chance alone, the dearth of statistically significant correlations here is noteworthy.

Haloperidol

Three subjects in this study (# 4, #10 and #17), received haloperidol, in doses of .52, .84, and .32 mg/kg. Patients #4 and #10 received only haloperidol; patient # 17 also received 0.06 mg/kg of cogentin. Data for these subjects are shown in Table 30.

Patient #17 showed duration effects that were much steeper than average, whereas these effects were not as clear-cut in the other two patients, who had received higher haloperidol doses.

Table 30

Duration Effects for Patients Given Haloperidol and Comparison Values for All Patients, Patients Not Given Haloperidol, and Non-patients

		DURATION EFFECTS			
		Left Ear		Right Ear	
Patient Number	Haloperidol Dosage mg/kg)	1000 Hz Tone	White Noise	1000 Hz Tone	White Noise
4	.52	26	19	21	22
10	.84	19	16	18	14
17	.32	37	34	48	31
Mean (n = 3)	.56	27.3	23	29	22.3
Standard Deviation	(.26)	(9.07)	(9.64)	(16.52)	(8.5)
Mean (and SD) of All Psychiatric Patients [a]		21.8 (5.03)	17.7 (5.58)	21.6 (7.47)	16.5 (5.74)
Mean of Psychiatric Patients Not given Haloperidal (SD) [b]		20.75 (3.47)	16.7 (4.17)	20.25 (4.20)	15.3 (4.58)
Mean (and SD) of the Nonpatient Group (n = 10)		20.2 (3.15)	17.4 (2.07)	18.7 (2.75)	17.5 (3.72)

[a] n = 19 for Tone data and 18 for Noise data

[b] n = 16 for Tone data and 15 for Noise data.

There was no relationship between Project diagnosis and the administration of haloperidol medication; patient #4 was not given a Project diagnosis, having been called affective, schizophrenic, and unclassified/other by different raters. Patient #10 was given a Project diagnosis of schizophrenic based on the agreement of all raters; patient #17 was called affective by Project diagnosis, and by three of the raters; the third rater called him schizophrenic. No characteristic symptom profile pattern existed for this group.

CHAPTER IV

DISCUSSION

Diagnosis

As Salzinger (Note 11) has indicated, agreement in diagnosis or symptom rating is likely to be higher when using tape-recorded interviews, because only certain limited information is presented. A substantial amount of diagnostic variability may be attributed to the elicitation of different material from patients by different interviewers, which is often followed by different approaches to interpretation, synthesis, and follow-up probes. This is true even for highly structured interviews. Environmental factors, the stimulus value of the interviewer, and the experiences of the patient just prior to the interview are among the factors which contribute to the variability of diagnoses made from independently conducted interviews.

The use of tape-recorded structured or semi-structured interviews, as in the present study, should have reduced many of these sources of variability (Cooper, 1970; Wing, Birley, Cooper, Graham & Isaacs, 1967). However, in the present study, some of the patients had communication problems, and the quality of the audiotapes was not optimal. Spitzer et al. (1974) have usually found kappa values of .50 to .60 for diagnostic agreement when audiotaped interviews were used by expert raters. The low kappa values (.15 for schizophrenia, .24 for affective disorders, and .001 for unclassified/other) found for the diagnoses used to derive the final Project diagnoses in the present study cast some doubt on the validity of the use of nominal diagnoses in this study.

Even though kappa values contain corrections for chance guessing, it is important to note that diagnostic reliability tends to be higher when a few broad patient categories are employed (Mehlman, 1952; Raines & Rohrer, 1955; Schmidt & Fonda, 1956), and reliability tends to decrease as finer-grained diagnoses requiring discrimination between closely-related subtypes are employed. However, low kappas were observed in the present study despite the use of broad subdivisions: schizophrenic/affective/unclassified-other.

One reason for the low reliability observed here may involve the use of diagnostic categories which are too broad. It is suggested here that there is an optimum category width for good diagnostic discrimination. Although the use of broad diagnostic categories can add to the apparent reliability of diagnoses, the resultant within-group heterogeneity can present problems. Specifically, it should be noted that, although DSM III places schizoaffective disorder in a category separate from schizophrenic or affective disorders, the project diagnoses in the present study allowed for the inclusion of subjects diagnosed as schizoaffective in the schizophrenic group. This diagnostic procedure may have produced an overly heterogeneous sample of project-diagnosed schizophrenics, and contributed to low reliability. Subjects with schizoaffective disorder, but with primarily affective symptomatology, may have presented a special problem. Even an expert in the classification of tangerines, grapefruits and oranges may have difficulty in reliability of tangelo diagnosis, if no special category is provided. Inter-rater reliability for the more numerous and well-operationalized symptom profile scores was generally much higher than that of the Project diagnoses in the present study.

The reliability of diagnoses based on DSM III are likely, according to Spitzer, Williams and Skodol (1980) to be "quite good"; Spitzer, Foreman and Nee (1979) had found better reliability for DSM III than for DSM I or II diagnoses. DSM III's main advantages over earlier DSM forms lie in the better definition of syndromes and the alteration of diagnostic categories to a more realistic and parallel breadth.

As Salzinger (Note 11) has observed, the problem of reliability in diagnosis resides ultimately in the validation of diagnosis. The demonstration of high diagnostic reliability does not necessarily imply the existence of an underlying construct validity, however. For instance, diagnostic judgments based on stereotypes held by all raters may show high reliability, but have low underlying validity. But, as Spitzer and Fleiss (1974) have noted, since unreliable diagnostic systems cannot be valid, "studies of the unreliability of psychiatric diagnosis provide information on the upper limit of its validity".

Yet, such diagnoses may still be of heuristic value. Gurland (1973) has suggested that clustering or typological procedures can prove useful in the provision of information on previously unrecognized syndromes in a given patient group. Zubin and Kietzman (1965) and Sutton (1973) have observed that psychophysical techniques provide culture-fair indicators for iterative approaches to the identification of homogeneous sub-groups both within and across patient groups.

Bannister (1968) has suggested that it may be more pragmatic to correlate task performance with ratings in several areas of pathological behavior, rather than to deal with broad diagnostic categories. This

is especially important in cases where there is a substantial overlap in symptomatology between nominal diagnostic categories. In a survey of the frequency of presence of 35 symptoms in 793 "psychoneurotic", "schizophrenic", "manic-depressive" and "character disordered" patients, Zigler and Phillips (1961) found extremely high overlap across these groups in the occurrence of the 35 symptom factors.

In the present study, parallel results were seen in the similarity of the mean symptom profiles of the groups given Project diagnoses of schizophrenia and affective psychosis. Schizophrenic patients scored higher than affective patients on Flat Affect, Incomprehensibility, and Visual and Auditory Hallucinations, but these differences were not statistically significant ones, given the small number of subjects tested. It is interesting to note, however, that Auditory Hallucinations and Flat Affect were found to be correlated with higher brief stimulus thresholds in the affective group, which had lower overall scores on these factors than did the schizophrenics.

Evidence supporting the validity of the Project diagnoses for the subjects in the present study is given by the demonstrated relations of these diagnoses to differences in dichotic summation (Yozawitz et al., 1977), and to click thresholds (Bruder et al., 1980) in these same subjects. In the present study, which used these same diagnoses, Bruder's findings of higher click thresholds in these affective subjects were replicated. There was also a strong replication of this group's findings relating high correlations between Speech Retardation and click thresholds in affective patients. In

addition, Bruder et al. (1980) have replicated the differences in dichotic summation found by Yozawitz et al. (1977) in these same patients, using patients given RDC diagnoses by the staff of Biometrics Research Unit and the Depression Clinic of New York State Psychiatric Institute.

In an attempt to specify more reliable clinical correlates of the previously-derived Project diagnosed groupings, as well as to investigate relationships between the psychophysical measures used in the present study and the patients' clinical status, symptom profiles for these patients were employed in conjunction with the Project diagnoses, and are included in Appendix III. These provide a multi-dimensional quantitative assessment based on previously derived patient norms. The symptom profiles may be used in contrast to, or as a complimentary measure with the nominal categories used in the Project diagnoses.

The psychiatric patients studied in this analysis differed from the standardization sample norms derived by Fleiss et al. (1971) on only one factor. Both the schizophrenics and affectives had more ($p < .05$) Grandiose Delusions than did the standardization sample subjects.

The schizophrenics scored at least 5 standard score units (10 units = 1 standard deviation) above the affectives on Flat Affect, and Incomprehensibility, 8 units higher on Visual Hallucinations, and 10 units higher on Auditory Hallucinations. The affectives averaged 8 units higher than the schizophrenics on Obsessions. These differences are consonant with Spitzer, Endicott

and Robins' (1977) characterization of schizophrenia as involving "definite instances of marked formal thought disorder, accompanied by either blunted or inappropriate affect, delusions or hallucinations of any type, or grossly disorganized behavior". However, when within-group variability was taken into account, no statistically significant differences in sympromatology were found between the patients given Project diagnoses of affective vs. schizophrenic disorder.

Estimates of the reliability of the symptom factors indicated overall agreement to be moderate (mean Cronbach's α = .805; SD = 1.43). Rater B.K.G. showed the greatest agreement with the other two raters.

An analysis of variance of the ratings showed that subjects interacted with raters significantly on 10 of the 19 factor scales. Furthermore, significant "between raters" effects were seen for 7 factors. These were Depression, Speech Retardation, Reported Belligerence, Lack of Insight, Depersonalization/Derealization, Grandiose and Control Delusions.

Reliability was found to be uncorrelated with scale length.

In the present study, the total number of subjects in each category was too small to permit the use of powerful multiple linear regression, clustering, or factor analytic techniques, but it is suggested that in future research, data collected in a parallel form may be pooled to permit such analyses.

It should be noted, however, that the depressive patients who showed Auditory Hallucinations or Flat Affect, and Bizarre Behavior and Speech Retardation associated with steeply-sloped temporal integration functions in the present study appear to fall into the retarded/psychotic/endogenous depressive group which has, according to Blashfield and Morey (1979), been consistently found in 11 cluster analysis studies.

Auditory Measures

Brief Tone and Noise Thresholds Treated as Click Data

Bruder et al. (1975) and Bruder and Yozawitz (1976) had reported significantly higher (6 dB, significant at $p < .05$) thresholds to a right ear transient (click) stimulus in affective patients when they were compared to schizophrenic subjects and non-patients. These higher thresholds were associated with a higher symptom profile score on the factor of Speech Retardation ($r = .56$). Bruder, Spring, Yozawitz and Sutton (1980) found significantly higher right ear, but not left ear, thresholds in affective patients when their thresholds were compared to those of non-patient controls. No significant differences were found for the schizophrenic patient group in either ear.

The 2 ms stimuli used in the present study were sufficiently clicklike in character to permit a confirmation of these findings, as well as an examination of right vs. left ear 1000 Hz tone vs. white noise differences. Brief (click) thresholds could also be compared to long thresholds via the duration effect measure (to see whether the elevated patient thresholds were a result of an overall higher threshold, or were the result of elevated thresholds to only the brief stimuli). These factors could also be assessed vis-a-vis symptomatology for the different patient groups and for patients as a whole.

The present results replicate several prior findings:

(1) Bruder et al. (1975) and Bruder and Yozawitz (1976) had found thresholds for affective subjects to be 6 dB higher, compared to the thresholds of non-patient controls. The present study

found the thresholds for the affective group to be 7.9 dB higher than non-patient thresholds, a difference which was statistically significant.

(2) In addition, Bruder's studies found no significant differences between the right ear performance of the schizophrenic patients and either the affective or the non-patient groups. None of these differences were found to be statistically significant in the present study.

(3) Bruder, Spring, Yozawitz and Sutton (1980) reported significantly higher thresholds (5 dB) for affective vs. non-patient subjects to click stimuli presented to the right ear. At the same time, no significant differences were found for schizophrenics and non-patients or for left ear data. These findings were all replicated in the present study.

It should be noted, however, that a partial overlap in subjects exists between the present study and that of Bruder et al. (1980). Different stimuli were employed in the two studies, and the subjects were tested in separate sessions for the two procedures. The consistency of findings therefore indicate the presence of retest reliability.

Following the logic of Kimura (1964), Cohn (1971) and Molfese (1972), Bruder and Yozawitz (1976) suggested that click stimuli are processed preferentially by the right (non-dominant) hemisphere. If this is so, one could expect to find <u>lower</u> (more sensitive) left ear thresholds for click processing in most individuals, since each

cerebral hemisphere receives 60% of its input from the contralateral ear. In addition, Flor-Henry (1974) has hypothesized the existence of a right hemisphere dysfunction in affective patients. Such a deficit should produce poorer left ear vs. right ear processing performance in affective patients.

The present study, which found slightly higher left ear thresholds for the brief stimuli does not lend support to Bruder and Yozawitz's (1976) suggestion that click stimuli are processed preferentially by the right hemisphere. Following their rationale, a right hemisphere advantage in such a task should have resulted in lower left ear thresholds for click processing.

Poorer affective performance on left ear vs. right ear click thresholds would have been consonant with Flor-Henry's (1974) hypothesis ofright hemisphere dysfunction in affective patients.

The average left ear affective values were only .8 dB higher than their right ear values, and this difference was only 1/10 of the standard deviation for threshold in this group. In addition, both the schizophrenic and non-patient subjects showed a greater right ear advantage than did the affectives. The schizophrenic group's right ear advantage was 2 dB, and the non-patients' right ear thresholds were 2.5 dB lower than their left ear thresholds. None of these laterality differences were statistically significant; all were under one standard deviation in magnitude.

The present lack of support for a click lateralization effect should not be construed as a disproof of Bruder's findings, however. Bruder et al. (1980) have suggested that a lack of demonstrable

ear asymmetry in a monotic (single ear) task may be due to a lack of excitatory and inhibitory interhemispheric interaction. Tasks involving dichotic stimuli (presented to both ears) may be more senstiive to measures of lateralized hemispheric dysfunction. Some of the patients who participated in both Bruder et al.'s 1980 study and in the present investigation, did show ear asymmetries indicative of a right hemisphere advantage in click processing on a task using dichotic stimuli (Yozawitz, 1977; Yozawitz et al., 1979).

It may be that the slightly higher left ear thresholds seen in this study were influenced by testing conditions. The fan in the testing chamber, which produced a low-level ambient white noise, was mounted on the wall, slightly closer to the subjects' left ears. It may have produced a slight difference in masking for the two ears.

The present study, like the work of Babkoff et al. (1980) had the advantages of "multivalent" measures. If differences are seen between subject groups on only some measures, and not on other similar measures, the effects observed are less likely to be interpretable as the result of gorup differences on confounding factors (such as criterion, motivation, or attention). Although the use of a forced-choice procedure controls for criterion level, differences in general attention and motivation inpatient groups can present a severe problem (Bruder et al., 1976; Sutton, 1973; Waldbaum, Sutton & Kerr, 1975; Zubin et al., 1975). Specifically, Miller (1975) has suggested that depressive patients tend to be "less concerned about external stimulation". This could result in motivational/attentional confounding of perceptual studies involving depressed subject groups.

The higher and more variable 2 ms thresholds seen in the affective patient group can be interpreted as being due to less efficient processing in this condition, rather than to overall poorer performance, since this group appeared to perform at a better level (with a tendency towards lower thresholds and less overall variability) than the schizophrenic group on the 500 ms threshold conditions. In other words, they did not show signs of poorer attention than the schizophrenic or nonpatient subjects on an extremely similar task. Although the affectives' thresholds and within-group variability did tend to be slightly higher than those of non-patients, this trend was not statistically significant.

Thus, poorer performance was seen in the affective group for only the 2 ms conditions. This finding of a steeper sloped temporal integration function for the affectives implies a "processing" deficit in these subjects, since what is observed here is not just an overall elevation of threshold values, but a selective effect involving short time constant processing.

Correlations Between Click Thresholds and Speech Retardation

Bruder et al. (1975) and Bruder and Yozawitz's (1976) report of a relationship between right ear click threshold and Speech Retardation, and Bruder et al.'s (1980) report that this relationship existed in affective, but not in schizophrenic patients, was strongly replicated. In the present study, no significant correlations were found between schizophrenic patients' click thresholds and Speech Retardation, whereas a dramatic pattern was seen here for the Project-diagnosed affective subjects.

The demonstration of statistically significant correlations of threshold values with Speech Retardation for only the affective group lends validity to the Project diagnoses. Although the contributing diagnoses had low reliability with each other when the kappa values were calculated, the use of these Project diagnoses permitted a meaningful discrimination of subjects on the relationship between auditory and clinical measures. The two patient groups had not shown significant differences in mean scores on Speech Retardation, and evidenced identical variability on this factor (affectives $\bar{X}$ = 51.63; SD = 13.15; schizophrenics $\bar{X}$ = 54.42; SD = 13.15).

The utility of the duration effect measure was also demonstrated. When the overall average of tone and noise thresholds for the total patient group was correlated with Speech Retardation, no significant findings had emerged. However, when the duration effect was used to "correct" these thresholds for 500 ms threshold differences, statistically significant results were obtained. Duration effect may also be conceptualized as a measure of temporal integration; steeper-sloped temporal integration functions were associated with Speech Retardation.

Ear differences had been observed by Bruder et al. (1980); affective subjects had higher click thresholds in their right ears, and these were correlated with the presence of Speech Retardation. Similar ear differences have not been observed in the present study, however.

Correlations Between Duration Effect and Auditory Hallucinations and a Speech Retardation, Flat Affect and Bizarre Behavior Cluster in Affectives

Like Speech Retardation, Flat Affect and Bizarre Behavior were found to be significantly correlated with duration effect in the affective group. These correlations were not found to be ear-dependent, and were not found in the schizophrenic group.

This suggests that Speech Retardation, Flat Affect and Bizarre Behavior, which were found to be highly correlated with each other in the affective population, are related to a non-lateralized deficit in short time constant processing in affectives. Auditory Hallucinations, a factor which was also found in conjunction with higher duration effects in both ears of these affective patients, did not show a statistically significant correlation with these other symptoms. However, all of these symptom factors are highly language-loaded; these findings have relevance in the light of relationships between brain damage and linguistic functioning which were discussed in the Introduction to this paper.

Relationships Between Auditory Hallucinations, Diagnostic Group and Auditory Threshold Measures

When the patients were grouped as hallucinators vs. non-hallucinators, it was found that the hallucinating subjects had higher brief stimulus thresholds than did the non-hallucinators. This was found for both left and right ears, This provided support for differences between the thresholds of hallucinating patients with schizophrenic symptomatology and non-hallucinating schizophrenics

found by Bazhin, Wasserman and Tonkonogii (1975) and Babkoff et al. (Note 1), by showing that hallucinations were related to auditory temporal integration.

However, there were differences between the present findings and those of the other studies. Bazhin et al. had found relationships between auditory hallucinations and steeper-sloped temporal integration functions in the right ears of schizophrenic patients; Babkoff et al. had only collected right ear data, and had also found steeper-sloped temporal integration in a patient group with schizophrenic symptoms. The affectives in Babkoff's study had shallower-sloped temporal integration functions. In the present study, it was the affectives who had the steeper-sloped temporal integration functions, and they showed this effect in both ears.

When analyses of the present data were performed, employing hallucinating schizophrenic and hallucinating affective groups, a slightly greater "groups" effect was found than that seen in the ANOVAR which employed only a hallucination (and not an additional schizophrenic/affective) dimension. It is of interest to note that a similar ANOVAR which employed the schizophrenic/affective/non-patient distinction showed no significant main effect for group. (However, by pooling the noise and tone data for the 2 ms condition, and treating these as "click" data, significant differences between 2 ms thresholds for the affective and non-patient groups were seen and were shown to be independent of overall 500 ms threshold levels.)

Summary

In summary, in contrast to the findings of prior research (Bazhin, Wasserman & Tonkonogii, 1975; Babkoff et al, Note 1), it was the hallucinating affective subjects (and not the hallucinating schizophrenic group) who had significantly higher brief thresholds and greater duration effects (indicative of steeper-sloped temporal integration functions). In addition, Bruder et al.'s findings (1975; 1976; 1980) of higher click thresholds in affective patients were replicated.

In the affective group, Auditory Hallucinations, and a symptom cluster of Speech Retardation, Flat Affect and Bizarre Behavior were found to be related to elevated 2 ms thresholds (greater duration effects), which implies a deficit in short time constant processing in these subjects. None of these effects were lateralized in nature, and these relationships were not found to be statistically significant in the schizophrenic group.

Drug Dosage

The effects of medication were investigated in order to evaluate the likelihood of confounding of results by this uncontrolled variable, as well as to determine if medication was in any way related to the auditory or diagnostic measures obtained.

Medication and Auditory Measures

The finding of no overall relationships between drug dosage and the auditory threshold measures for either the schizophrenic or affective subjects supports Babkoff et al.'s (Note 1) findings. In addition, it extends these results to 1000 Hz tone data and to data permitting the comparison of the two ears, and it deals with

schizophrenic and affective subjects separately, as well as in a pooled patient population.

However, one patient treated with a combination of a low dose of haloperidol and cogentin showed elevated brief tone thresholds to all conditions, with normal level long tone thresholds. This resulted in duration effects approximately double the normal level. It was not possible to conclude whether these auditory findings were due to medication interactions or to some other factor (i.e. brain injury) in this subject.

Medication Level and Within-session Threshold Variability

It is noted in Appendix IV that within-session threshold variability was not conclusively found to be related to drug dosage level or type in any of the patient groups.

Medication Level and Diagnosis

No relationships were found between medication level and diagnosis, but the Project-diagnosed schizophrenic patients received a more varied medication level.

Symptomatology and Medication Level

The only relationship between symptomatology and medication was seen in the finding that patients with high scores on the Lack of Insight factor received a higher dosage. Further analysis showed that this relationship existed primarily for the Project-diagnosed schizophrenic patients, and was not as strongly evidenced in the affectives. The present findings cannot discriminate between two possible interpretations: (1) schizophrenic patients displaying lack of insight were given heavier medication (2) overmedication tended to confuse the patients, impairing insight.

Interactions of Medication with Diagnosis and Symptomatology

Since the affective and schizophrenic sugjects received similar medication levels, and did not present strikingly different symptom profiles, and since there were no strong correlations between symptomatology and medication (except for the Lack of Insight factor) either for the affectives or schizophrenics, or for both groups together, it could be argued that there were no appreciable relationships between medication level and symptomatology. However, it could also be maintained that the similarities in clinical profile for these two patient groups, as well as the low reliability (kappa) scores for diagnoses were due, in part, to effects of medication subh as the "blunting" of manic symptomatology into a schizomimetic pattern, or to "akinetic depression" in both patient groups (as suggested by Rifkin et al., 1975 and Van Putten and May, 1978).

Re-analysis of Medication Data Excluding Atypical Subjects

Symptomatology. Analyses of relationships between symptom profiles and medication level excluding the subject (#17) who received haloperidol and cogentin and excluding the undiagnosable subject (#4) were performed, to ascertain that data from these atypical subjects had not masked any relationships. No significant correlations between symptomatology and medication were found for the total patient group. For the affectives, a negative correlation ($r = -.75$; $p = .05$) emerged for phenothiazine dosage and the Incomprehensibility factor. Since 57 correlations between medication level and symptomatology were calculated, about three would have been expected to be statistically significant on the basis of chance alone.

Threshold Data. Re-analyses of auditory threshold data for the total patient group and the affective group, excluding these subjects revealed no statistically significant correlations with medication.

These analyses provided some reassurance that the atypical subjects' data had not served to mask any underlying trends in the general population's medication data.

Possible Effects of Patient #17's Data on the Analysis of Variance Results. Patient #17's atypical response patterns contribute to nonadditivity of subject effects in any ANOVARs dealing with auditory measures and groups in which his data are included. This would produce a negative bias in F tests for treatment effects, as the denominator of the F ratio would include both random error and the interaction of treatment levels with subjects (blocks in a randomized blocks design) (Kirk, 1968).

A Caveat: The Chapmans' Critique and the Generalized Deficit Hypothesis

An alternative, which acts as a null hypothesis to be considered in the context of this research, arises from the work of Chapman and Chapman (1973 a; b). These authors have discussed the confounding of experimental results by psychometric artifact. The implications of the Chapmans' critique for psychophysical/psychophysiological research with psychiatric patients have been examined by Mannuzza and Krooss-Glover (Note 17).

This problem becomes relevant whenever one is attempting to specify the existence of a specific differential deficit in performance on tests or tasks of different psychometric discriminating power in a group of subjects which tends to display a generalized deficit

(i.e., perform at a level below that of the normal control group). What appears to be a differential deficit in performance on one task (the more discriminating one) shown by the low-performance group may actually be the result of psychometric artifact, i.e., the greater discriminating power of that task. The difference in discriminating power may be due to differences in level of difficulty, rather than the hypothesized specific deficit on the constructs supposedly tapped by that test.

For instance, consider a situation in which psychiatric patients were to perform with a true score of one standard deviation below the mean of the normal group on a wide variety of tests. If some tests were more discriminating (i.e., "better" tests, with less error variance in their obtained scores), the more discriminating tests would show a patient deficit of one standard deviation, whereas the less discriminating tests might show a smaller patient deficit in obtained scores (i.e., scores only 1/2 of a standard deviation below the mean of the normal group). Errors of measurement would cause regression to the mean. Patients would show what appears to be a differential deficit on one task compared to the other. Even if the generalized deficit hypothesis were invoked to account for the slightly poorer patient performance of 1/2 of a standard deviation on one task, the greater difference in performance of one standard deviation on the second task might be interpreted as reflecting a "differential deficit" of 1/2 of a standard deviation, compared to typical patient performance. What actually exists is merely the generalized deficit, poorer overall performance by patients, but it was measured with differing degrees of accuracy by different tests.

It is well documented that patients tend to perform worse than do normal subjects (see Zubin et al., 1979) due to factors such as attention, motivation, and understanding of the task.

It is possible that a differential deficit shown by patients in some of the test conditions in the present investigation might be the result of psychometrically-induced difference in measurement of generalized patient deficit on some conditions relative to other conditions.

Attempts have been made in the present study to deal with some aspects of this dilemma. (1) Equal psychometric discriminating power of the tests was sought by the use of an own-control design, in which patients' ears and performance on different duration and frequency parameters can be compared. Any lateralized effects are not likely to be due to a generalized deficit, nor are effects that occur at only one duration. (2) Testing conditions for all parameters and values of the independent variable were identical, and (3) a threshold-level task was employed, which controls for some aspects of task difficulty.(4) In addition, tests which have not been psychometrically matched may provide legitimate evidence of a differential deficit in ability if patients do not perform more poorly, (i.e., do not show a "generalized deficit") on certain tasks, which are demonstrated to be equally or more discriminating than another task on which patients do show a deficit. (5) Also, if two or more pathological groups (i.e., diagnostic subtypes) evidence equal generalized deficit on most tasks, but one of these groups performs in a strikingly different manner on certain tasks, and

especially if crossover effects (one group performs better on one condition, and worse on the other) are observed, a differential deficit may be shown. (5) The within-session variability analysis presented in Appendix IV showed no greater variability for the brief vs. long and noise vs. tone stimulus conditions. If tasks differed in psychometric discriminating power, it might be expected that they would differ in their variability. This was not seen, however.

The possibility does remain that in the present study the detection of brief stimuli at threshold is a more difficult (and therefore, probably more discriminating) task than is the detection of longer stimuli. It is also possible that the noise condition was more difficult than the tone condition. White noise is more variable in its composition than is a pure tone stimulus. Both of these possibilities are supported by the higher thresholds shown by subjects to these conditions, although this possibility is not supported by the variability analysis shown in Appendix IV. In the absence of extensive normative data to equate these brief and long threshold tasks and 1000 Hz vs. white noise tasks on their psychometric discriminating power, conclusive statements cannot be made with respect to this point. Such an investigation would require the use of a large sample of normal subjects, including some who perform poorly enough to be within the patient performance range, an undertaking which is outside the scope of the present study.

APPENDIX I

PILOTING

Aims of Piloting

Before the beginning of the main study, three pilot experiments were performed:

(1) To compare the results of brief staircase procedures using different stepping rules. Staircases requiring three and four revisitations of some intensity value at the 5 dB and 1 dB step levels were contrasted in order to select a procedure for use in subsequent testing.

(2) To determine the extent to which the temporal integration function was affected by the frequency of the stimulus when it was measured at a very brief (1 ms) rise and decay time. Stimuli of certain frequencies are more likely to have their threshold measures confounded by a rapid rise and decay time. The more a subject's sensitivity to a particular frequency differs from his sensitivity to the click and noise components of the stimulus added by switching transients, the greater will be the influence of these factors on observed thresholds. This is especially true at brief durations, for which the switching transients compose a greater proportion of the stimulus. Piloting was performed to aid in the choice of stimulus frequencies for later testing with psychiatric patients and non-patient controls. Temporal integration functions at those frequency parameters least confounded by switching transients would be expected to be those exhibiting the greatest log-log linearity, (i.e., $I \times T = C$). If switching transients played an increasing role, especially at brief durations, temporal integration functions would

be expected to depart from log-log linearity at low stimulus durations. Stimulus frequencies for which temporal integration functions were the most linear (i.e., least confounded by the brief rise and decay time) were considered to be the most desirable ones for use in subsequent testing, so that the subjects' brief threshold measurements would not be confounded by differences in their absolute sensitivity to that frequency being tested and to the click-noise components of the switching transients.

(3) To examine the effects of stimulus rise and decay times on the slope of the temporal integration functions for the white noise and 1000 Hz stimuli, which had been chosen for use in the main study. In this way, an evaluation could be made of the extent to which these functions were affected by the presence of rapid switching transients at the briefest stimulus durations, and an appropriate rise and decay time value could be chosen for use in the main study.

In addition to these aforementioned points, these three pilot investigations provided information on:

(4) The amount of time needed to measure a brief staircase threshold.

(5) The stability of the brief staircase thresholds upon replication.

(6) The comparability of data obtained using the brief staircase procedure in this laboratory with reports in the early literature and with contemporary data from other laboratories which have used similar procedures.

(7) Whether temporal integration functions could be adequately represented using data at only two stimulus durations, as well as identifying these "critical" stimulus durations.

Piloting Subjects

These pilot data were collected using two right-handed Caucasian college (J.T.) and graduate (A.Y.) students. They had no history of neurological dysfunction, psychiatric treatment, criminal record, or drug or alcohol addiction. A.Y. was an experienced, well-practiced subject who was familiar with the testing procedure; J.T. was experimentally naive. Only A.Y. participated in Pilot Study 1; both subjects participated in Pilot Studies 2 and 3.

Pilot Study 1; Brief Staircase Procedure

Rationale

The block up and down, three-interval forced-choice (BUDTIF) procedure provides an accurate, although time-consuming (about 50 blocks of three trials each; 150 trials; 45-90 minutes) measure of auditory threshold (Bruder, Sutton, Babkoff, Gurland, Yozawitz, & Fleiss, 1975). Since many threshold measures were to be obtained in the planned study with psychiatric patients, and since these subjects were to be concurrently participating in other testing (Bruder, Spring, Yozawitz, & Sutton, 1980; Yozawitz, 1977), an economical modification of this method of threshold measurement was required.

A brief staircase procedure (Bruder et al., 1980) was developed to meet this need. It consisted of a modified descending staircase which rapidly homed in on a near-threshold level, using

a series of stepping rules which are described in detail in the Procedures section of the present study.

Each staircase started at about 60 dB SL, a level sufficiently above threshold for all subjects to perform with 100% accuracy. After each correct choice in the three-intervel forced-choice task, the stimulus intensity was decreased by 5 dB, trial after trial, until the subject made his first error. Subsequently, the stimuli were presented in blocks of three trials, all at the same intensity level. Stepping rules were used to determine whether the stimulus intensity would increase, decrease, or remain constant in the next block. If the subject was correct in all three trials, stimulus intensity was decreased by one step in the next block of three trials. If only two trials were correct, that intensity level was maintained on the next block of three trials. If the subject was incorrect on any of the trials in the next block, or gave a correct response to only one trial, the stimulus intensity was increased by one step in the next block of three trials. This procedure homed in on a 67% correct threshold level.

Before the beginning of extensive patient testing, assurance was needed that this new procedure could provide quick and stable measures of threshold. If the brief staircase threshold procedure employed too few observations, unstable threshold measures might result. On the other hand, too lengthy a testing session involved the risk of fatiguing the subjects, causing them to lose motivation or to "forget" the cues that they had used to detect the threshold-level signal.

It had been decided that a series of stepping rules should be employed to produce a more efficient threshold measurement procedure. A number of blocks would be run after the subject's first error, using a 5 dB step size for changes in stimulus intensity, until a certain number of revisitations (either 3 or 4) of one intensity level by the staircase of stimulus blocks had occurred. At this point, the stepping rule would be altered to 1 dB intensity changes in stimulus level between blocks, until a certain number of revisitations (either 3 or 4) at some intensity level had again occurred. It should be noted that it was not necessary for the revisitations at the 1 dB step size to be accumulated at the same intensity at which the 5 dB step size revisitations had occurred. The choice of 3 or 4 revisitations at each of these step sizes for use in this investigative piloting was made based on other piloting experience (Bruder, Note 18).

Using this brief threshold procedure, one could quickly home in on an intensity value near threshold in 5 dB steps, and then make a more precise threshold determination using the 1 d B step size.

This formal piloting study was undertaken to resolve the question of whether the use of 3 revisitations (rather than 4) as a criterion for changes in step size and termination of the staircase would reault in an adequate estimation of threshold, and to help determine the reliability of brief staircase procedure measures. It was decided that if the procedure requiring only 3 revisitations of some intensity values in the 5 dB and 1 dB step ranges was not substantially less reliable than the longer procedure (which required 4 revisitations),

the quicker procedure would be used for patient testing, to minimize subject fatigue effects.

Procedure

For subject A.Y., right ear data for several stimulus conditions were collected using different forms of the brief staircase.

Using white noise stimuli with rise and decay times of 1 and 5 ms, thresholds were obtained for 5, 10, 50, 100 and 500 ms duration stimuli, using the criterion of 4 revisitations at the same intensity at the 5 dB step level and 4 revisitations of some value at the 1 dB step level. Brief staircases for these different stimulus conditions were collected in a randomized order.

In addition, using a white noise stimulus with a 5 ms rise and decay time, thresholds were obtained for 5, 10, 50, 100 and 500 ms duration stimuli for two different revisitation criteria; 4 revisitations at both the 5 dB and 1 dB step levels, and 3 revisitations at the 5 dB and 1 dB step levels. Thresholds were obtained in a randomized order for these conditions.

Stimulus duration, as defined in this study, consists of the time between the half-power points of onset and offset of the stimulus. Thus, a 5 ms stimulus with a 1 ms rise and decay time would include a 1 ms rise time, a 4 ms steady stimulus, and a 1 ms decay time, (i.e., $(\frac{1}{2} \times 1) + 4 + (\frac{1}{2} \times 1)$).

Results

These staircases were examined to see what the thresholds would have been had the criterion of only 3 revisitations at the 1 dB step level (rather than 4 revisitations) been used. For these two different threshold task criteria, comparisons were made between the

obtained threshold values and between the number of blocks after the subject's first incorrect response that were needed to reach threshold. (see Table A)

In nine out of ten cases, threshold using the 3 and 4 revisitations criteria were identical. In one case, the 4 revisitation threshold was 5 dB higher.

The 4 revisitations threshold required an average of 15.2 blocks (47 trials) of testing after the subject's first error. The truncation produced by the use of the 3 revisitations criterion at the 1 dB level produced a decrease of staircase length to 12.5 blocks (37.5 trials average) to reach threshold.

It should be noted, however, that the distribution of increases in the number of blocks required for the 4 revisitations criterion was positively skewed, with two anomalously long runs observed. Most (7) of the 4 revisitations thresholds were only one block longer; one was 2 blocks longer, but one was 8, and another 10 blocks longer than would have been required for a criterion of three revisitations at the 1 dB step level. In the latter two cases, the additional staircase length was subjectively significant, in that the subject reported that the 24 and 30 additional trials added to the staircases significantly affected his level of fatigue and attention.

Comparisons between the thresholds obtained in the Brief Staircases requiring only 3 revisitations at both the 5 dB and 1 dB step levels and those requiring 4 revisitations at the 5 dB step level and 3 or 4 revisitations at the 1 dB step level could not be made in terms of their reliability since the thresholds for staircases requiring 4 revisitations at the 5 dB step level and 3 revisitations at the 1 dB

Table A

Comparison of Length of Brief Staircase Procedure and Threshold Values for Brief Staircases Using Different Stepping Rules, for One Subject (AX).

STEPPING RULES	NUMBER OF REVISITATIONS					
At 5 dB Step Level	3	4	4	3	4	4
At 1 dB Step Level	3	3	4	3	3	4
	NUMBER OF BLOCKS AFTER FIRST ERROR NEEDED TO REACH THRESHOLD			OBTAINED THRESHOLD IN dB SPL		
White Noise Rise & Decay time = 1 ms						
STIMULUS DURATION						
5 ms	-	12	13	-	29	29
10 ms	-	14	15	-	25	25
50 ms	-	13	14	-	23	23
100 ms	-	14	24	-	21	21
500 ms	-	8	9	-	13	13
White Noise Rise & Decay time = 5 ms	$\bar{X}$ =	12.2	15			
	s.d.=	2.49	5.52			
STIMULUS DURATION						
5 ms	11	14	15	27	31	31
10 ms	10	11	12	28	28	28
50 ms	12	9	10	24	22	22
100 ms	19	13	15	19	21	21
500 ms	13	17	25	15	12	17
	$\bar{X}$ =	13	12.8	15.4		
	s.d.=	3.53	3.03	5.77		
	$\bar{X}$ =	12.5	15.2			
	s.d.=	2.63	5.33			

level had been derived from the staircase using 4 revisitations at both levels, and were therefore not really independent measures. Examination of these data shows that the thresholds for the 3 revisitations criterion at each level are slightly more sensitive.

Discussion

On the basis of this piloting, it was decided that since threshold measurements based on 3 revisitations seemed equally adequate when compared with those based on 4 revisitations, the more economical stepping rule of 3 revisitations at any intensity at both the 5 dB and 1 dB step ranges would be used to determine threshold in the Brief Staircase Procedure in subsequent testing.

Preliminary data on this procedure indicated that it would require about 13 blocks of 3 trials each (39 trials) after the subject's first descending error to reach criterion.

In the data actually collected in the main study, the brief staircase with the 3 revisitations criterion proved slightly shorter than this value obtained from piloting. For 19 psychiatric patients, the threshold procedure averaged 11.8 blocks for the 1000 Hz and 11.6 blocks for white noise stimuli. The 10 non-patient subjects averaged 10.7 blocks for the 1000 Hz stimuli and 11.4 blocks for white noise.

A comparison of brief staircase click thresholds with 3 additional click thresholds obtained using a longer version of this threshold procedure for these same psychiatric patient subjects was performed by Bruder (Note 18). The longer procedure employed a Block Up and Down Three-interval Forced-choice staircase with a step size of 1 dB and blocks of 3 trials. These staircases began at a threshold level obtained in the preceding session, and , using the stepping rule for

obtaining 67% correct threshold, staircases were continued until a minimum of 5 blocks at the same intensity were obtained. All staircases in this type of procedure were continued until at least 10 blocks were observed, even if the "5 revisitations" criterion was met. Staircases which did not result in 5 revisitations within 24 blocks were discarded (Yozawitz, 1977). The median of the signal levels revisited in a staircase served as the threshold estimate, in contrast to the brief staircase procedure, which took as its threshold estimate the value at which the required number of revisitations at the 1 dB step size was reached. An analysis of variance confirmed that there was no significant difference across sessions, comparing these two procedures for right ear thresholds ($F = 0.67$, d.f. = 3,78, $p > .05$), and brief staircases were found to produce reliable threshold estimates when compared to those obtained using the longer procedure.

Pilot Study 2: Stimulus Frequency

Rationale

Since the earliest literature on auditory temporal integration, it has been noted that the slope and intercept of temporal integration functions differ with respect to the frequency parameter.

Garner (1947b) and Miakolczy-Fodor (1959) reported flatter slopes with a 250 Hz tone and steeper slopes with a 1000 Hz tone as compared to the slopes for white noise or 4000 Hz stimuli.

If the frequency under investigation neighbors a significantly more or less sensitive frequency, or differs greatly in threshold compared to the white noise of its switching transients, then "frequency splash" effects will be apt to confound brief threshold measurements to a greater extent. Frequencies displaying a significant departure

from log-log linearity in their temporal integration functions would not be employed in subsequent testing of duration effects in psychiatric patients.

Procedure

In order to assess the relationship between stimulus frequency and temporal integration, right ear audiograms for two non-patient subjects (J.T. and A.Y.) were obtained for 250, 500, 1000, 2000 and 4000 Hz at stimulus durations of 2, 10, and 500 ms. Stimulus duration is defined, as it was in the prior piloting study, as the time between the half-power points of stimulus onset and offset. The briefest and longest durations used here were those which were used in the subsequent investigation of relationships between the thresholds at different durations and psychiatric symptomatology. The 10 ms condition was included in this piloting as an added check on the linearity of the temporal integration functions examined here. The rise and decay time was 1 ms, chosen because it would permit the use of the brief 2 ms stimulus duration condition. This 1 ms rise and decay time was the one which was later used in the main study with psychiatric patients.

Using the three-interval-forced-choice brief staircase procedure and the stepping rules established in Pilot Study 1 (3 revisitations at both the 5 dB and 1 dB step levels), thresholds were measured at 250, 500, 1000, 2000 and 4000 Hz.

Data for each stimulus duration were collected in a separate session, and determinations of threshold at the different stimulus frequencies within each session were made in a predetermined random order.

The 500 ms threshold was measured initially, then the 2 ms audiogram was measured in the next session. The 500 ms audiogram was subsequently replicated followed by the 10 ms audiogram in the next session.

Results

Averaged data for the two subjects are shown along with a least squares fit to these data in Figure A. Individual data for each subject, along with least squares fits are shown in Figures B and C. Since temporal integration is expected to be linear on a log-log axis, log duration and threshold in dB SPL were used.

Table B gives the obtained threshold values for these subjects, their averages, and the least squares fits, slopes, and y-intercepts (projected 1 ms thresholds) for these subjects. Tables C and D give individual data for each subject.

Reliability. Since a replication had been made for both subjects of the data at 500 ms for all frequencies, reliability of these measures could be examined.

For subject J.T., four threshold values were replicated within 1 dB, and one threshold value was replicated within 3 dB. For subject A.Y., two threshold values on the 500 ms brief audiogram were exactly replicated; two values were replicated within 1 dB, and one value was replicated within 2 dB.

Temporal Integration as a Function of Stimulus Frequency. Averaging across the two subjects, linear fits with the steepest slopes were found for 1000, 250, and 2000 Hz stimuli. Their slopes were -9.7, -8.32, and -8.04, respectively. Shallower slopes were seen for 500 Hz and 4000 Hz stimuli. These slopes were -7.72 and -7.59, respectively.

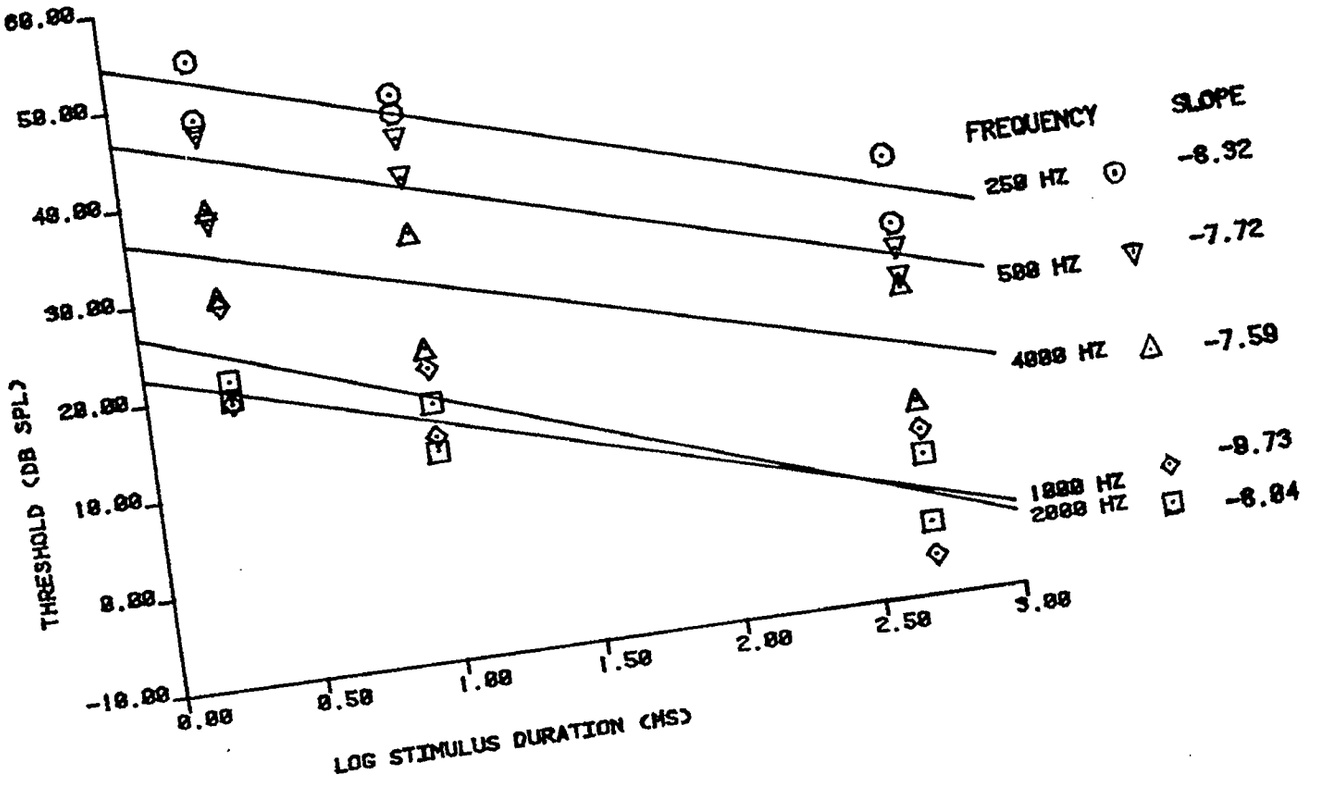


Figure A. Least-squares fits for pilot data on two subjects.

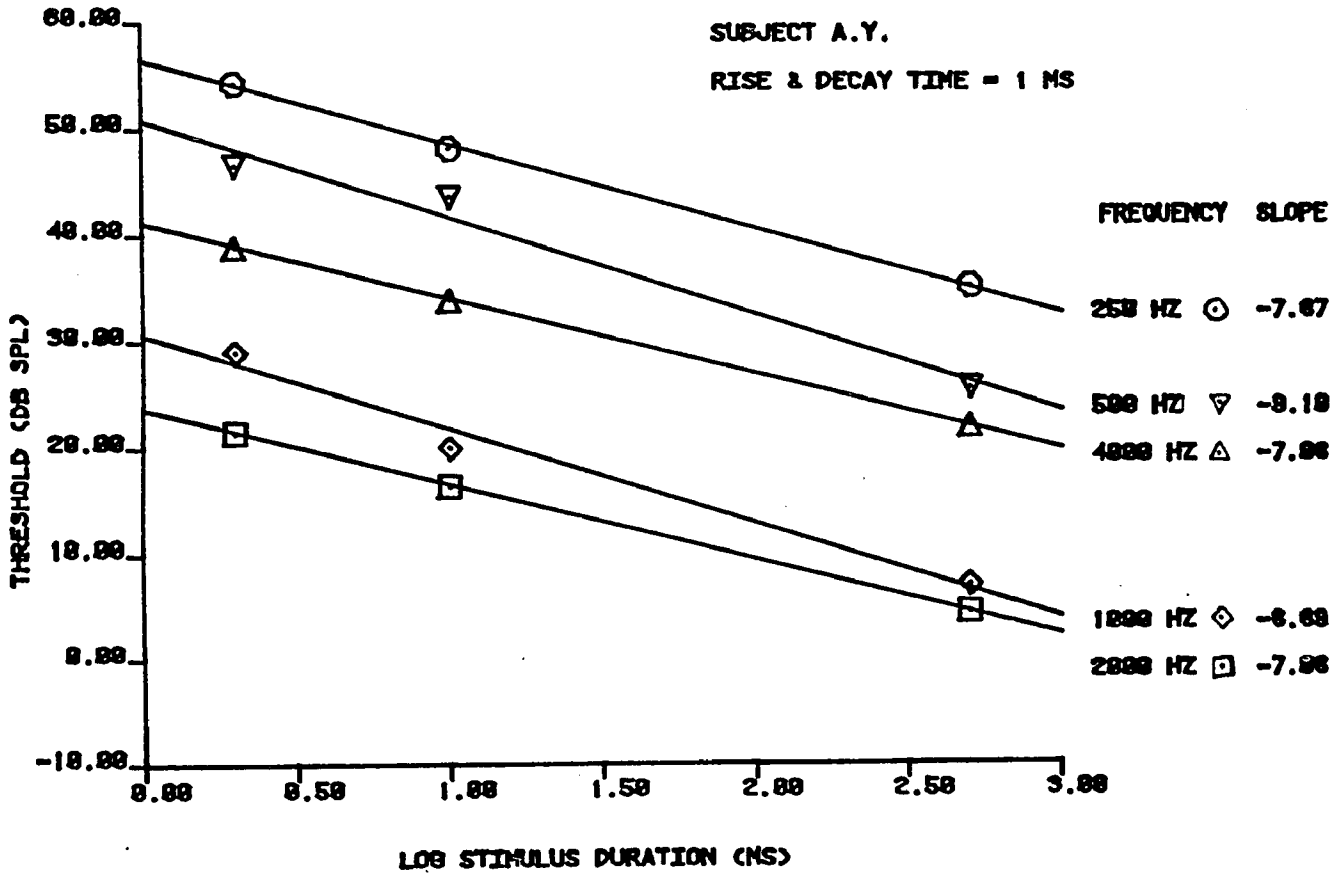


Figure B. Least-squares fits for polot data for subject A.Y.

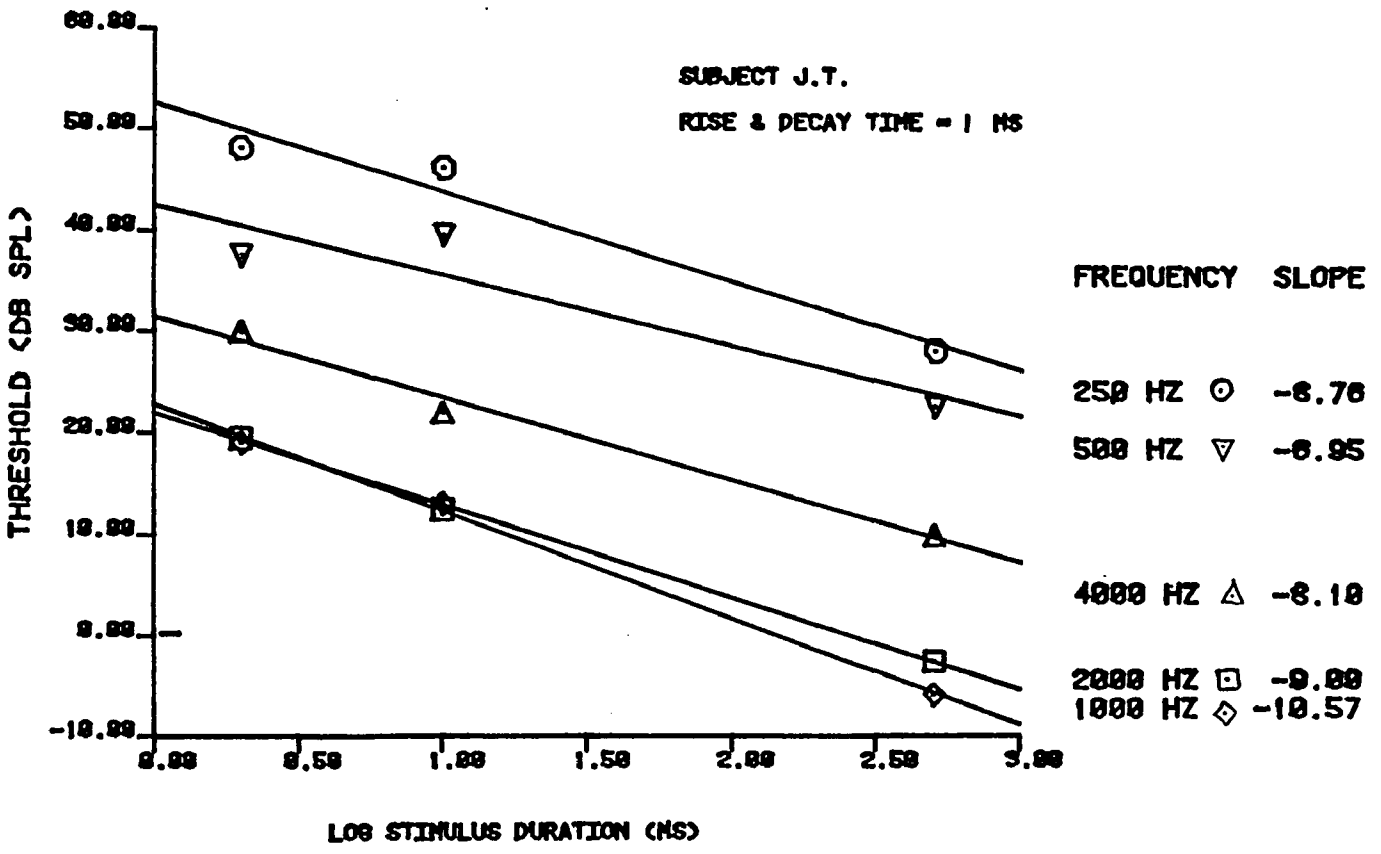


Figure C. Least-squares fits for pilot data for subject J.T.

Table B

Data for Two Subjects at Three Durations and

Five Frequencies: Least Squares Fits to Assess Linearity

	2	10	500[a]		STIMULUS DURATION (ms)
250 Hz	54.2	48.2	35.2	AY	Thresholds in dB SPL
Rise & Decay	48.2	46.2	28.2	JT	
Time = 1 ms	51.2	47.2	31.7	Mean	
	51.95	46.14	32.01		Least Squares Fit
	r = -0.9958		r^2 = 0.9916		
	a = 54.46		b = -8.32		
500 Hz	46.6	43.6	25.6	AY	Thresholds in dB SPL
Rise & Decay	37.6	39.6	22.6	JT	
Time = 1 ms	42.1	41.6	24.1	Mean	
	43.60	38.21	25.09		Least Squares Fit
	r = -0.9531		r^2 = 0.9085		
	a = 45.93		b = -7.72		
1000 Hz	29.0	20.0	7.0	AY	Thresholds in dB SPL
Rise & Decay	19.0	13.0	-6.0	JT	
Time = 1 ms	24.0	16.5	0.5	Mean	
	23.71	16.91	0.38		Least Squares Fit
	r = -0.9995		r^2 = 0.9991		
	a = 26.64		b = -9.73		
2000 Hz	21.4	16.4	4.4	AY	Thresholds in dB SPL
Rise & Decay	19.4	11.4	-2.6	JT	
Time = 1 ms	20.4	13.9	0.9	Mean	
	20.04	14.41	0.75		Least Squares Fit
	r = -0.9989		r^2 = 0.9979		
	a = 22.46		b = -8.04		
4000 Hz	39.0	34.0	22.0	AY	Thresholds in dB SPL
Rise & Decay	30.0	22.0	10.0	JT	
Time = 1 ms	34.5	28.0	16.0	Mean	
	34.01	28.70	15.80		Least Squares Fit
	r = -0.9978		r^2 = 0.9956		
	a = 36.29		b = -7.59		

Note.

[a] Average of two replications.

Table C . Data For Subject AY at Three Durations and Five Frequencies:

Least Squares Fits to Assess Linearity

	2	(5)**	10	(50)**	(100)**	500*	Stimulus Duration (ms)
250 Hz Rise/Decay Time=1 ms	54.2		48.2			35.2	Threshold (dB SPL)
	53.99		48.49			35.12	Least Squares Fit
	r = -.9996		r^2 = .9993		a = 56.36		b = -7.87
500 Hz Rise/Decay Time=1 ms	46.6		43.6			25.6	Threshold (dB SPL)
	47.99		41.63			26.17	Least Squares Fit
	r = -.9880		r^2 = .9762		a = 50.73		b = -9.10
1000 Hz Rise/Decay Time=1 ms	29.0		20.0			7.0	Threshold (dB SPL)
	27.84	24.31	21.63	15.42	12.74	6.52	Least Squares Fit
	r = -.9913		r^2 = .9828		a = 30.52		b = -8.89
2000 Hz Rise/Decay Time=1 ms	21.4		16.4			4.4	Threshold (dB SPL)
	21.38		16.43			4.39	Least Squares Fit
	r = -.9999+		r^2 = .9999+		a = 23.51		b = -7.08
4000 Hz Rise/Decay Time=1 ms	39.0		34.0			22.0	Threshold (dB SPL)
	38.98		34.03			21.99	Least Squares Fit
	r = -.9999+		r^2 = .9999+		a = 41.11		b = -7.08

Notes.

* Average of Two Replications

** Least Squares Points for Reliability Comparisons with Pilot Study 3

r = Correlation of Data with Least Squares Fit

r^2 = Index of Linearity

a = y Intercept

b = Slope of Temporal Integration Function

Table D. Data For Subject JT at Three Durations and Five Frequencies: Least Squares Fits to Assess Linearity

	2	(5)**	10	(50)**	(100)**	500*	Stimulus Duration (ms)
250 Hz Rise/Decay Time=1 ms	48.2		46.2			28.2	Threshold (dB SPL)
	49.91		43.79			28.90	Least Squares Fit
	$r = -.9808$		$r^2 = .9619$		$a = 52.55$		$b = -8.76$
500 Hz Rise/Decay Time=1 ms	37.6		39.6			22.6	Threshold (dB SPL)
	40.44		35.58			23.77	Least Squares Fit
	$r = -.9229$		$r^2 = .8518$		$a = 42.54$		$b = -6.95$
1000 Hz Rise/Decay Time=1 ms	19.0		13.0			-6.0	Threshold (dB SPL)
	19.57	15.37	12.19	4.80	1.62	-5.76	Least Squares Fit
	$r = -.9985$		$r^2 = .9969$		$a = 22.76$		$b = -10.57$
2000 Hz Rise/Decay Time=1 ms	19.4		11.4			-2.6	Threshold (dB SPL)
	18.69		12.40			-2.89	Least Squares Fit
	$r = -.9968$		$r^2 = .9936$		$a = 21.40$		$b = -9.00$
4000 Hz Rise/Decay Time=1 ms	30.0		22.0			10.0	Threshold (dB SPL)
	29.03		23.27			9.60	Least Squares Fit
	$r = -.9927$		$r^2 = .9854$		$a = 31.47$		$b = -8.10$

Notes.

* Average of Two Replications

** Least Squares Points for Reliability Comparisons with Pilot Study 3

r = Correlation of Data with Least Squares Fit

r^2 = Index of Linearity

a = y Intercept

b = Slope of Temporal Integration Function

For each subject treated individually, slopes for 250, 500, 1000, 2000 and 4000 Hz were, respectively; for AY, -7.87, -9.10, -8.89, -7.08 and -7.08; for the other subject, JT, slopes were, -8.76, -6.95, -10.57, -9.00 and -8.10.

Linearity of the Temporal Integration Functions. Squared multiple correlation values (r^2) are used here as a measure of the linearity of the temporal integration functions. In this context, they should not be viewed as indices of correlation on predictability from individual threshold values. The least squares linear fits to these data accounted for over 99% of the variance for 250 Hz, 1000 Hz, 2000 Hz, and 4000 Hz when the data were pooled for the two subjects. For 500 Hz, the least squares fit accounted for over 90% of the variance when the data were pooled for the two subjects.

For subject AY., the least squares fit accounted for over 99% of the variance for 250 Hz, 2000 Hz, and 4000 Hz. At 500 Hz and at 1000 Hz, linear components were over 97 and 98%, respectively.

For J.T., linear components were over 99% for 1000 Hz and 2000 Hz. at 250 Hz, 500 Hz, and 4000 Hz, they accounted for over 96, 85, and 98% of the variance respectively.

Discussion

It can be observed from the data of pilot subject J.T. (see Figure C and Table D) that the temporal integration functions for the frequencies at which he had the highest absolute threshold (250 and 500 Hz) did not maintain their linearity at the briefest durations, and have a lower threshold than would be expected from predictions based solely on intensity x time reciprocity. This subject was probably detecting a noise stimulus (produced by switching transients)

to which he was more sensitive, rather than a pure tone stimulus at these durations. One can note, however, that the linearity of the function is unimpaired at the frequencies to which he was the most sensitive (1000 and 2000 Hz) and a slight break in linearity can be seen for his 4000 Hz thresholds at a 2 ms duration. J.T.'s data for 1000 Hz provided a replication of Garner and Miller's (1945; 1947) and Garner's (1947b) perfect temporal integration findings for 1000 Hz stimuli. These authors reported slopes with absolute values of over 10 for 1000 Hz stimuli for functions including durations under 8 ms.

For A.Y.'s data, no relationship between his sensitivity (absolute threshold) at different frequencies and the linearity of the temporal integration function at these frequencies was found. All A.Y.'s data in this piloting were highly linear (the smallest r^2 was .976).

Based on the results of this piloting, it was decided that instead of collecting full-range audiograms at several stimulus durations for the psychiatric patient subjects, the less time-consuming procedure of examination of only brief (2 ms) and long (500 ms) thresholds for 1000 Hz and white noise stimuli for both the right and left ears would be adopted. As the temporal integration functions for the 1000 Hz and white noise conditions were linear, they could be economically specified by two data points. Choice of white noise was based on the findings that white noise is not appreciably altered by switching transients, as it is already broad-band in character (Miller, 1948); this had been substantiated by piloting work.

As Baru and Karaseva (1972) have noted, the use of white noise bursts has the advantage of presentation of an acoustic stimulus with

uniform spectral density at all frequencies. Changes in spectral composition due to switching transients and decreased stimulus duration are less marked for white noise than for tones.

250 and 500 Hz stimuli were not used because the linearity of their temporal integration functions was found to be imperfect at brief durations for subject J.T. (probably due to switching transients). 4000, 2000 and 1000 Hz stimuli remained as possible candidates for employment in further investigation. 1000 Hz was chosen, based on its more extensive use in the published literature. In a review of auditory temporal integration literature from 1893 to 1973, Wright (Note 19) cited 32 studies which used 1000 Hz stimuli, 24 studies which used 4000 Hz stimuli, and only 15 studies which used 2000 Hz.

1000 Hz stimuli provide a more satisfactory measure to complement white noise stimuli, lying at the region of maximum auditory sensitivity, and being relatively undisturbed by auditory changes due to old age or cochlear disease. At brief durations, however, tonal stimuli do tend to lose their characteristic frequency. At the briefest durations, even a "click-pitch" is not detectable.

One unfortunate disadvantage inherent in the use of gaussian white noise stimuli is their fluctuations in frequency composition at very brief durations.

One solution to the instability problem in dealing with noise stimuli and with very brief tonal stimuli would involve the use of "frozen" recorded stimuli, which would be recorded at each intensity level, and re-played on each stimulus presentation. This would make the stimuli identical from trial to trial. This was unfeasible in the present study, as the necessary equipment was unavailable.

Pilot Study 3: Stimulus Rise and Decay Time

Rationale

As Miller (1948) noted, switching transients produced by the onset and offset of a tone alter the frequency components of the stimulus, making it impossible to produce the sensation of a pure tone. This problem becomes more severe at brief stimulus durations and with the shorter rise and decay times.

As the duration of a sinusoidal stimulus decreases, the contribution of the "frequency splash" due to switching transients becomes greater. At extremely brief durations, the sinusoidal stimulus is perceived as being more clicklike. If the ear tested is more or less sensitive to the wider band of frequencies of the click components of the stimulus, the threshold estimate will not correctly reflect the sensitivity to the sinusoid.

The bandwidth of a tone is inversely related to its duration. This implies that the bandwidth of a pure tone increases as its duration decreases, thus affecting the slope of the I x T function. However, the temporal integration function for white noise should not change in slope at short durations to as great an extent as the temporal integration function for a sinusoidal stimulus, because it is already a broadband stimulus. However, as noted above, white noise stimuli do become more variable at brief durations. This variability has only a slight effect on threshold measurements.

It had been decided that it was desirable to select stimulus durations for use in the main study which would maximize the duration effect (the difference between thresholds to the brief and long stimuli). The shorter the brief stimulus used, the greater would be

the duration effect observed.

If a long stimulus rise and decay time were chosen, less confounding of stimulus frequency by switching transients would occur. However, a long rise and decay time would lengthen the duration of the brief stimuli, as rise and decay time play a role in determining effective stimulus duration. Since effective stimulus duration is calculated by adding the stimulus duration per se and ½ of the rise + decay times of the stimulus, it would be impossible to have a stimulus of under 5 ms in duration if a 5 ms rise and decay time were employed.

This piloting was performed to assess the influence of 1 and 5 ms rise and decay times on the shape of the temporal integration functions for the 1000 Hz and noise stimuli to be used in the main study. It was decided that if these functions retained substantial linearity for the brief (1 ms) rise and decay times, these parameters would be employed in the main study, allowing for the use of briefer total stimulus durations.

Procedure

In order to examine the effect of stimulus rise and decay times on threshold at different total stimulus durations, piloting was performed on the two non-patient subjects, J.T. and A.Y.

Rise and decay times of 1 ms and 5 ms were employed using both 1000 Hz and white noise stimuli at total equivalent stimulus durations of 5, 10, 50, 100 and 500 ms. Thresholds were collected for each duration using one rise and decay time per session, and one frequency per session, with order of total stimulus durations randomized. Total equivalent stimulus duration was defined as stimulus duration plus ½ the stimulus rise + stimulus decay time. Rise and decay times were

always equal. Replications of some points were made in separate sessions. Only right ear data were collected.

Results

Stability of threshold upon replication. Some thresholds were replicated in order to determine the reliability of the obtained measures. In late data analysis, the average of these two determinations was used when the average of both subjects' performance was examined. For the analysis of the individual subject's data, both replications were included in the least squares fits.

As can be seen in Table E , for subject J.T., two replications resulted in thresholds 1 dB apart. Nine replications were obtained for A.Y.'s thresholds. Three of these threshold replications resulted in identical values, two obtained a 1 dB difference, two produced a 2 dB difference, and 4 and 5 dB differences were obtained on one replication each. For these eleven replications, the mean threshold difference was 1.54 dB (s.d. = 1.63).

Data were averaged across the two subjects and fit by a least squares linear regression (see Table E). Individual data for the two subjects are shown in Figures D and E and in Tables F and G .

Reliability. An examination was made of the similarity between the 1000 Hz, 1 ms rise and decay time condition investigated in Pilot Study 3 and the 1000 Hz condition examined in Pilot Study 2. Using the least-squares linear fits to these data, the 500 ms duration conditions were within .07 dB of each other for A.Y., and within 3.76 dB for J.T.; the 10 ms duration conditions were within 0.4 and 0.27 dB of each other, and the y-intercepts of the temporal integration functions were approximately 0.59 and 1.76 dB apart.

Figure D . DATA FOR SUBJECT J.T.

WHITE NOISE & 1000 HZ

AT RISE & DECAY TIMES = 1 & 5 MS

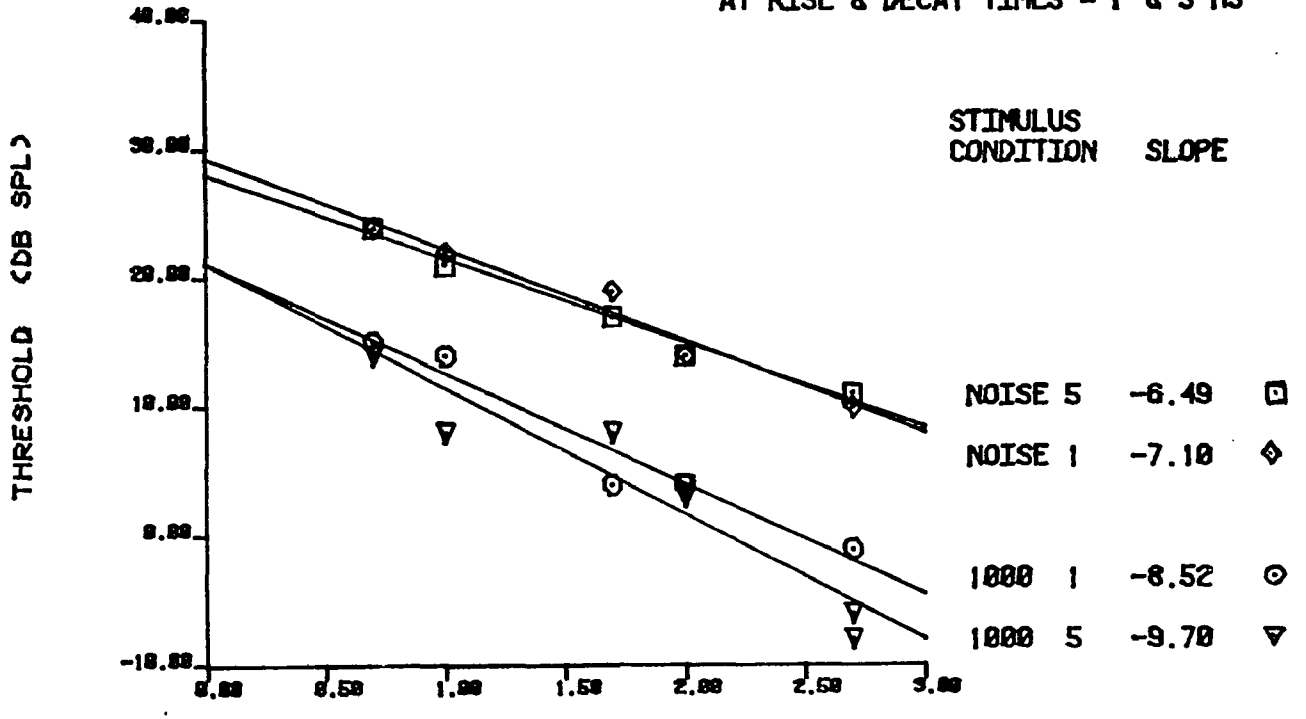


Figure E. DATA FOR SUBJECT A.Y.

WHITE NOISE & 1000 HZ

AT RISE & DECAY TIMES = 1 & 5 MS

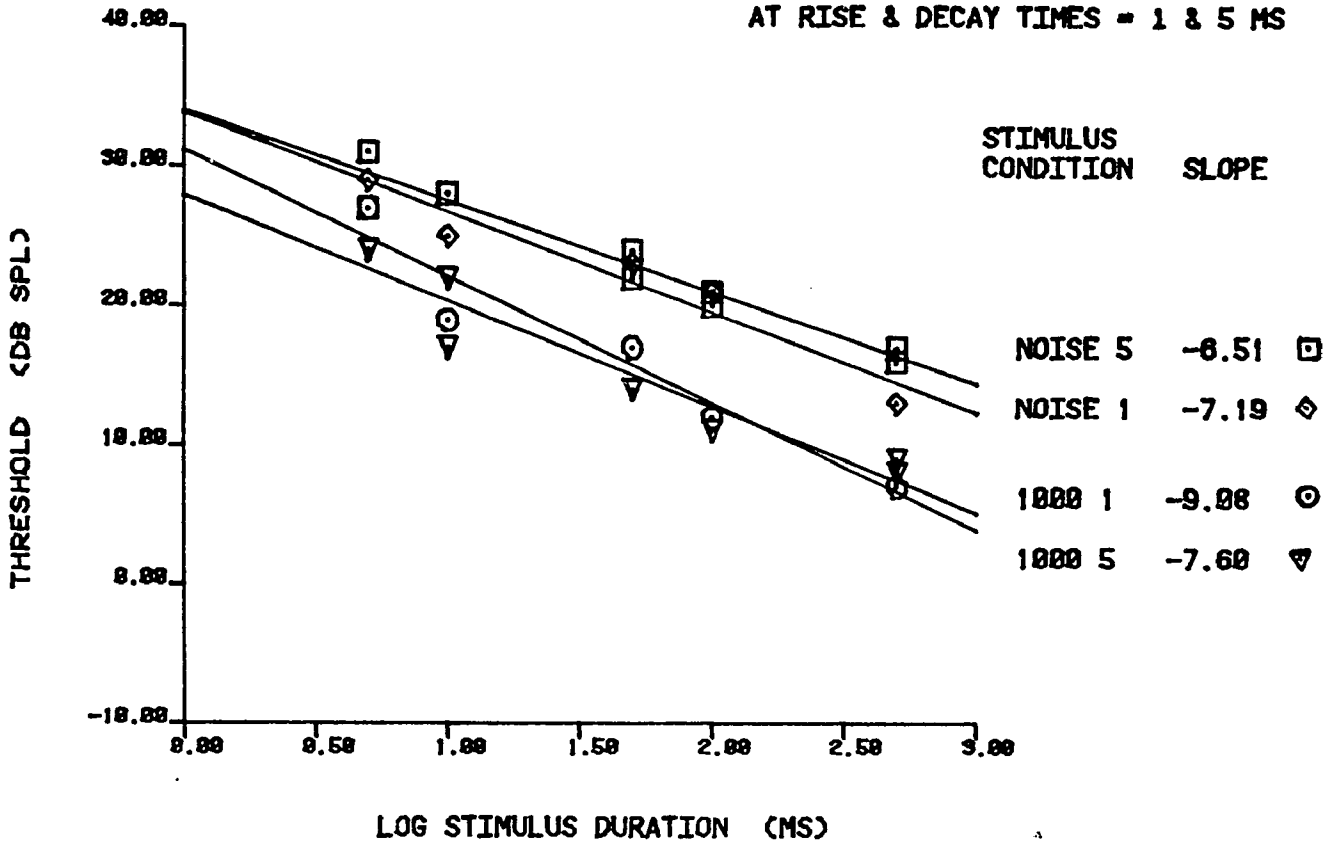


Table E. Data for Two Subjects at Two Rise and Decay Times and Two Frequencies: Least Squares Fits

	5	10	50	100	500		STIMULUS DURATION (ms)
1000 Hz	27	19	17	12	7	AY	Thresholds in dB SPL
Rise & Decay	15	14	4	4	-1	JT	
Time = 1 ms	21	16.5	10.5	8	3	Mean	
	19.90	17.25	11.10	9.48	2.29		Least Squares Fit
	r = -0.9929			r^2 = 0.9859			
	a = 26.06			b = -8.80			
1000 Hz	24	17	14	11	8	AY	Thresholds in dB SPL
Rise & Decay	24	22	14		9		
Time = 5 ms	14	8	8	4	-6	JT	
				3	-8		
	19	13.75	8	7.25	.75	Mean	
	17.53	15.04	9.07	6.49	.51		Least Squares Fit
	r = -0.9860			r^2 = 0.9721			
	a = 23.61			b = -8.56			
Noise	29	25	23	21	13	AY	Thresholds in dB SPL
Rise & Decay	24	22	19	14	10	JT	
Time = 1 ms	26.5	23.5	21	17.5	11.5	Mean	
	26.58	24.42	19.43	17.28	12.29		Least Squares Fit
	r = -0.9850			r^2 = 0.9702			
	a = 31.57			b = -7.14			
Noise	27	28	24	20	15	AY	Thresholds in dB SPL
Rise & Decay	31	28	22	21	17		
Time = 5 ms	24	21	17	14	11	JT	
	26.5	24.5	20.0	17.25	13.5	Mean	
	26.43	24.44	19.82	17.83	13.22		Least Squares Fit
	r = -0.9979			r^2 = 0.9959			
	a = 31.05			b = -6.61			

Notes.

a = y axis intercept, predicted value of threshold at 1 ms duration (log 1 = 0)
r = correlation of data with least squares fit
b = slope of temporal integration function

Table F . Data for Subject AY at Two Rise and Decay Times and Two Frequencies: Least Squares Fits

	(2)*	5	10	50	100	500	Stimulus Duration (ms)
1000 Hz Rise/Decay Time=1 ms		27	19	17	12	7	Threshold in dB SPL
	(28.38)	24.76	22.03	15.68	12.94	6.59	Least Squares Fit
		r = -.9619			r^2 = .9253		
		a = 31.11			b = -9.08		
1000 Hz Rise/Decay Time=5ms		24	17	14	11	8	Threshold in dB SPL
		24	22	14		9	
	(25.19)	22.45	20.39	15.58	13.52	8.72	Least Squares Fit
	Using average for each duration:						
		r = -.9511			r^2 = .9045		
		a = 27.26			b = -6.87		
	Using individual values:						
					r^2 = .9177		
		a = 27.88			b = -7.60		
Noise Rise/Decay Time=1ms		29	25	23	21	13	Threshold in dB SPL
	(31.68)	28.82	26.65	21.63	19.46	14.44	Least Squares Fit
		r = -.9672			r^2 = .9355		
		a = 33.84			b = -7.19		
Noise Rise/Decay Time=5ms		27	28	24	20	16	Threshold in dB SPL
		31	28	22	21	17	
	(32.16)	29.49	27.46	22.76	20.74	16.04	Least Squares Fit
	Using average for each duration:						
		r = -.9714			r^2 = .9435		
		a = 34.19			b = -6.72		
	Using individual values						
					r^2 = .94584		
		a = 33.94			b = -6.51		

Table 6. Data for Subject JT at Two Rise and Decay Times and Two Frequencies: Least Squares Fits

(2)*	5	10	50	100	500	Stimulus Duration (ms)
1000 Hz Rise/Decay Time=1ms	15	14	4	4	-1	Threshold in dB SPL
(18.44)	15.05	12.48	6.52	3.96	-2.0	Least Squares Fit
	$r = -.9748$			$r^2 = .9503$		
	$a = 21.00$			$b = -8.52$		
1000 Hz Rise/Decay Time=5ms	14	8	8	4 3	-6 -8	Threshold in dB SPL
(18.09)	14.23	11.31	4.54	1.62	-5.16	Least Squares Fit
	$r = -.9458$			$r^2 = .8945$		
	$a = 21.01$			$b = -9.70$		
Noise Rise/Decay Time=1ms	24	22	19	14	10	Threshold in dB SPL
(27.16)	24.33	22.20	17.24	15.10	10.14	Least Squares Fit
	$r = -.9830$			$r^2 = .9662$		
	$a = 29.29$			$b = -7.10$		
Noise Rise/Decay Time=5ms	24	21	17	14	11	Threshold in dB SPL
(25.96)	23.38	21.42	16.88	14.93	10.40	Least Squares Fit
	$r = -.9917$			$r^2 = .9834$		
	$a = 27.91$			$b = -6.49$		

Linearity of the temporal integration functions. Inspection of Tables F and G reveals that for subjects A.Y. and J.T., the linear components accounted for 93 and 95 percent of the variance ($.93 \leq r^2 \leq .95$) for the 1000 Hz 1 ms rise and decay time condition. Linear components accounted for 92 and 89 percent of the variance for the 1000 Hz 5 ms rise and decay time condition for these two subjects, respectively. It can be seen that the use of the briefer rise and decay time did not decrease the linearity of this function for these two subjects in the 1000 Hz condition.

For the noise condition, linear components accounted for 94 and 97 percent of the variance for A.Y. and J.T. respectively for the 1 ms rise and decay time condition. For the 5 ms rise and decay time condition, linear components accounted for 95 and 98 percent of the variance. Thus, for the noise condition, use of the briefer rise and decay time slightly decreased the linearity of the function.

At the briefest stimulus duration investigated in this piloting (5 ms), the obtained data differed from the linear fits by 1.38 and .05 dB for A.Y. and J.T. for the 1000 Hz 1 ms rise and decay time condition. For the 1000 Hz 5 ms rise and decay time condition, using averages of two points, when replications were performed, the differences from the linear fits for A.Y. and J.T. were 1.55 and 0.23 dB, respectively. For the noise condition, at a 1 ms rise and decay time, data for A.Y. and J.T. differed from the linear fits by 0.18 and 0.33 dB. For the 5 ms rise and decay time noise condition, differences from the linear fit were 1.75 and 0.78 dB for A.Y.'s two replications and .62 for J.T.

At the longest duration investigated here, departures from the

linear fit were 0.31 and 1 dB for A.Y. and J.T. for the 1000 Hz 1 ms rise and decay time condition. For the 5 ms rise and decay time 1000 Hz condition, A.Y.'s two replications differed from the linear fit by 0.84 and 2.82 dB. For the noise condition with a 1 ms rise and decay time, departures from linearity were 1.44 dB for A.Y., and 0.14 dB for J.T. For the noise condition at a 5 ms rise and decay time, A.Y.'s two replications yielded 0.82 and 0.73 dB differences from linearity; J.T.'s observed threshold was 0.6 dB from that predicted by the linear fit. These threshold estimates are surprisingly good, when one considers that these temporal integration functions were derived from five data points each, and that they were measured in 1 dB steps.

Slopes of the temporal integration functions. For A.Y. and J.T., using the 1000 Hz stimuli, the obtained slopes were -9.08 and -8.52 (the average of the two subjects slope was -8.80) for the 1 ms rise and decay time. Slopes were -7.60 using all points, and -6.88 using averaged data for replications for A.Y. and -9.10 for J.T., (average = -8.56) for the 5 ms rise and decay time. The noise slopes were -7.19 and -7.10 (average = -7.14) and -6.51 using all points and -6.72 using averaged data for replications for A.Y., and -6.49 for J.T. (average = -6.61) for the 1 and 5 ms rise and decay times, respectively.

Threshold values. The predicted thresholds at the 1 ms duration, based on the linear fits were 31.11 and 21.00 (average was 26.1) dB and 27.26 and 21.01 (average was 23.6) dB for the 1 and 5 ms rise and decay 1000 Hz conditions for A.Y. and J.T., respectively. Higher thresholds were observed for the noise condition, with 33.84 and

29.29 (average = 31.6) dB and 34.19 and 27.91 (average = 31.1) dB thresholds at the 1 ms duration predicted for the 1 and 5 ms rise and decay time stimuli. These predicted threshold values were obtained using an extrapolation to 1 ms duration, based on the least squares fits to the obtained data. For these predictions, and for use in subsequent discussions in this section, calculations were performed using the averaged value of any replications, rather than treating all replications as individual values, to avoid thresholds to certain durations having greater influence than did others in determining the least squares fits.

Comparability to Other Data

1000 Hz. Using an ascending method of limits procedure, Garner and Miller (1945; 1947) and Garner (1947b) reported slopes of -10 (dB change in threshold per log unit change in stimulus duration). Although Garner did not report a rise and decay time for these data, they were probably "instantaneous" (this was in common use at that time). This may, in part, account for the steeper slope observed by Garner, who reported that the absolute value of his slope was greater than 10 for stimulus durations below 8 ms. This supports the view that switching transients played a role in determining his observed results. Garner also mixed monaural and binaural data in his studies. The present data were all monaural (right ear). In the present piloting, for the 1000 Hz tone, averaging over two subjects, slopes of -8.80 and -8.56 were observed for the 1 and 5 ms rise and decay times, respectively. For subject A.Y., these

slopes were -9.08 and -6.87 for the 1 and 5 ms rise and decay times. For J.T., these values were -8.52 and -9.70. In Pilot Study 2, at a rise and decay time of 1 ms for 1000 Hz stimuli, the average slope for the two subjects was -9.73, and -8.89 for A.Y. and -10.57 for J.T. when their data were treated separately. The present observation of less than perfect temporal integration for 1000 Hz stimuli is not unusual. Some of the possible reasons for this finding are presented in the Introduction section of the main body of this paper.

White Noise. The slopes of the noise functions for 1 and 5 ms rise and decay times obtained in this piloting, when averaged over the two subjects were -7.14 and -6.61, respectively. For subject A.Y., these values were -7.19 and -6.72, and for J.T., they were -7.10 and -6.49. Garner (1947b) reported slopes of -8, and cited that similar slopes had been obtained by Miller (1948). These data employed a mixture of monaural and binaural conditions, and used unspecified (probably "instantaneous") rise and decay times. Babkoff and Gombosh (1976) found that monaural and binaural temporal integration curves for noise at threshold had similar slopes, but binaural data had an overall lower threshold function, due to binaural threshold summation.

Most studies have reported slopes for temporal integration of threshold level noise to be about -7 (Babkoff & Gombosh, 1976; Penner, 1978). Using a procedure similar to that used in this study (a monaural block up and down three-interval forced-choice task, with a 1 ms rise and decay time, Babkoff (1975) obtained a slope

of -6.13 ($\pm$ 0.74)). The slope obtained in the present piloting for the comparable condition, averaging over the two subjects, was -7.14.

Discussion

These pilot data show essentially similar and linear functions for the noise and 1000 Hz data at two different rise and decay times. Noise and 1000 Hz tone functions differed in amplitude with a higher threshold value obtained for the noise condition.

It had been anticipated that at the briefest rise and decay times at the briefest durations, confounding of stimulus frequency content for the 1000 Hz tone might have occurred. Addition of switching transients might have caused it to resemble the white noise stimulus at the briefest durations. As can be seen from Table E, the essential linearity of the 1000 Hz temporal integration for the two pilot subjects at 1 and 5 ms rise and decay times was unimpaired. It is supposed, nevertheless, that as the stimulus durations would decrease towards a hypothetical infinitely small value, the functions for the noise and the more steeply sloped, but lower threshold 1000 Hz conditions would converge due to their differences in slope. At 500 ms durations, the noise and tone functions averaged over the two subjects differed by 10.00 and 12.71 dB for the 1 ms and 5 ms rise and decay times; at the projected 1 ms stimulus values, the difference between the noise and tone thresholds was almost halved; 5.51 and 7.44 for the 1 and 5 ms rise and decay times, respectively.

One chief concern of this piloting was whether the noise components in the frequency splash due to switching transients at a very brief rise and decay time would confound the measurement of temporal integration, especially of the 1000 Hz stimuli. Miller (1948) commented:

> "The best we can do with short auditory stimuli is to control their complexity. This means it is necessary either to compute or measure carefully the spectrum of the short tone, or to employ sounds which are just as complex as the products of modulation. The second alternative was adopted in the present research. Random white noise, a hissing sound compounded of all audible frequencies, can be keyed on and off rapidly without a noticeable 'click' because the products of modulation are indistinguishable from the sustained noise itself. Consequently, random noise makes possible a spectrum which does not change materially as a function of the duration of the sound."

One way of investigating the contribution of switching transients is to note the linearity of the temporal integration function. Addition of switching transients will cause a departure from linearity, except (as Miller has noted) when they do not alter the character of a stimulus which is already broadband in character, i.e., white noise.

As the linearity of the 1000 Hz data obtained here was actually slightly better for the 1 ms rise and decay time than for the 5 ms rise and decay time, no support was given to the possibility that this function's linearity was greatly disrupted by noisy switching transients due to the very brief rise and decay time. Dallos and Johnson (1966) had similarly found that various rise and decay times of 0 - 49 ms did not alter the threshold to a 1000 Hz stimulus, provided that the equivalent stimulus duration was unchanged. Thus, it seems that thresholds to 1000 Hz stimuli are not highly vulnerable

to confounding by switching transients. Consequently, the decision was made to employ this briefer (1 ms) rise and decay time in the main study. This choice carried with it the advantage of making possible the use of a very brief 2 ms stimulus condition, which had been investigated in Pilot Study 2.

Another result of this piloting was the reassurance that adequate measures of temporal integration could be obtained using only two threshold values.

Based on these data, the decision was made to employ only brief and long (2 and 500 ms) stimuli at 1 ms rise and decay times for white noise and 1000 Hz tone data to be collected in subsequent research with psychiatric patients and non-patients.

Limitations of Pilot Data

It should be noted that these pilot data were obtained for the right ears only of two non-patient university students. One of these subjects (A.Y.) was a well-practiced observer who was familiar with the procedures employed.

These subjects were not representative of the psychiatric patients tested later in the main study. It was anticipated that the patients would be less highly motivated and would fatigue more easily. These conjectures helped influence the choice of the briefest staircase procedure and of a temporal integration function described by only two points. The decision was made that the time saved by these modifications would be used for replication of patient threshold measures for which the data seemed overly

variable or questionable due to poor motivation or confusion on the part of the subjects. It was also hoped that a rapid testing procedure would reduce subject attrition rates.

APPENDIX II

RIGHT TEMPORAL LOBE LESIONED NEUROLOGICAL PATIENTS

Auditory thresholds were obtained for both ears of the two temporal lobe lesioned subjects at 250, 1000 and 4000 Hz and for white noise stimuli at durations of 2 and 500 ms, with a rise and decay time of 1 ms, The threshold data for these patients (U.J. and S.G.) are shown in Table A. No clear-cut differences in duration effect were seen for these subjects, although a greater duration effect had been expected for their left ear data.

Such an effect was seen for U.J. at 1000 Hz and for the white noise condition, but it was not seen at 250 and 4000 Hz. For S.G., a greater left ear duration effect was seen only for white noise, but this was not replicated upon retesting.

Reasons for the inability to provide a better demonstration of a lateralized difference in temporal integration in these subjects will be considered. The most striking reason for these negative findings is a confounding due to the presence of sensorineural hearing loss in both of these patients.

Sensorineural hearing losses tend to produce a flattening of the slope of the temporal integration function (Gengel & Watson, 1971; Harris, Haines & Myers, 1958; Miskolczy-Fodor, 1953; Pedersen & Elberling, 1973; Sanders & Honig, 1967; and Wright, 1969). The involvement of the auditory nerve or brainstem could also induce a similar effect (Baru & Karaseva, 1972). The presence of a condition which tends to flatten the slope of temporal integration functions could counteract the demonstration of a lateralized difference in duration effect due to cortical lesions, especially if

Table A

Data for the Two Right Hemisphere Lesioned Patients

Compared to Data for Ten Non-patient Subjects

Stimulus Frequency	THRESHOLDS Right Ear 2 ms	500 ms	D.E.	Left Ear 2 ms	500 ms	D.E.	Ear Difference in D.E.
Subject U.J.							
250 Hz	55.2	33.2	22	52.0	32.0	20	2
1000 Hz	33.0	24.0	9	34.7	14.7	20	-11
4000 Hz	55.0	44.0	11	59.9	51.9	8	3
White Noise	33.0	19.0	14	48.6	29.6	19	-5
Subject S.G.							
250 Hz	53.2	34.2	19	51.0	32.0	19	0
1000 Hz	21.0	-1.0	22	22.7	4.7	18	4
	(27.0)	(6.0)	(21)	(28.7)	(8.7)	(20)	(1)
4000 Hz	30.0	18.0	12	48.9	36.9	12	0
White Noise	28.0	14.0	14	33.6	13.6	20	-6
	(29.0)	(10.0)	(19)	(25.6)	(12.6)	(13)	(6)
	(33.0)	(14.0)	(19)	(36.6)	(20.6)	(16)	(3)
Ten Non-Patients							
1000 Hz threshold	27.0	8.3	18.7	29.7	9.5	20.2	-1.5
SD	5.4	5.7	2.8	6.0	6.9	3.2	
White Noise threshold	33.0	15.5	17.5	35.2	17.8	17.4	+0.1
SD	4.1	5.0	3.7	3.7	3.7	4.3	

Notes.

Data are in dB SPL.

( ) indicates a replication.

these sensorineural losses are not bilaterally symmetrical.

In the present study, psychiatric patient and non-patient subjects who showed a 10 dB threshold difference across ears or who had thresholds 20 dB above International Organization for Standardization (ISO; 1964) norms were routinely excluded from testing. Due to the difficulty of obtaining patients with temporal lobe lesions, these same stringent selection criteria were not applied to this group.

ISO norms for 250, 1000 and 4000 Hz stimuli are 24.5, 6.5, and 9 dB SPL, respectively. Subject U.J.'s right ear thresholds were 8.7, 17.5, and 35 dB above these respective values. His left ear thresholds were 7.5, 8.2, and 41 dB above ISO norms, indicating an auditory impairment which would have disqualified him from participation in this study, had he been a psychiatric patient or a control subject.

Subject S.G. showed an average deviation above ISO norms of 9.7 and 7.5 dB for his right and left ears at 250 Hz, and was slightly more sensitive than average at 1000 Hz for both ears. However, his 4000 Hz threshold was 9 dB above the ISO standard for his right ear, and 27.9 dB above these norms for his left ear. All these thresholds and ISO values are for 500 ms stimuli.

It is suggested that the flattening of the slope of the temporal integration function for these two subjects due to their sensorineural hearing loss tended to counteract any increases in slope which could be expected to result from central nervous system damage.

Another factor which may have militated against the demonstration of a lateralized abnormality in temporal integration in these subjects

is the possibility that they may have had central nervous system involvement which was bilateral in nature. Both S.G.'s heart attack and U.J.'s hematoma and resulting craniotomy are likely to have had some bilateral effects.

Although the confounding effects of sensorineural hearing loss and the lack of information on the exact loci and extent of central nervous system damage in these two subjects provide an explanation of the failure to conclusively demonstrate an increase in duration effect contralateral to the site of lesion in these individuals, one is still faced with the problem of why such effects have not been as reliably demonstrated in recent work in the U.S. as they have been in the pioneering work done in the Soviet Union. Cranford (1979) and Cranford and Igarashi (1977) had difficulty in providing a reliable demonstration of such effects in cats, whose peripheral auditory integrity, and extent and loci of central lesions were verified.

Wright has suggested that alterations in brief stimulus thresholds resulting from cortical damage may be frequency-specific and related to an interaction between the locus and extent of cortical lesions and the tonotopic projections to auditory cortex.

Tonotopic localization on cortex has been examined by electrical recording (Licklider, 1942; Licklider & Kryter, 1942) in cat and monkey, and in dog (Lipman, 1940). Woolsey and Walzl (1942), working with cochlear stimulation and electrically-recorded cortical mapping in cats found well-organized tonotopic projection, with the exception of projections from the apical region of the cochlea, which corresponded to low frequency tonal stimulation. Tunturi (1944; 1945; 1946), in his classical cortical mapping work, noted that spread of activity on

cortex varies with the intensity of stimulation; with weak tonal stimuli, a complex pattern of cortical responses was elicited, with several loci responding for the same frequency stimulus.

Separate auditory projection systems with short and long time constants have been postulated to exist (Gersuni, 1963; 1973), both converging on cortex. Damage to auditory cortex would disrupt the final integration of these systems. Gersuni and his co-workers have suggested that the existence of these two separate systems could account for the discrepant results obtained in lesion studies using stimuli of different durations. Baru's (1967) findings of increased brief tone sensitivity using caffeine and of increased long tone sensitivity using l-amphetamine provides support for the presence of two distinct systems for brief and long tone processing.

Gersuni (1967) suggested that impulses from the fastest auditory neurons and the initial short-latency spikes of slow neurons converge on auditory cortex within 10-20 ms after stimulus onset. If the neurons connecting these two systems are impaired, a disturbance in brief stimulus perception will result. Gersuni, Gasanov, Zaboeva and Lededinskii (1964) and Gersuni, Shevelov and Kikhnitskii (1964) found that critical summation time for evoked responses recorded from auditory cortex coincides with the time scale within which detection of short acoustic stimuli is impaired by cortical lesions.

Gersuni (1971) has noted that frequency projections along auditory cortex have been demonstrated only for evoked potential studies using signals under 10 or 15 ms in duration (Tunturi, 1950;

1960; Kiang and Goldstein, 1959). The existence of longer latency systems which do not evidence tonotopic projection would account for the general finding that ablation of auditory cortex does not impair intensity and frequency discrimination for longer duration signals (Neff, 1961).

Demonstration of greatly increased duration effects in the ear contralateral to a central lesion may be possible only if the stimuli employed are brief enough to be processed solely by the well-localized short time constant system, and if the lesion involves all areas necessary for the integration of the brief stimulus, and spares no areas sufficient for such integration. The processing of different frequencies would involve different cortical loci, so greatly enhanced duration effects may be observed only at some stimulus frequencies for any given cortically lesioned patient.

Gersuni (1963) has also suggested that the impairment of brief tone perception in patients with temporal lobe lesions may be interpreted as related to a deficit in short-term memory. Gersuni has hypothesized the existence of a mechanism for the discrimination of brief sounds on the basis of "reproduction" or short-term memory. In this model, "as a consequence of relatively long reverberation of the excitatory process in neural circuits, this reproducing apparatus may put into operation a slowly reacting discriminating mechanism and prolong the effect of the brief signal action to the required extent" (Gersuni, Baru, Karaseva & Tonkonogii, 1971). If there are fewer lateral connections between neurons, either as a result of an ablation, or of more diffuse cortical damage, traces

will reverberate for less time. Traces from fast afferent fibers may have greatly subsided before traces from the slower fibers, activated by the same stimulus, reach cortex. This would lead to an increase in thresholds to briefer stimuli, whereas longer stimuli would continue to activate the fast fibers for a long enough time for them to provide temporally overlapping excitation with the slower afferents.

The more variable nature of the white noise stimuli, as well as their more diffuse projection might make them better tools for the assessment of diffuse central nervous system damage than are the more discretely-projected pure tone stimuli.

An increased white noise duration effect in the ear contralateral to the lesion was seen for both neurological patients. U.J.'s left ear duration effect for white noise exceeded his right ear duration effect by 5 dB, and S.G.'s left ear duration effect for white noise was initially 6 dB greater than his right ear duration effect. Although these findings appeared promising, especially in the light of hypotheses that the spectral composition of stimuli might be an important factor, and with more variable stimuli being more likely to produce an effect, replication of S.G.'s white noise testing failed to support the initial findings. Not only was there a failure to replicate the 6 dB difference -- it <u>was</u> found, but with opposite lateralization. A third testing showed a 3 dB lateralized difference in duration effect, with greater temporal integration shown by the right ear.

APPENDIX III

SYMPTOM PROFILES FOR THE 19 PSYCHIATRIC PATIENT SUBJECTS: STANDARD SCORES BY EACH OF THREE RATERS, AND AN AVERAGE SCORE

Symptom Factors for Patient # 01	RATER A.Y.	B.K.G.	S.M.	$\bar{X}$
1. Depression	46.19	47.54	40.79	44.84
2. Anxiety	45.74	58.34	61.49	55.19
3. Speech Retardation	46.44	46.44	46.44	46.44
4. Hypomania	46.87	46.87	46.87	46.87
5. Somatic Concern	45.84	45.84	45.84	45.84
6. Observed Belligerence	46.30	46.30	46.30	46.30
7. Reported Belligerence	42.04	42.04	42.04	42.04
8. Obsessions	46.18	46.18	46.18	46.18
9. Disorientation	46.40	59.01	52.70	52.703
10. Lack of Insight	42.41	42.41	42.41	42.41
11. Depersonalization/ Derealization	45.70	45.70	45.70	45.70
12. Paranoid Delusions	58.25	64.51	45.71	56.157
13. Grandiose Delusions	60.81	60.81	47.30	56.307
14. Control Delusions	47.19	55.00	47.19	49.793
15. Visual Hallucinations	47.26	47.26	47.26	47.26
16. Auditory Hallucinations	45.83	45.83	45.83	45.83
17. Bizarre Behavior	48.02	48.02	48.02	48.02
18. Flat Affect	55.38	45.77	45.77	48.973
19. Incomprehensibility	45.16	45.16	45.16	45.16

Symptom Factors for Patient # 02	RATER A.Y.	B.K.G.	S.M.	$\bar{X}$
1. Depression	43.49	42.14	40.79	42.14
2. Anxiety	42.58	42.58	42.58	42.58
3. Speech Retardation	46.44	46.44	46.44	46.44
4. Hypomania	95.75	71.31	71.31	79.457
5. Somatic Concern	45.84	45.84	45.84	45.84
6. Observed Belligerence	46.30	46.30	46.30	46.30
7. Reported Belligerence	47.28	62.98	42.04	50.767
8. Obsessions	46.18	46.18	46.18	46.18
9. Disorientation	46.40	46.40	46.40	46.40
10. Lack of Insight	42.41	71.61	61.87	58.63
11. Depersonalization/ Derealization	45.70	45.70	45.70	45.70
12. Paranoid Delusions	83.31	83.31	89.58	85.40
13. Grandiose Delusions	74.32	87.84	60.81	74.323
14. Control Delusions	47.19	47.19	47.19	47.19
15. Visual Hallucinations	47.26	47.26	47.26	47.26
16. Auditory Hallucinations	45.83	45.83	45.83	45.83
17. Bizarre Behavior	48.02	48.02	48.02	48.02
18. Flat Affect	45.77	45.77	45.77	45.77
19. Incomprehensibility	45.16	45.16	45.16	45.16

Symptom Factors for Patient # 03	RATER A.Y.	B.K.G.	S.M.	$\bar{X}$
1. Depression	48.89	46.19	40.79	42.14
2. Anxiety	42.58	42.58	42.58	42.58
3. Speech Retardation	46.44	46.44	46.44	46.44
4. Hypomania	71.31	71.31	71.31	71.31
5. Somatic Concern	65.04	55.44	65.04	61.84
6. Observed Belligerence	46.30	46.30	46.30	46.30
7. Reported Belligerence	68.22	68.22	62.98	66.473
8. Obsessions	46.18	46.18	46.18	46.18
9. Disorientation	46.40	46.40	46.40	46.40
10. Lack of Insight	61.87	71.61	71.61	68.363
11. Depersonalization/ Derealization	53.24	53.24	35.70	50.727
12. Paranoid Delusions	70.78	83.31	89.58	81.223
13. Grandiose Delusions	101.35	114.86	87.84	101.35
14. Control Delusions	47.19	62.81	47.19	52.397
15. Visual Hallucinations	47.26	47.26	47.26	47.26
16. Auditory Hallucinations	64.17	77.92	75.62	72.57
17. Bizarre Behavior	48.02	48.02	48.02	48.02
18. Flat Affect	45.77	45.77	45.77	45.77
19. Incomprehensibility	52.53	59.91	74.65	62.363

Symptom Factors for Patient # 04	RATER A.Y.	B.K.G.	S.M.	$\bar{X}$
1. Depression	44.84	42.14	40.79	42.59
2. Anxiety	42.58	42.58	42.58	42.58
3. Speech Retardation	65.59	75.16	46.44	62.397
4. Hypomania	46.87	46.87	46.87	46.87
5. Somatic Concern	45.84	45.84	45.84	45.84
6. Observed Belligerence	46.30	54.01	61.72	54.01
7. Reported Belligerence	47.28	42.04	42.04	43.789
8. Obsessions	46.18	46.18	46.18	46.18
9. Disorientation	46.40	46.40	46.40	46.40
10. Lack of Insight	61.87	61.87	61.87	61.87
11. Depersonalization/ Derealization	45.70	45.70	45.70	45.70
12. Paranoid Delusions	58.25	45.71	45.71	49.89
13. Grandiose Delusions	47.30	47.30	47.30	47.30
14. Control Delusions	47.19	55.00	47.19	49.793
15. Visual Hallucinations	47.26	47.26	47.26	47.26
16. Auditory Hallucinations	45.83	61.88	59.58	55.763
17. Bizarre Behavior	48.02	48.02	48.02	48.02
18. Flat Affect	45.77	65.00	45.77	52.18
19. Incomprehensibility	45.16	45.16	45.16	45.16

Symptom Factors for Patient # 05	RATER A.Y.	B.K.G.	S.M.	$\bar{X}$
1. Depression	36.74	38.09	36.74	37.19
2. Anxiety	52.04	45.74	52.04	49.94
3. Speech Retardation	46.44	56.02	46.44	49.633
4. Hypomania	59.09	71.31	59.09	63.163
5. Somatic Concern	45.84	45.84	45.84	45.84
6. Observed Belligerence	69.44	92.60	84.88	82.307
7. Reported Belligerence	57.75	52.51	52.51	54.257
8. Obsessions	57.61	91.93	46.18	65.24
9. Disorientation	46.40	46.40	46.40	46.40
10. Lack of Insight	42.41	71.61	42.41	52.143
11. Depersonalization/ Derealization	45.70	45.70	45.70	45.70
12. Paranoid Delusions	83.31	89.58	45.71	72.867
13. Grandiose Delusions	114.86	128.38	47.30	96.847
14. Control Delusions	70.62	55.00	47.19	57.603
15. Visual Hallucinations	47.26	47.26	47.26	47.26
16. Auditory Hallucinations	68.75	71.04	45.83	61.873
17. Bizarre Behavior	48.02	48.02	48.02	48.02
18. Flat Affect	45.77	45.77	45.77	45.77
19. Incomprehensibility	45.16	59.91	45.16	50.077

Symptom Factors for Patient # 06	RATER A.Y.	B.K.G.	S.M.	$\bar{X}$
1. Depression	36.74	36.74	36.74	36.74
2. Anxiety	42.58	42.58	42.58	42.58
3. Speech Retardation	56.02	46.44	46.44	49.633
4. Hypomania	46.87	46.87	46.87	46.87
5. Somatic Concern	45.84	45.84	45.84	45.84
6. Observed Belligerence	46.30	46.30	46.30	46.30
7. Reported Belligerence	42.04	42.04	42.04	42.04
8. Obsessions	46.18	46.18	46.18	46.18
9. Disorientation	46.40	52.70	46.40	48.50
10. Lack of Insight	61.87	71.61	61.87	65.117
11. Depersonalization/ Derealization	45.70	45.70	45.70	45.70
12. Paranoid Delusions	45.71	45.71	45.71	45.71
13. Grandiose Delusions	101.35	101.35	87.84	96.847
14. Control Delusions	47.19	47.19	47.19	47.19
15. Visual Hallucinations	92.99	102.13	92.99	96.037
16. Auditory Hallucinations	82.50	82.50	87.08	84.027
17. Bizarre Behavior	48.02	48.02	48.02	48.02
18. Flat Affect	74.62	45.77	45.77	55.387
19. Incomprehensibility	45.16	45.16	45.16	45.16

Symptom Factors for Patient # 07	RATER A.Y.	B.K.G.	S.M.	$\bar{X}$
1. Depression	43.49	44.84	43.49	43.94
2. Anxiety	48.89	48.89	45.74	47.84
3. Speech Retardation	46.44	46.44	46.44	46.44
4. Hypomania	71.31	59.09	59.09	63.163
5. Somatic Concern	45.84	55.44	65.04	55.44
6. Observed Belligerence	46.30	46.30	46.30	46.30
7. Reported Belligerence	68.22	73.46	57.75	66.477
8. Obsessions	80.49	103.37	80.49	88.117
9. Disorientation	46.40	46.40	46.40	46.40
10. Lack of Insight	61.87	61.87	61.87	61.87
11. Depersonalization/ Derealization	45.70	53.24	53.24	50.727
12. Paranoid Delusions	64.51	70.78	45.71	60.33
13. Grandiose Delusions	74.32	74.32	74.32	74.32
14. Control Delusions	47.19	47.19	47.19	47.19
15. Visual Hallucinations	47.26	47.26	47.26	47.26
16. Auditory Hallucinations	64.17	57.29	45.83	55.763
17. Bizarre Behavior	48.02	48.02	48.02	48.02
18. Flat Affect	45.77	45.77	45.77	45.77
19. Incomprehensibility	59.91	52.53	82.03	64.823

Symptom Factors for Patient # 08	RATER A.Y.	B.K.G.	S.M.	$\bar{X}$
1. Depression	48.89	44.84	48.89	47.54
2. Anxiety	42.58	42.58	42.58	42.58
3. Speech Retardation	56.02	94.31	75.16	75.163
4. Hypomania	46.87	59.09	59.09	55.017
5. Somatic Concern	45.84	45.84	45.84	45.84
6. Observed Belligerence	46.30	46.30	46.30	46.30
7. Reported Belligerence	57.75	47.28	42.04	49.023
8. Obsessions	46.18	46.18	46.18	46.18
9. Disorientation	46.40	46.40	46.40	46.40
10. Lack of Insight	61.87	71.61	42.41	58.63
11. Depersonalization/ Derealization	45.70	45.70	45.70	45.70
12. Paranoid Delusions	64.51	45.71	45.71	51.977
13. Grandiose Delusions	47.30	47.30	47.30	47.30
14. Control Delusions	47.19	47.19	47.19	47.19
15. Visual Hallucinations	47.26	47.26	47.26	47.26
16. Auditory Hallucinations	45.83	45.83	45.83	45.83
17. Bizarre Behavior	48.02	48.02	48.02	48.02
18. Flat Affect	84.23	74.62	45.77	68.207
19. Incomprehensibility	59.91	59.91	45.16	54.993

Symptom Factors for Patient # 09	RATER A.Y.	B.K.G.	S.M.	$\bar{X}$
1. Depression	61.05	63.75	57.00	60.60
2. Anxiety	45.74	45.74	42.58	44.687
3. Speech Retardation	46.44	46.44	46.44	46.44
4. Hypomania	59.09	46.87	59.09	55.017
5. Somatic Concern	45.84	74.64	65.04	61.84
6. Observed Belligerence	46.30	46.30	46.30	46.30
7. Reported Belligerence	47.28	47.28	47.28	47.28
8. Obsessions	46.18	46.18	46.18	46.18
9. Disorientation	46.40	46.40	52.70	48.50
10. Lack of Insight	42.41	42.41	42.41	42.41
11. Depersonalization/ Derealization	45.70	53.24	45.70	48.213
12. Paranoid Delusions	45.71	83.31	51.98	60.333
13. Grandiose Delusions	60.81	74.32	47.30	60.81
14. Control Delusions	47.19	47.19	47.19	47.19
15. Visual Hallucinations	47.26	47.26	47.26	47.26
16. Auditory Hallucinations	45.83	45.83	66.46	52.707
17. Bizarre Behavior	48.02	48.02	48.02	48.02
18. Flat Affect	45.77	45.77	45.77	45.77
19. Incomprehensibility	45.16	45.16	45.16	45.16

Symptom Factors for Patient # 10	RATER A.Y.	B.K.G.	S.M.	$\bar{X}$
1. Depression	52.95	55.65	50.24	52.947
2. Anxiety	45.74	42.58	42.58	43.633
3. Speech Retardation	46.44	46.44	46.44	46.44
4. Hypomania	59.09	46.87	46.87	50.943
5. Somatic Concern	45.84	45.84	45.84	45.84
6. Observed Belligerence	46.30	46.30	46.30	46.30
7. Reported Belligerence	42.04	62.98	62.98	56.00
8. Obsessions	46.18	46.18	46.18	46.18
9. Disorientation	46.40	46.40	46.40	46.40
10. Lack of Insight	61.87	71.61	71.61	68.363
11. Depersonalization/ Derealization	45.70	45.70	45.70	45.70
12. Paranoid Delusions	83.31	70.78	89.58	81.223
13. Grandiose Delusions	60.81	60.81	74.32	65.313
14. Control Delusions	55.00	62.81	55.00	57.603
15. Visual Hallucinations	47.26	47.26	47.26	47.26
16. Auditory Hallucinations	77.92	71.04	73.33	74.097
17. Bizarre Behavior	48.02	48.02	48.02	48.02
18. Flat Affect	45.77	45.77	45.77	45.77
19. Incomprehensibility	45.16	52.53	52.53	50.073

Symptom Factors for Patient # 11	RATER A.Y.	B.K.G.	S.M.	$\bar{X}$
1. Depression	39.44	38.09	38.09	38.54
2. Anxiety	42.58	42.58	42.58	42.58
3. Speech Retardation	46.44	46.44	46.44	46.44
4. Hypomania	71.31	46.87	59.09	59.09
5. Somatic Concern	45.84	45.84	45.84	45.84
6. Observed Belligerence	46.30	46.30	46.30	46.30
7. Reported Belligerence	68.22	62.98	42.04	57.747
8. Obsessions	46.18	46.18	46.18	46.18
9. Disorientation	46.40	46.40	46.40	46.40
10. Lack of Insight	42.41	42.41	42.41	42.41
11. Depersonalization/ Derealization	45.70	53.24	53.24	50.727
12. Paranoid Delusions	51.98	45.71	45.71	47.80
13. Grandiose Delusions	74.32	101.35	60.81	78.827
14. Control Delusions	47.19	78.44	62.81	62.813
15. Visual Hallucinations	47.26	47.26	47.26	47.26
16. Auditory Hallucinations	68.75	64.17	66.46	66.46
17. Bizarre Behavior	48.02	48.02	48.02	48.02
18. Flat Affect	45.77	45.77	45.77	45.77
19. Incomprehensibility	45.16	45.16	45.16	45.16

Symptom Factors for Patient # 12	RATER A.Y.	B.K.G.	S.M.	$\bar{X}$
1. Depression	61.05	58.35	47.54	55.647
2. Anxiety	42.58	45.74	42.58	43.633
3. Speech Retardation	46.44	65.59	46.44	52.823
4. Hypomania	59.09	46.87	46.87	50.943
5. Somatic Concern	55.44	45.84	65.04	55.44
6. Observed Belligerence	46.30	46.30	46.30	46.30
7. Reported Belligerence	52.51	47.28	47.28	49.023
8. Obsessions	46.18	57.61	46.18	49.99
9. Disorientation	46.40	46.40	46.40	46.40
10. Lack of Insight	42.41	42.41	42.41	42.41
11. Depersonalization/ Derealization	53.24	53.24	45.70	50.727
12. Paranoid Delusions	58.25	64.51	64.51	62.423
13. Grandiose Delusions	60.81	60.81	47.30	56.307
14. Control Delusions	47.19	47.19	47.19	47.19
15. Visual Hallucinations	83.84	83.84	83.84	83.84
16. Auditory Hallucinations	75.62	45.83	45.83	55.76
17. Bizarre Behavior	65.86	65.86	48.02	59.913
18. Flat Affect	45.77	45.77	45.77	45.77
19. Incomprehensibility	52.53	74.65	67.28	64.82

Symptom Factors for Patient # 13	RATER A.Y.	B.K.G.	S.M.	$\bar{X}$
1. Depression	54.30	54.30	55.65	54.75
2. Anxiety	45.74	45.74	42.58	44.687
3. Speech Retardation	56.02	46.44	46.44	49.633
4. Hypomania	46.87	46.87	46.87	46.87
5. Somatic Concern	45.84	45.84	45.84	45.84
6. Observed Belligerence	46.30	46.30	46.30	46.30
7. Reported Belligerence	42.04	42.04	42.04	42.04
8. Obsessions	46.18	46.18	46.18	46.18
9. Disorientation	46.40	46.40	52.70	48.50
10. Lack of Insight	61.87	71.61	61.87	65.117
11. Depersonalization/ Derealization	45.70	45.70	45.70	45.70
12. Paranoid Delusions	77.04	70.78	70.78	72.867
13. Grandiose Delusions	87.84	87.84	74.32	83.333
14. Control Delusions	47.19	47.19	47.19	47.19
15. Visual Hallucinations	92.99	92.99	83.84	89.94
16. Auditory Hallucinations	73.33	61.88	55.00	63.403
17. Bizarre Behavior	48.02	48.02	48.02	48.02
18. Flat Affect	45.77	45.77	45.77	45.77
19. Incomprehensibility	45.16	52.53	45.16	47.617

Symptom Factors for Patient # 14	RATER A.Y.	B.K.G.	S.M.	$\bar{X}$
1. Depression	39.44	44.84	40.79	41.69
2. Anxiety	42.58	42.58	42.58	42.58
3. Speech Retardation	46.44	46.44	46.44	46.44
4. Hypomania	59.09	46.87	46.87	50.943
5. Somatic Concern	45.84	45.84	45.84	45.84
6. Observed Belligerence	46.30	46.30	46.30	46.30
7. Reported Belligerence	62.98	57.75	42.04	54.257
8. Obsessions	46.18	46.18	46.18	46.18
9. Disorientation	46.40	46.40	46.40	46.40
10. Lack of Insight	52.14	52.14	61.87	55.383
11. Depersonalization/ Derealization	53.24	53.24	53.24	53.24
12. Paranoid Delusions	45.71	58.25	45.71	49.89
13. Grandiose Delusions	74.32	47.30	47.30	56.307
14. Control Delusions	47.19	70.62	47.19	55.00
15. Visual Hallucinations	47.26	47.26	47.26	47.26
16. Auditory Hallucinations	45.83	45.83	45.83	45.83
17. Bizarre Behavior	48.02	48.02	48.02	48.02
18. Flat Affect	45.77	55.38	65.00	55.383
19. Incomprehensibility	67.28	67.28	74.65	69.737

Symptom Factors for Patient # 15	RATER A.Y.	B.K.G.	S.M.	$\bar{X}$
1. Depression	46.19	47.54	47.54	47.09
2. Anxiety	42.58	42.58	45.74	43.633
3. Speech Retardation	46.44	46.44	46.44	46.44
4. Hypomania	71.31	59.09	59.09	63.163
5. Somatic Concern	45.84	45.84	45.84	45.84
6. Observed Belligerence	46.30	46.30	46.30	46.30
7. Reported Belligerence	73.46	78.70	73.46	75.207
8. Obsessions	57.61	46.18	57.61	53.80
9. Disorientation	46.40	46.40	46.40	46.40
10. Lack of Insight	42.41	42.41	42.41	42.41
11. Depersonalization/ Derealization	45.70	45.70	45.70	45.70
12. Paranoid Delusions	45.71	45.71	45.71	45.71
13. Grandiose Delusions	101.35	87.84	47.30	78.83
14. Control Delusions	47.19	47.19	47.19	47.19
15. Visual Hallucinations	47.26	47.26	47.26	47.26
16. Auditory Hallucinations	45.83	45.83	45.83	45.83
17. Bizarre Behavior	48.02	48.02	48.02	48.02
18. Flat Affect	45.77	45.77	45.77	45.77
19. Incomprehensibility	45.16	45.16	45.16	45.16

Symptom Factors for Patient # 16	RATER A.Y.	B.K.G.	S.M.	$\bar{X}$
1. Depression	39.44	40.79	39.44	39.89
2. Anxiety	42.58	45.74	42.58	43.633
3. Speech Retardation	56.02	75.16	56.02	62.40
4. Hypomania	46.87	46.87	46.87	46.87
5. Somatic Concern	84.24	93.84	93.84	90.64
6. Observed Belligerence	46.30	54.01	46.30	48.87
7. Reported Belligerence	42.04	47.28	47.28	45.533
8. Obsessions	46.18	46.18	46.18	46.18
9. Disorientation	46.40	46.40	46.40	46.40
10. Lack of Insight	42.41	42.41	42.41	42.41
11. Depersonalization/ Derealization	45.70	45.70	45.70	45.70
12. Paranoid Delusions	64.51	77.04	51.98	64.51
13. Grandiose Delusions	74.32	87.84	74.32	78.827
14. Control Delusions	47.19	47.19	47.19	47.19
15. Visual Hallucinations	83.84	83.84	83.84	83.84
16. Auditory Hallucinations	82.50	89.37	91.67	87.847
17. Bizarre Behavior	48.02	48.02	48.02	48.02
18. Flat Affect	45.77	74.62	45.77	55.387
19. Incomprehensibility	59.91	59.91	74.65	63.823

Symptom Factors for Patient #17	RATER A.Y.	B.K.G.	S.M.	$\bar{X}$
1. Depression	54.30	57.00	54.30	55.20
2. Anxiety	52.04	67.79	45.74	55.19
3. Speech Retardation	65.69	84.73	94.31	81.543
4. Hypomania	46.87	46.87	46.87	46.87
5. Somatic Concern	45.84	45.84	65.04	52.24
6. Observed Belligerence	46.30	46.30	46.30	46.30
7. Reported Belligerence	52.51	62.98	62.98	59.49
8. Obsessions	46.18	57.61	46.18	49.99
9. Disorientation	46.40	59.01	52.70	52.703
10. Lack of Insight	42.41	71.61	71.61	61.877
11. Depersonalization/ Derealization	45.70	53.24	45.70	48.213
12. Paranoid Delusions	58.25	77.04	77.04	70.777
13. Grandiose Delusions	60.81	60.81	60.81	60.81
14. Control Delusions	47.19	94.06	62.81	68.02
15. Visual Hallucinations	47.26	47.26	56.40	50.307
16. Auditory Hallucinations	48.13	71.04	45.83	55.00
17. Bizarre Behavior	65.86	48.02	48.02	53.967
18. Flat Affect	74.62	55.38	65.00	65.00
19. Incomprehensibility	45.16	52.53	74.65	57.447

Symptom Factors for Patient # 18	RATER A.Y.	B.K.G.	S.M.	$\bar{X}$
1. Depression	51.60	47.54	48.89	49.343
2. Anxiety	48.89	52.04	45.74	48.89
3. Speech Retardation	56.02	84.73	75.16	71.97
4. Hypomania	46.87	71.31	59.09	59.09
5. Somatic Concern	45.84	45.84	45.84	45.84
6. Observed Belligerence	46.30	46.30	46.30	46.30
7. Reported Belligerence	47.28	47.28	42.04	45.533
8. Obsessions	46.18	46.18	46.18	46.18
9. Disorientation	46.40	46.40	46.40	46.40
10. Lack of Insight	42.41	42.41	42.41	42.41
11. Depersonalization/ Derealization	45.70	60.78	45.70	50.727
12. Paranoid Delusions	89.58	83.31	77.04	83.31
13. Grandiose Delusions	47.30	47.30	47.30	47.30
14. Control Delusions	47.19	55.00	47.19	49.793
15. Visual Hallucinations	47.26	47.26	47.26	47.26
16. Auditory Hallucinations	45.83	45.83	45.83	45.83
17. Bizarre Behavior	48.02	48.02	48.02	48.02
18. Flat Affect	93.85	65.00	65.00	74.617
19. Incomprehensibility	52.53	45.16	45.16	47.617

Symptom Factors for Patient # 19	RATER A.Y.	B.K.G.	S.M.	$\bar{X}$
1. Depression	48.89	51.60	48.89	49.793
2. Anxiety	52.04	55.19	58.34	55.19
3. Speech Retardation	46.44	46.44	46.44	46.44
4. Hypomania	71.31	59.09	71.31	67.237
5. Somatic Concern	45.84	45.84	45.84	45.84
6. Observed Belligerence	46.30	46.30	46.30	46.30
7. Reported Belligerence	42.04	42.04	42.04	42.04
8. Obsessions	46.18	46.18	46.18	46.18
9. Disorientation	46.40	46.40	46.40	46.40
10. Lack of Insight	42.41	42.41	52.14	45.653
11. Depersonalization/ Derealization	45.70	60.78	45.70	50.727
12. Paranoid Delusions	45.71	45.71	45.71	45.71
13. Grandiose Delusions	87.84	114.86	47.30	83.333
14. Control Delusions	47.19	47.19	47.19	47.19
15. Visual Hallucinations	47.26	92.99	74.70	71.65
16. Auditory Hallucinations	73.33	73.33	45.83	64.163
17. Bizarre Behavior	48.02	48.02	48.02	48.02
18. Flat Affect	45.77	45.77	45.77	45.77
19. Incomprehensibility	45.16	52.53	45.16	47.617

APPENDIX IV

VARIABILITY OF THRESHOLD MEASURES IN PSYCHIATRIC PATIENTS

Introduction

The rationale for this analysis has several bases. First of all, Gruzelier and Hammond (1979) have reported greater variability in the right ear va. left ear threshold measures for schizophrenic patients. This was interpreted as indicative of disturbance in left hemisphere temporal-limbic function in these patients. They suggested that the concept of "strength of nervous system" discussed in conjunction with schizophrenia in the Soviet literature (Pavlov, 1941) might prove relevant in this context. Teplov (1972) has reported that several Soviet researchers (Ippolitov, 1972; Nebylitsyn, Note 20; and Teplov, 1955) have found lower absolute auditory thresholds which increase with prolonged stimulation for subjects with "weak inhibitory" nervous systems. An alternative hypothesis, suggested by Gruzelier and Hammond (1979) to explain this variability involved endocrine functioning, with diurnal and long-term plasma cortisol level changes paralleling threshold alterations.

The variability observed by Gruzelier and Hammond was of a long-term variety; with a significant ear x session x frequency effect observed over testing of several weeks' duration, and an ear x time of day interaction approaching statistical significance observed in daily testing.

A question exists as to whether such right ear variability might be observed on a short-term basis, i.e., within one session of 10 - 15 minutes' duration, and whether such variability, if demonstrated, would be related to some distinct symptomatology

profile in psychiatric patients.

Gruzelier and Hammond had selected schizophrenic subjects and compared them to non-patient controls. In the present investigation, threshold variability was examined, and correlates of this in patient symptomatology were sought for the affectives and schizophrenics, as well as for the total patient group.

A second reason for the investigation of threshold variability involved the medication question. If medication level had acted as a confounding factor in this study (as discussed in the body of the main text), one might expect variability within threshold measures to be correlated with medication, either in all patients, or in the affective and/or schizophrenic groups, or one might expect greater threshold variability in one of the patient groups.

A third reason for this investigation is that, as Chapman and Chapman (1973 a; b) have noted, demonstrations of "differential deficit" in patient populations such as the findings of the present study, could be the result of "psychometric artifact". That is to say, a more discriminating task is more likely to demonstrate a patient deficit, and if tasks of unequal discriminating power are compared, an artifactual differential deficit might be wrongly inferred, when all that is actually present is across-the-board poorer patient performance. Such poorer patient performance may be the result of something as simple as poorer motivation or attention. The rationale of the Chapmans' critique is discussed in more detail in the main text.

If the tasks used in this study were of unequal discriminating power, differences in patient variability for some conditions (i.e., the 2 ms or noise values) and for some patient groups, might be expected. Analyses of within-session threshold variability cannot disprove the Chapmans' critique, but they can provide some evidence as to the likelihood of this problem being relevant to the present study.

A fourth aspect of this variability analysis involves the question of whether the placement of the fan in the subjects' testing chamber might have differentially affected thresholds in the two ears. A right vs. left ear comparison of variability would help to answer this question.

It should be noted that for all the aspects of this variability analysis, the failure to find differences could not disprove the hypotheses in question; it would only not provide support for them. It may be that the variability measure used was not of appropriate sensitivity to detect the hypothesized differences.

Methods

As auditory thresholds were measured using a brief staircase procedure which required three revisitations at a stimulus intensity level in the 5 dB and 1 d B ranges, the number of blocks of trials after the subject's first descending error could be used to provide an index of threshold variability which was independent of threshold level. Subjects who were more variable would take more stimulus presentations to reach the criteria for "threshold".

The number of blocks of trials needed to reach criterion for the 1000 Hz and white noise stimuli at 2 and 500 ms durations for the right and left ears, and average staircase length for all right vs. all left ear threshold measures were compared for patients and non-patients, and for subjects given Project diagnoses of affective disorder and of schizophrenia; and correlations with psychiatric symptomatology factors were examined, using a two-tailed test of significance of Pearson correlation coefficients.

Results

Comparisons of the number of blocks needed to meet the criterion of three revisitations of a threshold value at the 5 dB level and three revisitations at the 1 dB step level showed no significant differences in threshold length (i.e. within-session threshold variability) for the patients vs non-patients and the schizophrenics vs. affectives vs. non-patients. No right vs. left ear differences in variability were found, for all subjects as a group, or for any of the sub-groups of subjects. In addition, none of the stimulus durations or stimulus spectral composition conditions, or combinations of these conditions for any of the gorups resulted in significantly longer (more variable) thresholds.

Pearson correlations of clinical factors (symptom profile factors, using the average of three raters' determinations) and phenothiazine dosage with the threshold procedure length (for the 1000 Hz and white noise thresholds at stimulus durations of 2 and 500 ms for right and left ears, and for left and right ear averages, and for overall right vs. left ear measures) were calculated for all patients.

Of these 240 correlations, only 8 were statistically significant at the p = .05 level, using two-tailed tests of significance:, for all patients grouped together.

Right ear, 1000 Hz, 500 ms, number of blocks to threshold:

r = +0.48; p = .037 with Hypomania

r = +0.48; p = .036 with Paraniod Delusions

Right ear, noise, 2 ms, number of blocks to threshold

r = -0.49; p = .038 with Depersonalization/Derealization

Left ear, 1000 Hz, 2 ms, number of blocks to threshold

r = -0.53; p = .018 with Visual Hallucinations

Left ear, noise, 2 ms, number of blocks to threshold

r = +0.63; p = .005 with Grandiose Delusions

r = +0.47; p = .050 with Speech Retardation

Left ear, average of all threshold measures, number of blocks to threshold

r = +0.48; p = .039 with Control Delusions

r = +0.50; p = .028 with Reported Belligerence

Since 5% of these correlations could be expected to show a fortuitous statistical significance if the measures were unrelated, the observation of 8 significant correlations where 12 might be expected on the basis of chance cannot be interpreted as a positive result.

It is of interest to note, however, that no significant correlations were observed between phenothiazine dosage and threshold procedure length, which adds support to the assumption that threshold measures were not confounded by drug dosage effects.

Furthermore, using these measures, no support was found for greater short-term right ear variability analogous to that observed in long-term testing of schizophrenics by Gruzelier and Hammond.

In addition, threshold measures for all conditions were of equal variability, which provides some argument that these tasks were equivalent in psychometric power, and that the location of the fan in the testing chamber did not introduce artifact.

Discussion

The lack of clear-cut findings of greater right ear variability in threshold for schizophrenic patients should not be viewed as a failure to replicate Gruzelier and Hammond's (1978) findings. In the present study, variability was measured over a very brief period of time (i.e., within approximately 10 minutes), whereas Gruzelier and Hammond studied threshold variability occurring over the course of the day or over a long course of repeated testing.

Although the "weak inhibitory" nervous system interpretation of the variability observed by Gruzelier and Hammond might also be consonant with increases in variability observable over a rather short time course, an interpretation of the phenomenon based on diurnal and long-term plasma cortisol changes would not predict higher variability in one ear over such a short time course.

The finding that drug dosage was not related to variability within threshold measures helps to provide assurance that the measures of auditory threshold were not confounded by medication level. Likewise, the finding that there were no differences across ears in variability suggests that fan placement effects were not severe.

The demonstration of no statistically significant differences in threshold procedure length (i.e., short-term variability) suggests that the findings of the main study are not likely to be artifacts of unequal psychometric disceiminating power of the tasks employed.

It should be reiterated that the failure to demonstrate any of these effects does not guarantee that any of these factors did not contribute to the present results. However, had some of these analyses resulted in positive findings (with respect to the possibility of medication effects, fan effects, or psychometric artifact), they might have provided cause to suspect confounding by these variables.

APPENDIX V : CORRELATIONS

Threshold-Threshold Correlations for All 19 Patients

Pearson r

	T01	T02	T03	T04	T05	T06
T01	*****	.7799	.4273	.5532	.5344	.3142
T02		*****	-.2326	.4351	.7042	.0340
T03			*****	.2317	-.1876	.4404
T04				*****	.6365	.8153
T05					*****	.0724
T06						*****
T07						
T08						
T09						
T10						
T11						
T12						
T13						
T14						
T15						
T16						
T17						
T18						

Notes.

See Table 15 on p. 125 for an explanation of threshold code numbers.

For tests of significance (two tails), p = .10 = .378; p = .05 = .444; p = .02 = .516; p = .01 = .561 p = .002 = .679.

Threshold-Threshold Correlations for All 19 Patients

Pearson r (continued)

	T07	T08	T09	T10	T11	T12
T01	.7453	.4989	.3411	.4821	.5210	.1785
T02	.5786	.7624	-.0370	.2534	.6584	-.2084
T03	.3223	-.3260	.5835	.3842	-.1421	.5803
T04	.5514	.1436	.4233	.7710	.6213	.4521
T05	.5149	.6951	-.0649	.5675	.7998	.0636
T06	.3265	-.3361	.5961	.5710	.2030	.5369
T07	*****	.3993	.6750	.6347	.4656	.4081
T08		*****	-.4069	.1744	.6330	-.2848
T09			*****	.4797	-.0623	.6341
T10				*****	.5765	.7665
T11					*****	-.0829
T12						*****
T13						
T14						
T15						
T16						
T17						
T18						

Threshold-Threshold Correlations for All 19 Patients -- Pearson r (continued)

	T13	T14	T15	T16	T17	T18
T01	.4154	.5642	.1280	-.0405	-.0654	.1337
T02	.3276	.5674	.2835	-.0076	-.1464	.2544
T03	.1722	.0571	-.2114	-.0522	.1098	-.1603
T04	.0734	.4872	.3775	.0495	-.3347	.3587
T05	.0966	.2005	.1286	.2094	-.0806	.0072
T06	.0224	.4795	.3916	-.2213	-.3723	.4584
T07	-.2968	.3814	-.0965	.0201	-.5606	-.0955
T08	.1698	-.1004	-.0384	.0201	.2294	-.0441
T09	-.4324	.4608	-.0632	.0033	-.7432	-.0576
T10	-.1583	.1684	-.2986	-.0808	-.2739	-.2227
T11	.1466	.2090	.0928	-.4195	-.0445	.2952
T12	-.3083	.0412	-.4371	.2311	-.2991	-.5037
T13	*****	.2877	.3403	-.0927	.6711	.3477
T14		*****	.4853	-.0372	-.5169	.4476
T15			*****	.0434	-.1033	.8615
T16				*****	-.0494	-.4700
T17					*****	-.0662
T18						*****

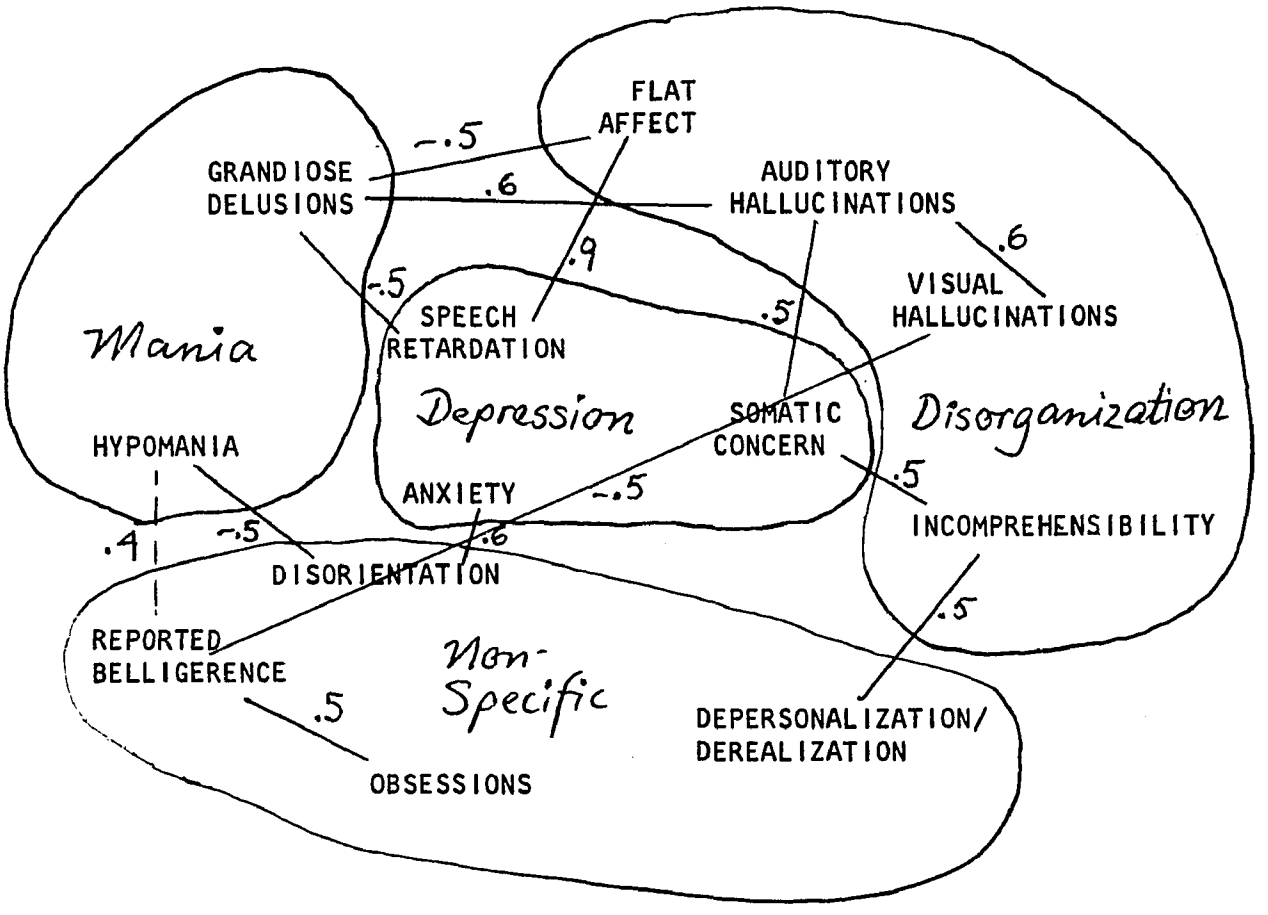
	Depression	Anxiety	Speech Retardation	Hypomania	Somatic Concern	Observed Belligerence	Reported Belligerence	Obsessions	Disorientation	Lack of Insight
Depression	***	.202	.178	-.173	.012	-.377	-.054	-.175	.274	-.060
Anxiety		***	.198	-.040	-.140	.156	-.150	.185	.608	-.231
Speech-Retardation			***	-.343	.116	-.033	-.156	-.159	.238	.043
Hypomania				***	-.131	.104	.417	.233	-.460	-.014
Somatic Concern					***	-.081	.010	.026	-.069	-.209
Observed Belligerence						***	.001	.325	-.152	-.014
Reported Belligerence							***	.472	-.195	.132
Obsessions								***	-.138	.114
Disorientation									***	.013
Lack of Insight										***
Depersonalization/Derealization										
Paranoid Delusions										
Grandiose Delusions										
Control Delusions										
Visual Hallucinations										
Auditory Hallucinations										
Bizarre Behavior										
Flat Affect										
Incomprehensibility										
Phenothiazine Dosage										

Symptom-Symptom Correlations for all 19 Patients. Pearson r

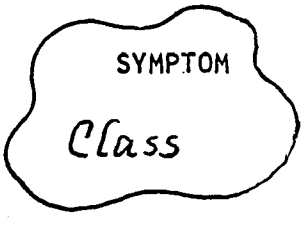
p = .10 = .378
p = .05 = .444
p = .02 = .516
p = .01 = .561
p = .002 = .679

for two-tailed tests of significance.

	Depers./Derealization	Paranoid Delusions	Grandiose Delusions	Control Delusions	Visual Hallucinations	Auditory Hallucinat.	Bizarre Behavior	Flat Affect	Incomprehensibility	Phenothiazine Dosage
Dep.	.104	.236	-.389	-.044	.024	-.269	.431	.024	-.017	.112
Anx.	.078	.024	-.059	.256	-.099	-.198	.105	.136	-.022	-.230
Sp. Ret.	-.112	.126	-.501	.246	-.048	-.145	.257	.864	.130	-.130
Hypo.	.216	.296	.380	-.134	-.384	-.211	-.232	-.297	-.094	-.064
S.C.	.006	.139	.153	-.167	.280	.499	.095	-.020	.500	-.157
Obs. Bell.	-.263	.134	.301	.222	-.142	.073	-.097	-.143	-.088	-.123
Rep. Bell.	.216	.067	.248	.315	-.490	-.132	.016	-.222	.284	.226
Obsess.	.140	.003	.193	-.031	-.191	-.091	-.006	-.230	.299	-.294
Disorient.	-.223	-.013	-.150	.312	.031	-.132	.181	.165	-.180	-.019
Lack Ins.	-.185	.301	.230	.162	.016	.254	-.154	-.015	.130	.498
Dep/Der.	***	-.079	-.091	.193	-.141	-.160	.245	.047	.513	-.296
Par. Del.		***	.086	.160	-.158	.035	.064	.070	.083	.152
Grand. Del.			***	.010	.340	.622	-.250	-.511	-.050	.061
Control Delusions				***	-.373	.067	.153	.131	.074	.298
Vis. Hall.					***	.584	.290	-.078	.082	-.206
Aud. Hall.						***	-.093	-.211	.110	.301
Biz. Behav.							***	.026	.378	-.102
Flat Aff.								***	.106	-.254
Incomp.									***	-.229
Phenothi.										***

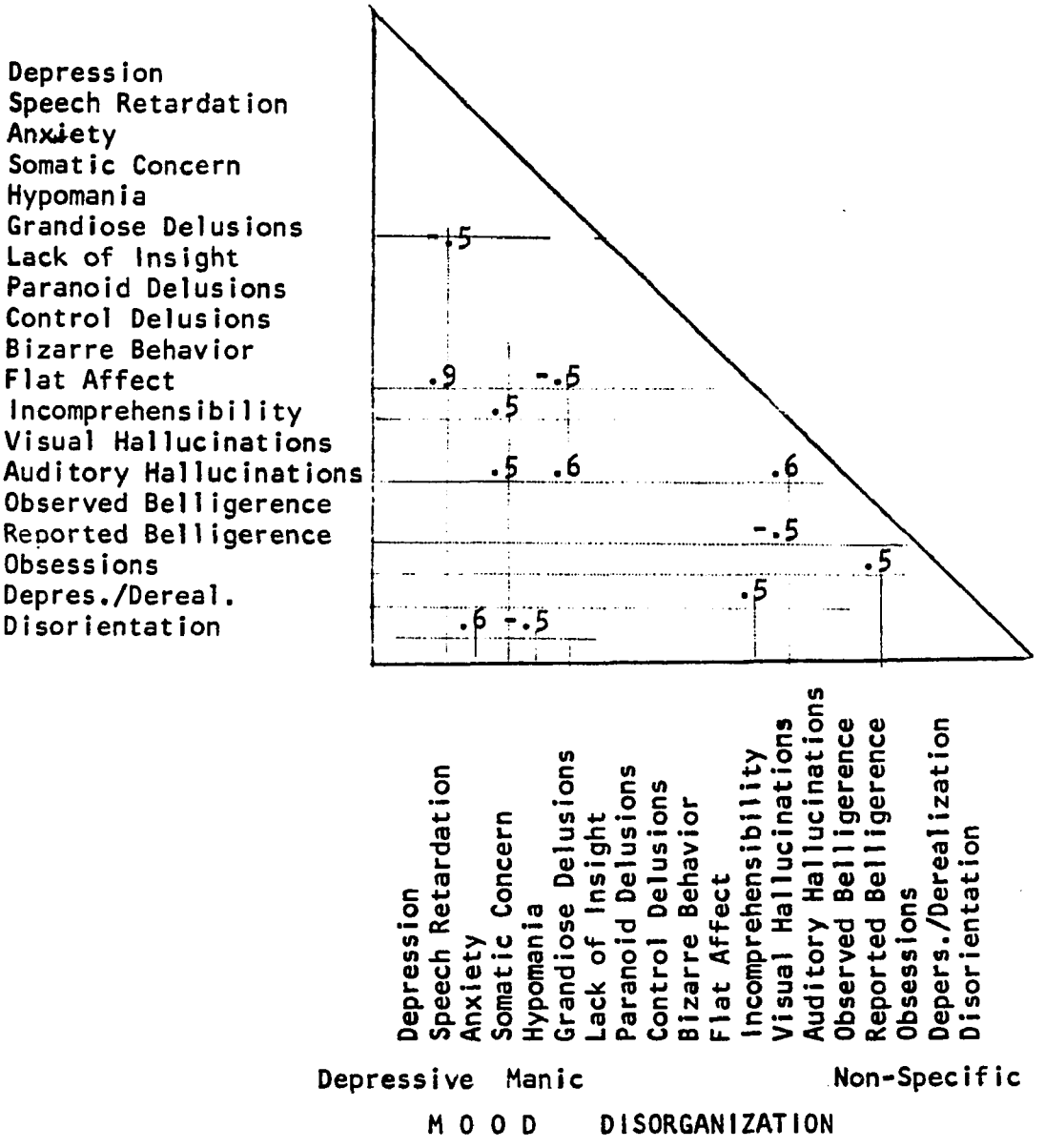


A hodological/topographical representation of relations between symptom factors for all patients (n = 19).

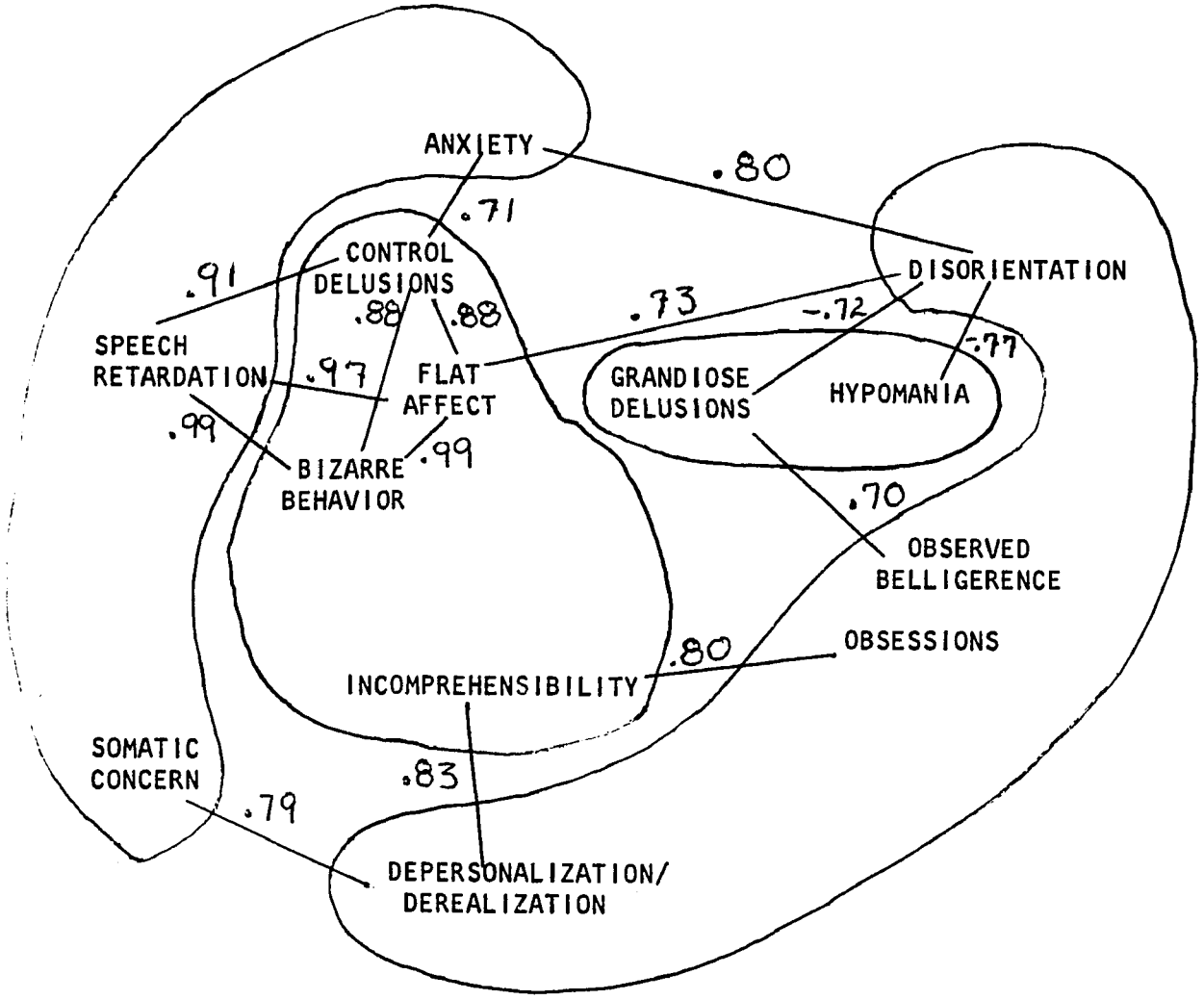


.6 CORRELATION ($p < .05$) BETWEEN SYMPTOMS

.4 NON-SIGNIFICANT CORRELATION ($p > .05$) BETWEEN SYMPTOMS



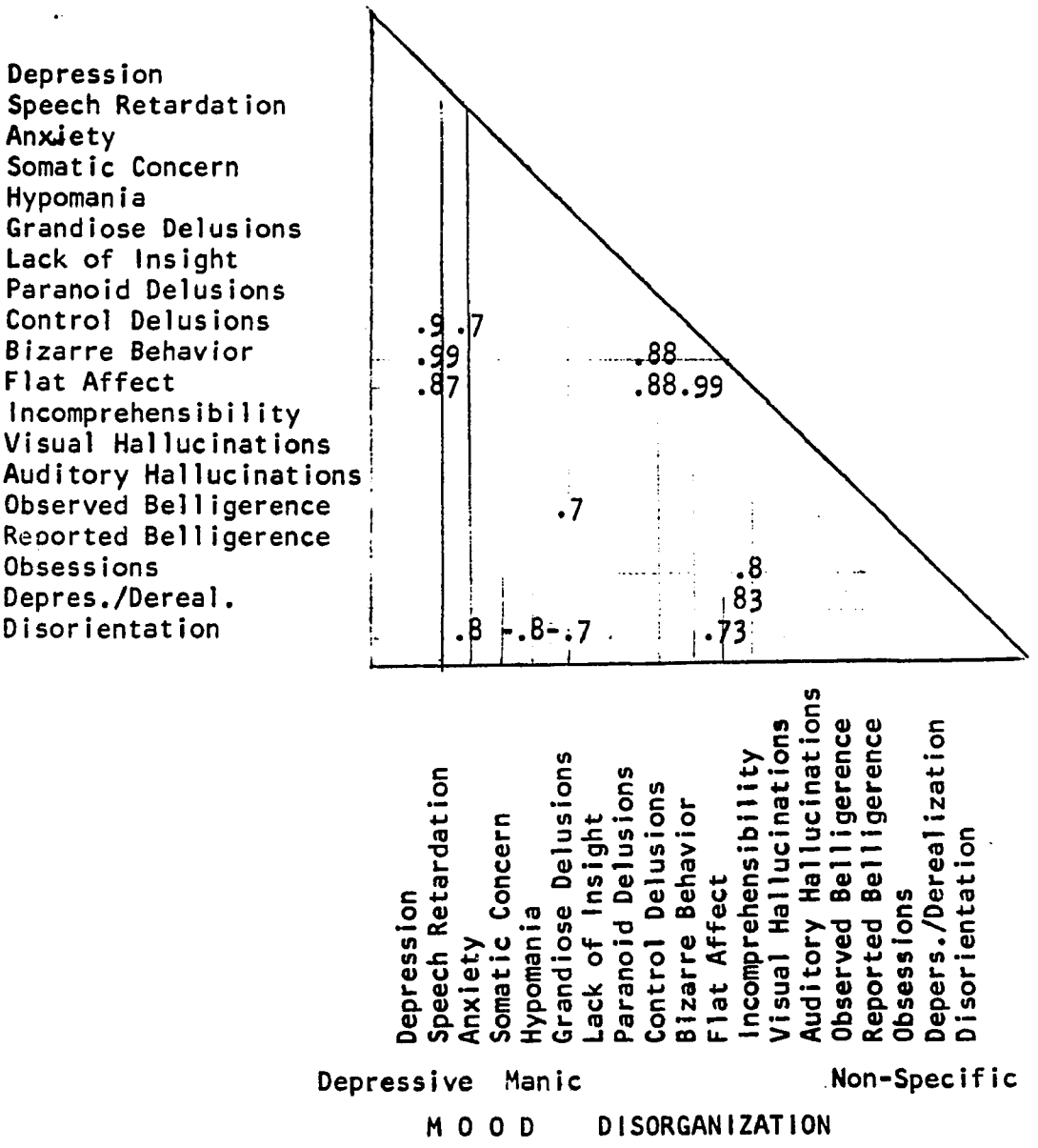
Correlations Between Symptom Factors by Three Raters; Statistical Significance ($p < .05$, two-tailed test of significance for Pearson r) for all Psychiatric Patients ($n=19$).



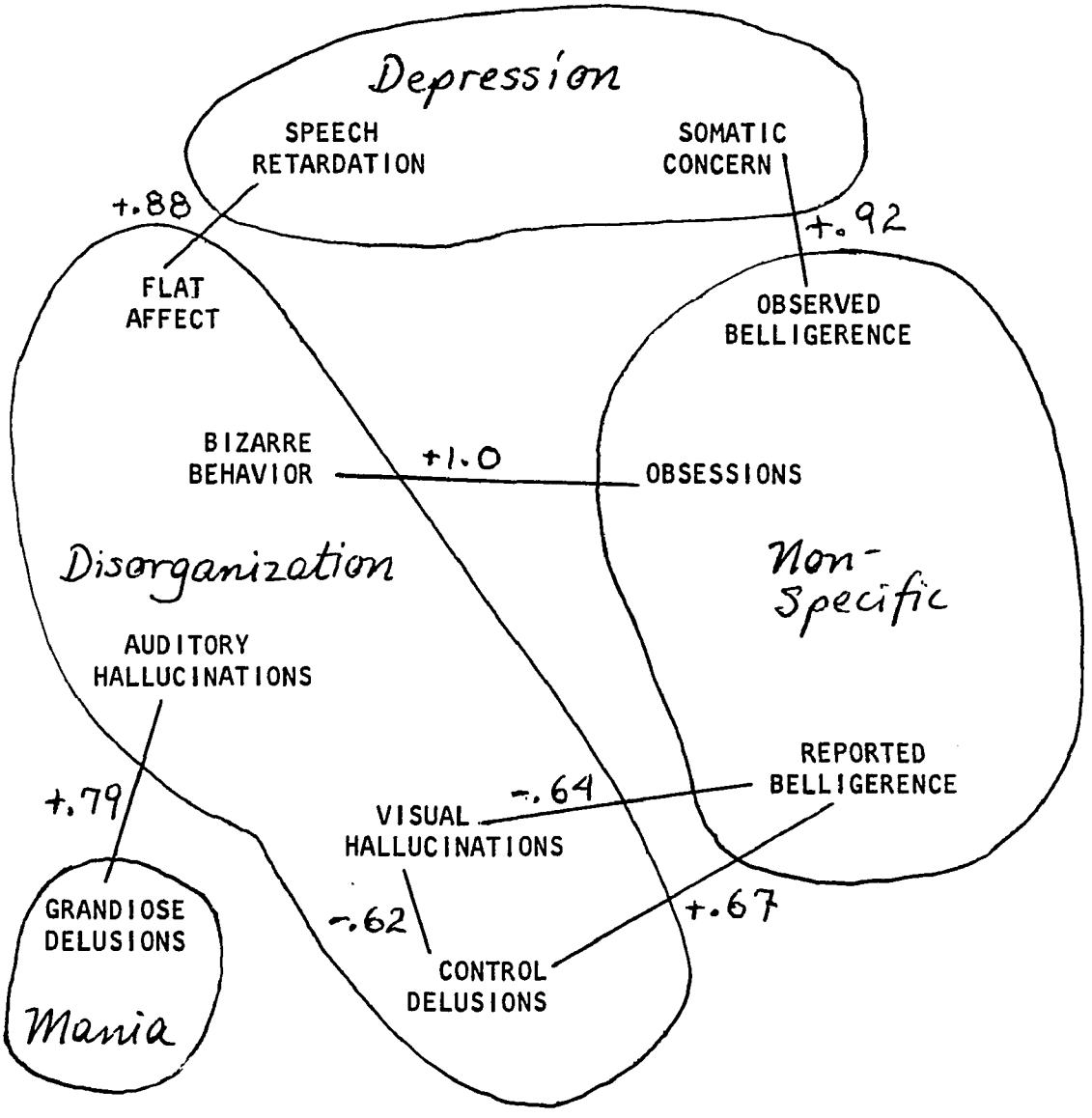
A hodological/topographical representation of relations between symptom factors for Project-diagnosed avvectives (n = 8)

SYMPTOM Class

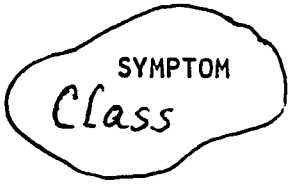
.7 CORRELATION ($p < .05$) BETWEEN SYMPTOMS



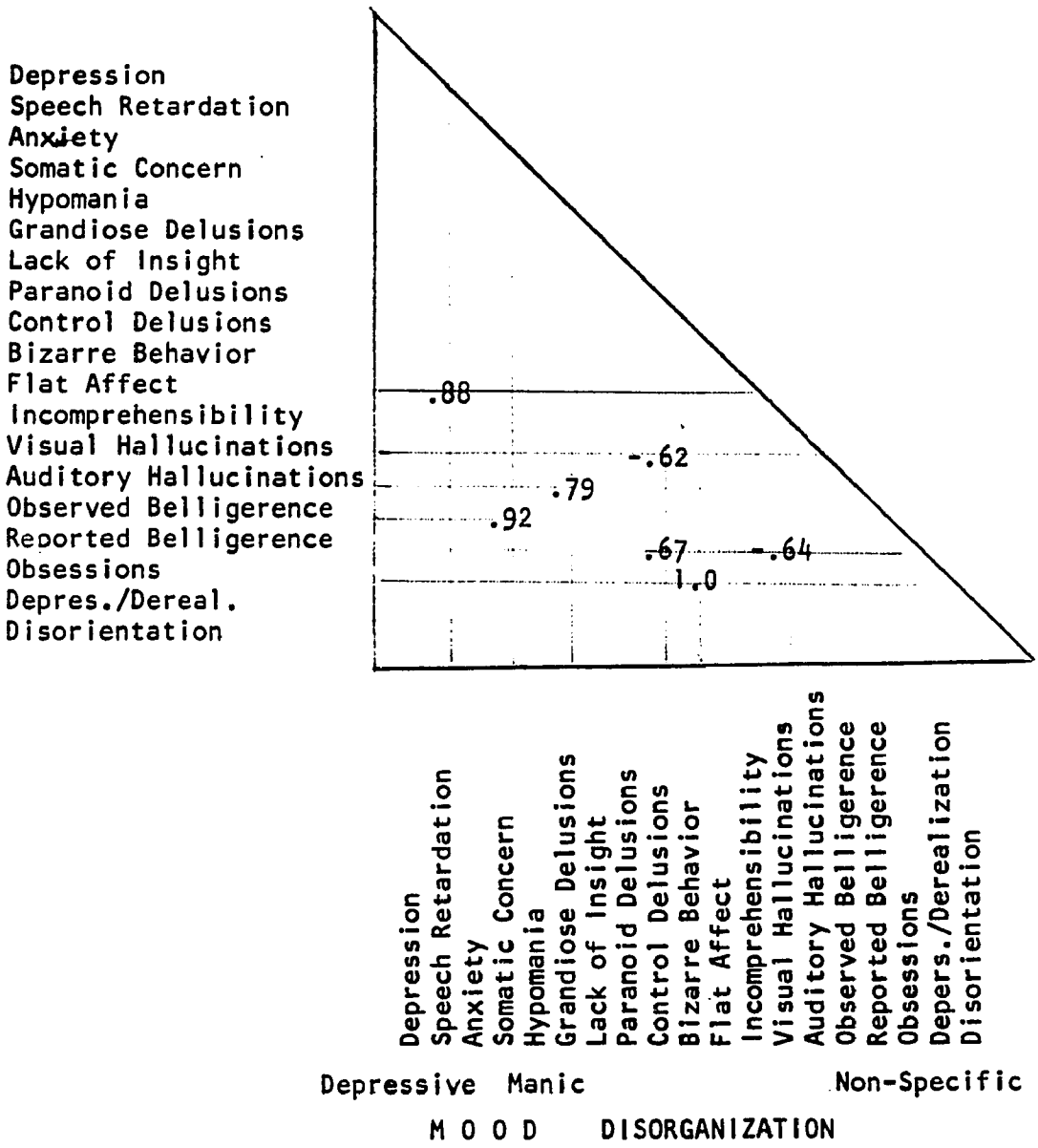
Correlations Between Symptom Factors by Three Raters; Statistical Significance ($p < .05$, two-tailed test of significance for Pearson r) for Project-diagnosed Affective Patients (n = 8).



A hodological/topographical representation of relations between symptom factors for Project-diagnosed schizophrenics (n = 10).



.6 CORRELATION ($p < .05$) BETWEEN SYMPTOMS



Correlations Between Symptom Factors by Three Raters; Statistical Significance ($p < .05$, two-tailed test of significance for Pearson r) for Project-diagnosed Schizophrenic Patients (n = 10).

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