Attentional and Vigilance Deficits Among MMPI-Detected Schizotypal College Students on a Continuous Performance Test

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Running head: ATTENTIONAL AND VIGILANCE DEFICITS
Abstract
Attentional and vigilance deficits were investigated among hypothetically schizotypal college students using a different version of the continuous performance test (CPT). Subjects were undergraduate college students at a large midwestern university and were selected for participation on the CPT according to MMPI profile types. The 2-7-8 and 8-9 profile types served as the schizotypal groups, the 4-9 profile type served as the psychiatric control group, and the "inflation-free" profile type served as the normal control group. The 8-9 profile type was employed to further support the use of this profile type as an additional indicator of schizotypy. The CPT task employed a response-reversal technique in responding to stimuli which demanded three levels of processing. Signal detection indices were applied to false alarm rates and hit rates to obtain overall sensitivity level (d') and response criterion level (β). It was hypothesized that the 2-7-8 and 8-9 groups should display similar deficits on d' further supporting the use of the 8-9 group as an additional indicator of schizotypy and further supporting a deficit on d' as being a possible trait marker of the schizophrenic state. Statistical analysis revealed no significant differences between groups on any of the measures; however, group trends indicated that the 2-7-8 group obtained the highest d', contradicting previous research.
Attentional and Vigilance Deficits

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Kraepelin (1919), in describing what he termed dementia praecox wrote: "Dementia praecox consists of a series of states, the common characteristic of which is a peculiar destruction of the internal connections of the psychic personality" (p. 3). Kraepelin further described dementia praecox as a disease with a single morbid process beginning in adolescence which may be expressed in a variety of forms. One observation Kraepelin made regarding individuals with dementia praecox was that these individuals suffered from "a certain unsteadiness of attention" (p. 6). More recently, deficits in attention and information processing have been postulated as existing in what is now known as the schizophrenic disorders (Nuechterlein & Dawson, 1984; Silverman, 1964; Venables, 1964).

Because much of the symptomatology associated with schizophrenia may reflect underlying information processing deficits, information processing has become a key area of research in schizophrenia. However, as argued by Mednick and McNeil (1968) and, more recently, Garfield (1978), certain information processing deficits observed in hospitalized schizophrenics may actually be the result of the sociomedical consequences of the disorder such as institutionalization and medication rather than the actual disorder itself. Thus an alternative to the confounding factor of hospitalization effects on active schizophrenics, as suggested by Mednick
and McNeil, is the study of individuals who are at heightened risk for developing schizophrenia but who have not yet displayed overt symptomatology.

Studying individuals who are thought to be vulnerable to developing schizophrenia not only avoids the sociomedical confoundings of schizophrenics with overt symptomatology, but also allows the investigation of possible trait markers leading to this thought disorder. The identification of a trait marker implies that a deficit will be observable in individuals prior to, and independent of, the psychotic state associated with schizophrenia (Zubin & Spring, 1977). The identification of such a trait marker would allow the investigation of the trait deficit prior to the psychotic state. The identification of a trait marker would also further allow the identification of individuals who are "at-risk" for developing schizophrenia prior to psychosis.

Although the study of "at-risk" populations avoids many of the confounding variables associated with hospitalization, difficulty exists in selecting these at-risk individuals. The process of selecting a risk sample due to the presence of a family history of schizophrenia has been a common practice for many researchers (Asarnow, Steffy, MacCrimmon, & Cleghorn, 1978; Nuechterlein, 1983; Rutschmann, Cornblatt, & Erlenmeyer-Kimling, 1977). However, since only 10-15% of active schizophrenics have a family history of schizophrenia (Gottesman & Shields, 1982; Rosenthal, 1970), the resultant risk sample selected by this criterion may not be representative
of the entire at-risk population. An alternative approach to selecting at-risk individuals involves the identification of individuals with a personality organization associated with a predisposition to schizophrenia.

Schizophrenia has been conceptualized by Meehl (1962) as containing both a genetic component and a social learning component. Meehl referred to the genetic component of schizophrenia as the schizotaxia. Schizotaxia represents the inherited predisposition for a neural integrative defect(s) associated with schizophrenia. This predisposition inevitably results in a personality organization known as schizotypy. Although the schizotaxic individual has inherited the genetic predisposition, psychotic decompensation is influenced by the schizotypic personality organization in combination with the individual's social learning history. Schizotypy is thought to include well-adjusted schizotypes who do not show overt symptomatology to the fully decompensated schizotypes who experience schizophrenic episodes. Through this model Meehl suggests that an individual can inherit the neural integrative defect yet display many different levels of decompensation due to the individual's social learning history. This decompensation can range from remaining well-adjusted with no overt symptomatology to repeated schizophrenic episodes.

Behavioral correlates of individuals who obtained 2-7-8 profiles on the Minnesota Multiphasic Personality Inventory (MMPI) have revealed that this profile type may be associated with schizotypy (Fujioka & Chapman, 1984; Kelley & King, 1979; Koh & Peterson, 1974; Marks, Seeman, & Haller,
As a consequence, individuals classified as schizotypal due to a 2-7-8 MMPI profile type have been studied by many researchers (Fujioka & Chapman, 1984; Koh & Peterson, 1974; Merritt & Balogh, 1984; Merritt, Balogh, & Leventhal, 1986; Nakano & Saccuzzo, 1985; Nuechterlein & Dawson, 1984; Steronko & Woods, 1978). Additionally, recent evidence suggests that the 8-9 MMPI profile type may be another indicator of a vulnerability to schizophrenia (Balogh & Merritt, 1985; Merritt & Balogh, 1984; Merritt et al., 1986). The present study investigated both the 2-7-8 and the 8-9 MMPI profile types as possible indicators of a vulnerability to schizophrenia.

Steronko and Woods (1978) compared the visual backward masking performance of schizotypics (MMPI 2-7-8 profile type) with a psychiatric control group (MMPI other inflations) and a normal control group (MMPI inflation free). In evaluating the results, Steronko and Woods noted that the 8-9 scales were the two best predictors of critical inter-stimulus intervals (ISI) obtained by the psychiatric control group. Merritt and Balogh (1984) argued that the 8-9 profile type is worthy of consideration as an additional indicator of schizotypy. Because the 2-7-8 profile type has been associated with schizotypy, similar displays of information processing deficits in the 8-9 profile type may further suggest the 8-9 profile type as an additional indicator of schizotypy. However, these profile types may identify two different subgroups of schizotypy (Merritt & Balogh, 1984). As a result, the identification of similar information processing deficits
Attentional and Vigilance Deficits

among schizotypic subgroups may further qualify these deficits as a trait marker of the schizophrenic state.

Many investigational techniques of information processing deficits have failed to employ signal detection methods in separating stimulus sensitivity level (d') and response bias criterion (β) (Marcus, 1973; Merritt & Balogh, 1984; Steronko & Woods, 1978; Wood & Cook, 1979). This results in an inability to compare motivational differences between subject groups and motivational effects on the group task performance. Because motivational effects may influence task performance, signal detection indices must be employed to isolate this effect. One task which allows the application of signal detection indices to measures of vigilance and sustained attention is the continuous performance test (CPT).

The original CPT was designed by Rosvold, Mirsky, Sarason, Bransome, and Beck in 1956 for the purpose of studying brain damage in human subjects. This CPT design involved the fixed, rapid presentation of visual stimuli (letters of the alphabet). The task involved responding via a response key within an allotted response time whenever a certain single "target" stimulus (the letter "X") was presented or, responding in a second sequential target condition, whenever a certain target stimulus was found to immediately follow the presentation of another predesignated stimulus (the letter "A"). The application of signal detection theory indices (see Green & Swets, 1966) involves the transformation of the response errors -- failing to respond to a target stimulus (error of omission or missed target)
and responding to a non-target stimulus (error of commission or false alarm) -- into indices of signal/noise discriminability (d') and the amount of perceptual evidence required by the individual before responding (β).

Response errors are transformed into d' and β by separating the normal distributions of signal/noise and noise and calculating the abscissa and ordinate values of the standardized normal distributions.

Many variations of the CPT have been employed and have been found to yield varying results among at-risk samples. The use of a single numeral target CPT (Asarnow et al., 1977) yielded no significant deficit among children of schizophrenic mothers as compared to children of parents with no psychiatric disorders. The use of a single color target CPT (Grunebaum, Weiss, Gallant, & Cohler, 1974) resulted in a failure to obtain a significantly poorer performance among five-year-old high risk children. The use of a sequential playing card target CPT under conditions of audio distractors vs. no distractors (Rutschmann et al., 1977) revealed significant differences for d' among high risk children. A response-reversal technique (responding only to non-target stimuli) using a single numeral target CPT (Nuechterlein, 1983) has revealed significant deficits on d' among offspring of schizophrenic mothers. Also, a degraded stimulus condition (Nuechterlein, 1983) has revealed significant deficits on d'. Among these studies, no differences in β were observed. Furthermore, while active schizophrenics typically perform more poorly on many CPT tasks, the performance of at-risk individuals is more variable, which may account for
the difficulty in obtaining significance levels among some of the literature. This literature suggests that stimuli which involve a greater processing load in terms of stimulus complexity, and response techniques which place more demand for vigilance, increase the discriminating power of the task, in terms of \( d' \) differences, between at-risk subjects and control subjects.

Nuechterlein (1985) investigated attentional and vigilance deficits among MMPI 2-7-8 profile types using a degraded-stimulus CPT. His findings indicated that the 2-7-8 group showed significantly poorer signal-detection performance than either the "other elevations" or the "no elevations" control groups combined. The 8-9 schizotypal profile type was not introduced in this study. Nuechterlein, in concluding the results, stated that the degraded-stimulus CPT demanded a high level of processing, but cautioned that other versions of the CPT need to be investigated to further address this issue.

The present study investigated attentional and vigilance deficits in schizotypic individuals as compared to psychiatric and normal control groups on a different version of the continuous performance test. Individuals were classified according to MMPI profile types. The 2-7-8 profile type was used as the traditional index of schizotypy and the 8-9 profile type was used as a possible additional indicator of schizotypy (Merritt & Balogh, 1984). As suggested by Merritt and Balogh (1984), a homogeneous psychiatric control group and an "inflation-free" control group served as comparison groups. To maximize discriminability differences, the
Attentional and Vigilance Deficits

present CPT adaptation employed a stimulus which demanded that subjects process three dimensions (a geometric shape, the color of the shape, and an inscribed letter) in addition to a response-reversal technique. It was predicted that attentional and vigilance deficits would be demonstrated among schizotypic individuals as compared to the control groups. This deficit should be demonstrated by a decreased sensitivity level $(d')$ when signal detection indices are employed. Furthermore, the 8—9 group was expected to demonstrate similar deficits as the 2—7—8 group further suggesting the 8—9 profile type as an additional indicator to schizotypy. Lastly, the findings may further establish the utility of the CPT as a measure of possible vulnerability to schizophrenia.

Method

Subjects

Approximately 2000 undergraduate students enrolled in an introductory psychology course at a large midwestern university received experimental participation credit for their participation in the initial screening sessions during which a demographic questionnaire and the MMPI was administered. Any subject who reported a history of substance abuse, cerebral dysfunction, or usage of phenothiazines was excluded from the CPT portion of the study. The four groups were formed according to their MMPI profile types: a 2—7—8 schizotypic group, an 8—9 schizotypic group, a 4—9 psychiatric control group, and an inflation-free control group. Approximately 40 subjects qualified for the 2—7—8 group, 60 qualified for
the 8-9 group, 30 qualified for the 4-9 control group, and 100 qualified for
the inflation-free control group. The first 12 subjects from each group who
agreed to participate in the CPT served as subjects. The exception to this
was the 8-9 group which contained only 11 participants.

Inclusion in the 2-7-8 group involved the following criteria: scales 2
(Depression), 7 (Psychasthenia), and 8 (Schizophrenia) ≥ 70 I, E ≤ 90 I, and a
maximum of 2 other scales ≥ 70 I but no higher than scales 2, 7, and 8
(scale 5, the Masculinity-Femininity scale, was not used in the formation of
the four groups). Inclusion in the 8-9 group involved the following criteria:
scales 8 and 9 (Hypomania) ≥ 70 I with scale 8 > scale 9 or scale 9 not
exceeding scale 8 by more than 4 I, scale 8 exceeding scale 7 by at least 5
I, E > L and K with E not exceeding 90 I, and scale 0 < 70 I. Inclusion in the
4-9 group involved the following criteria: scales 4 (Psychopathic Deviant)
and 9 ≥ 70 I, scale 8 ≤ 60 I (1 subject included in this group obtained a
score of 61 I on this scale), E ≤ 90 I, and a maximum of two other scales ≥
70 I but < scales 4 and 9. Inclusion in the inflation-free group involved the
following criterion: all scales ≤ 60 I. Subjects who wore glasses or
contact lenses were instructed to wear them for the CPT portion of the
study. Subjects received payment of $5.00 for participation in the CPT
portion of this study.

Apparatus

An Apple IIe microcomputer with an extended 80 column text card and
a TimeMaster II H.O. time card controlled the presentation of stimuli and the
storage of data. Stimuli were presented on a Panasonic CT-1920M color video monitor. Responses were recorded via a peripheral response key.

**Stimuli**

Stimuli for the CPT consisted of a colored geometric shape circumscribing a white letter. All stimuli were designed using Apple IIe high resolution graphics and color. The geometric shape consisted of a square (5 cm x 5 cm) presented randomly in one of two forms: as a square at 0° rotation or as a diamond at 45° rotation. The geometric shape was randomly assigned one of three colors: blue, orange, or pink. The white letter (1.2 cm x 1.2 cm) displayed in the center of the geometric shape was randomly chosen from the letters C, E, F, G, H, O, P, and S. Order and elements of the stimuli were randomly sequenced so that target to total stimuli ratio equalled 25%. A stimulus was designated a target stimulus when it was exactly identical in geometric shape, color, and centered letter as the stimulus immediately preceding it in order. Target stimuli were always followed by a new non-target stimulus eliminating the chance of two or more target stimuli following each other in sequence. A total of 48 stimulus presentations (12 targets and 36 non-targets) composed the practice trials and 528 stimulus presentations (132 targets and 396 non-targets) composed the experimental trials. The order of the stimuli was identical for each subject. Stimuli were presented on a black screen at a duration of 50 msec with an inter-stimulus interval (ISI)/response interval of 1.0 sec. A ready signal was verbally supplied prior to the first
stimulus presentation of both the practice trials and the experimental trials.

Procedure

Subjects were seated in a desk chair 50 cm away from the front of the monitor in a well-lit room. The response key was placed on the desk and could be moved to comfortably accommodate right or left-handed subjects. A response-reversal technique was employed: Subjects were instructed to press the response key within the 1 sec ISI whenever a non-target stimulus was presented and to refrain from pressing the response key whenever a target stimulus was presented. Subjects were instructed to concentrate more on accuracy of the response rather than quickness of the response.

After carefully being read the instructions and shown examples of stimuli, the subjects were presented with the 48 practice trials which contained visual feedback printed on the monitor regarding the correctness of the response. A practice trial consisted of the 50 msec presentation of the stimulus followed by the 1 sec ISI/response interval. At the conclusion of this time interval, feedback printed on the monitor consisted of the following contingency messages: a message indicating a correct response, an incorrect response, an error in forgetting to release the button from the previous trial, or, if the subject responded in an anticipated fashion (within 20 msec of stimulus presentation), an anticipated response error was presented. After the amount of time allotted for adequate reading of the feedback message had elapsed, the presentation of the next stimulus.
immediately followed. The practice trials lasted approximately 3 min.

The practice trials were followed by the 528 experimental trials which were presented without feedback on correctness of response. The experimental trials lasted approximately 13 min. The data collected from the experimental trials included the following: number of correctly identified targets (correct hits), number of incorrectly identified targets (missed targets), number of correctly identified non-targets (correct misses), number of non-targets incorrectly identified as targets (false alarms), and mean response time for missed targets and correct misses. Missed targets and correct misses account for all trials in which the button was pressed. Following the example of Rutschmann et al. (1977), all trials with responses under 20 msec were treated as anticipated guesses and were therefore not included in any of the analyses.

From the collected data, hit rates (correct hits/total number of targets) and false alarm rates (false alarms/total number of non-targets) were calculated. Signal detection indices were applied to the hit rate and false alarm rate of each subject to calculate the index of discriminability ($d'$) and response bias criterion ($\beta$).

Results

Because two subjects (one from the 4-9 group and one from the 2-7-8 group) obtained false alarm rates of less than 1%, these subjects' data were eliminated from $d'$ and $\beta$ analysis.
Analysis of $d'$

A one-way analysis of variance revealed no significant difference in $d'$ for the four groups. The means of the groups were 2.46 (SD = .56) for the 2-7-8 group, 1.80 (SD = .58) for the 8-9 group, 1.82 (SD = .67) for the 4-9 group, and 1.99 (SD = .49) for the inflation-free group. However, a planned comparison did reveal a significant difference between the means of the 2-7-8 and the 8-9 groups ($t(19) = -2.53, p < .01$). Additional planned comparisons revealed no significant difference between either the 4-9 group and the inflation-free group or between the 2-7-8 group and the inflation-free group.

Analysis of $\beta$

A one-way analysis of variance revealed no significant difference in response criterion level for the four groups. The means of the groups were 6.19 (SD = 2.07) for the 2-7-8 group, 5.77 (SD = 4.63) for the 8-9 group, 4.16 (SD = 2.21) for the 4-9 group, and 5.01 (SD = 2.99) for the inflation-free group. A planned comparison revealed no significant difference between the means of either the 2-7-8 group and the 8-9 group or the 4-9 group and the inflation-free group. Also, no significant difference was found for the pooled comparison schizotypic groups and the control groups.

Other Analyses

A one-way ANOVA revealed no significant difference for response times for the groups. The means for the groups were 278.93 (SD = 72.91) for the 2-7-8 group, 232.96 (SD = 73.30) for the 8-9 group, 265.39 (SD =
47.99) for the 4-9 group, and 246.71 (SD = 67.67) for the inflation-free
group. The number of trials obtained below the 20 msec cut-off criterion
also did not differ significantly between groups. To assess reliability of
the measure, a pooled split-half correlation of d' for all groups using the
Spearman-Brown Prophecy formula revealed a reliable relationship (p <
.001).

Discussion

The present study failed to support the initial hypotheses.
Furthermore, the current findings are contrary to past research using
MMPI-detected schizotypics on a continuous performance test (see
Nuechterlein & Dawson, 1984).

Signal Sensitivity Level (d')

In the present study, the 2-7-8 group and the 8-9 group did not
display significant deficits on d' when compared to the control groups. In
fact, although not statistically significant, the 2-7-8 group actually
obtained the highest mean sensitivity level of all the groups. Furthermore,
a planned comparison between the 2-7-8 group and the 8-9 group (the group
which obtained the lowest mean sensitivity level) revealed a significant
difference -- further refuting the initial hypothesis that these schizotypal
groups should display similar deficits. However, the 8-9 group did obtain
the lowest d' level further suggesting its use as an indicator of a subgroup
of schizotypy.
Attentional and Vigilance Deficits

Although past research has obtained significant deficits on d' among at-risk subjects using a continuous performance test (Rutschmann et al., 1977; Nuechterlein, 1983; Nuechterlein & Dawson, 1984), the present study provides no support for these findings. The 8–9 group did display the predicted trend, although not significantly, of obtaining a d' deficit; however, the 2–7–8 group appears to have somehow benefited from the CPT employed in this study by obtaining the highest level of sensitivity of all the groups.

Response Criterion Level (β)

No significant differences were obtained among the groups; however, the 2–7–8 group obtained the highest β. An increased demand of perceptual evidence before responding appears to be consistent with alternative interpretations of past research findings involving critical stimulus duration (Merritt & Balogh, 1984; Merritt et al., 1986). Critical stimulus duration (CSD) refers to the minimum duration a stimulus must be presented to be identified. However, because signal detection indices were not employed in these studies, a high CSD may actually have been reflective of a high β.

Response Time

Although no significant differences were obtained, the trend for the 2–7–8 group appeared consistent with past research on reaction time (Asarnow et al., 1977; Marcus, 1973). Because the 2–7–8 group did achieve the longest response time, the possibility exists that this group may have
somehow benefited from taking more time in responding. This present finding may further support these past research findings of reaction time deficits among schizotypal individuals.

Additional Concerns

This study used stricter criteria in selecting subjects than has been used in past research (Nuechterlein, 1985; Steronko & Woods, 1978). A group selected under stricter criteria should, intuitively, amplify results obtained using less strict criteria. Because of this assumption, the discrepancy between findings in the present study and previous research appear to be related to the subject task instead of the subject selection criteria. The CPT employed in this study produced no ceiling effects in any of the groups; therefore, the task appears to be adequately difficult. Because the task appeared adequately difficult, perhaps the discrepancy in findings involves the stimuli presented.

Nuechterlein (1983) cautioned that the CPT task parameters appear to be the critical factors in revealing differences in d' levels among schizotypics and control groups. The present study further supports this statement. Nuechterlein reported the greatest group differences on d' using a degraded stimulus CPT. This was achieved by slightly blurring the image. Thus, the low spatial frequency component was maximized. By contrast, the CPT employed in the present study presented well-defined stimuli which demanded the processing of three stimulus dimensions. Thus, the high spatial frequency component was maximized. Perhaps the 2-7-8 group
somehow benefited from the well-defined, linear stimuli presented in this study resulting in a higher d'. If this is the case, perhaps 2-7-8 individuals are more susceptible to CPT tasks which involve stimuli with a greater low spatial frequency component. Additional research needs to be conducted concerning these issues. Also, because the 8-9 group did achieve the lowest d' of all the groups, perhaps this may indicate a subgroup of schizotypy which is susceptible to stimuli with high spatial frequency components. Therefore, the use of the 8-9 profile type as an additional indicator of schizotypy is worthy of more research.
Attentional and Vigilance Deficits

References


Attentional and Vigilance Deficits


