Backward Masking Spatial Frequency Effects Among Hypothetically Schizotypal Individuals

by Rebecca Davis Merritt and Deborah Ware Balogh

Abstract

The present investigation relied upon a neurophysiological explanation of visual masking and compared the backward masking susceptibility of hypothetical schizotypal individuals to that of controls. In order to assess the relative contributions of the visual system's transient and sustained channels to the backward masking deficit characteristic of the schizophrenia spectrum, performance within low spatial frequency (LSF) and high spatial frequency (HSF) masking conditions was compared. Because this design was intended to test the hypothesis that a transient channel abnormality underlies the spectrum masking deficit, only the transient facilitating, LSF masking condition was expected to produce group differences. Although the two masking conditions were equivalent in their stimulus energies, as predicted, the at-risk subjects evidenced an LSF masking deficit, but did not differ from controls in the sustained facilitating, HSF masking condition. These results suggest that multichannel neurophysiological models of masking may help to direct research designed to gain an increased understanding of the specific nature of the spectrum masking deficit.

Borrowing from the experimental literature, many researchers have used an information processing strategy to identify characteristics shared by members of the schizophrenia spectrum (Kietzman et al. 1985; Holzman 1987; Patterson 1987). The initial goal of comparing abilities of schizophrenic and control subjects on a wide range of perceptual and cognitive tasks resulted in the demonstration of multiple processing deficits among schizophrenic subjects. Subsequently, individuals believed to be at risk for schizophrenia were assessed in attempts to delineate episodic or state markers and vulnerability or trait markers of schizophrenia with the hope that this delineation might lead to an etiological understanding of schizophrenia (Zubin and Spring 1977; Zubin and Steinhauer 1981). Recently, several researchers have suggested that research efforts be increasingly directed toward determining the specific nature of processing deficits demonstrated by members of the schizophrenia spectrum (Knight 1984; Kietzman et al. 1985; Balogh and Merritt 1987). Researchers who endorse this approach argue that gaining an increased understanding of the processes that may underlie or produce specific information processing deficits is needed to assess how these processes may be related to risk factors and symptom expression.

The purpose of the present study is to gain an increased understanding of the specific nature of the visual backward masking deficit characteristic of spectrum members. Subjects with paranoid and non-paranoid schizophrenia, schizophrenia in remission, clinically defined schizotypal personality disorders, and psychometrically defined schizotypic characteristics have demonstrated increased masking as compared to controls (Saccuzzo et al. 1974; Saccuzzo and Miller 1977; Steronko and Woods 1978; Miller et al. 1979; Braff 1981; Braff and...
Saccuzzo 1981, 1982; Saccuzzo and Braff 1981; Saccuzzo and Schubert 1981, Schwartz et al. 1983; Merritt and Balogh 1984; Balogh and Merritt 1985; Nakano and Saccuzzo 1985; Green and Walker 1986; Merritt et al. 1986). Additionally, multiple studies have demonstrated that the accuracy of identification of a single target letter in the absence of a masking stimulus is significantly impaired among some subjects with schizophrenia spectrum disorders (Balogh and Merritt 1987). The present study evaluated the masking performance of a sample of college students identified as being at risk for schizophrenia by virtue of their responses on a psychometric measure of vulnerability.

Although the identification of individuals who are at risk for schizophrenia has traditionally been accomplished by selecting the biological relatives of schizophrenic patients, this approach has been criticized for its limited generalizability and has spawned the use of alternative (although not necessarily mutually exclusive) definitions of vulnerability. Within this context, the Chapmans and their associates have developed several scales of psychosis proneness, each of which is thought to measure a dimension of schizophrenia-like symptomatology (Chapman et al. 1982). Of these scales, the individual and combined Perceptual Aberration and Magical Ideation Scales have received the most empirical attention and have been suggested to be the most promising for identifying subjects prone to schizophrenia (Chapman and Chapman 1985). For example, subjects who have extreme scores on one or both of these two scales have demonstrated, as schizophrenic patients themselves do, a reaction time deficit (Simons et al. 1982), autonomic hyporesponsivity (Simons 1981), referential communication deficits (Martin and Chapman 1982; Allen et al. 1987), and a backward masking deficit (Balogh and Merritt 1985).

Our decision to compare the masking performance of subjects psychometrically defined as vulnerable to that of normal controls was mediated by two factors: (1) at the time this study was conducted, we did not have access to recent onset or remitted schizophrenic patients whose study would minimize state characteristics (e.g., the effects of medication, significant thought disorder, hospitalization, and chronicity) in our assessment of trait markers of schizophrenia; and (2) we were interested in what sensory-perceptual or information processing factors might underlie the backward masking deficit previously demonstrated by college students with extreme scores on the Perceptual Aberration and Magical Ideation Scales (Balogh and Merritt 1985).

Visual backward masking refers to a group of phenomena in which processing and identification of an initial target stimulus is interfered with by the presentation of a subsequent “masking” stimulus. The potency of the masking effect is determined by a number of stimulus parameters, including the temporal relationship between target presentation and mask presentation, the energy ratio between the two stimuli, and the structural elements of and relative positions occupied in the visual field by the two stimuli.

Researchers sometimes obtain an estimate of the target duration necessary for each subject to achieve a predetermined accuracy criterion in attempts to minimize the impact of individual differences in processing of the target stimulus in the absence of the masking stimulus. This predetermined target duration is then used throughout the masking portion of the study. Although this critical stimulus duration procedure (CSD) has both benefits and liabilities (Saccuzzo and Schubert 1983; Schwartz 1983; Balogh and Merritt 1987), the rationale governing the use of the CSD within masking studies is to increase the interpretability of subsequent group differences in masking functions. However, the CSD procedure only ensures that subjects are broadly equated in the accuracy of target identification. A CSD estimate cannot be assumed to be a pure measure of sensory-perceptual threshold because response bias factors affect the CSD estimate derived for subjects. Masking effects are described as a function of the interstimulus interval (ISI) between target offset and mask onset when a CSD procedure is used. Studies using a standard target duration (STD) may also assess masking effects as a function of the time interval between target and mask onsets (stimulus onset asynchrony, or SOA).

Independent of the specific methodology used, it has been suggested that a disturbance in the normally complementary relationship between the visual system's transient and sustained channels might underlie specific visual processing deficits characteristic of subjects in the schizophrenia spectrum (Schwartz and Winstead 1982; Balogh and Merritt 1987). Although some researchers do not endorse a multichannel model of visual masking, others who favor this interpretation argue that neurophysiological mechanisms involving intrachannel and interchannel inhibition of the transient and sustained channels initiating at the ganglion layer of the
retina account for visual masking (Weisstein 1972; Rogowitz 1983; Breitmeyer 1984). Transient channels project directly from the retina to the superior colliculus and indirectly via the lateral geniculate nucleus. These channels exhibit selectivity for low spatial frequencies, have an extremely short latency following the onset of a visual stimulus, and have high temporal resolution. Sustained channels project directly from the retina to the lateral geniculate nucleus and from there project to the visual cortex. These channels exhibit selectivity for high spatial frequencies, have longer latencies than the transient channels, and have low temporal resolution. Thus, transient channels primarily respond to the movement of stimuli and the appearance/disappearance of stimuli, while sustained channels primarily analyze pattern details.¹

¹The distinction between transient function and sustained function is not an absolute one. The transient channel can perform crude pattern identification, and the sustained channel can detect stimulus change, but the relative speed and proficiency of each channel favors a conceptualization of transient channels as primarily on/off detectors and sustained channels as feature analyzers.

Transient channels function as “early warning signals” indicating that a change has occurred in the visual field. When a visual stimulus initially appears, transient activity responds to its onset with a brief burst of activity. If the stimulus remains on, transient activity will subsist until stimulus offset produces another burst of brief transient activity. The amplitude of transient activity is affected by stimulus characteristics and by temporal factors. For example, although abrupt onset/offset of both low and high spatial frequency stimuli should elicit transient activity, the low spatial frequency stimulus should result in an increased amplitude of transient firing (“as spatial frequency increases, the transient response ought to decrease in magnitude and increase in latency” [Breitmeyer 1984, p. 22]). Additionally, for non-prolonged stimuli, transient activity will be less at stimulus offset as compared to onset. Sustained channels read out the information in the visual field and, when possible, provide feature identification. Backward masking may be explained by the faster responding transient channel activity elicited by the masking stimulus onset interfering with the sustained channel responding elicited by the previous target (Breitmeyer and Ganz 1976). In other words, within a restricted period of time, the onset transient evoked by the mask overrides the ongoing processing of target features necessary for identification.

Researchers who endorse multichannel models of masking often employ sine and square wave gratings as target or masking stimuli. A square wave grating mask consists of alternating black and white bars with the spatial frequency determined by the width of the bars. The spatial frequency is reported as cycle per degree (c/deg) of visual angle, with a cycle consisting of one dark bar plus one white bar of equal width. Relatively greater c/deg values indicate a stimulus composed of narrow bars, while relatively smaller c/deg values indicate a stimulus composed of wide bars. Two gratings that differ in spatial frequency but are equal in visual field size have equivalent light and dark areas (and, thus, equivalent stimulus energies), although the distribution of light and dark areas differs.

In a previous investigation, Per-Mag subjects (those who scored high on the Perceptual Aberration or Magical Ideation Scales) showed a masking deficit when single capital letters were used as targets, targets were presented at individualized durations, and a high-energy pattern mask that contained some structural elements of the target was used (Balogh and Merritt 1985). This type of design conformed to the methodology traditionally used in studies of masking in the schizophrenia spectrum. Although this study demonstrated that groups formed on the basis of the Chapman psychosis-proneness scales had a masking deficit similar to that in patients with schizophrenia, it revealed little about the specific nature of this deficit.

In the present study, we relied upon contemporary multichannel models of masking to evaluate the Per-Mag masking deficit and altered the nature of the masking stimulus. The spatial frequency characteristics of a masking stimulus were manipulated to test our previous hypothesis that aberrant transient channel activity elicited by the masking stimulus may account for the masking deficit (Merritt et al. 1986). If this hypothesis is tenable, then differential effects of the low spatial frequency (LSF) and high spatial frequency (HSF) masks should be apparent among Per-Mag subjects in that the LSF mask would maximize the effect of aberrant transient channel activity...
on their target identification accuracy. Because normal subjects are not expected to have aberrant transient activity, the spatial frequency manipulation is not expected to affect their performance.

Aberrant transient activity could occur in several ways. Transient activity might be more easily triggered in spectrum subjects, the amplitude of transient channel activity might be abnormally high, the temporal resolution of the transient channel might be prolonged as compared to normals, and the cumulative effect of onset and offset transients might be more disruptive for spectrum subjects than for normals. It is unlikely that an isolated sustained channel abnormality could account for the pattern of visual information processing deficits demonstrated by spectrum members. Although impaired sustained processing could explain the CSD deficit exhibited by some spectrum subjects, it cannot explain the characteristic backward masking deficit that occurs even in masking studies using a CSD method of target presentation. However, a transient abnormality (e.g., abnormally potent offset transient activity) could account for both the CSD and the backward masking deficit. Impaired sustained processing cannot account for the spectrum backward masking deficit when a CSD is used. The relatively long latency of the sustained channel activity, as compared to the more immediate responding of the transient channel, cannot account for the temporal pattern descriptive of spectrum members’ backward masking deficit. In other words, the sustained activity generated by a backward mask would occur after much of the target feature information had been encoded. However, the transient activity generated by a backward mask may interfere with ongoing processing of target feature information.

Methods

Subjects. As part of an ongoing screening procedure, approximately 800 undergraduates enrolled in Introductory Psychology at two large midwestern universities were screened for participation in subsequent information processing studies. This screening battery consisted of the Minnesota Multiphasic Personality Inventory (MMPI; Walters 1988), the Psychosis Proneness Scales (PPS; Chapman et al. 1982), the Shipley-Hartford Institute of Living Verbal Intelligence Scale (Shipley 1940), and a demographic data questionnaire. Subjects received experimental participation credits for participating in the 3-hour screening session. A Per-Mag group and a normal control group were formed on the basis of the data obtained in the screening session. The first 15 subjects in each group who agreed to return for the masking portion of the study were paid $5.00 for their participation. There were eight males and seven females in the Per-Mag group and six males and nine females in the normal control group.

Separate group means and standard deviations (SDs) for males and females were obtained for each of the Chapman scales. The Per-Mag group was formed on the basis of a score of two or more SDs above the mean on the Perceptual Aberration Scale, the Magical Ideation Scale, or both. The normal control group consisted of subjects whose scores on all of the scales were no greater than 1/2 SD above the same-sex group mean and who produced an MMPI profile with no scores greater than 60 T. Subjects who reported treatment for substance abuse, usage of psychiatric medication, or head trauma were eliminated from the study.

Apparatus. Stimuli were binocularly presented in a Gerbrands three-field tachistoscope (Model 61150A) with a viewing distance of 76 cm. Test stimuli were single letter displays, which consisted of the capital letters A, T, H, M, W, X, V, and Y. These letters were formed by mounting 14-point white paratype on black stimulus cards. A grating mask which was 1 c/deg and which completely covered the stimulus card was used for the LSF condition. A grating mask which was 13 c/deg and which covered the stimulus card was used for the HSF condition. Because both masks were of the same size, the visual area of the masks was equivalent. In addition, both masks had equivalent black and white areas with dissimilar distribution of those areas. A fixation point consisting of a small white circle was presented for 1 second and was followed by a 500 ms blank field before target onset. The letters subtended a vertical visual angle of 0.26°. The luminance of the fixation, target, and ISI fields was 30.8 cd/m² and the luminance of the masking field was 21.2 cd/m².

We elected to use a more restrictive definition for inclusion in the normal control group because of our previous finding that approximately 35 percent of subjects designated normal by the Psychosis Proneness Scales produced clinically elevated MMPI profiles (Merritt et al. 1987). Other researchers have also used more restrictive criteria to define normal controls when using the Psychosis Proneness Scales because of a concern that subjects with psychopathology would be inadvertently included within the normal control group (Josiassen et al. 1985).
Because both of the grating masks contained identical white areas, the luminance of the LSF condition was equivalent to that of the HSF condition, ensuring that the luminance summation of target and mask energies was equivalent across the two conditions. The equivalent luminance between the two masking conditions, however, resulted in the HSF condition’s having lower contrast than the LSF condition. In other words, equal luminance in the two conditions meant that the finer lines of the HSF condition had reduced visual resolution as compared to the bolder LSF condition. The lower contrast increased the masking produced by sustained channel activity in the HSF condition because lower contrast reduces the latency of the sustained channel firing such that it can approximate that of the transient channel (Breitmeyer 1984). Thus, maintaining equivalent luminance between the two masking conditions assisted in producing equivalent levels of masking (i.e., difficulty level) in both conditions among normals. In both mask conditions, the energy of the masking stimulus was less than that of the target stimulus, a condition that favors interruption masking and minimizes the effects of integration masking.

**Design and Procedure.** Before the masking portion of the study began, written and verbal informed consent was obtained from all subjects. Visual acuity screening ensured that each subject had at least 20/30 natural or corrected vision. After the vision screening, the subject was seated in front of the tachistoscope and allowed to adapt to the dim light for 15 minutes. A practice period consisting of 32 presentations of target stimuli of varying durations was given; each of the eight stimulus letters was presented four times within the practice period (a complete description of the practice format is provided in Merritt et al. [1986]). Following the practice period an estimate of target display time necessary for each subject to achieve at least a 70 percent identification accuracy rate in the absence of a masking stimulus was obtained, using an up-down transformed method (a variation of the method of limits; Wetherhill and Levitt [1965]). All subjects received the same previously determined randomized order of target stimuli, and no feedback was given during this procedure.

Subjects then received the LSF and HSF masking conditions which were presented in counter-balanced order within groups. Within each masking condition, target and mask duration corresponded to each subject’s 70 percent accuracy rate estimate to facilitate interruption masking. There were six ISI conditions: 20, 60, 100, 140, 180, and 220 ms. Each subject received a predetermined randomized order of ISI conditions within each mask condition. Sixteen trials were given at each ISI. Subjects were given a verbal ready signal before stimulus presentation. A foveally presented fixation point was presented before the target onset for 1 second with a 500 ms ISI between fixation point onset and target onset. Subjects were asked to identify the target stimulus verbally. They were instructed to respond to each trial, even if that meant guessing. The presentation of the 16 stimulus letters (each of the 8 target letters was presented twice) resulted in a total of 96 trials per subject per masking condition. The target stimulus was changed after each trial. Subjects did not receive any feedback about their performance accuracy. The total number of correct identifications at each ISI was recorded.

**Results**

A series of one-way analyses of variance (ANOVAs) was conducted on the following demographic variables: age, years of education, and estimated verbal IQ. No significant differences were found among groups on these demographic variables. The mean age was 19.00 (SD = 2.80) for the control subjects and 18.87 for the Per-Mag subjects (SD = 2.00); the mean years of education were 13.33 (SD = 0.62) for the control subjects and 13.27 (SD = 0.59) for the Per-Mag subjects; and the mean verbal IQ was 109.00 (SD = 7.61) for the control subjects and 108.67 (SD = 6.40) for the Per-Mag subjects.

The mean time necessary for 70 percent target identification in the absence of a masking stimulus was 20.30 (SD = 9.60) for the Per-Mag group and 12.87 (SD = 7.83) for the normal control group. A one-way
ANOVA revealed that the Per-Mag group needed significantly more time to view the single capital letter than did the normal control group ($F = 5.55; df = 1, 28; p < 0.03$).

Group masking functions were analyzed in a three-way ANOVA (Group $\times$ Spatial Frequency $\times$ ISI) with repeated measures on the last two factors. This analysis revealed a significant main effect for Group ($F = 15.55; df = 1, 28; p < 0.001$), a significant main effect for Spatial Frequency ($F = 30.93; df = 1, 28; p < 0.001$), and a significant main effect for ISI ($F = 17.47; df = 5, 140; p < 0.001$). This analysis also revealed the predicted Group $\times$ Spatial Frequency interaction ($F = 25.26; df = 1, 28; p < 0.001$) and a Spatial Frequency $\times$ ISI interaction ($F = 2.97; df = 5, 140; p < 0.02$). Figure 1 depicts the LSF and HSF masking functions for the two groups.

A simple main effects analysis was conducted to interpret the Group $\times$ Spatial Frequency interaction, which was of critical importance to the hypothesis of interest in the present article. This analysis revealed that the LSF condition produced group differences ($p < 0.01$), whereas the HSF condition did not. Furthermore, the LSF condition resulted in significantly more masking for the Per-Mag subjects ($p < 0.01$), whereas the normal controls produced equivalent rates of target identification in the two masking conditions.

A simple main effects analysis, conducted to interpret the Spatial Frequency $\times$ ISI interaction, revealed that performance in the two masking conditions did not differ at the two highest ISIs (180 and 220 ms) and that intermediate ISIs (60 and 100 ms) produced the greatest difference between the two masking conditions, with the LSF mask especially impairing target identification ($p < 0.01$). Within each of the two masking conditions, performance differed significantly as a function of ISI ($p < 0.01$). As can be seen in figure 1, subjects could more readily identify the target as the ISI value increased for both masking conditions, demonstrating that both conditions did, in fact, result in visual masking.

**Discussion**

The methodology used in the present evaluation relied on the growing
sophistication of masking methods and explanations available in the experimental literature. More specifically, the methodological refinements included the following: the manipulation of a single dimension of the masking paradigm that may be related to aberrant visual information processing for spectrum subjects (i.e., the spatial frequency manipulation) and the equating of luminance values across masking conditions to minimize differences in the difficulty levels of the two masking conditions. With these refinements, Per-Mag subjects performed more poorly than normal control subjects in the LSF masking condition. However, use of an HSF backward mask did not produce group differences in target identification. These results suggest that when sustained channel activity is maximized by a backward mask (HSF condition), subjects vulnerable to schizophrenia perform equivalently to normals, but when transient channel activity predominates, subjects vulnerable to schizophrenia show a backward masking deficit. Thus, our evidence suggests that aberrant transient channel activity may account for the frequently demonstrated masking deficit in these subjects.

The results presented here conform to the Merritt et al. (1986) investigation in which schizotypal subjects experienced increased metacontrast masking as compared to psychiatric and normal control subjects. The 1986 study and the current investigation both used an LSF mask and similar target duration and luminance parameters. The criteria for establishing the relationship between the target and mask stimulus energies were the same for both studies, with energy for the mask being slightly lower than for the target. Although the poorer performance of the Per-Mag subjects in the present study mirrors the 1986 metacontrast finding, a direct comparison of results with those obtained in two earlier masking investigations is precluded by differing masking and target stimulus parameters (Merritt and Balogh 1984; Balogh and Merritt 1985). For example, the study of Balogh and Merritt demonstrated that Per-Mag subjects were more susceptible to the effects of a high intensity pattern mask than were normal controls. The mask contained HSF elements and the increased mask duration and luminance level, as compared to the target stimulus, facilitated a Type A masking condition. This form of masking is thought to result from both integration and interruption masking and has been the type of masking most frequently studied by spectrum researchers (Balogh and Merritt 1987). Because the effects of integration and interruption masking are confounded within Type A masking studies, little information can be gleaned about the possible etiologies of the spectrum masking deficit(s). Although both the Balogh and Merritt (1985) mask and the HSF condition of the current study share some spatial frequency characteristics, they cannot be assumed to be equivalent masking conditions.

Thus, the similar performance of normals and Per-Mag subjects in the HSF condition of the present study does not necessarily contradict the findings of Balogh and Merritt (1985). Our findings may be related to findings obtained within the vigilance paradigm endorsed by Nuechterlein. It has been reported that a degraded version of the continuous performance task that used blurred visual stimuli was most effective in discriminating at-risk subjects from controls (Nuechterlein 1985). Stimuli such as these have had their HSF components drastically reduced while leaving the LSF elements available for target recognition. If schizophrenia spectrum subjects have aberrant transient channel activity, they would be expected to perform more poorly under such degraded stimulus conditions.

Although the application of Breitmeyer's multichannel interpretation to the present findings (and those of Nuechterlein) suggests the presence of a sensory-perceptual deficit among spectrum members, not all researchers subscribe to Breitmeyer's position. For example, a cognitive deficit has been suggested by other researchers to underlie aberrant information processing (Knight 1984; Knight et al. 1985). Indeed, Knight et al. (1985) have suggested that backward masking effects may, in part, reflect the tendency of schizophrenic patients with poor premorbid adjustment to process a nonmeaningful mask as if it had meaning. Although this possibility is intriguing, it cannot account for the differential performance among Per-Mag subjects in the LSF versus HSF conditions because the masks were equally devoid of meaning in both conditions. However, it would be interesting to compare the target identification accuracy of spectrum members and controls within backward masking conditions that control for spatial frequency characteristics of the target and masking stimuli while manipulating the meaningfulness of the mask.

In the present study, aberrant transient channel activity may occur in various ways (Merritt and Balogh 1984; Merritt et al. 1986)—easily triggered transients, abnormally potent transients, and prolonged transient channel activity. It is also possible
that spectrum subjects have normal transient activity but are unusually susceptible to multiple transient bursts in a short period of time. In this case, a backward masking deficit would be caused by the spectrum subjects being more susceptible to the effects of target and mask onset and offset transients within the restricted timeframe associated with masking paradigms (e.g., < 1 second). We have no evidence that this is the case, because the two masking conditions did not differ in the number of target and masking stimuli onsets and offsets, yet the spectrum subjects evidenced a backward masking deficit in only the LSF condition. Although the present results appear to argue against additive transient susceptibility as an explanation, they do not rule out the three alternative explanations described above. Indeed, while the present study was designed to evaluate the possible involvement of transient channel activity, future studies need to address the nature of the transient channel dysfunction(s) suggested by the present findings and apply these questions to spectrum members within clinical populations.

Our interpretation of the present findings depends upon the adequacy of the two mask conditions used. It has been argued that when performance on two tasks is compared within a study, the psychometric properties of the two tasks need to be equated (Chapman and Chapman 1973). This is typically accomplished statistically by manipulating task variables until performance on the two tasks meets the equivalence criterion. This strategy was not used in the present study because psychometrically equating two conditions within an information processing study designed to evaluate the effects of a single manipulation often requires systematic unmatching on one or more extraneous variables that may obscure the perceptual phenomena of interest. Although we did not equate the psychometric properties of the two spatial frequency conditions, we were concerned that discrepant difficulty levels between the two masking conditions could hamper the interpretation of our findings. We chose to deal with the potential for differential difficulty level by equating luminance levels in the two masking conditions which resulted in roughly equating them in the amount of masking (e.g., difficulty level) each produced for normal subjects.

Other researchers have agreed that investigators interested in assessing information processing cannot uniformly apply Chapman and Chapman's (1973) task-matching prescription due to the nature of the phenomena under investigation (Neufeld and Broga 1981; Knight 1984). The strategy we used appears to have been effective because it is evident that the normal controls experienced equivalent masking in the LSF and HSF conditions. Thus, differences between normal and PerMag subjects in the LSF condition are unlikely to be an artifact produced by an interaction of task difficulty with group membership. Although our methodology allowed us to "match" the difficulty level of the two mask conditions for normal subjects given the single manipulation of interest (i.e., spatial frequency), in most information processing studies the researcher cannot simultaneously test a hypothesis involving a specific stimulus parameter and equate the psychometric properties of two or more experimental conditions. Frequently, the phenomena of interest define the nature of the experimental manipulation to be used and thereby prohibit the option of "fiddling" with stimulus parameters that alter the phenomena of interest in order to achieve psychometric parity. For example, if a subsequent study were to assess the effect of equivalent contrast across the two spatial frequency masking conditions, this would result in differing difficulty levels for normals between the two conditions.

When considering the level of masking associated with the two masking conditions, it is important to keep in mind that our use of the CSD procedure decreased the likelihood of obtaining masking effects, because each subject viewed the target at an individualized duration which, in the absence of the masking stimulus, ensured at least a 70 percent accuracy rate in identifying the target. Thus, this procedure maximizes subjects' chances of evading the effects of a backward mask in that target identification information may already be transferred to short-term memory at the time of mask presentation. Although the CSD procedure provides a lower limit estimate of subjects' sensory ability, it does not ensure an upper limit of performance, due to the effects of response bias. In fact, in both masking conditions the majority of subjects in each of our groups had an accuracy rate greater than 70 percent at one or more ISIs. Yet, both groups experienced masking, as may be seen by the presence of our significant ISI effect and the absence of a significant Group × ISI or a significant Group × ISI × Spatial Frequency effect.

We used a CSD-ISI methodology in this study because of the length of subject participation time needed to compare the two spatial frequency
masking conditions. In this paradigm, each subject could participate, in one sitting, in two complete backward masking experiments (the LSF and HSF conditions) that were counterbalanced within and across groups. By requiring only one visit to the laboratory, we avoided the loss of data from subjects failing to return for subsequent participation and obviated the problem of temporal effects. Thus, use of a CSD-ISI or a single STD and SOA paradigm would allow us to compare the two masking conditions within one laboratory visit. While the STD-SOA paradigm would be preferable, given the multichannel model of masking used in the present study (Balogh and Merritt 1987), a single STD may not allow a comparison of masking functions between vulnerable and control subjects. Indeed, when the vulnerable group requires increased CSD values, use of a single STD can result in a generalized performance deficit for the at-risk group due to the subthreshold nature of an STD value which will allow masking for controls; also, in order to use an STD that is visible to most of the schizophrenic subjects, very little masking may occur for controls due to the suprathreshold nature of the STD (Pretorius 1988). Thus, part of our rationale was to devise a methodology that would allow us to rule out a generalized performance deficit among at-risk subjects. For a more comprehensive evaluation of the spatiotemporal nature of the masking deficit, future work needs to use a range of STD values within an SOA paradigm.

An intriguing finding in the present study is that both groups experienced the greatest difference between the two masking conditions at the intermediate ISIs (60 and 100 ms), which are the ISIs most commonly associated with the time-frame of interruption masking. Additional studies assessing the time-course of interruption masking within an STD paradigm allowing the interpretation of results within an SOA framework are needed for a more complete understanding of the effects of transient channel abnormalities upon interruption masking. Previous researchers have stressed the importance of delineating the timecourse of masking effects. For example, in their assessment of the mixed integration-interruption masking of schizophrenic subjects, Braff and Saccuzzo (1985) found a CSD deficit as well as increased masking at intermediate ISIs.

Although our interest in visual masking has been directed toward the evaluation of masking deficits as potential trait markers of schizophrenia (Balogh and Merritt 1987), we purposely have refrained from viewing the results of the present investigation within a trait marker conceptualization because of our use of the Psychosis Proneness Scales. Interview data offered by the Chapmans and associates, as well as our own laboratory experiences with subjects selected on the basis of one or more of the Psychosis Proneness Scales, have suggested that an unknown number of these subjects are already experiencing significant thought disorder and other psychotic or schizophreniform symptomatology (Edell and Chapman 1979; Chapman et al. 1980; Merritt and Balogh 1986). This finding does not eliminate the usefulness of the Psychosis Proneness Scales in schizophrenia research, but it limits their effectiveness in trait marker investigations because state factors of schizophrenia or psychosis may obscure a clear interpretation of a study’s findings. In addition, the use of the Psychosis Proneness Scales does not facilitate having a “psychiatric” control group within an information processing study, an inclusion necessary to assess the specificity to schizophrenia of any processing abnormality demonstrated. Indeed, the goal of our research with the Psychosis Proneness Scales is to find converging patterns of performance among at-risk subjects identified by differing measures of vulnerability, some of which allow the identification of “psychiatric” controls (e.g., the MMPI). Conclusions about the specificity of a masking deficit among at-risk subjects cannot be based solely upon comparisons between normal controls and the at-risk group. Our current research efforts include the evaluation of transient-sustained interactions among MMPI-identified schizotypal subjects, “psychiatric” controls, and normal controls.

In conclusion, the most important contribution of the present study may be corroborating that the masking deficits reported by multiple researchers during the past 15 years may be related to aberrant transient channel activity in subjects with spectrum disorders. This finding suggests a new direction for masking research, one in which various researchers attempt to isolate specific factors related to suspected transient channel dysfunction(s) among spectrum members.

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The Authors
Rebecca Davis Merritt, Ph.D., is Assistant Professor of Psychological Sciences at Purdue University, West Lafayette, IN, and Clinical Assistant Professor of Psychology, Department of Psychiatry at the Indiana University School of Medicine, Indianapolis, IN. Deborah Ware Balogh, Ph.D., is Professor of Psychological Science at Ball State University, Muncie, IN, and Clinical Associate Professor of Psychology, Department of Psychiatry at the Indiana University School of Medicine, Indianapolis, IN.