The Pupillary Response as a Potential Indicator of Vulnerability to Schizophrenia

Stuart R. Steinhäuer, B.A.*
Gad Hakerem, Ph.D.,** and Bonnie J. Spring, Ph.D.***

This study deals with pupillary activity in psychiatric patients. It is part of a larger project investigating vulnerability to schizophrenia. The approach consists of a search for performance characteristics and physiological measures that would identify subjects at risk for schizophrenia. Markers of vulnerability to schizophrenia should detect deviances present before, during, and following episodes of schizophrenic disorder. Such enduring trait characteristics could result from hereditary factors or from major life experiences which have a permanent effect on the individual (1).

One of the most consistent findings in the literature on pupillary activity is that schizophrenic pa-

---

*Veterans Administration Hospital, Pittsburgh, Pennsylvania
**New York State Psychiatric Institute and Queens College, New York, New York.
***Harvard University, Cambridge, Massachusetts.
patients tend to show a smaller contraction to light than do normal subjects (2,3). In this study, reactions of the pupil to both sensory and cognitive aspects of stimuli were recorded. Since the vertex-evoked potential has been observed to discriminate between patient groups and nonpatients in a similar task (4) and has been shown to be highly correlated with the pupillary response (5), the evoked potential was also recorded from selected scalp locations.

All subjects were males between 18 and 36 years of age. One of the criteria for the selection of the schizophrenic patients was the availability for testing of one brother in the same age range who had never been hospitalized for psychiatric disorder. All subjects were diagnosed using Research Diagnostic Criteria. Patient groups and normal controls were matched for ethnic background, age, and level of education. Data were obtained from 12 schizophrenics, 12 siblings of these schizophrenic patients, 6 depressives, and 15 control subjects.

Pupil diameter and evoked cortical potential recordings were obtained simultaneously in darkness. The pupil diameter was measured with a Lowenstein infrared scanning pupillometer. At each trial, either an auditory click or a light flash was presented. Light and sound stimuli occurred with a probability of .5. In the certain condition, subjects were told in advance what the next stimulus would be. In the uncertain condition, the subject guessed verbally whether the next stimulus would be a light or sound. After each trial, the subject reported which stimulus had been presented. At the uncertain (guessing) trials, he also reported whether his initial guess had been right or wrong.

Subjects received a 2-cent reward for each correct guess and 1 cent for each successful report under the certain condition. Trial data were stored on tape and averaged by computer. For each subject, the computer printed digital data and analog plots for each of the individual outcomes.

The pupillary reaction to light stimulation is a contraction followed by a slow redilation. The range of contractions in this study was usually between .5 and 2.0 mm.

The pupillary response to sound stimuli is a small dilation (less than .1 mm.) under conditions of certainty. However, under conditions of uncertainty, the dilation is greatly enhanced (5) to between .1 and .5 mm., with a peak diameter at 1200 msec. after stimulus onset.

In general, the authors confirmed previous findings of a smaller extent of contraction to light stimuli for the patient group. The new finding was that all patients showed little or no difference in the dilation response to sound between the certain and uncertain condition. Three normal controls and two healthy siblings also showed no increased dilation in the uncertain condition. All other normal controls and healthy siblings showed greatly increased dilations in the uncertain condition. Pupil diameter for these subjects also differentiated between right and wrong responses, with a greater pupil diameter exhibited in the period following peak dilation for correct guesses than for incorrect guesses. Since all subjects, including patients, were required to report all outcomes, the absence of differential pupillary response to certain vs. uncertain and right vs. wrong conditions cannot be easily attributed to lack of attention.

The P300 component of the evoked cortical potential also showed a minimal difference between certain and uncertain responses in the patient group, while in the normal subjects, large differences existed between these two conditions.

The findings of this study to date indicate that monitoring of the pupillary response and evoked potential under conditions of certainty and uncertainty, particularly with respect to auditory stimuli, can provide an indication of impaired functioning. Further study of patients and their relatives is in progress. Several studies are underway with drug-free patients and patients in remission to determine whether these differences are maintained between normals and patients when the patient is in remission. The next step, naturally, is then to determine whether this indicator can be used as a marker of vulnerability.

References