Pupillary Reactions in Schizophrenics and Normals

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This study is part of a large project, in which we have been exploring the functioning of mental patients on five different levels. There are the physiological, sensory, perceptual, psychomotor and conceptual levels. The rational for such an exploration has been given elsewhere. In the context of such a classification, the present study would fall into the "physiological" category.

In this study we were concerned with the pupillary reaction to light in acute and chronic schizophrenics and we compared the reactions of these two groups with those of normal controls.

There are several reasons why we chose the pupillary reactions as a measure in our studies of schizophrenia.

In the literature on psychopathology one finds numerous references to pupillary disturbances observed in patients of all diagnostic categories.

Bunke, in 1904, and Bach in 1911, summarized the papers which had appeared...
if we consider the often very small and fast changes which occur in the
diameter of the pupil under different and changing conditions. From
Table I, one can see the range of different observations made by the
different clinicians. Since, however, both the clinical entities of the
psychoses and the external conditions under which these observations were
made vary greatly, such a divergence is not surprising. Some of these
authors tried to connect specific papillary syndromes, present at the beginning
of the illness, with the eventual outcome. Enke proposed that the absence
of papillary reactions to pain present at the onset of the disease would
indicate an eventual deterioration of the patient. There are, however, no
longitudinal studies available to verify these prognoses. Peterson (1956)
summarizes his brief review of these older studies in the remark, "One
gets the impression that the great interest (in papillary reactions) was
provoked more by the availability of the pupil for observation than by
any rightful expectation to find symptoms leading to an explanation of the
illness."

It should be mentioned, however, that one specific reaction syndrome
of the pupil has been associated with a psychotic state in which a brain
organic basis could be identified. This is the Argyll-Robertson pupil in general paresis (no reaction to light but reaction to changes in accommodation. Although the exact reason for this pupillary condition is still, today, subject of controversy, the consistent connection of such a syndrome with a specific organic and behavioral condition probably greatly increased the general interest in pupillary reactions connected with other subgroups of the large entity of psychiatric diseases.

During the last 50 years progress has been made in the technique to record pupillary behavior. We have, today, thanks to the lifelong efforts of Lowenstein ( ), methods available which enable us to record changes in pupillary diameter with a minimum of error. The latest method in electronic scanning device has been described in a paper by Lowenstein and Lowenfeld ( ). The other method, using infrared photography was also developed by Lowenstein and will be described in the apparatus section.
and, after synapsing in the ciliary ganglion, reach the sphincter muscle of the iris. Contraction of this muscle reduces the size of the pupil. The Westphal Edinger nucleus is also under control of fibers from the cortex and hypothalamus activity transmitted by these fibers serves to inhibit contraction of the pupil to light stimuli. Thus, the control exerted by the Westphal Edinger nucleus on the sphincter muscle is the resultant of the antagonistic action of two sources of innervation. The fibers bringing about contraction of the pupil are parasympathetic and the term central sympathetic has been applied to the inhibitory action of the higher centers.

A second sympathetic control is exerted via fibers leaving the spinal cord at the level of the 1-3rd thoracic vertebrae and arising in the cervical sympathetic chain to the brain to the dilator muscle of the iris is referred to as peripheral sympathetic innervation. Any general activation of the autonomous sympathetic system also will activate this muscle and dilate the pupil.

There are a few studies on psychotics with the newly developed objective recording devices. Lowenstein and Westphal reported in 1933 on an extensive survey of mostly chronic psychotic patients. Comparing their findings with earlier findings on normals, they concluded that within the group of patients there was greater variability of pupillary reactions. They found frequently a sluggish
reaction to light in schizophrenics. In catatonic patients they found frequently a reaction, which was similar to those present in patients lesions in the diencephalon. This reaction, a fast contraction from relatively low initial diameter and a fast dilatation was called the tonicclonic reaction. This type of pupil reaction was also found, acc to Alinsky, in schizoid states and in introverted persons of the schi phrenic group. C. Wastlyn described in 1907 a pupil he frequently for in psychiatric patients. In the condition which he calls the "catatonic pupil," the pupil is in a mid-dilation that is not very large and not small, with responses to light varying from prompt reaction to absolu rigidity. The pupil changes from moment to moment not only in reaction but also in size and equality. Levine and Schilder in 1912 reported a

In this study we tried to repeat as closely as possible the cond under which Lowenstein performed his latest experiments and tests, so we could compare our results with findings on patients with known les along the pupillary pathways.

The apparatus consisted of a 35 mm. movie camera which was driven by a synchronous motor at a speed of
10 frames per second. Double lenses (Wollensak F. 4.5 Fl. 101 mm.) were used to eliminate the nasal part and thus obtain larger picture. A light source was mounted on the camera and a parallel beam directed on the subjects left or right eye. The light patch was 10 mm. in diameter and yielded 15 fts of intensity at the level of the cornea. With a coupled episcotister a cycle of one second on and three seconds off was produced for the light patch. We used Kodak infrared sensitive film. As infrared light source we used condenser lamps with 65 bulbs 6.5 v. A Kodak Wratten 88A filter was mounted in front of the lamps. The produced light was visible to the subject as 2 dark red spots. The infrared light was directed on the eye at a level at about 45° angle from below.

The subject was seated in a comfortable chair which could be adjusted for height. His head rested on a head rest (dentist type) and his chin was supported by a chin rest. A pinpoint light was directed on his forehead on which a small black dot had been painted. By this device we could control the position of the subject relative to the camera 64 and the stimulus light without restraining him. The subjects in this experiment were a group of 37 acute schizophrenic patients, 37 chronic schizophrenic patients and 22 normal controls. Since according to some reports, pupillary reaction
Changes with age we limited our group to those in the age range between 18-37. The chronic patients had been uninterrupted in the hospital for at least five years. In order to decrease the heterogeneity of our patient groups, we selected only patients who manifested auditory hallucinations or produced delusional material during a recorded interview immediately before the testing. None of them had had any tranquillizing drugs or antipsychotic treatment in the two weeks preceding testing. Subjects with known neurological or ophthalmological disorders were not used.

Procedure.

The subjects were adapted for 10 minutes to the very dim illumination.
The exposed film was then developed and projected on the screen. The horizontal diameter was measured and plotted in its proper time sequence on graph paper (Fig.). The curve obtained by connecting the obtained points is called the pupillogram.

A quantitative analysis of the pupillograms which would do justice to the total course of contraction and relaxation turned out to be rather difficult. I experimented with several methods including the use of an analog computer. However, all methods had enough flaws to warrant their rejection. We therefore, abstracted certain measures from the pupillograms and compared the groups on each of these measures separately. The reason for selecting these measures were based on inspecting pupillograms of patients with known lesions and experimental animal preparation. We considered each of these measures as representing a specific state in the relationship of the sympathetic and parasympathetic causes in producing any pupillary diameter. We considered the following:

1. **Initial diameter** is the size of the adapted pupil at the time the light stimulus is presented. There is a latency of 1
Extent of contraction is the difference between initial diastasis and point of maximal contraction.

Time of contraction is the time in seconds it takes the pupil to reach its point of maximal contraction.

Peak speed gives the maximum contraction speed achieved, seconds unit of.

Elongation of curve indicates in seconds the time the pupil remains at maximal contraction.

A rather large difference between the males and the females.

Three groups, and therefore analyzed males and females.

Because of large intra-group variability we found a non-

statistic more adequate to handle our data.

And each of the measures on each of the 16 reactions ( 8 with

light to the right ear and 8 with stimulus light on left ear)
The results of these analyses are tabulated in tables II-V.

Discussion

Table II shows the group differences for the initial diameter. It can be seen that there is a significant difference between the male chronic and male acute in all 16 reactions. Since there is usually a difference in the initial diameter between the first and the other reactions, the second mean of the second reaction in each run and compared two measures over all the group and the results are listed under run 16, 17, and 18. Although the differences for the females in this group are not significant the direction of the difference is consistently in the same direction as in the males. There is no difference between normals and chronic in either sex group.

Normal males and acute males again are significantly different in all 16 reactions, nearly always at the .01 level. The females show a difference.

This means that the male normals have the largest initial diameter, the acute males have the smallest. If, as many researchers assume,
a wider pupil in the acute patients. Schilder and Levine report that the schizophrenics in their study had a pupil of mid-dilation.

In a study in 1992 report that the acute schizophrenics they observed had consistently a smaller pupil than the normals. Whenever the patient got better, or became chronic, his pupils would assume a larger diameter under their standard observation condition. Each exacerbation of the psychotic symptoms would again decrease the pupillary diameter.

Table III shows the extent of the contractions to the light stimulus. There are only few and scattered significant differences in these comparisons. On 4 of the 16 comparisons between normal males and acute males, the difference is significant. The direction of the difference, namely that the normals have a larger extent is consistent in all 16 comparisons. Since the normals have a larger initial diameter, one would expect such direction.

Table IV shows the comparisons of the time of contraction. In terms of our anatomical scheme of pupillary reflex control, a fast contraction would indicate a lack of sympathetic inhibition and could be linked to the presence of a relative small initial pupillary diameter.

In 6 of the 16 comparisons between normal males and acute males there is a significant difference indicating that the pupil of the normals reach
its point of maximal contraction later, that is, the pupil centri-

In 9 of the other 10 comparisons the direction is consistent at

significant level is reached. It should also be noted that some

differences between the normals and chroniccs, both male and fe-
ficses.

There is a tendency that the pupils of the patients, both i
serve as a predictor for outcome of illness. It should be noted that this reversal of rank order does not occur when, as in the left eye series, the sensory stimulus is presented immediately before the fifth light stimulus.

Table 7 shows the comparisons on the measure flatness of curve. No systematic consistent significant differences can be observed. There is, however, a trend which indicates that the time the pupils of the patients and specially the anules remain longer at the level of maximal contraction.

Except for the initial diameter there is no measure derived from these pupillograms which significantly consistently differentiates patients and even here, a difference exists only in the male patients. There is, however, a trend expressed by the sign + or - (+ indicating the larger mean rank) in the following direction: patients seem to have a smaller
Since we don't have an exact evaluation of these radiation curves yet, we can concern ourselves mainly with the contraction curve. The fast contraction and the long flatness of curve are indicative of a lack of inhibition, which is transmitted from the hypothalamus. It is a well known fact that patients with disturbances in the basal ganglia, such as Parkinsonism, Athetosis, etc., show a pupillary contraction curve which is characterized by a small initial diameter and a fast contraction, plus a long flatness of curve. Pettler, in his paper, 1953, has specified the role of the stratum which is part of the basal ganglia in schizophrenia. He points out that the role of the basal ganglia is to integrate incoming stimuli from different sensory modalities. Any disturbance in this area would create a lack of integration which could lead, according to Pettler, to the symptoms of perceptual distortions which are common in schizophrenia. Pettler assumes malfunctioning of the stratum in schizophrenia. Our findings would, to some extent, confirm the findings line with Pettler's speculations. The small initial diameter and fast contractions are found both in our acute patients and in the patients with known lesions in ( ) basal ganglia areas. However, surveyed a much larger group of patients of those ( )
and with different symptomatic entities, in order to come to any conclusions.

The following observations should be mentioned here: in experimenting

with the newer electronic device of Lowenstein be observed so that patients

who had shown tonochaptic reactions in recording with the photographic method
did not show that more or to a lesser degree in recording with the new

instrument. We compared the difference between these two instruments and

the previous study done by Lowenstein and Westphal was mainly in the amount

of light necessary for recording. Lowenstein and Westphal had to use a

blue ( ) white light in order to obtain a photographic rendition.

With the photographic method the infrared illumination necessary for this

purpose was rather low but still clearly visible to the subject. In the

electronic device the infrared light shown was no longer visible since it's

scanned with a great speed across the eye. But in the latter instrument, the

subject was in complete darkness. This, and other observations, indicate

that the amount of background illumination contributes to the appearance

of the fast reaction of relatively low neural initial diameter. Yet,

therefore, are undertaking at the present time series of parametric studies.
and with the pupillary reaction curve. We would predict that with
of background illumination the techoptic curve would appear earlier
patients than in normals. We were able to show that with a rather
background illumination techoptic light curve appears in all subj