THE RELATIONSHIP BETWEEN THE SPIRAL AFTEREFFECT TEST AND ELECTROENCEPHALOGRAPHIC RECORDS IN ADULTS

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Abstract

The relationship between the spiral aftereffect (SAE) and electroencephalograms (EEG) of an adult population was evaluated. The spiral aftereffect test (SAET) was administered to two groups of patients--20 with abnormal EEGs and 20 with normal EEGs. The results indicated all patients reported SAE. It was concluded that the SAET failed to discriminate between adult patients with abnormal EEGs and adult patients with normal EEGs.

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The illusion or aftereffect following the rotation of a spiral has been known and used in experimental psychology since first reported by Plateau in 1850 (Boring, 1950).

After observing a rotating spiral, subjects usually perceive an aftereffect for a period of time after the rotation has stopped. Subjects usually experience a visual negative aftereffect of either expansion or contraction of the spiral immediately following rotation--e.g., an aftereffect of expansion if the spiral were perceived as contracting during rotation and vice versa.

The use of spiral aftereffects as a technique for psychological assessment of cortical damage was introduced by Freeman and Josey (1949). Their results revealed that most of their subjects with clinically judged memory impairment did not report or were unable to perceive this distinctive aftereffect.

The Freeman and Josey (1949) data led Price and Deabler (1955) to speculate that the spiral aftereffect (SAE) phenomenon might be utilized for the development of a technique for consistent differentiation of organic from nonorganic cases. Their study hypothesized that nonorganic patients would be able to perceive the aftereffect, while organic patients, especially

those with cortical involvement, would be unable to perceive it. The results were impressive. In the brain-damaged group, 98% failed to perceive the SAE in each of the four consecutive trials. Ninty-five percent of the nonorganic psychiatric population and 92.5% of the normal population were able to perform satisfactorily on each of the four trials.

Subsequent studies substantiated the technique in differentiating subjects with cortical damage from normal subjects with no cortical damage (Garrett, Price, & Deabler, 1957; Page, Rakita, Kaplan, & Smith, 1957).

Continued research by Gallese (1956) correctly identified 100% normals, 95% schizophrenics and 66% of a group of mixed organics by using SAE. He also introduced the first major inconsistency by showing that 12 lobotomized patients all scored normally. Page et al. (1957) also noted that prefrontal lobotomy patients responded as well as normals. Garrett et al. (1957) reported results that indicated only 2.5% of persons diagnoised as chronic brain syndrome had a perfect SAE score. Aaronson (1958) suggested from the results of his study that SAE responses are eliminated if there is involvement of damage in the temporal lobes. He suggested that no reporting of SAE was due to an inability to verbalize the experience and was not the result of an inability to perceive the aftereffect.

Berger, Everson, Ruthedge and Koskoff (1958) attempted to evaluate the relationship between the aftereffect and various neurological indices. The results of their study confirmed the general usefulness of the spiral aftereffect test (SAET) as a heuristic laboratory technique for the study of brain pathology; however, an inability to perceive the SAE did not differentiate severe pathology from the less severe. However, the results did show that those persons who performed satisfactorily on the SAET had significantly better visual acuity as measured by the Snellen chart.

Spivak and Levine (1958) reported data that confirmed previous work based upon the occurence/non-occurence of the illusion in brain-damaged groups and also demonstrated that, when reported, SAE in organic subjects was of significantly longer duration than in nonorganic subjects. Philbrick (1959) reported results of a contradictory nature, noting that organic patients who reported SAE seem to notice it for a shorter duration.

Continued experimentation yielded conflicting results with the use of the SAET for differentiating organics from nonorganics being seriously questioned (Gilberstadt, Schein, & Rosen, 1958). The use of the SAET for detecting pathological cortical brain damage, according to Gilberstadt et al. (1958), did not significantly improve the diagnostic efficiency which would be obtained by using the base rates, which is a technique for evaluating the

differences between the observed results and the results expected. Pickergill and Jeeves (1958) did not test any abnormal subjects but found that five percent of a sample from a normal population did not perceive SAE. Holland and Beech (1958) found no impressive discrimination when comparing scores of an organic group and a group of university students on incidence and duration of the SAE. Only one subject in their organic group failed to see the SAE all four trials and only one more failed on three trials.

It should be noted that the many studies dealing with the SAET were hardly comparable since there was much variation in experimental methods and instruction specification. Holland (1960) observed that the inconsistencies among various studies were numerous since SAE is dependent on the interaction of many variables. In a complete review of SAE research, Holland (1965) suggested relevant variables, whose lack of control produced discreprant results, included speed of rotation, visual angle, illumination of the spiral and instructions to the subject.

SAE stimulus variation research by Sinberg (1961) found significant differences in the occurence of SAE with variation in the speed of rotation. The results demonstrated that a disk rotation of 54-90 rpm appeared to yield optimal results.

Instructions were examined in several studies (London & Bryan, 1960; Mayer & Coons, 1960). It was concluded that the reported impairment of perception found in brain-damaged persons

was a case of failure in reporting rather than a failure in perceiving the SAE. These studies suggested that with a given instructional set, the organically involved patients responded to the SAET as frequently as normals. Failure to report SAE, these suggested, was due to anxiety and hesitancy to report any experience that was not strongly manifested.

Although research continued on the SAET, the question of what constituted brain-damage was not clearly defined. Blau and Schaffer (1960) defined brain-damage in terms of a normal and abnormal EEG; their investigation used children with abnormal and normal EEGs. Performance on the SAET was used to predict the EEG record. The results were impressive in that with 86% accuracy, Blau and Schaffer (1960) were able to predict abnormal EEGs.

The present study considered some methodological issues peculiar to SAE research that have been pointed out in recent studies (Hersen, Levine, & Church, 1972; Holland, 1965). These findings revealed that instructions, speed of rotation, proper illumination, and visual angle significantly affected SAET results. The present study considered some of these issues and attempted to provide a uniform subject population, adequate instructional set and a clear definition of brain damage from EEG records. Specifically, the current study examined the relationship between the

SAET and EEGs in an adult population, and it was predicted that adults with abnormal EEGs would not report seeing the aftereffect.

Method

Subjects

The subjects (Ss) were 40 patients, 26 male and 14 female, ages 18-60, at Broughton Hospital, Morganton, North Carolina. All Ss were without noticeable symptoms of neurological, visual or visual-motor disturbances. Two groups of Ss were used: 20 Ss with normal EEG records and 20 Ss with abnormal EEG records. Selection for abnormal and normal EEG records was based on a two hour EEG record. Using the judgment of an electroencephalographer, diagnosis was based on the factors of: 1) focal findings vs. no focal findings and 2) diffuse findings vs. no diffuse findings. Those cases which showed any EEG anomalies, either focal or diffuse, were called the abnormal EEG group, and those Ss whose EEGs resulted in no findings were considered normal. The SAET was conducted approximately two months after the EEG was given and most of the SAETs were given within a two weeks period of the EEG administration.

Apparatus

An electric motor commonly used for color mixing experiments was used to rotate a white 8 inch disk on which was painted a black Archimedes spiral of 920 degrees or about $2\frac{1}{2}$ turns. The motor was reversible with a variable speed control. The EEG was administered according to the international 10-20 electrode placement system, using 24 leads, with a mid-forehead ground electrode.

Procedure

The S was seated five feet from the spiral. Testing was conducted in a room with adequate illumination, and the S was eye level with the spiral.

Four trials were administered: two counter-clockwise rotations of the spiral giving a negative aftereffect of contraction (Spiral A) and two clockwise ratations of the spiral creating a negative aftereffect of expansion (Spiral B). The trials were presented ABBA or BAAB. Each trial was 30 second's duration and the spiral was rotated at 78 rpm. The instructions were similar to Hersen et al. (1972):

"This is a special eye test. Look at this line here. The line will start turning and I want you to look at the dot in the center and keep looking at it. After this disk has stopped turning around a number of things could be happening: the line may be getting bigger or appear to come towards you; or it may appear to be getting smaller or going away from you; or it may just stop and nothing happens."

After S observed the turning disk for 30 seconds, the experimeter (E) stopped the disk and asked, "Is anything happening?" If the answer was yes, the E asked, "What?" If the answer was no, three additional trials were given. After each trial the S was asked, "Is anything happening?"

Scoring was on an all-or-none basis. Any report of seeing the aftereffect was scored as "passing" the SAET.

Results

A total of 40 Ss were systematically evaluated by means of an exact binominal test. Of these, all of the Ss in both the abnormal and normal groups were able to pass the SAET (binominal test, $p < .001$). Under the conditions of this study, there was no differentiation of abnormal EEGs from normal EEGs by the SAET. Although two Ss failed to report the SAE on the first trial, they both reported the SAE on the three remaining trials, thus passing the SAET. Half scores were not used in this study. Although some studies (Gallese, 1956; Price & Deabler, 1955) used this half-score method, recent studies (Hersen et al., 1972) have not used that method.

Discussion

The results of the present study contrasts with the Blau and Schaffer (1960) study in which they predicted abnormal EEGs in children. In the current study, the essential features of the Blau and Schaffer (1960) study were replicated with the exception of the differences in population--i.e., in the Blau and Schaffer (1960) study, the children's ages were 5 to 16. The current study used adults ages 18 to 60. This, then suggests that the effectiveness of SAET in identifying abnormal EEGs may be restricted to children.

A previous study (Harding, Glassman, & Helz, 1957) was interpreted as lending support to the hypothesis that children below

a certain age level, presumably because of insufficient neural maturation, exhibit some behaviors similar to those of brain-damaged adults. Therefore, the Blau and Schaffer (1960) data may be the consequence of a complex interaction between age, neural maturation, and degree of EEG anomaly. Due to the age of the sample used in the current study, this interaction was not present, and the Blau and Schaffer (1960) findings were not confirmed.

The results of the current study also do not support the findings of Hersen et al. (1972) that organics with facilitated instructions report fewer SAE than schizophrenics or normals. Certain methodological issues suggested by Hersen et al.(1972) and Holland (1965) such as facilitated instructions, size of the spiral and amount of light were considered, but their findings were not confirmed.

In the Hersen et al. (1972) study, however, the definition of brain-damage was not always clear. The present study tried to define more clearly brain damage and this may have affected the findings.

The results of the current study, however, support the findings of Holland and Beech (1958). Their study found no impressive discrimination when comparing scores of an organic group and a group of university students on incidence and duration of the SAE.

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