Effects of homogeneous stimulation on the visual figural after-effect

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Abstract

A hypothesis was proposed that atypical subjects such as schizophrenics and mental retardates are characterized by abnormally high basal levels of neural inhibition. On the visual figural aftereffect (FAE) such subjects have a smaller FAE than normals when measurements are made immediately after inspection and exhibit counter-displacement when measurements are made 30 and 60 seconds after inspection. It was predicted that a pattern of figural displacement similar to that evidenced by atypical subjects could be induced by artificially raising the basal level of inhibition prior to testing for the FAE.

Eighteen subjects served in both the experimental and control conditions in a counterbalanced design. An increase in the basal level of inhibition was produced by pre-inspecting three horizontal lines prior to measuring the FAE with vertical lines. The results showed that homogeneous stimulation decreased the FAE immediately after inspection and produced counter-displacement 30 seconds after inspection.

The evidence was discussed in relation to the theories of Klein and Krech (1952) and Eysenck (1955), which utilize concepts of cortical conductivity and inhibition to account for differences in personality. It was pointed out that any theory utilizing constructs such as conductivity and inhibition must differentiate between basal levels of inhibition and inhibition due to local or transitory stimulation. In addition, tests of such theories must clarify which aspects of inhibition are measured before an adequate evaluation can be made.

Introduction

Experiments on visual figural after-effects (FAE) in atypical subjects are limited, but the findings generally show that such subjects exhibit smaller-than-normal figural displacements when measurements are made immediately after inspection. Wertheimer (1954) and Wertheimer and Jackson (1957) showed that schizophrenics had a smaller FAE than normal and Spitz and Blackman (1959) found that the same relationship decreased the same for retardates. The present investigators (Kelm, 1962; Prysiazniuk and Kelm, 1963) have verified these findings in a series of studies with an apparatus similar to that used by Hammer (1949).

A likely explanation for differences in the FAE is that there are individual differences in the rate at which satiation develops at the cortical level. But it is difficult to say what is the immediate cause of such differences in rates.

Investigators who have concerned themselves with individual differences in the FAE have either postulated inherent differences in the development of satiation (Eysenck, 1955; Klein and Krech, 1952) or have introduced physiological constructs to account for such differences (Wertheimer, 1954; Wertheimer and Jackson, 1957).

There is, however, an unexplored concept suggested by Köhler and Wallach (1944) by means of which differential rates of development of satiation may be explained. In other words, the rate of development of satiation due to inspection is
inversely related to the level of generalized homogeneous satiation\(^3\) that already exists. [The idea is clarified and elaborated in the drawing and the legend provided in Figure 1].

\[\text{Figure 1. Hypothetical distributions of patterns of satiation following prolonged inspection of the I-figure. A higher basal level of satiation produces a wider spread and flatter gradients. If it is assumed that the degree of displacement is directly related to the gradient of satiation, then in the above cases, the T-figure will be displaced to a lesser degree when basal satiation is high than when it is low.}\]

This view can readily account for the decreased FAE in atypical subjects if it is assumed that such subjects have exaggerated levels of homogeneous satiation, i.e., their basal level of satiation is high. Inspection of a figure will produce a smaller increment in satiation as compared to normals who receive the same amount of stimulation. Differential local satiation will manifest itself in different magnitudes of the FAE.

The view that atypical subjects have increased basal levels of generalized satiation can be readily tested. If the basal level is artificially increased in normals, they should then exhibit a pattern of figural displacement\(^4\) to that of atypical subjects. Schizophrenics and mental defectives have a smaller-than-normal FAE when tested immediately after inspection. They also exhibit counter-displacement (movement of the T-figure toward the I-figure) when measurements are made 30 and 60 seconds after inspection (Kelm, 1962; Prysiazniuk and Kelm, 1963).

The primary aim of the present study was to determine whether a decreased FAE at the immediate test-period and counter-displacement at the 30- and 60-second test-periods could be induced in normal subjects by increasing the basal level of satiation prior to testing for the FAE.

**Method**

**Subjects.** Seven men and thirteen women who were student psychiatric nurses at the Saskatchewan Hospital, Weyburn, volunteered to participate in the experiment. Two subjects were eliminated in a practice session given prior to the experiment. One subject made no attempt to follow instructions and another had defective vision in one eye. The mean age of the remaining subjects was 19.3 years. None was familiar with the apparatus and the object of the study.
**Apparatus.** The apparatus was the same as described previously by Kelm (1962). It consisted of a black 34 x 30 x 27 inch tunnel at the rear of which were centered two vertical lines of white light (I- and T- lines) and a pinpoint of red light which served as a fixation (F-) point. The two lines of light were produced by cutting a .750 inch long and a .001 inch wide aperture in two black pieces of plastic which were then mounted, one above the other, in a metal frame. Both lines could be moved independently in a horizontal direction by the experimenter but the subject could only move the upper line by turning a knob located on his right.

The arrangement of the lines for the T-figure was as follow: The bottom line was located .250 inch to the left and .250 inch above the F-point. The upper line, which was .250 inch above the lower line was placed, prior to each alignment, at a random distance to the subject’s right of the F-point. The placement of this line could be measured accurately to within .001 inch by a vernier caliper mounted at the rear of the apparatus. For the I-figure, the configuration was the same except that the lower line was placed .190 inch to the left, and the upper line .215 inch above and to the right, of the lower T-line position.

The figure for increasing the basal level of satiation consisted of an F-point and three horizontal lines of white light. This F-point, which was also a pinpoint of red light, was located 5.5 inches directly above the first F-point. The three horizontal lines, which measured 3 inches long and .001 inch wide were placed, one above the other, at intervals of .5 inch. The distance between the bottom horizontal line and the F-point was .625 inch. The spatial arrangement of the displays is shown in Figure 1.

![Figure 2](image)

*Figure 2. Configuration of inspection-figure, test figure, fixation points and the pre-inspection horizontal lines for inducing homogeneous satiation*

The lines of light in both figures were illuminated by 10-watt bulbs (set at 90 volts), which were encased in .125 inch thick frosted glass. These cases were located two inches behind the plastic slide with the line and, to minimize stray light, were painted black on all sides except that facing the plastic slide. In the figure used to measure the FAE, each vertical line and the F-point could be illuminated
independently. A single switch controlled the illumination of the figure used to produce a homogeneously stimulated field.

A headrest, which was used throughout the experiment, was mounted 24 inches in front of the figures.

**Procedure.** Each subject was first given several practice alignments. He was seated in front of the apparatus and asked to put his head in the rest as he fixated with both eyes on the red light. The lines were then placed in the T-figure position and the subject turned a knob on his right in a counter-clockwise direction until the upper and lower lines appeared to form a single straight line. At this point, he was to stop turning and announce “Now”. These practice trials continued until five consecutive settings did not vary by more than .050 inch. In addition, the subjects were trained to maintain constant fixation and to make their alignments within approximately 5 seconds.

The basic procedure for obtaining the FAE was as follows: The room was darkened so that all the subject could see was the T-figure and the F-point. He was then instructed to make 3 alignments, which were measures of the point of subjective equality (PSE). Each alignment was separated by an interval of 30 seconds. The lines were then placed in the I-figure position and, following a 2-minute rest, the subject was asked to look at the F-point for 10 seconds. Immediately after this inspection, the lines were again placed in the T-figure position and the subject, continuing fixation on the red light, made an alignment. Alignments were also made 30 and 60 seconds after inspection. This procedure, constituting one trial, was repeated three times with a 2-minute rest between trials. Following a 2-minute rest after the last trial, 3 more alignments were given to establish the PSE. The interval between those trials was again 30 seconds. In every interval between alignments, i.e., as soon as the subject announced “Now”, the figure was turned off and he rested in complete darkness.

In the experimental condition, the only difference in procedure was that a period of 30 seconds of inspection on the 3 horizontal lines was given prior to inspection of the I-figure. After the first 3 alignments measuring the PSE, the horizontal lines were illuminated and the subject stared at the appropriate F-point for 30 seconds. The horizontal lines were then turned off and the I-figure was illuminated. After 10 seconds of inspection, the lines were placed in the T-figure position and alignments were made immediately, 30, and 60 seconds after inspection. This procedure was repeated 3 times after which 3 more settings measuring the PSE were made. The time intervals between trials were exactly the same as in the control condition.

Each subject served in both the experimental and control conditions. The order of presentation of conditions was counter-balanced between subjects. Half the subjects received the control condition first and the other half received the experimental condition first. The initial condition was alternated between subjects in order of their appearance at the laboratory. An interval of three weeks separated the two testing sessions.
Results

For each subject, the six control alignments made before and after the FAE trials were averaged to establish the PSE. The three alignments made at each of the three test-periods were averaged and represented the experimental alignment for each test period. The difference between the mean PSE and the mean of the experimental settings was a measure of the subject’s FAE. The changes in the FAE as a function of test-time for the experimental and the control conditions are shown in Fig. 2.

A treatments x treatments x subjects analysis of variance (Lindquist, 1953) was employed to determine what variables had an effect on the magnitude of the FAE. It was found that homogeneous stimulation of the visual field decreased the magnitude of the figural displacement \( F = 22.4; F_{0.01} = 5.29 \). In addition, as the time after inspection increased, the FAE decreased \( F = 18.2; F_{0.01} = 8.40 \). However, the treatments x treatments interaction was statistically significant \( F = 6.66; F_{0.01} = 5.29 \). This result indicates that the pattern of displacement under the various test periods is different for the control and experimental conditions. Whereas, in the control condition, the FAE steadily decreased with test time, under homogeneous stimulation the FAE showed a reversal in trend at the 60-second test period.

In order to determine whether significant counter-displacement occurred under homogeneous stimulation, \( t \)-tests for correlated measures were employed. The value of \( t \) between the PSE and the magnitude of counter-displacement 30 seconds after inspection was 3.18 \(( p < .01)\). However, 60 seconds after inspection counter-displacement was not statistically significant \(( t = 1.61; p > .05)\). This tendency for counter-displacement to diminish at the 60-second test period has been noted in a previous study which utilized the same I-figure, T-figure and F-point complex. Kelm, Jensen and Ramsay (1963) measured the FAE of alcoholics to whom lysergic acid diethylamide had been administered. LSD decreased the magnitude of displacement immediately after inspection and produced significant counter-

![Figure 3. The effect of pre-inspecting horizontal lines prior to measuring the figural after-effect with vertical lines](image-url)
displacement 30 seconds after inspection. However, there was no effect evident at the 60-second test period.

One interpretation of the presence of counter-displacement at certain critical intervals after inspection is that the rate at which counter-displacement appears is related to the magnitude of the FAE immediately after inspection. If the initial FAE is large, counter-displacement is delayed; but, if the initial FAE is small, counter-displacement appears early and decreases on subsequent test periods. In order to provide some evidence on this point of view, the subjects in this study were divided into two groups of nine on the basis of the magnitude of the FAE immediately after inspection. For the nine subjects who had the largest initial FAE under homogeneous stimulation, the displacements were +.021, -.010, and -.014 inch at 0, 30 and 60 seconds after inspection. For the remaining subjects, the respective magnitudes were +.001, -.016, and .000 inch. An analysis of variance, using only the data at the 30- and 60-second test periods, revealed that the groups x test-time interaction was highly significant ($F = 9.68; F_{.01} = 8.53$). Hence, it appears that the time at which counter-displacement appears under homogeneous stimulation is dependent upon the initial size of the FAE.

The data from this study were subjected to one other analysis. Earlier it was proposed that inspection on a figure will produce a smaller increment in satiation in those individuals with a higher basal level, as compared to those with a lower basal level, of satiation. If the FAE reflects the basal level of satiation, homogeneous stimulation should produce the greatest decrement in the FAE in those subjects with initially large FAEs. To test this prediction, a product moment correlation coefficient was calculated between the FAE at the immediate test period in the control condition and the magnitude of decrement in the FAE at the same test-period following homogeneous stimulation. The resulting coefficient was +.63 which was statistically significant beyond the .01 level of confidence. This result is consistent with the view that the FAE is dependent upon the basal level of satiation in the cortex.

**Discussion**

The finding of greatest significance in the present study is that artificially raising the basal level of satiation produces a decrement in the FAE immediately after inspection and counter-displacement 30 seconds after inspection. This is very similar to the pattern exhibited by such atypical subjects as schizophrenics and retardates. Thus, these results provide a confirming instance of the hypothesis that atypical subjects are characterized by exaggerated basal levels of satiation.

These results are of some importance in light of two recent attempts at relating certain personality characteristics to differences in cortical inhibition and conductivity. In one of these attempts, Klein and Krech (1952) contend that transmission of excitation, or differential cortical conductivity, can account for individual differences in cortical integration. They claim that different individuals are characterized by different basal levels of cortical conduction. Some individuals have high basal conduction; others lower basal levels of conduction. Stimulation which produces changes in the cortex such as is necessary for perception and learning, would have different effects on different types of individuals. They
content that those persons with high basal conduction would “suffer a relatively small drop in conductivity as a consequence of a given amount of local stimulation” whereas those individuals with an initially lower basal level of conductivity would “...suffer a relatively large drop in conductivity as a consequence of the same given amount of local stimulation (p. 121)”. 

This analysis is contrary to that outlined in this paper. If it is assumed that conductivity and inhibition are simply different aspects of the same state-of-affairs, then Klein and Krech are stating that a person with high basal conductivity (lower basal inhibition) suffers a smaller increment in inhibition than one with a low level of conductivity (high basal inhibition). The results of the present study do not support this view. When the basal level of inhibition was increased, those individuals with a large FAE decreased more than those with an initially smaller FAE. This result is interpretable in terms of the concept that inhibition develops as a negatively accelerated decreasing function of the amount of inhibition already present in the stimulated region. 

However, the crux of the difference between the present analysis and that of Klein and Krech lies in their interpretation of the factors that produce FAEs. In this paper it is contended that it is the magnitude and pattern of local inhibition produced by an I-figure that is responsible for the FAE. Thus, the greater the degree of local inhibition possible, the larger the FAE. Klein and Krech, however, state that “the lower the conductivity, the greater the figural after-effect (p.124).” Translating the frame of reference from conductivity to lack of conductivity, this statement would read that the higher the basal inhibition the greater the FAE. That this interpretation is incorrect, at least for the visual FAE, is attested to by the fact that increasing basal inhibition by homogeneous stimulation decreased the FAE. 

Another major attempt at relating personality differences to differences in the inhibitory characteristics of the nervous system was made by Eysenck (1955). He stated that differences between introverts and extraverts are due to differences in the rate at which they develop inhibition. He contended that extraverts generate inhibition more quickly and to a greater degree than introverts. In addition, he postulated that the rate of dissipation of inhibition is slower in extraverts than introverts. Experimental attempts at verifying these notions have been decidedly contradictory with some investigators finding significant differences between the two personality types and others not. One possibility for such contradictory evidence is that there has been a failure to distinguish between rates of development of inhibition and basal levels of inhibition together with a failure to analyze what aspect is being measured by the methods used. It may be that extraverts do not develop inhibition faster as a function of local stimulation, but rather they have higher basal levels of inhibition. If this were the case, then contrary to Eysenck, extraverts would develop inhibition at a slower rate than introverts. Indeed, there is some empirical evidence to show that extraverts may have higher basal inhibition than introverts. Rechtschaffen (1958) compared the visual FAE in introverts and extraverts. The figure he used consisted of a centered F-point with a stationary T-line in the right and a variable comparison line on the left. To establish a PSE, subjects set the comparison line at the same distance to the left of the F-point as the T-line appeared to the right of the F-point. The FAE was
obtained by inspecting the F-point and a bar located between the F-point and the position of the T-line then setting the comparison line after inspection. The results showed that there were no differences between groups in the magnitude of the FAE. However, there appeared to be a consistent tendency for extraverts to have a smaller PSE than the introverts. Rechtschaffen states that on none of the experimental trials did the PSEs differ significantly. However, the procedure of comparing trials independently may not be warranted in this case. In all, measurements of the PSE were made on three practice and three experimental trials and on every trial the extraverts had a smaller PSE than the introverts. This means that the distance between the F-point and the T-line was shorter for extraverts prior to the introduction of any experimental variable. Although this difference is not predicted from Eysenck’s theory, it is predictable from the view that there are differences in inhibition between extraverts and introverts prior to the introduction of stimulation. Köhler and Wallach (1944) have repeatedly shown that “if two objects lie in a homogeneously satiated region their distance is shorter than that of similar objects in a neutral region (p.356).” In Rechtschaffen’s figure the distance between the F-point and the T-line is shorter for extraverts than for introverts to begin with. The most compelling explanation for this fact is that the visual area in extraverts has a higher degree of homogeneous satiation than that of introverts.

In conclusion, it can be said that present theories that attribute personality differences to differences in inhibitory characteristics suffer from two major weaknesses. In the first place, they make little attempt at differentiating between rates and levels of inhibition and the marked dependency of the former variable upon the latter. Secondly, the lack of differentiation between the two concepts has led to the use of techniques that yield equivocal results. Until such a conceptual distinction is recognized, personality theories based on inhibition constructs will remain inadequate.

References

Notes
1 This study was supported in part by a National Health Grant, Project No. 607-5-198. We wish to thank Dr. A. Hoffer for drawing the graph.
2 Now at psychology Department, University of Alberta, Edmonton.
3 For convenience of expression, Kohler and Wallach’s term “homogeneous satiation” is used to indicate an increased level of generalized unpatterned inhibition.
4 The term “displacement” is reserved for displacements of the T-figure away from the I-figure and “counter-displacement” for movement of the T-figure toward the I-figure.

Comments
The above report appears to be a revision a paper that was submitted for publication in 1964. I am unable to say why it is so badly written. The version presented here retains the original style and, for the most part, only minor grammatical changes have been made. The one major addition is Figure 1, which clarifies the nature of the argument. For many years, I presented a hybrid theory of figural aftereffects (an amalgam of Kohler & Wallach and Osgood & Heyer) to my undergraduate class in Perception as an example of a neurophysiological approach to conscious experience. It was only after I began employing a version of Figure 1 that students found the theory easier to understand. Perhaps, had such a figure been diagrammed in the original, my writing would have been less obtuse.
A second perplexing question is, “Why am I the senior author?” Clearly, the research was carried out in Weyburn and was supported by a grant to that institution. Was it my idea to use orthogonal contours to enhance basal inhibition? I think not, although it was my idea to employ sleep deprivation to do so. Harold Kelm and I had many intensive discussions that focused on the problem of counter-displacement i.e., the reversed figural aftereffect and considered that the notion of homogeneous satiation (which he emphasized) could provide a pivotal explanatory idea. So the question of authorship remains. It may well be that we were beginning to tie our work to proposals that Eysenck was developing and that I had agreed to do the writing.
As I read this 50-year-old report, I thought that it was pretty interesting and wondered why I had failed to see it through. Almost certainly the answer is that I was beginning to have serious reservations about the phenomenon itself. My doctoral dissertation attempted to explore intricacies such as the distance gradient, which was crucial to our theorizing. I was so deeply distressed at the noisy nature of the raw data that I was becoming uncomfortable committing a career to unravel the effect.

Moreover, when we discovered that a geometric illusion such as a Poggendorff yielded robust and reliable differences between atypical groups and normal controls, I started to toy with idea that figural aftereffects could be a cognitive phenomenon of contrast and that the reversed (counter-displacement) effect an example of assimilation.

One last point. I submitted a report to the Journal of Experimental Psychology, which was not accepted. A sentiment that Dr. David Grant offered was revealing. Accepting an article of figural aftereffects meant that we would be “reading it more and enjoying it less.” I interpreted this to mean that interest in the phenomenon was in decline and concluded, once again, that a change of focus was in order.

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