CHAPTER I

INTRODUCTION AND REVIEW OF LITERATURE
In order to understand the exact nature of figural after-effects, Eysenck (1967a) in his review emphasizes the need of examining the phenomenon as a function of many parameters such as personality, drugs, length of the inspection period etc. So far not many studies are available where such type of relationships have been investigated. Moreover, as is reported in the pages to follow the results of most of them do not present a consistent and clearcut picture. The present study explores the relationship, if any exists, between figural after-effects (both visual and kinesthetic) and personality and drugs.

Basic Mechanism of Figural After-Effects:

Köhler and his associates (Köhler, 1940; Köhler & Wallach, 1944; Köhler & Dinnerstein, 1947; Luchins & Luchins, 1953) suggest that the figural after-effects are probably the observable results of a hypothetical process of satiation or inhibition which accompanies and follows the passage of neural-current consequent upon stimulation. Hull (1943) also points out:

"All responses leave behind in the physical structure involved in the evocation, a state or substance which acts directly to inhibit the evocation of the activity in question".
This implies that the constant stimulation of parts of certain sensory surfaces, such as the retina, probably sets up a state of inhibition in the corresponding areas in the cortex which have measurable effects on the perception of the stimuli later presented to the same region.

Köhler and Wallach (1944) maintain that the speed of currents builds up resistance to their own passage through the cortex i.e. the inspection of the figure modifies the apparent size, tilt and location of contours later viewed in the same part of the visual field. He postulates that the localized resistance to current flow develops in the visual projection area (of the cortex) during inspection in a manner such that input from the subsequently presented test figure is displaced into nonsatiated regions. Hence Köhler and Wallach assume that every visual figure is associated with currents in the visual sector of the nervous system. These currents are the result of a difference in density and brightness between the figure and ground. Considering the visual sector as analogous to a volume conductor, the authors maintain that the figure currents polarize all the
surfaces through which they pass. This polarization and certain other after-effects in the affected cells have been named by them as electrotonous. It is a common observation that this condition of electrotonous persists for some time after polarizing currents have ceased to flow.

Satiation has its main effect a localized inhibition i.e. the electrical currents are presumed to follow paths of least resistance. The flow of current through tissues polarizes its membrane and increases resistance to further passage of currents, i.e. acts as an inhibitory agent and thus forces the currents to detour into neighbouring regions. This process results in a gradient of increased resistance. Satiation thus displaces the test object from the affected region i.e., the inspection of a figure with a well defined border causes a later fixated figure phenomenally displaced away from the boundary of the first figure. This satiation effect persists after the first figure has been removed and can be measured by observing distortions in the subsequent figure. Hence satiation is the electrotonic effect of the figure currents on the cortical section. And the
figural after-effects, thus denote alterations which test objects may show when their figure currents pass through a satiated region.

Thus according to Köhler and his associates (Köhler, 1940; Köhler & Wallach, 1944; Köhler & Dinnerstein, 1947; Luchins & Luchins, 1955) the underlying mechanism of figural after-effects is satiation, a condition of the mediating neurons akin to a localized fatigue effect in the sensory projection areas. One of the basic assumptions of this theory is that a stimulus figure is isomorphically projected on the cortex, producing coincident with its contours, a state or condition of increased resistance to subsequent stimuli in the same area. This anelectrotonous lowers the polarizability of the affected membrane and any subsequent figure current in the same area is deflected away from the satiated region and into an area of lesser resistance or higher response potential. The resulting perceptual changes are referred to as figural after-effects.

Klein and Krech (1952), Wertheimer and Wertheimer (1954), Eysenck (1955) and others also suggest that the hypothetical neural operations are equivalent to
the process of cortical satiation. Gibson (1933), Köhler (1940), Köhler and Wallach (1944), and Luchins and Luchins (1953) also hold a similar opinion and suggest that the stimulation of certain parts of sensory surfaces such as those of retina generates a state of inhibition in the corresponding areas of the cortex and that the measures of figural after-effects thus provide an index of cortical inhibition.

In recent years Ganz (1964, 1966) has presented a series of findings and proposed a quantitative theory for visual figural after-effects. The theory calls for two separate mechanisms, one explains the displacement of contours and the other deals with filling in of the temporal gaps between the removal of the I-figure and the presentation of the T-figure. The former is observed in a hypothesized neural lateral inhibition process which accounts for optical illusions, simultaneous contrast etc. The latter is dependent on the development of after-image from the inspection figure which then continues to function. The theory, however, has not yet been fully established and has been criticized on many grounds (Stadler, 1972).
Most of the work in this area has been on figural after-effects affecting contours. In this work an inspection figure is fixated for a fairly lengthy period of time; this is then withdrawn and two test figures are substituted. One of these test figures falls within the same area as the inspection figure while the other is well removed from this area. Differences in size between the two figures which are objectively equal are usually observed and are supposed to be a consequence of satiation set up by the inspection figure (McEwen, 1958). Other effects also may be observed and made the basis of measurement. Thus when a bright inspection figure is fixated for any length of time and is then withdrawn, then a test figure exhibited in the same region should look rather darker, as a consequence of satiation, than an equally bright test figure exhibited elsewhere.

Specifically with reference to kinesthetic figural after-effects Köhler and Dinnerstein (1947) maintain that if a person holds the inspection object between thumb and index finger for a few seconds or minutes and subsequently attempts to estimate the width of the test objects he will in general underestimate the width of the test objects that are
narrower than inspection objects and overestimate the width of test objects that are wider than the inspection objects. They further suggest that figural after-effect will not occur or may occur in little amount when test and inspection objects are of equal width.

**Personality and Figural After-Effects:**

Klein and Krech (1952), Wertheimer and Wertheimer (1954), and Eysenck (1955) while describing the neural processes in terms of which people differ, have used the terms such as cortical conductivity, metabolic efficiency and reactive inhibition. The basis of their propositions was a proposal that non-adaptive features of behaviour such as rigidity, perseveration, and concreteness of thought are causally dependent on the way the central nervous system responds to impinging stimulation and recovers from the effects of preceding stimulation. Each theorist suggested, however, that the hypothetical neural operations to which he made reference were equivalent to the process of cortical satiation outlined by Köhler and Wallach (1944). On these grounds it was argued that each theory could be tested by establishing whether
individual differences in the cognitive behaviour with which the theory was concerned correlated with individual differences in the onset, magnitude, and decay of figural after-effect.

The early studies of individual differences in figural after-effect were in part directed toward establishing whether measurement of after-effects had value in clinical diagnosis. An additional justification offered for the experiments, however, was that they enabled tests to be made of deductions derived from theories relating personality and cognitive disorders to neural functioning.

In 1952 Klein and Krech reported that brain-injured people are more susceptible to figural after-effects than are controls. A series of experiments published soon afterwards indicated that groups of subjects classified in terms of psychiatric condition (Wertheimer, 1954), metabolic efficiency (Wertheimer & Wertheimer, 1954; Wertheimer, 1955), introversion - extraversion (Eysenck, 1955), and mental retardation (Spitz & Blackman, 1959; Spitz & Lipman, 1961) can be differentiated from normal control groups through measures of visual after-effect and kinesthetic
after-effect. None of these findings were consistently replicated in later studies. The Table I summarizes the main results of some of the many experiments that have examined individual differences in figural after-effects.

With a view to explore individual differences in figural after-effects, in recent years, the work has been done primarily within the framework of Eysenckian theory of personality. The concept of reactive inhibition (a localized fatigue effect in the sensory projection areas) is one of the cornerstones of Eysenck's (1955) theory of personality. Eysenck thereby asserts that there is a great similarity between the concepts of reactive inhibition (as defined by Hull, 1943). Eysenck (1963) also considers satiation as analogous to the perceptual aspect of inhibition. Thus through the theory of satiation, the concept of reactive inhibition is applicable to the perceptual phenomena. And inhibition in its broadest meaning has been referred by him to a process within the central nervous system that interferes with the ongoing perceptual, cognitive and motor activities of the organism.
<table>
<thead>
<tr>
<th>Experimenter(s)</th>
<th>Main finding</th>
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<tbody>
<tr>
<td>Klein &amp; Krech (1952)</td>
<td>Larger KAE with brain-injured</td>
</tr>
<tr>
<td>Jaffe (1954)</td>
<td>No difference in VAE between brain-injured and controls</td>
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<tr>
<td>Wertheimer, Lipton, Herring, Greenhouse, &amp; Means (1965)</td>
<td>Smaller KAE with brain-injured</td>
</tr>
<tr>
<td>Wertheimer &amp; Jackson (1957)</td>
<td>Smaller KAE and VAE with schizophrenics.</td>
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<tr>
<td>Day, Burns, Singer, Holmes, &amp; Letcher (1967)</td>
<td>No difference in KAE or VAE between schizophrenics and controls, or between mental retardates and controls. Larger VAE with children than young adults</td>
</tr>
<tr>
<td>Spitz &amp; Lipman (1961)</td>
<td>Smaller KAE with mental retardates</td>
</tr>
<tr>
<td>Pollack (1960)</td>
<td>Larger VAE with young adults than children</td>
</tr>
<tr>
<td>Thurner &amp; Seyfried (1962)</td>
<td>No age trend with VAE</td>
</tr>
<tr>
<td>Eysenck (1955)</td>
<td>KAE larger for extraverts than introverts</td>
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<tr>
<td>McEwen &amp; Rodger (1960)</td>
<td>No correlation between introversion-extraversion and either KAE or VAE</td>
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Note: KAE=kinesthetic after-effect; VAE=visual after-effect.  
* Results relative to controls.
Eysenck (1955) states:

"Individuals in whom reactive inhibition is generated quickly, in whom strong reactive inhibitions are generated and in whom reactive inhibition is dissipated slowly are thereby predisposed to develop extraverted patterns of behaviour ..........; conversely, individuals in whom weak reactive inhibitions are generated and in whom reactive inhibition is dissipated quickly, are thereby predisposed to develop introverted patterns of behaviour ............." (p.96).

This view was also held by Pavlov (1927) who asserts that satiation and inhibition are more pronounced in extraverts than introverts.

Thus Eysenck’s (1947, 1952, 1957, 1967a) theory of personality suggests that satiation is built up more strongly and quickly and persists longer in extraverts than introverts. It is implied, therefore, that if figural after-effects occur due to satiation then under equal conditions of stimulation the figural after-effects should develop quicker, appear more strongly and persist longer in extraverts than introverts (Eysenck 1955, 1956, 1960, 1967a; Eysenck & Easterbrook 1960a, 1960b). This hypothesis has proved difficult to test because of difficulties encountered in ensuring equal stimulation. Experiments
of this kind require visual fixation for several minutes, and the structures involved in maintaining fixation are also subject to inhibition. As this inhibition is again supposed to be greater in extraverts, these would tend to be poorer at fixating than introverts and would consequently receive less stimulation during equal periods of time, thus leading to the prediction that because of the lower degree of stimulation thus received, extraverts would show weaker figural after-effects. It is also possible that extraverts would receive less stimulation because satiation would soon block the perceptual pathways, thus reducing the amount of stimulation received by them as compared with introverts.

Fortunately these contradictory predictions can be reconciled by realizing that the satiation which gives rise to figural after-effects sets in rather quickly, possibly within a matter of milliseconds, while reactive inhibition sets in rather slowly, possibly in a matter of minutes. This prediction would seem to follow that when inspection periods are short, extraverts would be expected to show larger figural after-effects. When inspection periods are
long, introverts would be expected to show larger figural after-effects. With intermediate periods no great difference would be expected — short in this connection means 30 seconds or less; long means 3 to 4 minutes (Eysenck & Easterbrook, 1960α).

The studies in the sphere of kinesthetic figural after-effects, which support Eysenck's theory are:

The first study was conducted by Eysenck (1956) on hysterics (as a prototype of extraverted personality type) and dysthymics (as a prototype of introverted personality type). The study supported the following conclusions:

(i) hysterics developed satiation and figural after-effects more quickly than did dysthymics;

(ii) hysterics developed stronger satiation and figural after-effects than did dysthymics;

(iii) hysterics developed more persistent satiation and figural after-effects than did dysthymics.

Meier (1961) also found larger kinesthetic figural after-effects in persons in whom reactive inhibition was generated rapidly and dissipated slowly
(extraverts) than in whom reactive inhibition was generated slowly and dissipated rapidly (introverts). In recent studies, too, a positive relationship between extraversion and kinesthetic figural after-effect has been discovered (Gupta, 1974; Gupta & Kaur, 1978).

Petrie (1967) worked with another dimension of personality known as augmenters - reducers. According to the author the augmenters show a general tendency to increase the subjective size of the stimulus while the reducers decrease it. On the basis of a study conducted on kinesthetic figural after-effects she points out:

"At the end of the period of rubbing the wooden measuring block is perceived by the extreme augmenter as about double in size, by the extreme reducer as about halved - a fourfold difference between the two"

(Eysenck, 1967a; P.138)

Silverman (1967) also worked with augmenters - reducers dimension and found similar results. Eysenck (1967a), however, considers reducers as extraverted persons and augmenters as introverted
people. Thus the results of Petrie (1967) and Silverman (1967) are in agreement with the Eysenckian assumption.

The following studies on kinesthetic figural after-effects, however, do not support Eysenck's theory:

Nichols (1956) did not find significant correlation between extraversion and amount of kinesthetic figural after-effects. Rechtschaffen (1958) tried to verify Eysenck's assumptions about the relationship between visual figural after-effects and extraversion but found both of them unrelated. Rechtschaffen and Bookbinder (1960) replicated the study using a kinesthetic after-effect measure and again found negative results. Spitz and Lipman (1960) also failed to find a significant correlation between extraversion and measures of figural after-effects in kinesthetic as well as visual sensations. Broadbent (1961), Norcross, Lipman & Spitz (1961), Howarth (1963) and Byth (1972), too, could not find any significant relationship between extraversion scores and the extent of figural after-effect.

The above review of the studies suggests that the position regarding relationship between extraversion
and figural after-effect is not consistent. Most of
the studies have shown negative results. It is,
therefore, essential that the phenomenon be reexplored
after imposing necessary controls.

**Personality, Drugs and Figural After-Effects:**

In the field of figural after-effects and
drugs the literature is not extensive. Wertheimer
and associates (Wertheimer, 1954, 1955; Wertheimer
& Wertheimer, 1954; Wertheimer, Levine & Wertheimer,
1955) in a series of investigations have approached
the study of individual differences in figural
after-effect by the use of an electro-chemical concept
which asserts that differences in effects represent
differences in the modifiability of cortical conductivity
which in turn is related to metabolic efficiency.
Wertheimer has supported his explanatory theory both
by the use of metabolic drugs and by the use of a
criterion group of schizophrenics exemplifying small
figural after-effects and low metabolic rate. Wertheimer's
theory has pointed out that the magnitude of figural
after-effect is proportional to the perpetual
modifiability of the subjects; the metabolically
efficient individuals are more modifiable on such
perceptual measures and therefore likely to exhibit larger after-effects than the less metabolically efficient. Wertheimer also hypothesizes that pharmacologically, both metabolic increasers (stimulant drugs) and decreasers (depressant drugs) will reduce the magnitude and size of figural after-effect.

Eysenck's approach to the effect of drugs differs from that of Wertheimer. Eysenck (1955), as do Köhler and Wallach (1944), believes that figural after-effect occurs as a result of satiation. He has equated satiation with reactive inhibition, as used by Pavlov and Hull, and has assumed that the magnitude of figural after-effect is proportional to the amount of satiation produced. His theory of extraversion (Eysenck, 1955) which is based on the excitatory - inhibitory processes, predicts larger figural after-effect in extraverts than in introverts under conditions of equal stimulation. The drug postulate of his theory runs as follows:

"The depressant drugs increase cortical inhibition, decrease cortical excitation and thereby produce extraverted behaviour patterns; stimulant drugs decrease cortical inhibition, increase cortical excitation and thereby produce introverted behaviour patterns."

(Eysenck, 1960; p.105).
In its application to figural after-effects the drug postulate is quite clear. Clearly, therefore, stimulant and depressant drugs should decrease and increase the magnitude and persistence of figural after-effects.

By coalescing the two, the theory of extraversion and the influence of drugs, Eysenck (1960, 1963, 1967a) has proposed that the susceptibility to the action of drugs is determined by an individual's temperamental characteristics. It was probably McDougall (1929) who for the first time predicted such relationship. According to him:

"......... the markedly extraverted personality is very much susceptible to the influence of alcohol..... The introvert on the other hand is much more resistant to alcohol....."

( p.301)

Thus introverts being in a comparatively high state of cortical arousal (Gray, 1964, 1967, 1970; Claridge, 1967; Eysenck, 1967a; Davies & Tune, 1970; Passingham, 1970; Nebylitsyn & Gray, 1972), would probably require less quantity of a stimulant drug than extraverts to reach a specific state of excitation
but would probably require more quantity of a depressant drug to reach a specified state of inhibition.

The work done by Eysenck and his associates (Eysenck, 1963, 1966, 1967a) suggests that extraversion and other personality variables interact with drugs and this interactional aspect leads to masking of the drug effect by an increase in error variance if such personality variables are not controlled.

Wertheimer, Levine and Wertheimer (1955) have investigated the effects of some metabolic increasers (50 mg ephedrine sulphate, 22 mg strychnine sulphate, and 100 mg nicotinic acid) and decreasers (100 mg pethidine hydrochloride, 200 mg quinalbarbitone, and 60 cc of whisky) on perceptual measures, one of which was kinesthetic figural after-effect, but the decrease was significant for only the metabolic decreasers. Although consistent with their own theory, this finding contradicts the Eysenckian (1955) model which predicts an increase in figural after-effect under the influence of metabolic decreasers. In an other experiment Poser, Knight and Lehmann (1958) reported that a 15 mg dose of d-amphetamine sulphate significantly decreased the
extent of kinesthetic figural after-effect, a finding consistent with the theories of both Wertheimer and Eysenck. Poser et al. also investigated the effects of a 265 mg dose of sodium amylobarbitone on kinesthetic figural after-effect and found no significant drug effect, although six out of their ten subjects showed decreases in the figural after-effect, a finding that supports the results of Wertheimer et al. (1955). Eysenck and Easterbrook (1960b) later reported that the effects of 5 mg of d-amphetamine sulphate, 90 mg of sodium amylobarbitone, and 100 mg of meprobamate on kinesthetic figural after-effect agreed with Eysenck's theory, but the results were accepted at a rather low level of statistical significance. Costello (1962) has also reported results inconsistent with Eysenck's theory and has demonstrated that an 800 mg dose of meprobamate reduced the size of kinesthetic figural after-effect, results were, however, significant for the descending trials only. Spilker and Callaway (1969) on the other hand have reported results which are in line with Eysenck's theory. They found that the depressant drug phenylephrine enhanced the magnitude of kinesthetic figural after-effects.

In more recent experiments designed to test
Eysenck's theory, Gupta (1974) conducted a study of the effects of 10 mg of d-amphetamine sulphate and 100 mg of phenobarbitone on kinesthetic figural after-effect. Compared with placebo, d-amphetamine reduced and phenobarbitone enhanced the magnitude of figural after-effect. No significant interaction between extraversion and drug treatments was found, although in terms of Eysenckian theory the possibility of such a relationship could not be ruled out. The failure to discover a significant interaction might have been due to the lack of optimum conditions, since only a single dose of each drug was used. Janke and Debus (1968) have emphasized the need and importance of dose-response data in drug research. To date only one study has been available in which different dose levels of a drug were used. Gupta and Kaur (1978) investigated the effects of three doses of d-amphetamine (7.5 mg, 10.0 mg, 12.5 mg) on kinesthetic figural after-effect. The study demonstrated that under the influence of the drug the size of figural after-effect was reduced in the extraverted group of subjects and enhanced in the introverted group.

To certain extent whether a particular dose level of the drug would be effective or not depends partly on
the motivation of the subject and partly on the familiarity of environment. For example barbiturates (primarily CNS depressants) generally depress most forms of activity in most people and animals in most situations; but in some circumstances e.g., when motivation is exceptionally high (Hill, Belleville & Wikler, 1957), or if environments are novel (Steinberg, Rushton & Tinson, 1961; Rushton, Steinberg & Tinson, 1963), doses which normally depress activity can do the opposite and behave like stimulants and in very small doses the effects of barbiturates seem actually to be predominantly stimulant (Kinnard & Carr, 1957; Irwin, 1960).

Thus the above review clearly shows that the studies on personality and drug correlates of figural after-effects present neither a consistent nor a generally acceptable point of view.

Formulation of the Problem:

In view of the above, for evaluating the problem further the present study was planned to investigate the effects of centrally stimulating (10 mg of d-amphetamine) and depressing (100 mg of phenobarbitone) drugs on the visual and kinesthetic figural after-effect
scores of groups of subjects having more or less homogeneous scores on the extraversion and neuroticism dimensions of personality. This was with a view to discover the interaction of personality and drug treatments, if any exists, by providing optimum conditions.

Eysenck (1967a, 1967b) suggests that the neuroticism dimension of personality probably does not exert its influence in normal subjects under unstressed conditions. Although the present experimental situation is entirely non-anxiety provoking yet to avoid the possibility of an interaction, if any exists, between extraversion and neuroticism, the subjects were selected on the basis of their scores on both these dimensions according to a procedure adopted for 'zone analysis' (Eysenck, 1967a).

The Problem:

A study of visual and kinesthetic figural after-effect in relation to certain drugs and other variables.

( The 'other variables' have been delimited to the personality variables of extraversion and neuroticism only).
Hypotheses:

The study aims to explore the following hypotheses:

1. Extraverts will have larger figural after-effects (both visual and kinesthetic) than introverts; in relation to neuroticism no specific hypothesis is proposed and the objective is purely exploratory in nature.

2. The interaction of personality and drug treatments as envisaged by the Eysenckian theory and supported by a recent study (Gupta & Kaur, 1978), will be significant, suggesting thereby that the size of both visual and kinesthetic figural after-effect under the influence of d-amphetamine, primarily a central stimulant, will decrease for the extraverted group of subjects but will either increase or remain unchanged for the introverted group; for phenobarbitone which is primarily a central depressant the reverse is expected — an increase for the introverted group of subjects and a decrease or no change for the extraverted group. For a possible interaction of neuroticism with drug treatments no specific hypothesis
is proposed and the objective is purely exploratory in nature. Similarly no specific hypothesis is proposed for a possible three-way interaction among extraversion, neuroticism and drug treatments.