A CROSS-CULTURAL STUDY OF SUSCEPTIBILITY TO THE MÜLLER-LYER AND PONZO ILLUSIONS

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> "Life conditions — including current situation, past experience, cultural and socioeconomic factors, to name only a few — influence perceptual processes through their influence on the amount and variety of stimuli to which an individual is exposed, and through influencing the nature and amount of practice an individual gets in learning to discriminate stimuli from each other." (Deutsch, 1968, p. 59).

There is much evidence that the social and physical ecology to which the individual is exposed has clearly demonstrable effects on his visual perception. It is widely accepted that, to a large extent, perceptual organisation stems from experientially-facilitated capabilities and habits acquired by the individual as a member of a particular cultural group.

1.1 The Nativism-Empiricism Dichotomy in Perception

The early extreme views of the advocates of nativism and gestaltist phenomenology on the one hand and those of the supporters of empiricism and operational behaviourism on the other have been deposed by the general view that " ... a certain number of perceptual reactions are innate, but ... the perceptual processes are modifiable through experience." (Deutsch, 1968, p. 64).

The individual's genetic make-up, or genotype, is fixed at the moment of conception. Different potentials of this genotype are expressed at different stages of the individual's development, thus that behaviour which psychologists observe or measure is a phenotype produced by the interaction of the individual's internal genetic mechanisms and his physical and social environment. As the genotype sets definite limits to the operations which can be performed on it, however, traits are not infinitely manipulatable environmentally. (Thompson, 1967). Because of the difficulty of distinguishing between the original genotype and the experientially-modified phenotype, proven instances of genetically-determined perceptual responses are rare.

1.11 Genetically-Determined Differences in Visual Perception

It is known that a genetic aberration, Turner's Syndrome, can cause perceptual deficiencies (Jensen, 1969). People exhibiting this syndrome have only 45 instead of the usual 46 chromosomes, and lack

the sex-chromatin from one of the two chromosomes which determine sex. Such individuals always have the morphologic appearance of females but are sterile and small in stature. Although they show a normal IQ distribution on most verbal tests of intelligence, they exhibit a peculiar deficiency on tests of spatial-perceptual ability and organisation which is popularly termed "space-form blindness". However, the only instance of a cross-cultural difference in perception shown to be due to a genetic component is the considerable variation in the population frequencies of sex-linked partial colour blindness (dyschromoposia). (Spuhler and Lindzey, 1967). Segall, Campbell and Herskovits (1966), who conducted the most important study into cross-cultural responses to illusions, accepted the "biological homogeneity of culture-learning man", and this acceptance can be supported by relevant experimentation.

1.12 Culturally-Determined Differences in Visual Perception

Instances of differences in visual perception which can be argued to be culturally-determined are many. Examples can be drawn from the areas of language and linguistic relativity, person perception, and fine spatial discrimination skills.

Linguistic Relativity and Perception. Greenberg (1965, p. 416) made it clear that: "language, as a highly complex body of learned behaviour, forms part of the cultural heritage of the community which uses it. Indeed it has a central role as the fundamental vehicle for transmission of other cultural traits within and across social groups." The Sapir-Whorf, or linguistic relativity, hypothesis, as expressed by Whorf (1956), stresses that each language embodies and perpetuates a particular world view by structuring the thought of those who speak it. Brown (1958) cited Whorf's example of the Eskimo lexicon using three words to distinguish three varieties of snow, while the speaker of English has only the one word available. Because his language forces certain classificatory dimensions on him, the Eskimo is thought to come to perceive the stimulus attributes of different types of snow more readily than other people.

Similar evidence comes from a study by Doob (1957), who gave a group of Baganda a sorting task involving a number of pieces of cardboard which differed in shape, size and colour. Without a classifying system being suggested, the subjects were instructed to group the pieces into piles. Doob found that unacculturated Baganda based their

classification on size and shape, while those few who had been educated in European-type schools and through the medium of English based their classification nearly exclusively on colour. These findings derive their interest from the fact that the Baganda language is almost completely lacking in colour terms.

In a later study in the Togo section of Ghana, Doob (1960) found that a group of Ghanaian students clearly perceived different colours, but, because of linguistic limitations in colour terms, they had difficulty in communicating these differences. This study sounds a warning that, in practice, it may be difficult to distinguish between the extent to which the perceiver's language affects his perception and the extent to which it influences his verbal report.

In general, however, current theoretical and empirical evidence suggests that linguistic differentiation may well produce perceptual differentiation through the structuring effect of language on thought. "Languages are moulds into which infant minds are poured" (Brown and Lenneberg, 1954, p. 454) would appear to be more than a mere catch-phrase.

Binocular rivalry and fusion research provides striking examples of the influence of meaningful content upon the perceiver. Binocular rivalry and dominance occurs when the observer is stereoscopically presented with two different photographs or drawings (one being presented to each eye) and sees only one of the two pictures at a time, although alternation of which photograph is seen may take place. In particular, two studies show the influences of cultural characteristics on social perception.

Bagby (1957) tested matched groups of 12 American and 12 Mexican middle-class adults of superior education on 10 stereogram slide pairs. In each pair, one photograph was of a typical American scene showing one or more persons, and the other of a similar Mexican scene. The photographs were matched as far as possible, in terms of form, contour, definition, light and shade, etc., and possible eye dominance was controlled. Each subject gave a running descriptive account of what he saw during a 15-second exposure of the slides; the predominant one of each pair of slides being determined from the picture which was first reported and that which seemed to be present most of the time.

Bagby found that the scenes from the subject's own culture tended to be perceptually dominant, and concluded that " ... national cultural differences appear critical in affecting perceptual predominance ... " (p. 334). He favoured the position of the transactional school, who

regard experience and meaning as fundamental determinants of perception, as the most probable theoretical interpretation.

Pettigrew, Allport and Barnett (1958) used the binocular rivalry technique to ascertain whether members of four ethnic groups in South Africa identified each other differently from photographs. Five groups of subjects were tested: 20 Afrikaans-speaking Europeans, 22 English-speaking Europeans, 20 Indians, 20 Coloureds, and 40 Africans. Slightly less than half of the members of each ethnic group were women, and the investigators made a fore-doomed attempt to obtain a homogeneous socio-economic group of subjects.

The stimulus material for the steroscope consisted of 40 similarly-posed bust photographs of people, 20 of each sex and 10 of each ethnic group. Each subject was required to name the race represented by the person in each photograph — whereas in fact two different races were always represented in each of 20 trials.

Analysis and interpretation of the results of the study were coloured by the authors' conception of it as a study in race relations and the over-emphasis of the " ... the white people in South Africa are living in a state of considerable apprehension and are endeavouring to maintain white supremacy at all costs" (p. 268) type of statement. However the study did show that, while "Coloured" and "Indian" were the dominant responses for all groups of subjects, the Afrikaans-speaking Europeans gave less dominance to them than did any other group of subjects. The Afrikaners tended to report either "African" or "European". This departure from the modal tendency was attributed to the Afrikaners' regarding all non-Europeans as Africans because of their supposed threat to white supremacy. This interpretation is perhaps equivocal, yet the study does show that ethnic-group membership plays some role in determining perceptual dominance.

The perception of closure is an example which deals with a process rather more central to perceptual organisation than is person perception. In the context of this discussion, closure refers to the tendency to perceive an incomplete figure as if it were complete. Cross-cultural investigation of this process sheds light not only on the possible influence of the cultural environment on perception, but also on the Gestalt viewpoint that the laws of perceptual organisation are universal since sensory organisation arises from the elementary dynamics of the nervous system. If the process of closure is a learned response, members of a cultural milieu which inhibits the process should show different response patterns to closure stimuli than members of a culture

which facilitates the perception of closure.

Following this rationale, Michael (1953) tested 20 American male and female adults and 20 male and female adult Navaho Indians, both groups hailing from the same region of New Mexico, on nine stimulus circles. The circles, which were tachistoscopically projected, ranged in incompleteness from zero to eight degrees in one-degree steps. After each circle had been presented, the subjects were required to record a pencil and paper reproduction of what they had seen.

The particular interest of the study lies in that, while Western culture would appear to stress the concept of closure, as in the symmetry favoured in aesthetics and design, Michael noted that quite the reverse obtains for the Navaho people. Nonclosure receives primary emphasis in the Navaho value system, and the Navaho "fear of completing anything" (Kluckhohn and Leighton, 1946, p. 226) is shown in their pottery, basketwork and weaving. In view of these seemingly widely-divergent cultural attitudes, it is rather surprising that Michael found no significant differences in capacity to perceive closure between the two groups. Factors such as differential visual acuity, light intensity of the stimuli, "set" tendencies, and unfamiliarity with the experimental situation were examined and found wanting as explanations for the results, but Michael considered that the effect of the experimental context may have been a determinant in that, as the context was relatively meaningless for the Navaho, they did not perceive openings which would have been perceived had they been in context. While this study did not refute the Gestalt contention that closure is an innate and not a learned process, Segall, Campbell and Herskovits (1966) consider it a possibility that the cultural values emphasised by Michael were too abstract and indeterminate to cause differential response patterns to the straightforward experimental task.

Berry (1966) offers support for this contention in a study which based the a priori hypothesis that Eskimo and Temne groups would differ in their formation of closure, on ecological as well as cultural grounds. The visual environments of the Eskimo of the Arctic coast of Canada and that of the Temne of Sierra Leone differ greatly. Whereas the Temne are exposed to a wealth of visual stimulation in their well- and colourfully-vegetated land, the Eskimo environment is bleak and practically featureless. Berry considered that, in contrast to the Temne, who are predominantly peasant farmers, the widely-hunting Eskimo would have to develop certain perceptual discriminatory skills in order to hunt effectively and thus survive. In addition the language, arts and

crafts and socialisation systems of the Eskimo serve as cultural aids to facilitate the development of perceptual skills, while those of the Temne would seem to have a relatively inhibiting influence. While Michael's (1953) results were noted, Berry drew attention to the findings of Postman and Bruner (1952), which suggest that prior training with "open" circles could lessen the formation of closure. He felt that the Eskimo ecology and the Eskimo attention to minute detail would have a similar effect.

The subjects for the study ranged in age from 10 to over 40 years, males and females being equally represented. A Scottish group of 117 subjects was tested as well as the Temne (N=70) and Eskimo (N=112) groups. No significant differences in visual acuity were found between the two non-Western groups. A series of geometric forms, each successive one with a gap in its side increasing from one to 15 millimetres in one-millimetre steps, were tachistoscopically presented, and the subjects were required to draw what they had seen.

It was found that the Eskimo sample were significantly more aware of small gaps than were the Temne, and were also less liable to the formation of closure than were the Scottish group. Because of this Berry dismissed the possible influence of factors such as familiarity with printed material. He concluded that :

> "It is considered that a strong case has been made for the hypothesis that, despite equivalent acuity, the Eskimo will display a greater awareness of small detail than the Temne. It is apparent that the ecological necessity for detailed discriminations coupled with a long experience in their relatively barren visual environment, have made the Eskimo more aware of minute cues than the Temne."
> (Berry, 1966, p 227).

1.2 Cross-cultural Differences in Visual Perception Relevant to Susceptibility to Illusions

It may be accepted, then, that ecological factors influence the formation and nature of perceptual skills. Of special relevance to cross-cultural differentiation in illusion responses are studies in three areas: eidetic imagery, size constancy and phenomenal regression, and the perception of three dimensions in two-dimensional representations.

1.21 Eidetic Imagery

Eidetic images are defined by Haber and Haber (1964) as images which persist after stimulation, are positively coloured and relatively

accurate in detail, and are capable of being scanned. The eidetiker (one who experiences eidetic imagery) has the ability, the basis of which is unknown, to form as it were, a "mental transparency" of a visual percept, and to project and scan this image for some time after having perceived the original stimulus. Early investigators in this field, such as Jaensch and the Marburg School, (Allport, 1928) contended that the eidetic image stood midway between the after-image and the memory-image; in other words, that it had elements of both the neural traces presumably underlying after-images and the experientially-influenced, conceptual memory images. While this viewpoint was not accepted in toto, it is perhaps significant that after-image-producing tasks are still used as training sequences preceding the administration of eidetic imagery tests. Eidetic images are particularly vivid, and eidetikers scan them as they would a picture positioned a short distance from their eyes. While this type of imagery is not uncommon among Western children, probably some 8% possessing it, it is very rarely found among their adult counterparts. (Haber and Haber, 1964). However, Doob (1964) noted that anecdotal evidence suggested a high incidence of eidetikers among nonliterate peoples, who do not emphasise verbal memory and thus, presumably, lose the eidetic imagery ability.

In two studies, the first among the Ibo of Nigeria and the second among the Kamba of Kenya, Doob (1964) investigated the incidence and other aspects of eidetic imagery. In a small (N=45) group of Ibo of varying ages, sex and area of habitat, Doob found that 53% reported a trace or more of eidetic imagery, 20% being classified as pure eidetikers. All rural subjects reported eidetic imagery, which decreased slightly with schooling and age. Doob noted that the precise significance of these images within the Ibo culture remained unclear, as did their relation to specific personality and cultural factors. The second study conducted among a haphazard sample of 49 Kamba (Doob, 1965), produced results very similar to those of the first study, the incidence of eidetikers again being much higher than that reported among European adults. The results also suggested that, among the Kamba in the process of acculturation, eidetic imagery was being ousted by memory images, the modal images of Western society. This factor further emphasises the probable influence of cultural factors on the ability, yet should there indeed be a relationship between eidetic images and after-images, the role of such possible determinants as neural traces is as yet unknown.

1.22 Phenomenal Regression and Object Constancy

Phenomenal regression is the principle that what one perceives is intermediate between what would be expected from the nature of the physical stimulus and what would be expected from the object constancy, and that the percept tends with more careful observation to shift toward the former perception. (English and English, 1958). In the sphere of visual perception, object constancy refers to the fact that objects maintain a similar apparent size, form or colour when viewed at differing distances or angles, or in conditions of differential lighting, despite the fact that retinal stimulation does not remain constant. Due to this process, " ... the appearance of an object is maintained and it continues to appear what it is, or what it is known to be." (Fisher, 1968a, p. 35). Size-constancy occurs when an object maintains a similar apparent-size irrespective of its distance from the observer and differing retinal image sizes; and shape-constancy refers to the phenomenon of a familiar object maintaining its shape irrespective of its inclination to the angle of regard and the changing shape of retinal images. It is considered that the two phenomena are activated by a common perceptual mechanism (Fisher, 1968a), and it is obvious that experiential factors mediate the purely physiological retinal patterns. Cross-cultural studies provide an interesting indication of the direction of this mediation.

Thouless (1933) found that a group of 20 Indian students had higher scores in phenomenal regression to the real object (i. e. better size constancy and more accurate perception) than a group of 49 Scottish students. They were required to match the shape of a circular white disc, presented at an angle, with cardboard ellipses with varying axis ratios. In a rather unwarranted conclusion, Thouless contended that his results indicated that Indians did not understand the principles of perspective, and that this was evinced by the lack of perspective in Oriental art. Beveridge (1935), prompted by Thouless' findings and the lack of perspective in African art, administered a similar test to 49 West African students, and obtained similar results. In a later study, Beveridge (1939) found that West African students also had greater phenomenal regression for whiteness, i. e. colour-constancy, than did Scottish students.

Segall, Campbell and Herskovits (1966) challenge the interpretation which both Thouless and Beveridge accorded their results. While admitting that the laws of perspective were only relatively recently mastered by Western artists, and that Oriental and African artists

might be late to acquire them, Segall et al. consider it more likely that the absence of perspective in art merely reflects a "culturally sanctioned esthetic tradition" and that there may be no functional relationship between art style and phenomenal regression.

However, the differences in size constancy remain, and are substantiated by Winter's (1967) study. She pointed out that in Mundy-Castle and Nelson's (1962) report on the Knysna forest workers, an isolated and inbred European community, it was suggested that the greater phenomenal regression shown by these foresters, as well as by children and illiterate Africans, was due to a lesser conceptual influence on perception in these groups. Winter's report suggested that, while visual environment alone had no effect on the size constancy scores of Bushmen, African and European samples, there may be significant intercultural differences in phenomenal regression among these groups. She tested five distinct groups on a size constancy task, and obtained scores in the following order of superiority (i. e. from high to low size constancy): Bushmen (N=48), European psychologists (N=42), African psychologists (N=18), illiterate or semi-literate African loco-drivers (N=251), and European Optometrics students (N=25). While Winter found these results difficult to explain in terms of conceptual bias, they are exactly what would be expected providing that the results of the two groups of psychologists, who were probably familiar with the task, are excluded. If this were done, Winters' study would provide further evidence of heightened perceptual constancy among non-Western peoples.

1.23 Perception of Depth in Two-dimensional Representations

While the retinal receptors are distributed over a slightly curved surface, they are able to register only two-dimensional (2D) images, and, as in object constancy, experiential factors play a vital role in the accurate perception of the three dimensional (3D) environment. This would seem to be true also of the accurate perception of 2D representations, such as drawings and photographs, of 3D objects or scenes. Segall, Campbell and Herkovits (1966) mention that when early anthropologists showed photographs of local scenes to the people whom they were studying, "... reputedly the common finding was a temporary failure of perception ..." (p. 32). The implication — and it is a reasonable one when one considers the size, colours and contours of a black and white print — is that the interpretation of photographs is a learned response. Substantiation for this contention is found in the field of projective testing in Africa (see Hudson, 1967, pp. 92-93 for a short review) and in the

perception of safety posters by African industrial workers (Winter, 1963). In a study of the efficacy of safety posters for African miners, Hudson (1967) provided the following example of innacurate pictorial depth perception by African subjects :

> "A second picture was drawn to represent a demogogue haranguing a group of workers. As a dominating figure he was placed above the workers, and, in the background, to lend atmosphere to the scene, the artist drew in a long factory building with three tall smoking chimneys. Again by accident, the demogogue's outstretched hands were positioned just above the tops of two of the chimneys. Thirteen protocols referred to the madman who had climbed up to the tops of the houses and was warming his hands at the smoke." (Hudson, 1967, p. 93).

Hudson (1960, 1962a, 1962b, 1967) devised a Pictorial Depth Perception Test to investigate the problem. Six line-drawings and one photograph were constructed, each showing a hunter, an elephant and an antelope in similar relations to each other. (Scale models were used to pose the photograph.) The elephant, which was shown smaller than the hunter or the antelope, was positioned centrally but on a different plane. In the photograph and one drawing, object size was the sole depth cue. In two other drawings depth cues were provided by foreground contour lines overlapping on background and the hunter's spear or the antelope's head being superimposed on the elephant. In the remaining three drawings, perspective cues, such as converging straight lines representing a road stretching into the distance, were included. In all the pictures the hunter's spear was aligned on both the elephant and the antelope. Evidence of 2D or 3D pictorial depth perception could be easily obtained from a subject's responses to questions concerning whether the hunter was aiming his spear at the elephant or at the antelope, or which of the two animals was nearer to the man.

In his original study, Hudson (1960) tested 10 groups, six African and four European. The six African groups were made up of illiterate labourers, ex-primary school adult labourers, ex-high school adult clerks, Standard six pupils, secondary pupils, and graduate teachers. The European groups consisted of ex-primary school adult labourers and three samples of primary school children. In a later study, Hudson (1962b) also administered the test pictures to Coloured and Indian Standard six scholars.

Hudson found that the results of the European primary scholars suggested that they had difficulty in perceving 3D in pictures on entering primary school, but were competent in this respect by the time they left. The conclusion drawn was that the European scholars acquired competence in perceiving depth in pictures during the period of primary schooling. Hudson drew rather unjustified conclusions from the results of the school-attending African groups — because there were no significant differences between the scores of the graduate teachers, the secondary scholars and the higher primary school children, he made the implicit assumption that 3D perception was not developmental in African groups and found it strange that, because of the higher standard of education of the African groups, their results were not significantly better than those of the oldest European primary scholars. This was an unwarranted anticipation in view of the fact that European groups with post-primary education and other European primary groups were not tested to provide comparative results. The ex-primary school working groups of both Africans and Europeans also did not see depth in the pictures. These results were taken to indicate that formal education played only a contributory and not a decisive role in the growth of pictorial depth perception; that ethnic factors played no direct role; and that informal training in the home and habitual exposure to pictures was probably the major contributory factor.

The results of the four groups of Standard six scholars, European, Coloured, African and Indian, were the most directly comparable in terms of possible inter-ethnic differences. It was found that the proportion of 3D responses decreased in the above group order, with more than two-thirds of the Europeans and less than one-third of the Indians perceiving three-dimensionally. These results were predictable in terms of the proposed cultural determinants of 3D perception, as the Coloured sample was culturally nearer to the European one than the African. The scores of the Indian sample, however, are inexplicable unless one reverts to the Thouless/Beveridge-type argument that Indian art inculcates a perceptual habit which has to be unlearned before Western pictorial material can be perceived correctly.

Hudson (1962a, 1967) also conducted research into foreshortening, perspective applied to representations of figures of humans and animals; twisted perspective, a combination of frontal and profile views; and the positioning, size and orientation of drawing among illiterate African labourers and a group of European primary scholars. Most of the scholars saw foreshortened drawings in depth, while the labourers saw

them as flat. Differences between the two groups in drawing led Hudson to conclude that " ... the white man draws what he sees ... the unacculturated black man ... draws what he knows and not what he sees ... " (Hudson, 1967, p. 97). Rules of perspective and perceptual possibility, if known, were discarded by the African sample and Hudson attributed this to lack of meaningful exposure to Western forms of art.

Hudson's conclusions have been both supported and challenged by later researchers in the sphere of depth perception. Vernon (1965b) used certain of Hudson's drawings plus some of his own devising, and found that 60% of a group of II year old West Indian boys showed definite errors of perception on relatively easy pictures, while only 31% of a sample of English boys of similar age showed errors on more complex pictures. Mundy-Castle (1966) administered four of Hudson's drawings to 122 Ghanaian children between five and 10 years old. He found that only one child (a girl aged 8) gave consistent evidence of pictorial depth perception, and attributed this to lack of culturally-determined familiarity with pictorial material. Discussing an alternative possibility that the results may have been caused by egocentric, or immediate and syncretic, thinking, Mundy Castle did not exclude " ... the interesting possibility that given a culturally relevant context and culturally familiar materials, the older children would have exhibited a shift away from egocentric toward objective, relational thinking. " (Mundy-Castle, 1966, p. 300).

Although Hudson made a clear distinction between informal cultural training and formal education, it is difficult not to confound the two. Indeed, in the absence of strictly controlled and practically impossible longitudinal studies, no definitive statement about the relative contribution of the two to the development of depth perception can be completely acceptable. While Hudson acknowledged that both were determinants, studies by Kilbride, Robbins and Freeman (1963), Kilbride and Robins (1968), and Dawson (1967a) demonstrated the role of the educational factor. Kilbride et al. showed that cues to pictorial depth perception, such as object size, superimposition and linear perspective, become increasingly more available to more educated people. Their sample of 523 Baganda showed this to be time of both adults and children. Dawson (1967a), using some of Hudson's pictures and others of his own devising, found a tendency for an increase in 3D perception to be significantly associated with a rise in educational level

among a sample of 200 Sierra Leone males, although this was not the case for a small female sample. In an experiment aimed at training 2D perceivers to see 3D – the Renaissance "trick" of window-drawing was used – Dawson found that the skill could be taught.

Du Toit (1966) raised the Sapir-Whorf hypothesis and suggested linguistic relativity as an alternative explanation for Hudson's results, but did not question the validity of Hudson's methods. Instead, he argued that :

> "Bantu inability regarding pictorial depth perception might be caused by the fact that they do not automatically look for depth. They do not 'select out' depth because their language does not suggest or require them to think along these lines." (Du Toit, 1966, p. 59).

In discussing his findings, Hudson rejected the possibility that his results were due to artifacts of his test, and in his (1967) paper he dismissed Ferenczi's (1966) critique of his experimental design. Page (1970) however, has shown that there is a definite weakness in the semantic structure of the test, in that subjects' predisposition to 2D or 3D responses may arise from verbal cues. A sample of 70 Zulu youths were tested on Hudson's drawings and fabricated photograph as well as three black-and-white photographs of agricultural and urban scenes. It was found that significantly more 3D responses were made to these photographs than to Hudson's pictures (which suggests that Segall, Campbell and Herskovits' expectation that line drawings would be perceived more accurately than photographs " ... because of the relevancy of the dominant contours" may be unfounded) and that a slight change in the wording of one of Hudson's questions produced a significant increase in 3D responses. There was, however, an initial predisposition among the Zulu subjects towards 2D perception of Hudson's test items.

Deregowski (1968a, 1968b) administered Hudson's test and a geometrical model-construction task to subjects from various Bantu tribes in Zambia. In the construction task, the subjects were presented with line drawings of the Necker cube type and asked to construct apparatus models using wood and modelling clay. Deregowski's major finding may be summarised in his own words :

> "The frequency with which subjects who were 2D on Hudson's test made 3D responses to the construction test suggests that it is probably illegitimate to extrapolate from Hudson's findings to all types

> of pictorial material. A subject, it appears, cannot be classified as a 2D perceiver of all pictorial material merely because he is a 2D perceiver as far as Hudson's test is concerned. This does not invalidate Hudson's remarks about the difficulties which might arise owing to the cross-cultural differences in pictorial perception .... It does, however, limit their application by excluding, at least in part, the type of pictorial material used in the construction test." (Deregowski, 1968b, p. 203).

All in all, Segall, Campbell and Herskovits' (1966, p. 60) remark sums up the current status of Hudson's and subsequent research into pictorial depth perception: "although Hudson's findings may be specific to the materials employed and the questions asked, they do suggest that genuine perceptual differences can result from culturally mediated experiences." Of particular interest to the present discussion is the evidence that these differences may exist in respect of eidetic imagery, object constancy, and pictorial depth perception, as these factors may be contributory to cross-cultural differences in susceptibility to illusion.

2. Cross-cultural Differences in Susceptibility to Geometrical Visual Illusions

Differing degrees of susceptibility to certain geometrical visual illusions among ethno-cultural groups provide what is probably the most striking example of the influence of ecological and cultural factors on visual perception. Not only is this area of differentiation relatively well-researched, but it also enjoys a comprehensive theoretical basis in the Carpentered World and Foreshortening of Receding Horizontals hypotheses of Segall, Campbell and Herskovits (1966). The work of these three investigators was based initially on earlier studies in the field.

2.1 Important Studies preceding those of Segall et al.

The earliest evidence came from the first cross-cultural experimental psychology projects conducted, those of Rivers (1901, 1905), which were concerned in part with susceptibility to optical illusions. Soon afterwards, however, antipathy towards studying illusions seems to have arisen because of their alleged triviality and artificiality (Fisher, 1968a, pp. 108-109), and it was not until more than a half-century later, with the increasing interest of experimental psychologists in the field, that Allport and Pettigrew (1957) made the next important contribution. These studies either helped to instigate or greatly influenced the work of Segall et al.

2.11 Rivers (1901)

River's (1901) publication, which reported work performed by him and other members of the Cambridge Anthropological Expedition to the Torres Straits in 1898, is concerned chiefly with certain visual skills of the Torres Indians. In some contrast his (1905) study among the Todas of Southern India concerned itself with the other major sensory modalities as well as vision. In both studies, however, the Müller-Lyer illusion and the Horizontal-vertical illusion were prominent in the battery of tests which were administered.

The Müller-Lyer illusion was investigated quantitatively by using a subject-adjustable form of the illusion and a method similar to the average error procedure.

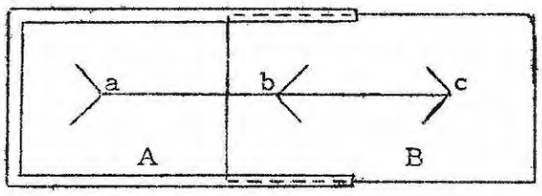


Figure 1. Diagrammatic Representation of Müller-Lyer Illusion Apparatus as used by Rivers (1901)

Rivers' Müller-Lyer apparatus is illustrated in Figure 1. Part B of the apparatus fitted into a groove in part A, this enabling the line ab to be matched with line bc. Each subject performed 10 trials, five consecutive ones with line ab initially as long as possible and five with the initial length of line ab as short as possible.

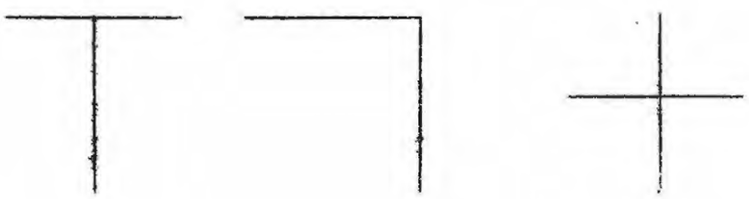
In this study, Rivers used six groups of subjects: 19 Murray Island (Papuan) men; 10 Murray Island boys; 9 Murray Island girls; 15 English adults who were familiar with illusions; 15 naive English adults; and 12 English children. (The sexes of the English groups were not specified.)

His results show that there were no significant differences in susceptibility to the illusion between the three English groups. They did show, however, significant differences when the Papuan and English ethnic groups were compared; the English being some 33% more susceptible to the illusion than the Papuans.

Rivers advanced a simple explanation for these results:

> "The fact that the illusion seemed to be distinctly less marked to the Papuan than to the European may possibly be due to the fact that the former concentrated his attention more completely on the special task he was given to perform, viz. to make the lines A B and B C equal to one another, and tended to disregard the other lines present in the figure. The European, on the other hand, probably recognizes at once that he is dealing with more than the simple problem of the relative length of two lines and tends to regard the figure as a whole." (Rivers, 1901, pp. 126-127).

The Horizontal-vertical illusion was investigated in a rather naïve although quantitative fashion among the Torres Indians.



(a) (b) (c)

Figure 2 (a), (b), (c). Three Forms of the Horizontal-vertical illusion

Twenty Murray Island men, 12 Murray Island boys, 15 English students and 12 English children were used as subjects. Each subject was presented with three separate sheets, each with a drawn horizontal line 100mm. long, and asked to draw a vertical line of equal length down from the centre of one; from one end of the second; and through the middle of the third. (See Figure 2).

Rivers found that the illusion was most marked in the case of the Murray Island men, and least marked among the English student group (all of whom were aquainted with the illusion and some of whom had been trained to overcome it). There were little differences between the performances of the Murray Island and the English children. The illusion was most pronounced in the form illustrated in Figure 2 (a), and least pronounced in the form illustrated in Figure 2 (c).

Rivers tended towards a physiological explanation, in terms of eye movements and size of field of vision, for these findings, but failed to relate these to the intergroup differences. (See 3. 31 for more modern physiologically-based theories.)

2. 12 Rivers (1905)

River's later work on cross-cultural susceptibility to illusions was in many respects an extension of the Torres Straits study, but it is valuable in that it utilized improved apparati and provided conclusions which greatly influenced the development of current hypotheses. It was carried out among the Toda, a tribe in the Nilgiri Hills of Southern India.

The Müller-Lyer illusion apparatus was revised as Rivers considered that the lines forming the figures on the equipment used in the

Torres Straits were too thick, and that observers were sometimes influenced by the junction between the stationary and moving parts, which was in the middle of the variable line (cf. Figures 2 and 3).

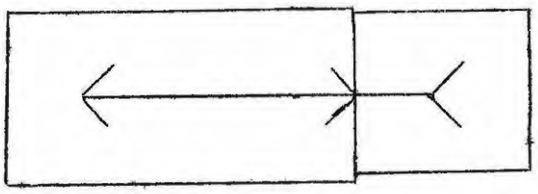


Figure 3. Diagrammatic Representation of Müller-Lyer Apparatus used by Rivers (1905)

The procedure followed was similar to that of the 1901 study. Forty Toda men were tested, twenty on the revised apparatus and twenty on the original apparatus. (No differences were found). Seventy English subjects (20 men, 25 women, 25 children) were also tested. (In addition, 23 Sholagas and Uralis, who are jungle inhabitants, were also tested. Their results, however, were rendered suspect by interpretation difficulties.)

It was found that the Todas occupied an intermediate position between the English group and the Papuan group, approaching the former in degree of susceptibility. The explanation advanced by Rivers for these results was again, as for the 1901 study, in terms of differing types of attention to the task.

The Horizontal-vertical illusion was also investigated in two ways. The "Torres Straits" method, which required the subject to draw vertical lines to match horizontal lines in length, was supplemented by a subject-adjustable apparatus, on which the subject matched the length of horizontal and vertical threads.

No appreciable differences were found in the results of the two methods, but, as was the case with the Papuans, the Todas were found to be significantly more susceptible to the illusion than the English groups. Rivers considered that the difference was due to the English using indirect means of comparing the lengths of the two lines, such as completing ideal triangles and comparing angles, whereas the Todas were unlikely to have done so.

Rivers' general conclusions on the results of his work with the Müller-Lyer and Horizontal-vertical illusions follow:

> "Although our knowledge as to the essential nature of these illusions is very defective, there is much reason to believe that they belong to two different categories. The illusion of compared horizontal and vertical lines probably belongs to that class of illusion which depends on physiological conditions, and the effect of experience in civilized life, such experience for instance as is derived from the study of geometry and drawing, is to diminish the illusion. The Müller-Lyer illusion, on the other hand, is one of those of which the explanation is probably more strictly psychological. The psychological factors upon which the illusion depends are however of a simple nature and affect both savage and civilized man, and the reason why the illusion is rather less marked to the Todas and Papuan is probably that which I have already suggested, viz. a difference in the direction of attention, the savage attending more strictly to the two lines which he is desired to make equal, while the civilized man allows the figure as a whole to exert its full influence on his mind." (Rivers, 1905, p. 363).

2.13 Allport and Pettigrew (1957)

Working with the Rotating Trapezoidal ("Ames") Window among the Zulu, Allport and Pettigrew (1957) made the second important contribution to the cross-cultural study of differential susceptibility to illusions when they stressed the possible importance of empiricistic factors on susceptibility to illusions.[1] While they did not claim to test directly the relative importance of nativistic or empiricistic factors, their results point to the importance of object connotation, as distinct from cumulative habit, or purely generalised experience, in the perception of illusions.

The Rotating Trapezoidal Window, developed by Ames (1951), has the frame and mullions of a normal rectangular window, but is trapezoidal in shape. When rotated on its vertical axis, it appears to oscillate or sway back and forth through 90° to 180° rather than to rotate through 360°, which, of course, is its actual movement. Ames considered that the illusion was dependent upon the window being perceived as a rectangular window in perspective, which would also form a trapezoidal

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1. It should be noted that for certain other illusions, such as the nongeometrical irradiation illusion, nativistic factors may be all-important. (See Heuse, 1957; Pettigrew and Nuttall, 1963.)

retinal image. (See Appendix Two for a fuller discussion.)

Four groups, each consisting of 20 boys aged 10 to 14, were tested: one urban European group and three Zulu groups, the latter being classified as relatively acculturated (urban scholars), fairly acculturated (rural), and relatively unacculturated (traditional tribal). Zulu groups were interesting samples for this particular experiment since:

> "Zulu culture is probably the most spherical or circular of all Bantu cultures, possibly the most spherical of all native African cultures .... The word "Zulu" means heavens or firmament, and the aesthetic ideal of round rather than angular styles affects native art, architecture, and speech." (Allport and Pettigrew, 1957, p. 106).

It was therefore expected that susceptibility to the illusion would increase with degree of acculturation. Each subject viewed the window binocularly and monocularly at both 10 and 20 feet. A control experiment was carried out later with different subjects.

Allport and Pettigrew found that, under optimal conditions (20 feet, monocular), almost as many tribal Zulus perceived the illusion as did urban Zulus or Europeans. However, under suboptimal or marginal conditions (especially 10 feet, binocular) there was a tendency for unacculturated subjects to report the illusion less frequently than acculturated ones. This was attributed by the authors to the effects of object connotation — the perceptual difference, in other words, was attributed to an environmentally-encouraged inference habit.

2.2 Hypotheses of Segall et al.

The work of Segall et al.,[2] particularly in its final form, documents the most important research in the sphere of cross-cultural susceptibility to certain visual illusions.

2.21 The Background Rationale

Noting studies of the type discussed up to this point, Herskovits et al. (1956) felt that despite the sometimes ambiguous evidence, the field of illusions provided a strong possibility for documenting authentic perceptual differences resulting from culturally-mediated differences in experience. Adopting what they termed a "moderate" empiricist

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2. Prior to the publication of the book by Segall et al. (1966) which reported the theoretical background and results of their major study, preliminary reports on various aspects of the study were published by Herskovits, Campbell and Segall (1956), Segall, Campbell, and Herskovits (1963), and Campbell (1964).

position, one which did not deny certain perceptual potentials of human genetic endowment, Segall et al. agreed with Allport's (1955) contention that basic to the perception process "... is the fact that the organism has built up certain assumptions about the world in which it lives. These assumptions, which are usually unconscious, (result in) the attaching of significance to cues ..." (Segall et al., 1966, pp. 73-74).

They considered that their general theoretical position was best epitomized by Brunswik and Kamiya's (1953) phrase "ecological cue validity", which recognised that certain perceptual learning may be caused, not by the "Gestalt dynamics of the brain field", but by the overall ecological validity of stimulus factors, such as proximity, in the natural cultural universe.

> "(Ecological cue validity) involves some general assumptions that Brunswik summarized as 'probabilistic functionalism'. It is hypothesized that the visual system is functional in general, although not in every specific utilization. The modes of operation are useful in the statistical average of utilizations. When this is applied to optical illusions, it is hypothesized that the illusion taps a process that is in general functional, although it is misleading in the particular instance because of 'ecological unrepresentativeness'; that is, the type of situation is unlike the general run of situations to which the process is functionally adapted and adaptive .... If one creates such a situation artificially, a compelling illusion, or mistaken judgement, occurs." (Segall et al., 1966, p. 74).

Brunswik and Kamiya emphasised that even cues of partial, or probabilistic, validity contribute to the organisation of the visual field. These cues, such as proximity, similarity and continuity, are used in the visual inference system. Under certain conditions, however, these inferences lead to non-veridical perceptions, as in the case of illusions. Segall et al. extended this line of reasoning to relate differential susceptibility to illusions among various societies to the different validities of cues in their ecologies. Finally, they pointed to cases of people who had regained the sight lost from birth or early infancy, and the effects of restrictions of visual input on the perception of chimpanzees, which suggest very strongly that the interpretation of visual data has to be learned. In particular, Gregory and Wallace (1963) showed that a 52-year old man, who had gained his sight for the first time after an operation 48 days before the date of testing, was not at all susceptible

to the Hering, Zollner, Poggendorf, Necker cube or Müller-Lyer illusions. Gregory and Wallace made the inference that the patient had not had the opportunity to learn the perceptual habits which underlay the illusions. Segall et al. postulated four preliminary hypotheses based on the evidence available:

> (i) "that the visual perceptual system used numerous cues of low and probabilistic (but still positive) validity";
>
> (ii) "that optical illusions demonstrate the function of normally useful cues but provide atypical visual performance settings";
>
> (iii) "if human groups differ in their visual inference tendencies, it is because their visual environments differ"; and
>
> (iv) "that given a hereditary and a learning explanation that both fit the data, the learning (empiricist) explanation is the more plausible". (Segall et al., 1966, pp. 77-79).

From the general theoretical hypotheses quoted above, Segall et al. proceeded to develop three specific hypotheses based on the concept of ecological cue validity. These hypotheses concerned the carpentered world; the foreshortening of receding horizontals; and the symbolising of three dimensions in two; and aimed at enabling the prediction of cross-cultural differences in susceptibility to several geometrical illusions.

The Carpentered World hypothesis is the basis of the predictions of cross-cultural differences in response to the Sander parallelogram and Müller-Lyer illusions; and, to a lesser extent, to a Perspective Drawing illusion which resembles a modified Ponzo illusion. While Segall et al. have not made a formal statement of this hypothesis, the following summarises their thoughts in this regard:

> "For figures constructed of lines meeting in non-rectangular junctions, there will be a learned tendency among persons dwelling in carpentered environments to rectangularize those junctures, to perceive the figures in perspective, and to interpret them as two-dimensional representations of three-dimensional objects.

> Such a tendency produces, or at least enhances, the Müller-Lyer illusion and the Sander parallelogram illusion. Since the tendency is assumed to have more ecological validity for peoples in Western, or carpentered, environments, it is predicted that Western peoples will be more susceptible to these illusions than peoples dwelling in uncarpentered environments." (Segall et al., 1966, pp. 96-97).

As did Ames (1951), Segall et al. noted that rectangular objects, with which Western environments are replete, are represented by nonrectangular images on the retina. The tendency among people in carpentered worlds to interpret obtuse and acute angles in retinal images as stemming from rectangular objects at various angles of regard is likely to be acquired unconsciously at an early age. However, those living in an environment relatively free of man-made rectangular structures would not learn this inference habit. Differences in degree may be found among rural and urban dwellers and among cold and hot clime inhabitants as well as Western and non-Western societies.

As the Müller-Lyer illusion dominates past and present theory on visual illusions, including the work of Segall et al., the attention of this discussion will be centered on the application of the Carpentered World hypothesis to this illusion. The Müller-Lyer figure in the form represented in Figure 4 is regarded as:

> "... a representation of three-dimensional objects extended in space. In this instance the two main parts of the drawing represent two objects. On the right, for example, if the horizontal segment were perceived as the representation of the edge of a box, it would be a front edge; while on the left if the horizontal segment were perceived as the edge of another box, it would be the back edge along the inside of the box. Hence the right-hand horizontal would 'have to be' shorter than the drawing makes it out to be, and the left-hand horizontal would 'have to be' longer." (Segall et al., 1966, p. 86).

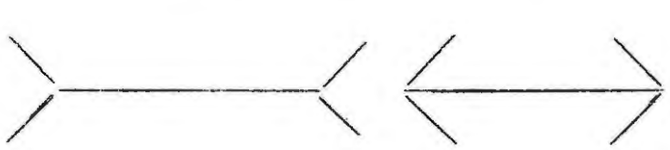

Figure 4. The Müller-Lyer illusion as used by Segall et al.

It is important, because of criticism below, to note that Segall et al. used this form of the illusion.

The Foreshortening of Receding Horizontals refers to the relatively greater foreshortening of those horizontal lines extending away parallel to the observer's line of regard, while those equally long horizontals transverse to the line of regard appear less foreshortened. Early theorists are quoted by Segall et al. in support of the view that a short vertical line may represent a long horizontal line extending away from the observer, this interpretation being thought to generate the Horizontal-vertical illusion (see Figure 5).

Figure 5 (a) and (b). Two Forms of the Horizontal-vertical illusion as investigated by Segall et al.

The cue validities of such an inference habit would vary in different visual environments. Because of limited opportunities for the formation and utility of the habit among people living in restricted visual surroundings, such as forest-, canyon- and some city-dwellers, they should be less susceptible to the Horizontal-vertical illusion than those living in open, spacious environments with wide vistas over water or land. Many non-Western societies, therefore, should be more susceptible to this illusion than Western peoples; although others, such as the rain forest dwellers, would be less susceptible.

Symbolising three dimensions in two is regarded as an arbitary decision most common among Western man. Frequent exposure to perspective drawings and photographs, as has been discussed in the previous Chapter, is thought to lead to certain habits of interpreting depth perception cues, which are necessary if the Müller-Lyer, Sander parallelogram, and possibly the Horizontal-vertical illusions are to be explained in terms of ecological cue validity. Learning to interpret drawings and photographs, therefore, should enhance these illusions.

However, learning to produce drawings representing three dimensions should reduce the illusions as accurate imitation of retinal

display necessitates the prior overcoming of the tendency, often found among young children, to draw things as "we know they are", right angles and all, rather than as they appear in proper perspective. Support of this is provided by Thouless (1932), who found that artists are relatively less subject to phenomenal regression and constancy effects. As adults are generally superior to children in the ability to analyse and compensate for known distortions, Segall et al. used this argument to explain the lesser susceptibility to illusions of adults as compared with children. (Wohlwill, 1960). In terms of the other two hypotheses, of course, the reverse should be generally true, due to the longer exposure of adults to the inference habits thought necessary for susceptibility to illusions to arise, unless a very early critical period for the formation of such habits is envisaged.

With the development of these three hypotheses, it remained for Segall et al. to put them to the test.

2.23 The Study

The materials and procedures employed in the study were contained in the Field Manual prepared by Herskovits et al. (1956). This manual enabled colleagues in widely different localities to provide standard information concerning ecological factors as well as to administer the tests in standard form. The manual contained a discussion of the research, detailed administration instructions and four preliminary "comprehension checks" as well as the stimulus material proper.

This last consisted of 50 drawings; 12 of the Müller-Lyer illusion, 7 of the Sander parallelogram, 20 of two forms of the Horizontal-vertical illusion and 11 examplars of a simple perspective drawing.

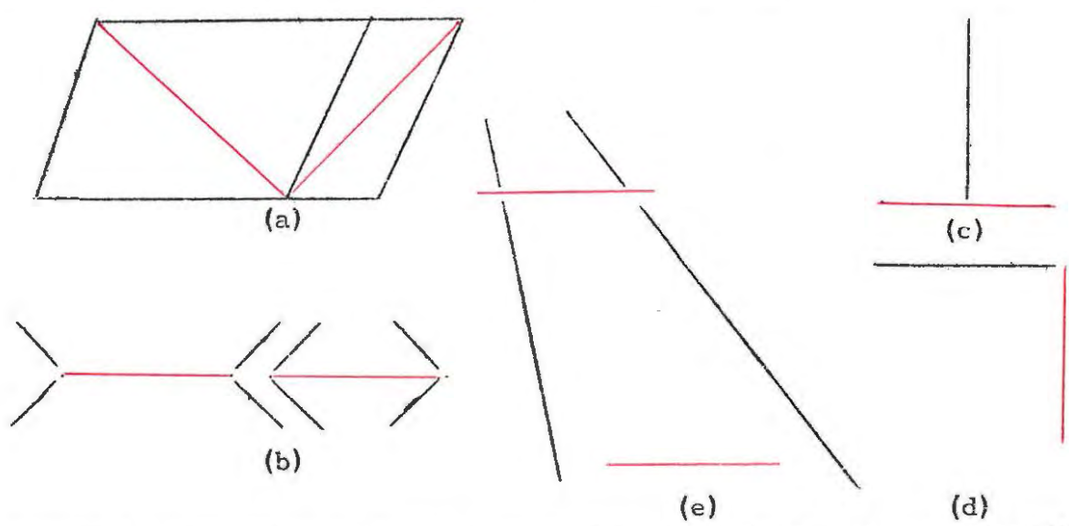

Figure 6. Examplars of stimulus materials used by Segall et al. (1966). (a) Sander parallelogram, (b) Müller-Lyer illusion, (c) and (d) Two forms of the Horizontal-vertical illusion, (e) perspective drawing.

(These examplars have been reproduced from pages 85, 87, 90, 92 and 93 of Segall et al. (1966) respectively.)

As shown in Figure 6, colour was used to render communication of the task easier; the comparison segments in each drawing being of a different colour from the context lines.[3] For the same reason, the segments in all the drawings (except the Sander parallelogram) were not connected, being terminated about one millimetre short of a junction.

The stimulus figures were exposed in prescribed order and standard position after the communication checks had been performed. The subject's task in all the preliminary and experimental figures was essentially that of deciding which of two lines was the longer; a variation of the psychophysical method of constant stimulus being used.

The 16 Samples tested between 1956 and 1961 consisted of 12 African groups, one Philippine group, an American urban group, an American undergraduate group, and one South African European group. Twenty research associates, who assisted in the administration of the stimulus material, were required to obtain equal percentages of both sexes in both adult and child groups, and also to provide certain ecological data. This data enabled Segall et al. to classify their samples in terms of acculturation and types of natural and artifactual visual environments. In toto, 1,878 protocols were analysed, the numbers in the various samples ranging from 30 to 344.

The analysis of the results was aimed at ensuring that any intersample differences which arose were not artifactual, but indicated genuine differences in perception. Each subject was assigned a score which represented his total number of illusion-supported responses to each of the five illusions; and Group PSE's (points of subjective equality) were determined on the basis of the samples being described in terms of the proportion of individuals making illusion-supported responses. Protocols biased through misunderstandings or response-sets were not included in the analysis, the criterion being that a check of the protocol's internal consistency had to reveal not more than one Guttman error. (An analysis of the results which included all cases produced results substantially the same as those obtained from the analysis of the consistent cases only.)

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3. In a study to determine the effect of the use of colours on illusion strength, Segall et al. (1966) reported that, for a sample of 20 undergraduates, illusion strength was lessened for the Müller-Lyer by contrasting comparison and context segments, but remained approximately the same for the other illusions.

2.24 Results and Conclusions

The Müller-Lyer illusion results show that the three Western adult samples (Evanstonians, American undergraduates and South African Europeans) did not differ significantly among themselves. This also applied, with a few exceptions which were considered to be due to suspect results, to the non-Western samples. However, the Western samples' performances all differed significantly from those of the non-Western groups (with the exception of suspect Senegalese and Zulu results), thus Segall et al. concluded that "... among adults, Western peoples are significantly more susceptible than non-Western peoples to the Müller-Lyer illusion." Although the only Western group which contained children was the Evanston sample, the conclusion quoted above would appear to be generally true for children as well as adults.

The Sander Parallelogram illusion results do not reveal as many significant differences as do the Müller-Lyer results, although the trend is in the same direction. Although the South African European group lay midway between the two American and the non-Western samples, it was found that, for adults, "... significantly greater illusion susceptibility is characteristic of the two most Western samples." (Segall et al., 1966, p. 161). There was virtually no evidence of differential susceptibility among the samples of children.

The Horizontal-vertical illusion results differ distinctly from the response-patterns of the Müller-Lyer and Sander parallelogram illusions. The three Western adult groups ranked 8th (Evanstonians), 10th (American students) and 12th (South African Europeans) of 15 samples in susceptibility to the inverted-T form of the illusion; and 9th, 10th and 12th respectively to the inverted-L illusion. The Evanston children sample occupied a similar low position in susceptibility to the illusion in the child samples. Significant differences stemmed for the most part from the very high susceptibility of several African samples to the illusion.

The Perspective Drawing illusion results indicated that, among adults, there were no differences in susceptibility to the illusion. This was also generally true of the child samples.

While these findings supported the hypotheses of Segall et al., althernative explanations were considered.

2.25 Alternative Interpretations of Intersample Differences

Communication of the task is a vital consideration in cross-cultural research, as failure in this respect may lead to differential

responses. However, as is detailed in Campbell (1964) and in Segall et al., "... it was concern for this sticky methodological problem that prompted the many precautions built into the materials and into the techniques for collecting and analysing responses to them." (Segall et al., 1966, p. 174). These precautions — the use of contrasting colours, the comprehension checks, the elimination of biased protocols — have been mentioned. However, application of the general epistomological principle that "... discrepancy can be noted and interpreted only against a background of nondiscrepant fit, or pattern repetition" (Segall et al., 1966, p. 175), provides a cogent cause for assuming adequate communication of the task. Because all the samples responded alike to certain of the wide range of stimulus materials, this context of agreement both indicated that the task was interpreted correctly and provided the base for noting particular response discrepancies.

Differences in test-administration, although inevitable because of the many ethnographers and interpreters used in the study, were minimised by using standard materials and procedures. It was considered, however, that inevitable administrative idiosyncracies across samples would not affect the major findings. Minor differences in the distance, the angle of regard and the inspection time of the stimulus materials were also not considered important contributory factors. However, it is noteworthy that certain of the African samples responded extremely quickly to the stimulus material, and that exposure time was neither recorded nor controlled.

Nonperceptual and behavioural factors, such as possible intergroup differences in motivation and task-attitude, were recognised by Segall et al., but they insisted that functional hypotheses were required before these possibilities could receive serious attention. So, for example, both Rivers (1905) and Doob (1964) suggested that differences in susceptibility to illusions may arise from non-Western perception being more analytic, presumably in the sense of being a-synthetic, than the holistic perception of European cultures.[4] With the exception in certain respects of the already-mentioned work of Berry (1966), however, no functional hypotheses linking ecological and cultural factors with visual skills have been postulated. Moreover, these types of hypotheses would find it difficult if not impossible to include Western

4. This suggestion, which refers to perception, is in direct contradiction to commonly-held views on African and European intellectual ability. (See, for example, Cryns, 1962.)

and non-Western differences in both directions, as, for example, Segall et al. have shown for the Müller-Lyer and Horizontal-vertical illusions. This consideration also precludes the attributing of intersample differences to the anatomy or physiology of the visual apparatus, or an "experience-with-pictures" explanation. Spitz (1963) suggested that it was possible that an explanation could be advanced in terms of "electro-chemical brain processes", but Segall and Campbell (1963) were sceptical of the possibility of such an explanation which could account for their complex, bi-directional findings. In terms of the "picture experience" hypothesis, failure to learn pictorial depth perception through cultural, educational or intellectual "deficiency" may be related to failure to acquire illusion-producing habits.[5]

2.26 Findings of Other Cross-cultural Studies of Visual Illusions

Studies conducted by investigators who utilised the Herskovits et al. test materials provide both support for, and challenges to, the hypotheses of Segall et al.

Morgan (1959) administered the stimulus materials to three South African groups, these being 70 illiterate African miners, 46 Kalahari Bushmen and 44 white students and graduates. Significant differences in susceptibility to the Müller-Lyer illusion were found between all groups, the whites being the most susceptible and the African miners the least. Although the differences were not significant, the reverse order obtained for the two forms of the Horizontal-vertical illusion. The Bushmen were not exposed to the Sander parallelogram, owing to difficulties of communication, but significant differences in the expected direction were found between the African and European groups. No significant differences were found in susceptibility to the Perspective illusion. These results highlight an inconsistency which arises to a lesser extent in the study by Segall et al. — in terms of their hypotheses, the Bushmen, because of their desert environment and lack of man-made artifacts, should be maximally susceptible to the Horizontal-vertical illusion and minimally susceptible to the Müller-Lyer — but do replicate the Western/non-Western differences. Morgan made an observation which is noteworthy in view of later discussion:

> "It was noticed that the responses of the illiterate groups were quicker and more spontaneous than those of the literate subjects. In many cases

5. See Hudson's previously-cited work.

> the mine labourers and the Bushmen responded as soon as the page was turned, without apparently giving the illusion figure any great consideration. Most of the white subjects, on the other hand, deliberated for some time before making a decision ...." (Morgan, 1959, p. 43).

In a later study, Mundy-Castle and Nelson (1962) tested a sample of Knysna forest workers, an isolated European community of apparently restricted intellectual level who live and work in the indigenous forests of the southern coast of South Africa, on the Herskovits battery as well as other perceptual and neurophysiological measures. They found that the responses of the Knysna foresters were more similar to Morgan's African and Bushmen groups than to her European sample. Interestingly, very few were able to perceive depth in Hudson's pictures, and they generally tended to underconstancy on a size constancy task. The overall visual performance of this relatively unacculturated European group, therefore, was very similar to that of non-Western peoples, and supported the hypotheses of Segall et al.

Gregor and McPherson (1965) tested these hypotheses among two groups of Australian Aborigines, each numbering 50, one group acculturated and living in a carpentered environment, the other unacculturated and living in a desert environment. The results support the hypotheses in general, in that differences in susceptibility to the Müller-Lyer and Sander illusions were in the expected direction, although no significant differences were found in the responses of the two groups to the Horizontal-vertical or the Perspective illusions. However, certain findings, such as that the unacculturated males were significantly more susceptible to the Sander Parallelogram than their female or their acculturated counterparts, led Gregor and McPherson to the conclusion that " ... in this particular instance the Herskovits hypothesis cannot be construed as providing exhaustive explanation of differential group and intra-group susceptibility to geometric illusion."

Jahoda (1966) emphasised that the degree to which the environment is carpentered and the interpretation of two dimensional drawings, although closely associated in Western cultures and in the Carpentered World hypothesis, are in fact distinct. As circumstances precluded his obtaining the Herkovits et al. test materials, Jahoda used "movable-slide" versions of the Müller-Lyer and Horizontal-vertical illusions to test 213 illiterate Ghanaians and 41 British university students and staff. (The use of these apparati and the method of

average error render Jahoda's results incomparable with those of Segall et al., but do not invalidate inter-group comparisons of his samples.) Two groups of Ghanaians, one living in open country in round huts without rectangular artifacts, and the other in rectangular surroundings, were tested. Thus, although the degree of carpenteredness of the environments of the two groups differed considerably, it was assumed that the two samples would be equally unfamiliar with the interpretation of depth in pictures. Jahoda found that, in regard to the Müller-Lyer, the British group was significantly more susceptible than the two Ghanaian groups, but that these two did not differ markedly in their responses. The Horizontal-vertical results showed that, while the Europeans were generally less susceptible to the illusion than the Ghanaians, the latter's performance was not completely in line with the Foreshortening of Receding Horizontals hypothesis. Certain of the "open-parkland" sample, who should have been maximally susceptible to the illusion, were extremely resistant to it. So much so in fact, that full details of Jahoda's methodology would be necessary before these results could be considered completely acceptable. If these few results are excluded, Jahoda's result would be in line with the hypothesis of Segall et al. His Müller-Lyer results, however, led to the proposal that:

> " ... illusion effects of the M-L type may be a combined function of two distinct variables: (1) the degree of rectangularity in the environment, which is the primary one, (2) the extent of the ability to interpret two-dimensional representations. It may well be that in the absence of (2), or with a deficiency in it, relatively moderate variations in (1) produce such limited changes in habits of perceptual inference that the difference cannot be detected by the relatively crude methods employed in the present study." (Jahoda, 1966, p. 198).

Jahoda's argument, however, failed to recognise that skill in interpreting pictures is far from a simple variable, as it is apparently dependent upon complex cultural and intellectual factors. Although he accused Segall et al. of neglecting Hudson's work, he himself neglected the fact that Segall et al. point out that an "experience with pictures" hypothesis cannot explain differential susceptibility found in both directions among Western and non-Western groups. It would appear that the distinct dichotomy proposed by Jahoda offers no functional advantage.

This view is supported by Dawson (1967), whose work among the Temne of Sierra Leone with the Sander parallelogram supported the Carpentered World hypothesis as well as, but to a lesser extent, Jahoda's proposals.

Segall et al. admitted quite explicitly that " ... while our data generally conform to the hypothesis, the fit is not so exact or so uniform as to rule out the possibility of other factors." (1966, p. 191). While the fits for the Müller-Lyer and Sander illusions were good, this was not true to the same extent of the Horizontal-vertical illusion. Deregowski (1967) suggested that, on the basis of current work on the illusion, only the L-shaped figure is suitable for testing the ecological hypothesis since the T-shaped figure generates dichosection effects and the symmetry of this figure tends to make it appear two-dimensional and thus decreases the illusory effect. This suggestion was borne out by tests administered to 48 Zambian schoolboys. However, Deregowski based his suggestion on the work of Kunnapas and his "shape of the visual field theory" (see 3.31), which can be challenged.

In addition, Berry (1968) felt that the confounding of ecological and developmental variables may result in possibly significant intergroup differences being concealed. So, for the Müller-Lyer illusion, an urban European group high in degree of carpenteredness (predicting high susceptibility) would also be relatively high in habits of visual analysis and perceptual development (predicting low susceptibility), whereas a rural European group may be low in carpenteredness (predicting low susceptibility) and also low in perceptual development (predicting high susceptibility). Thus, for different reasons, differences in susceptibility may or may not be exhibited.

To study the effects of the two hypothesised determinants, Berry selected two Eskimo and two Temne groups and administered the Herskovits test battery and the Kohs Blocks; the latter providing a measure of degree of perceptual development. A significant difference in the expected direction in susceptibility to the Müller-Lyer illusion was found among two Eskimo groups of equal perceptual development but differing degrees of "carpenteredness", while the same was true of two Temne groups of equal degrees of "carpenteredness" but of differing perceptual development. Berry felt that these findings possibly pointed to the reason for unexpectedly insignificant intracultural susceptibility to illusion findings, as, for example, by Morgan and by Jahoda above, and his findings left the Carpentered World hypothesis intact if not strengthened.

Bonte (1962), however, suggested that the findings of Segall et al. were due to artifacts of the stimulus material and measurement procedures. Using an earlier version of the Müller-Lyer section of the Herskovits battery, she tested 400 Bashi tribesmen (lake-side dwellers of the Congo) and 72 Europeans in the Congo and Belgium. It was found that the Europeans were significantly more susceptible to the illusion than were the Bashi. When, however, 100 Mbuti Pygmies (Congo forest dwellers), 50 Bashi and 20 Europeans were tested on a subject-adjustable, movable-slide-type piece of apparatus, no significant inter-group differences were found.

However, Segall et al. (1966) pointed out that the preliminary form of their battery used by Bonte was unsatisfactory in many respects in that the format made communication difficult (Bonte found it impossible to use on a Mbuti Pygmy sample) and encouraged response-sets. The movable-slide apparatus was criticised because of the very short obliques of the Müller-Lyer figure, graining of the wood of which it was constructed, and the very prominent vertical line at the junction of the slides. In addition, respondents may have misunderstood the task and matched the total figures on each slide. The view that these methodological issues are indeed suspect is supported by Jahoda's (1966) study, as his movable-slide apparatus did produce significant inter-group differences.

2.3 Interim Conclusions Drawn from Data Relevant to Cross-cultural Differences in Susceptibility to Geometrical Visual Illusions and the Hypotheses of Segall et al.

Segall et al. stressed the importance of the relationship of ecological cue validity and the effect of ecologically valid learned visual habits on susceptibility to certain visual illusions. The great mass of evidence, both from their study and from those of others, generally supports their Carpentered World and Foreshortening of Receding Horizontals hypotheses, which are also in line with cross-cultural findings in object-constancy tasks and perception of depth in pictures.

Certain inconsistencies, however, do exist in the published findings, and Segall et al. have been challenged on grounds of experimental design and neglect of possible developmental and cultural variables. However, because Segall et al. have demonstrated differences in susceptibility to illusions in both directions, their position has not been seriously threatened by counter-proposals, all of which cannot properly explain

this. Certain of these, however, are worthy of further research, as Segall et al. admit that the fit of their data is not perfect and that other variables may exert an effect on susceptibility to certain illusions. Of these, degree of perceptual development,as demonstrated by degree of field dependence, is considered important by Berry (1968), and is in line with other non-cross-cultural research.

It is therefore necessary to evaluate the position of Segall et al. in current research into susceptibility to illusions, and, in doing so, to delve further into the issue raised by Berry.

3. Theories Concerning Susceptibility to Geometrical Visual Illusions

Fisher (1968a), in an explanatory account of the visual illusions,[6] provides pictorial evidence which effectively shows that well-known illusions, including the Müller-Lyer, are often present in meaningful everyday scenes, yet the illusory distortions are apparently countermanded by some as yet unidentified mechanism. Illusions are not merely objects of "trivial and unconsequential psychological curiosity" (Fisher 1968a, p. 112), but probably exemplify special cases of otherwise veridical perceptual processes. Understanding the processes which underly illusions, therefore, would contribute to the understanding of space perception in general.

Evaluation of the position of Segall et al. within the body of modern illusion theory must be confined generally to those theories affecting the illusions studies by Segall and his associates, the Müller-Lyer, Sander, Horizontal-vertical, and Perspective Drawing. (The last is a form of Ponzo illusion.)

3.1 The Inappropriate Size-Depth Theories

The Carpentered World and Foreshortening of Receding Horizontals hypotheses owe much of their theoretical rationale to the Perspective and Size Constancy theories of susceptibility to illusions. Together these theories make up what Fisher (1968a, 1968b) terms the "inappropriate size-depth" explanations; there being strong relationships among theories in this class.

3.11 The Perspective Theory

First formulated by Thiery (1896), the Perspective theory of illusions rests upon the assumption that two-dimensional line drawings are inferred unconsciously to be representative of familiar three-dimensional objects or scenes. So, for example, the Müller-Lyer figures reminded Thiery of the cross-member and legs of a saw-horse, as seen from above and below.

The Ponzo illusion provides the best example of such reasoning, as it is strongly reminiscent of a road or rail-tracks receding into the

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6. See Appendix One for diagrams of 72 geometrical visual illusions.

distance. In fact, it is possible to incorporate the illusion into photographs or drawings of everyday perspective scenes.

In terms of the "ecological cue validity" position of Segall et al., the interpretation of two-dimensional patterns as representative of three-dimensional objects is both valid and useful in carpentered environments. Therefore, Segall et al. conclude that " ... there will be a learned tendency among persons dwelling in carpentered environments ... to perceive the figures in perspective, and to interpret them as two-dimensional representations of three-dimensional objects" (1966, p. 96).

3.12 The Size-Constancy Theory

Tausch (1954) extended the Perspective theory by proposing a "spatial correcting mechanism" which overcame distortions in visual space in certain systematic ways. When presented with visual illusions, this mechanism caused nonveridical perception. Tausch considered that the mechanism responsible for correcting spatial distortion is the same as that responsible for size-constancy. Gregory (1963, 1966, 1968, 1970) is the most prominent and consistent of the advocates of size constancy as an acceptable explanatory factor in susceptibility to illusions.

Although his theory is informal and undeveloped in certain ways, and his experimentation is inadequately-described, Gregory raised the point that certain illusion figures have a "dual reality", as they can be seen as representations of objects in perspective or as lines on a flat background. In either case, the illusory distortion is evident.

In this regard, Gregory provided evidence that a Necker cube, one of the "reversible" geometrical figures which reversed in depth when drawn on paper, also did so when it was constructed of wire, painted with luminous paint, and placed in a dark room. However, unlike the two-dimensional representation, whichever face of the cube model appeared to be more distant appeared the larger. So, too, Müller-Lyer models presented similar effects. In other words, the cube's background (the paper on which it was drawn) tended to cause it to be perceived two-dimensionally, but when background was absent, as with a model, it was only seen three-dimensionally and size constancy took place. Gregory reasoned that this phenomenon was caused by the tendency of the perceptual system to compensate for changes in the retinal image with viewing distance — that is, size constancy operates. Furthermore, he attributed size constancy to two different kinds of scaling, primary and secondary.

Primary constancy scaling is thought by Gregory to be "... set by perspective or other features normally associated with distance" (1963, p. 680). Secondary constancy scaling causes apparent size to be set simply by apparent distance. The primary system " ... seems to be primitive, and to be mediated by neural systems situated early in the perceptual system" (1963, p. 680), while experiential factors are deemed responsible for the modification of the perceptual mechanisms upon which the secondary system depends.

Primary scaling, set by perspective and other features of two-dimensional patterns which usually indicate distance, produces illusory distortion when such features are at variance, as when they are drawn on flat surfaces. Size constancy operates to enlarge the images of objects which are apparently further away, as for example, the upper line in the Ponzo illusion. Gregory argues — as do Perspective theorists — that the "arrow-heads" of the Müller-Lyer cause the illusion to be seen in perspective. Size constancy also operates in secondary scaling, due to the visual habit of maintaining the apparent sizes of objects regardless of their distance from the eyes.

In his 1968 publication, Gregory notes a practical application of his primary and secondary system hypothesis:

> "The traditional distortion illusions can be attributed to errors in the setting of the depth-cue scaling system which arise when figures or objects have misleading depth cues, particularly perspective on a flat plane. Although these illusions might occasionally bother investigators making visual measurements, they are seldom a serious hazard. The other kind of illusion — incorrect size-scaling due to an error in the prevailing perceptual hypothesis — can be serious in unfamiliar conditions or when there is little visual information available, as in space flight." (Gregory, 1968, pp. 72-73).

The small amount of work which has so far been published in this field indicates that, when a moving observer has insufficient or incorrect information about his velocity or his distance from various objects, " ... size constancy usually fails and can even work in reverse." (Gregory, 1968, p. 73).

3.13 Evaluation of the Hypotheses of Segall et al. in the Context of the Size-Depth Theories

Space research aside, it is obvious that Gregory has extended

the Perspective theory of illusions and postulated that size constancy and susceptibility to illusions are generated by the same mechanism, which, in Brunswikian terminology, has great ecological cue validity in carpentered environments. Segall et al. accepted Gregory's reasoning, and, in simplified guise, it underlies the Carpentered World hypothesis. Earlier discussion has pointed out that visual object-constancy is generated by experiential factors mediating retinal patterns; that artistic and experimental evidence indicates that certain unacculturated non-Western groups have difficulty in perceiving perspective in pictures; and that similar groups are generally more accurate perceivers in size-constancy tasks. The results of Segall et al. have shown that unacculturated groups, perhaps because of their uncarpentered environments, are less susceptible to the Müller-Lyer illusion than Western groups, but sometimes more susceptible to the Horizontal-vertical illusion. A possible anomaly arises in terms of the theory -- if unacculturated people do have the very active size constancy mechanisms that are suggested by available evidence, they should be more, not less, susceptible to the Müller-Lyer illusion than acculturated peoples. An answer to this problem would be that lack of exposure to rectangular artifacts prevents the formation of the visual inference habits that appear necessary for the size constancy process to operate in the Müller-Lyer illusion. In fact, Gregory (1963) used the findings of Segall et al. (1963) as support for his contention that constancy scaling is learned. As perception of apparent distance should be highly developed among certain unacculturated peoples, this would explain their heightened susceptibility to the Horizontal-vertical illusion. In other words, Gregory's primary and secondary systems fit the Carpentered World and Foreshortening of Receding Horizontals hypotheses very well, thus these hypotheses may be regarded as consistent with the inappropriate size-depth theories of illusion. However, how well-founded are the size-depth theories themselves?

3.14 Appraisal of the "Inappropriate Size-Depth Theories" of Illusion

Due to the extremely wide scope of Fisher's (1968a, 1968b, 1968c, 1968d, 1969)[7] research on geometrical illusions, and in particular his criticisms of Gregory's theories, other appraisals tend to be relatively overshadowed, even trivial.

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7. Fisher's (1968a) publication is a detailed report of a five-year research programme into certain aspects of perception, particularly the geometrical illusions. The subsequent publications deal with specific aspects of this programme.

Brown and Houssiadas (1964, 1965), for example, found that Gregory's contention that scaling can be set by the depth features of flat figures did not apply to a series of geometrical illusions of the Zöllner and Wundt illusions type. (See Appendix One). This was attributed to these figures not allowing the actual central stimulus figures to fit into their background. This is interesting only in the light of later discussions concerning field dependence. Figures of the Zöllner and Wundt type are more properly regarded as distortions than as illusions, and Brown and Houssiadas actually found that Gregory's contention did hold true for the Ponzo illusion.

Hamilton (1966) administered three size constancy tasks and a Müller-Lyer task to 20 normal and 20 intellectually subnormal 12-year old schoolboys. (Considerable variance in size-constancy responses were anticipated from these subjects, as it was expected that the children of low intelligence would not have attained " ... the degree of cognitive maturity which finds expression in full size constancy responses ...". This expectation was confirmed.) The Müller-Lyer task was of the traditional subject-adjustable sleeve and slide pattern, while subject-adjustable apparati were also used in judging the actual sizes of a rod, a square and a playing card at a 7^{o} angle of regard. The results provided no support at all for hypotheses relating size constancy and degree of illusion. In fact, the wide individual differences found inclined Hamilton to the view, which will be discussed in some detail later, that :

> "It is possible that this universality (of susceptibility to the Müller-Lyer illusion) is no more than the expression of a general perceptual tendency to apprehend a stimulus in its contextual stimulus field rather than in isolation, a response that has been acquired because it is most frequently appropriate ..." (Hamilton, 1966, pp. 71-72).

In a paper which is chiefly theoretical — the limited experimentation which is mentioned is ill-described — Hotopf (1966) cast doubt upon the independent existence of both primary and secondary scaling. While this work is clouded unduly by the consideration of illusional exotica such as combined Müller-Lyer, Hering and Wundt figures, the contention that " ... it is indeed difficult to see how a form of scaling which was not itself due to 'perspective and other features associated with distance' (primary scaling) could be 'set simply by distance' (secondary scaling)", seems irrefutable. Hotopf did, however,

contend that perspective is responsible for some visual illusion. A Gregory-type experiment with a luminous elongated Necker Cube and 32 subjects suggested that there was evidence for an association between apparent size and distance. Another theoretical point worthy of consideration is Hotopf's suggestion that " ... the convention of presenting visual illusions as simple geometrical figures may have overdetermined the theory that they derive mainly from environments with similar properties."

Fisher's (1968a, 1968d) challenges to the Size-Depth theories were based on experimentation in which he manipulated the properties of the contours of the illusions in attempting to reveal the reason for illusory distortions being generated. The most relevant of his arguments against the Size-Depth explanations provide examples of his approach.

The Ponzo illusion, as has been noted, presents the strongest evidence in favour of the Perspective theory. Fisher showed, however, that when the perspective features of the Ponzo figure are reversed, the distortion is not — the line nearest the narrower end of the figure always appears longer.

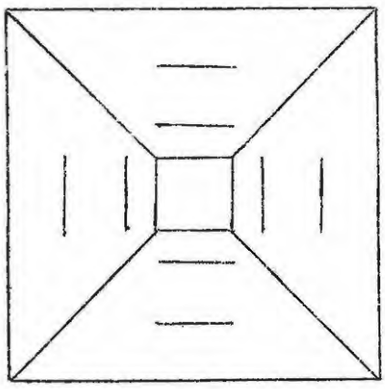

Figure 7. A version of the Ponzo Illusion (reproduced from Fisher, 1968d, p. 9).

The Ponzo illusions embodied in Figure 7 illustrate this point. The figure reverses readily in aspect — it can be viewed as the side-elevation of a room or the plan of a truncated pyramid — yet, irrespective of which aspect they reported, 123 subjects were unanimous in reporting the inner line of each pair as the longer. Fisher did not, however, ascertain whether the degree of illusion differed in the two aspects.

Gregory based his Size Constancy theory on investigations which concentrated on the Müller-Lyer figure and the Necker cube, only the former being a true illusion. He considered that both primary and secondary constancy scaling operated in making the apparently nearer line shorter and the apparently more distant line longer. In his research, he used the component form of the illusion as illustrated in Figure 8. (As did Segall et al.)

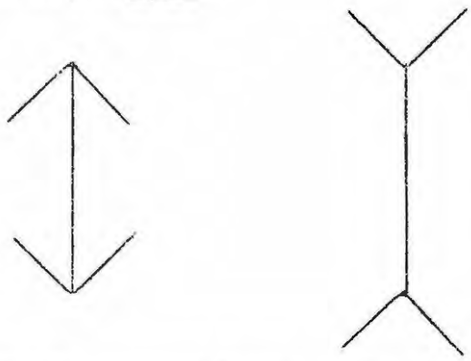

Figure 8. The Component Form of the Müller-Lyer Illusion

As Fisher (1968a, 1968b) pointed out, Gregory's explanation accepts that the arrowheads set the reference planes for distance which determine the perception of the total figures. While this argument is plausible when applied to the component form of the illusion, it is not valid for the composite form.

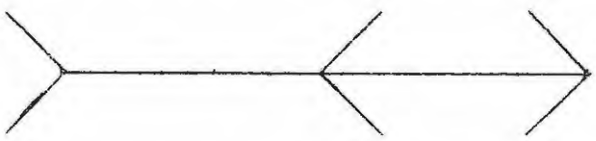

Figure 9. The Composite Form of the Müller-Lyer Illusion

As is shown in Figure 9, an arrowhead bisects the composite Müller-Lyer figure. If a depth interpretation is placed on this figure the ends of the middle arrowhead have to be seen as both in front of and behind the shaft, and the shaft seen simultaneously as both nearer to and further from the observer. We must agree with Fisher (1968b, p. 375) that " ... an interpretation of this kind seems highly questionable." However, Fisher did not attempt to evaluate the possible contribution of size constancy factors to the illusion by, for example, experimentally comparing the magnitude of the illusion as represented in component and composite forms. Direct evidence concerning this problem has not been published.

The Carpentered World hypothesis contends that certain illusions, notably the Müller-Lyer, owe their effect to people of carpentered environments inferring that the obtuse and acute angles of two-dimensional drawings are representative of three-dimensional rectangular surfaces. Fisher (1968a, 1968c) questioned the attribution of primary importance to the rectangularity and rectilinearity in the environment, and used curvilinear versions of various illusions to show that the illusory effect is still perceived in these forms, as it obviously is in the Müller-Lyer illusion in Figure 10.

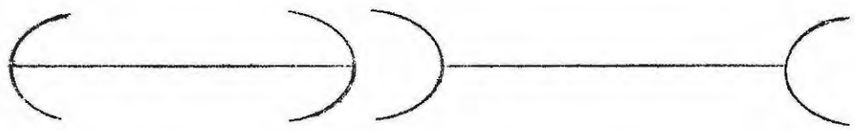

Figure 10. The Müller-Lyer Illusion with Curved Context Lines

Furthermore, he used four forms of the Ponzo illusion, which are illustrated in Figure 11 (reproduced from Fisher, 1968a, p. 134) to measure the extent of illusory distortion in each.

Figure 11. Four Forms of the Ponzo Illusion

One hundred adult subjects matched the lines in each form of the illusion on a subject-adjustable apparatus. A control situation was created by requiring the subjects to match two horizontal lines without context lines. The upper horizontal line was presented in a standard length of 100cm. The mean over-adjustment of the length of the lower lines in each figure were: (a) 13.44cm.; (b) 12.57cm.; (c) 10.85cm.; (d) 8.57cm.; (control) 0.37cm. Illusory spatial distortion was thus apparent in all four experimental displays.

While this experiment does suggest that rectilinearity may not be a prerequisite for illusions to be generated (as was also suggested by Hotopf, 1966), it does not preclude the interpretation of perspective elements in curvilinear illusions and it does show that the illusory effect is strongest in the rectilinear figure. This is important, as the curvilinear illusions may also be generated by visual inference habits and depth-perception skills which are undeveloped in certain non-Western societies. Particularly since cross-cultural experimentation with these illusions is lacking, Fisher's findings in this respect challenge peripheral rather than basic aspects of the work of Segall et al.

Indeed, Fisher's (1968a) further criticisms of this work concerned methodological rather than theoretical issues. He challenged the use of the 20 "on the spot" ethnographers, the employment of abstract rather than meaningful forms of the illusions (see Fisher, 1968a, pp. 109-113, 137), and the trustworthiness of the quantitative data. Pointing out that studies (e. g. Köhler and Fishback, 1950a, 1950b) have shown that the Müller-Lyer illusion decreases with prolonged experience, Fisher reasoned that in terms of the Carpentered World hypothesis it is possible that illusory distortions should be smaller for people living in carpentered environments because they are continuously exposed to them. However, the "satiation theory" explanation of Köhler and Fishback has been disproved (Moed, 1959; Pollock and Chaplin, 1964; Day, 1962), while there is also evidence that, when the illusion is experimentally reduced, there is quick spontaneous recovery. (Mountjoy, 1958). Fisher did make it clear, however, that he was not challenging that illusions are experienced differentially, but was merely questioning the rectilinearity-based explanation for this finding.

We may conclude that, in spite of Fisher's opposition to the "inappropriate size-depth" theories of illusion, he has failed to exclude perspective interpretations from being possible contributory factors, although he has shown that they are not the only factors in operation. As far as the Carpentered World hypothesis is concerned, Fisher's findings do not challenge the explanation of differential cross-cultural susceptibility to illusions in terms of visual inference habits and skills, but they do cast doubt about the relationship postulated between the rectilinear form of the Ponzo and Müller-Lyer illusions and rectangularity in the environment.

3.2 The Contour Proximity Theory

Fisher (1968a, 1969) is currently developing a new explanation for the geometrical illusions, which he has entitled "the contour proximity theory of illusions" (1969, p. 183). As yet, only the first of a planned series of papers dealing with the principles upon which illusory distortions depend, and a new theory based upon these, has been published. Fisher's first task was to determine whether the actual presence of the contours, or context lines, as sensory data, rather than their conceptual interpretation as possible depth cues, causes the illusory distortion. His 1969 paper described the three experiments discussed below, which indicated that the proximity, the dimensions and the contrast of the contours influenced the degree of illusory distortion. The "gradient of distortion", which refers to the progressive increase in apparent length of the stimulus lines in a special form of the Ponzo illusion, is used in these experiments, but in the context of short vertical bars, presumably to minimise perspective interpretations. (See Figure 12: reproduced from Fisher, 1969, p. 180.)

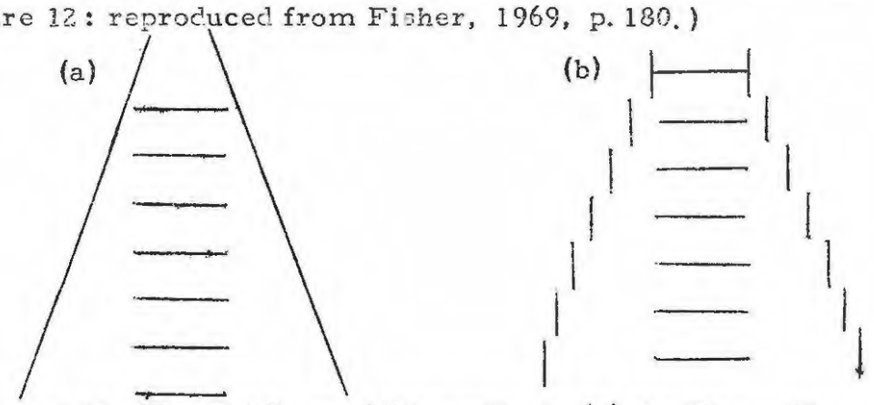

Figure 12. The Gradient of Distortion in (a) the Ponzo Figure and (b) Vertical Bars

The same one hundred subjects participated in all three experiments. Ranging in age from 15 to 57 years, 71 of these were a sample of urban dwellers and 29 were university students. (No marked differences were found between the responses of these two subgroups).

Reciprocating slide mechanisms embodied in the subject-adjustable apparatus enabled the subjects to match the length of each of the six lower horizontal lines with that of the standard upper horizontal line. Ten judgments were made in all six situations, which were presented in random order, this being changed each time the experiment was conducted. Although the three experiments are reported separately, they were actually performed together in randomly-determined order.

The first experiment demonstrated that the proximity of the vertical bars was related to the degree of illusory distortion — the further away the bars, the shorter the apparent length of the line — thus the gradient of distortion was not only present in the "vertical bar" figure but appeared to depend directly upon the proximity of the vertical bars. A control condition, which required matching of the lengths of the horizontal lines with the vertical bars absent, produced no illusory distortion.

By using five figures, each with vertical bars of a different width (2mm., 4mm., 6mm., 8mm. and 10mm.), Fisher found that although the distortion gradient was apparent in all five conditions, its magnitude varied directly with the width of the bars, being greatest for the widest bars and least for the narrowest.

To ascertain whether manipulation of the contrast properties of the vertical bars changed the extent of the distortion gradient, the black vertical bar figure was presented against five different backgrounds ranging from dark grey to white. It was found that, with a lightening of background, the distortion gradient increased, thus indicating that the contrast of the contours has a marked influence upon the extent of their effect.

Fisher has therefore demonstrated that three properties of contours — their proximity, dimensions, and contrast — influence the extent of illusory distortion. He stated that this research was:

> "... essentially the basis of 'the contour proximity theory of illusions'.... Subsequently, it will be shown that the appearance of all the geometrical illusions can be predicted from the principle of contour proximity and that it constitutes a necessary and sufficient psychological explanation for apparent distortions of this kind." (Fisher, 1969, p. 183).

It is interesting to note that Fisher (1968a) agrees with the contention of Segall et al. (1966) that people susceptible to the Müller-Lyer illusion will also be susceptible to the Ponzo illusion. However, while Segall et al. attributed this relationship to the carpenteredness of the environment, Fisher feels it is due to both these illusions depending upon the same principle of apparent-distortion. Following the premise that illusions which are related in nature generate distortions which are related in mechanism, Fisher used figures such as those shown

in Figure 13 to support his argument.

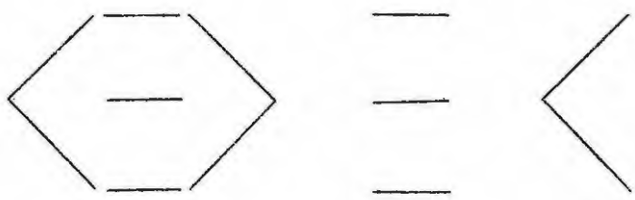

Figure 13. Four Ponzo Illusions Side by Side
(Reproduced from Fisher, 1963a, p. 164)

In this figure, which has the general appearance of a composite Müller-Lyer illusion, are embodied four Ponzo illusions. The central line bounded by the ingoing arrowheads appears shorter than the outer lines, while that bounded by the outgoing obliques appears longer than the outer lines. These distortions are consistent with both the Ponzo and Müller-Lyer illusions, and Fisher found it reasonable to conclude that they both depend upon the same principle of apparent distortion.

While Fisher has presented some impressive evidence, his theory cannot be properly evaluated until it has been presented in full. At this stage of its development it does not exclude alternative explanations of illusions. In fact, it actually provides support for the later-discussed theory relating differential susceptibility to illusions to field dependence. Interestingly enough, this latter behavioural explanation arose in part from physiologically-based theories.

3.3 Physiological Theories of Illusion

It has been noted that Segall et al. rejected physiological and nativistic explanations of susceptibility to the illusions studied by them, and the available evidence would seem to justify this viewpoint.

3.31 The Shape of the Visual Field

Künnapas (1955, 1958, 1959) proposed that the elliptical shape of the visual field of humans modifies the forms seen in binocular vision: vertical lines appear elongated since they reach the periphery of the vertical field, while horizontal lines appear foreshortened since they do not occupy a relative portion of the horizontal field. The distortion seen in the Horizontal-vertical illusion is consistent with this

view, but experimental evidence is not. Fisher (1968a) pointed out that if bars are added to the horizontal line, in the manner of Oppel (see Appendix One), the direction of the illusion is reversed. Over (1966) has found that the illusion is perceived both visually and tactually, thus its explanation in terms of the shape of the visual field is unacceptable.

3.32 The Contour Displacement Theory

Ganz (1966) suggested that figural aftereffects (FAE) are actually a type of simultaneous illusion. The rationale behind this theory begins with the following observation:

> "When contours of visual objects are close together, they often induce shifts in their respective apparent locations. Since the objects are not, in fact, changed in their positions in the visual field, it must be the neural correlates of these edges or lines which somehow interact, shifting each other's positions in their topographic projection in the visual system. The phenomenological result is a deviation in perception from veridicality, an illusion." (Ganz, 1966, p. 128).

Using illusions of the Orbison type (see Appendix One), Ganz felt that, as apparently occurs with FAEs, the edges of objects in the visual field appear to repulse one another when they are brought close together. He theorised that this displacement occurs because the neural correlates of visual contours inhibit one another; i. e. there is lateral inhibition in the visual system, probably in the retina. This inhibition will cause shifting of the apparent position of one contour on the retina.

However, the studies below show that Ganz's theory has no bearing on the present study. Robinson (1968) has shown that this theory cannot apply to the illusions proper although it is tenable for FAE theory and may be so for the visual distortions, such as the Orbison, Wundt, and Hering figures. Wagner (1968) supports Robinson's findings that Ganz's theory does not explain the illusory distortion in the Müller-Lyer and Ponzo illusions. Both Robinson and Wagner present evidence that illusions and FAEs have displacements in opposite directions and with different spatial characteristics. Moreover, as has already been mentioned, any theory of illusion in terms of purely retinal factors must be disregarded, as crossmodal transfer of perceptual

learning on visual and haptic versions of illusions has been clearly demonstrated. (Rudel and Teuber, 1963; Over, 1966).

Immergluck, in a series of short articles (1966a, 1966b, 1966c, 1968a, 1968b, 1970) has reported the relationships between FAEs, susceptibility to certain illusions, and the dimension of field dependence.[8] Immergluck found that people who exhibited strong FAEs were relatively field independent on the Rod-and-Frame Test and that they were better able to resist the Zöllner illusion. Thus, contrary to Ganz, Immergluck found a negative relationship between FAE strength and susceptibility to illusion, but a positive relationship between the analytical perceptual style of the field independent and the ability to resist illusions.

3.4 Field Dependence and Susceptibility to Illusions

In a massive factorial exploration of perceptual processes, Thurstone (1944) found significant correlations between the Müller-Lyer illusion on the one hand, and the Gottschaldt hidden figures and spatial intelligence on the other. Field independence, the ability to overcome an embedding context, was, however, not named and investigated systematically until the mid-1950's, when it was found that the Gottschaldt figures were a test of this dimension. Shortly afterwards, Gardner (1957) noted in a short report that the greater the field dependence, the greater the susceptibility to illusion in judging the lengths of lines in three "classic" illusions, which he did not name. In a study of two forms of the Horizontal-vertical illusion, Gardner and Long (1960a, 1960b) suggested that the illusion may be due in part to attention deployment; that is, the actual manner in which the illusion figure is inspected. It was not until his 1961 paper, however, that Gardner developed his theory fully.

The 1961 study tested the hypothesis that " ... Field Articulation and Scanning principles differentially affect subjects' responses to two classical types of illusion-producing figures." Field dependence was measured by the Rod-and Frame and Embedded Figures Tests, both of which require the overcoming of misleading visual backgrounds for their successful completion. It was hypothesized that, because overcoming the Müller-Lyer illusion would also seem to demand selective attention to nullify the effect of the arrowheads, field independent subjects would be less susceptible to the illusion than field dependent

8. Field dependence is discussed below.

subjects because the latter would not be able to cope with the misleading irrelevant cues. The second part of the hypothesis concerned the Horizontal-vertical illusion, which has no irrelevant lines, and which, therefore, probably cannot be explained in terms of field dependence. It was anticipated that scanning principles would have demonstrable effects upon susceptibility to this figure; i. e. susceptibility would be determined by the manner in which the subject's attention was deployed. Scanning was measured by two size estimation tests. Two all-female groups, numbering 80 and 68 respectively, were used for the two parts of the study. The hypotheses were supported by the results: field dependent subjects were more susceptible to the Müller-Lyer illusion than field independent subjects, and minimal scanners were more susceptible to the Horizontal-vertical illusion than those whose attention ranged more widely. However, there was no marked relationship between limited and extreme scanning and field dependence.

McGurk (1965) adopted Gardner's reasoning, and extended it:

> "The ability to overcome the effect of common visual illusions would appear similar to what Witkin ... has defined as the analytic attitude, but in dealing with illusions one must attempt to identify and then to ignore the distracting elements in a configuration. It would therefore follow that persons who can resist optical illusions should show personality traits such as independence, dominance and need achievement, as Witkin found for his field-independent people." (McGurk, 1965, p. 128).

McGurk administered the Gottschaldt Figures Test, an Illusions Test, the California Psychological Inventory and other pencil-and-paper tests to 87 undergraduates, two-thirds of whom were female. The Illusions Test was devised by McGurk, and was essentially a multiple-choice-type test featuring 22 illusion items and 10 non-illusion items, which were presented by a slide-projector. The illusions used, although chosen by " ... going through the early psychophysical literature and selecting standard illusions and variants thereof", were not named.

However, it was found that the Gottschaldt Test was significantly related to the Illusion Test, and McGurk concluded that the illusion-resistant subjects were relatively field independent. In terms of personality measures, they were dominant, had high needs for achievement, were flexible and self-controlled. In fact, they were very similar to the field independent type.

Hamilton's (1966) conclusions on susceptibility to illusions have already been mentioned — he considered that susceptibility to the Müller-Lyer illusion is no more than " . . . a general perceptual tendency to apprehend a stimulus in its contextual stimulus field than in isolation" (p. 71), and the evidence discussed above points in this direction.

It must be noted, however, that the relationship of field dependence to susceptibility to illusion may provide an acceptable explanation of differential susceptibility to illusions, both individual and intergroup, but it does not explain the reason for certain contours generating illusory distortions.

However, a grave anomaly arises when the field dependence explanation of individual differences in susceptibility to illusions is considered in the light of data from non-Western cultures, thus the concept of field dependence and its relation to cross-cultural illusion responses must be examined in some detail.

4. Field Dependence and Psychological Differentiation

The concept of field dependence, introduced by Witkin and his associates (Witkin, Lewis, Hertzman, Machover, Meissner and Wapner, 1954), and later restated in terms of the concept of psychological differentiation (Witkin, Dyk, Faterson, Goodenough and Karp, 1962), postulates a relationship between personality and perceptual and intellectual development.

4.1. The Development of the Differentiation Hypothesis

In their initial investigations of problems of spatial orientation, particularly the perception of the vertical, Witkin (1949a, 1949b, 1949c, 1950a, 1950b, 1952), Witkin and Asch (1948a, 1948b), and Asch and Witkin (1948a, 1948b) attempted to establish the roles played by such factors as the structure of the visual field, the magnitude of the gravitational impressions received from the subject's body, the effect of knowledge about stimulus conditions, and so forth. The principal tests employed in this research were the Rod-and Frame Test (RFT), the Room-adjustment Test (RAT), and the Body-adjustment Test (BAT). The RFT provided a measure of the individual's ability to overcome a distracting visual reference frame and to utilise bodily cues in determining the vertical. The RAT and the BAT were used to assess the individual's ability to relate the position of his body and his surroundings to the vertical.

It was found that because of striking intra-group variation, statements about the nature of perception under any given condition, derived for the group, did not hold true for many individuals in the group. So, for example, the visual field was found to be the main determinant of perception of the vertical. However, under given circumstances, it was almost entirely disregarded by some subjects. In the subsequent study of the causes of the variability among subjects, three principal hypotheses were examined by Witkin et al. (1954).

The first hypothesis accounted for individual differences in terms of "accuracy" in perception of the upright. This postulate was rejected in view of the negative correlations obtained between accurate perceivers on the BAT and on the RAT. Although these two tests were directly comparable in many respects, high negative correlations were found between the scores on these tests, indicating that accurate perceivers on either test were inaccurate on the other.

The second hypothesis postulated that the individual differences reflected differing sensitivity to bodily cues. However, using tests employing the ataxiameter and the stabilometer, tests of body steadiness and body balance respectively, the experimenters (Wapner and Witkin, 1950) found little relation to performance on the spatial orientation tests.

The third hypothesis became the basis of a new taxonomy of personality type. It was hypothesised that the ability to overcome an embedding context was responsible for the accuracy of perceptual judgements. In more general personality terms, this was seen as a greater or lesser degree of dependence on, and vulnerability to, the field, and thus was the field dependent personality identified. In terms of the extremes of the field dependence/independence continuum, personality type is classifiable in terms of either the tendency to be displaced by field effects or the power to accommodate for these through the exercise of a more analytical evaluation. The Embedded-Figures Test (EFT) was developed to test the above hypothesis, as this test does not involve body position but measures the ability to perceive an item independent of its context. The EFT was revealed to be highly related to the RFT and BAT, but only moderately related to the RAT. (Witkin et al. 1954).

Witkin designated the style of functioning of the field independent in relation to many diverse types of problems as an analytical field approach, whereas that of the field dependent is termed a global field approach. The experiments supporting Witkin's claim range from rather restricted perceptual problems to those having a clearly demonstrable bearing on the individual's broader functioning. Witkin conceived of this broader functioning in terms of psychological differentiation:

> " ... experience of the body-field matrix is early essentially global, and during development becomes progressively more articulated so that body, self, and objects in general are experienced as segregated. Segregation, or analysis, and with it structuring of experience — of what is outside and of what is inside — are manifestations of developed psychological differentiation. The growth of a segregated, structured self — or self-differentiation — is in this view part of the process of articulation of experience." (Witkin et al. 1962, p. 14).

4.2 The Origin of Mode of Field Approach

Witkin attributed the development of the mode of field approach to the mother/child relationship. This hypothesis stresses that children whose differentiation is limited, and are therefore field dependent, have had relationships with their mothers of such a nature as to interfere with the opportunities for psychological differentiation; highly differentiated field independent children have had relationships with their mothers of a nature that permitted or even fostered progress toward differentiation.

The necessity of establishing the interaction of nature and nurture operating in the development of the child's perceptual and intellectual functioning was fully realised:

> "The studies we have done on the possible role of constitutional and experiential factors in the development of differentiation were guided by an interaction approach. Thinking in the field of child development has long departed from the view, on the one hand, that the child is a piece of passive clay in the hands of the mother, who makes him whatever her own needs and wishes dictate and, on the other hand, that the child's growth is simply a unfolding along the predestined course laid down in his genetic make-up. An interaction approach is also consistent with current views of the nature of gene action .... Genes do not enforce a given inevitable expression 'from within themselves', genic expression depends, in varying degree, on the environmental conditions that obtain during development." (Witkin et al., 1962, pp. 270-271).

Studies by Mussen and Kagan (1958), Bieri (1960), and Seder (1957) supported Witkin's contention that the individual's mode of field approach is related to the kind of experience he has had in his family. In particular, Seder confirmed Witkin's findings that the mothers of children with a global field approach are unable to guide their children towards assumption of responsibility and self-assertion, discipline severely and in an irrational mood, and limit their children's activities because of their own fears and anxieties. Seder's findings also confirmed the following hypotheses:

(i) Field dependent subjects have been subjected to coercive or infantalizing child rearing procedures, with great stress upon conformity and authority.

(ii) Field dependent subjects have been submitted to harsh training or aggressive control.

(iii) Parents of field dependent children will have prevented the growth of independent assertive mastery of the environment and the assumption of an adult role.

(iv) Field dependent children have been reared in generally less accepting, warm and permissive homes than the field independent subjects.

(v) Field dependent subjects in general have been reared by less consistent methods than field independent subjects.

(vi) Mothers of field dependent children are anxious and emotional in dealing with their children, and insecure in their own judgements about child rearing.

(vii) Field dependent subjects come from maternally dominated homes, with a passive father providing an inadequate role model for assertive, aggressive behaviour.

4.3 Further Research relating to Psychological Differentiation

Further experiments relating to Witkin's claim of a distinction between the global and analytical approaches and the relationship of these to the concept of differentiation will be dealt with under the following headings, which approximate certain of those used by Witkin et al. (1962):

4.31 Intellectual and verbal skills
4.32 Structuring and articulation of experience
4.33 Articulation of body concept
4.34 Sense of separate identity
4.35 Nature of controls and defences
4.36 Activity
4.37 Sex differences

4.31 Intellectual and Verbal Skills

Witkin et al. (1962), in a factor analytic study, found evidence that aspects of intelligence which involve analytical ability contribute greatly to the over-all relationship between full-scale intelligence and

perception. A number of studies were quoted in further support. It was concluded that:

> " ... there is a general cognitive style which runs through perceptual and intellectual functioning. This finding also suggests that this common cognitive style underlies the observed relation between extent of field dependence and performance on standard tests of intelligence." (Witkin et al., 1962, p. 69).

Creativity, which is linked to field independence by Crutchfield (1963), is not purported to be measured by intelligence tests, yet the evidence suggests that this is what is being tapped. Those subtests of intelligence tests which correlate with analytical ability may well be measuring an important feature of creativity. High verbal scores, which are often taken as the best indicators of general intelligence, may correlate with this and yet not tap the same dimension. The following experiments appear to relate to the problem of creativity, with the experimenters having formulated or discussed their problem in this way in some cases, and in others not.

Guilford and his associates (1952, 1955a, 1955b, 1957) identified a factor, termed "adaptive flexibility", which appears similar to Witkin's analytical factor, and found that tests representing mode of field approach and adaptive flexibility were interrelated. Karp (1963) found that the EFT is partially loaded on such factors as concentration, attention and short-term memory.

Einstellung tests provide further evidence that the ability to overcome contexts is expressed in both the perceptual and intellectual function-overcoming set — which should be a factor in creativity. The relationship of set-breaking, which involves the ability to overcome an established mode of organising elements, to analytical field approach has been established. (Zaks, 1954; Fenchel, 1958; Goodman, 1960). The ability to overcome a personal set also appears to relate to this analytical approach, and Linton (1952) found that field dependence was negatively related to this ability.

Although Witkin et al. (1962) did not attempt specifically to explore the relationship between verbal skills and mode of field approach, some evidence emerged as a by-product of their overall investigation. They found no relation between field approach and "verbal expressiveness", the ability to give extended verbal accounts, or performance on

the vocabulary, information and comprehension subtests of the WISC and WAIS.

They did find, however, that verbal expressiveness tended to be absent in children with a global approach under the pressure of reality conditions with which they cannot really cope. Bing (1963) found that the offspring of parents who had fostered a close and dependent relationship with their children scored higher on verbal performance, whereas those whose parents had fostered independent behaviour scored higher on spatial problems. As Bing did not employ orientation tasks nor explore the concept of field dependence, no clear conclusion can be drawn from this study.

4.32 Structuring and Articulation of Experience

The structuring and articulation of experience is related to perceptual functioning, and the hypothesis presented by Witkin et al. was that children with an analytical field approach would be able to impose structure on a field which lacked it. Although a number of studies were quoted which supported this hypothesis, Witkin's (1954) study did not confirm this expectation for children in relation to specified and limited tests with the Rorschach. Witkin suggested that, as the ability to structure is a process which develops with age, it is difficult to test the ability with children.

Witkin attempted to explain the lack of confirmation of the hypothesis with TAT productions in terms of the idea that the ability to overcome an embedding context in a verbal medium is apparently unrelated to such an ability in a visual medium. Karp (1963) suggested that an alternative explanation may lie in the fact that verbal ability is not loaded on the same factor as the three orientation tests and the EFT. Bing's (1963) study, although not investigating field dependence, may be related and showed how dependent children (and hence perhaps field dependents) may be high on verbal skills. Elliott (1961), who interpreted his results in cognitive rather than personality terms, provided positive support for the structuring hypothesis.

Although Witkin found confirmation of his hypothesis that children with an analytical field approach would show greater cognitive clarity — as measured in terms of their articulation of everyday experiences — he pointed out the limitation of his study in that the interviews yielded information beyond the dimension specified, thus possibly biasing ratings. Partial confirmation of an aspect

of the findings that concerned with awareness of self and others, came from a study by Bieri, Bradburn and Galinsky (1958). These investigators found that women who were relatively field dependent on the EFT used external constructs in characterising others significantly more often that field independent women.

4.33 Articulation of Body Concept

Witkin et al. (1962) stated that:

> "The development of awareness of the 'separateness' of the body has its beginnings in the active exploration of the body and the experiences of being handled, with the attendant kinesthetic, tactual and visual sensations. It depends as much on the exploration of objects other than the body; such exploration, by providing quite different sensations from those generated by handling the body itself, helps sharpen the difference between the 'me' and 'not me'." (Witkin et al., 1962, p. 116).

Employing a scale developed from Machover (1954), where the criteria are based on directly-observable characteristics of figure-drawing rather than the more usual projective interpretations of the drawings, Witkin obtained results which support the hypothesis that extent of articulation of body concept, as reflected in figure drawings, is related to the style of field approach. However, the basis for Witkin's hypothesis has been attacked by Zigler (1963) and Fisher (1964) among others. It has been suggested, for example, that a narcissistic concern with the body could just as logically give rise to an articulated body image.

There is evidence which supports and evidence which contradicts the interpretation that the field dependent has a less articulated body concept, thus the matter cannot be regarded as settled. The results of Epstein's (1957) study are more convincing. It seems reasonable that in the Finger Apposition Test the " . . . ability to maneouver the hands vicariously in one's imagination in order to achieve a particular relationship between them would appear to require a relatively developed conception of the body." (Witkin et al., 1962, p. 130). Epstein found that field independents performed better than did field dependents.

4.34 Sense of Separate Identity

In the research of Witkin and others, the criteria used to judge the individual's sense of his separate identity were (i) his reliance on guidance and support from others, (ii) his maintenance of individual direction in the face of contradicting attitudes, and (iii) his maintenance of a stable view of himself in various social contexts.

As regards the performance of special tasks, Witkin et al. (1962) found a significant correlation between field dependence and extent of reliance on the examiner for task definition and attitude on the TAT. Konstadt and Forman (1965) have since found that field dependent children react with greater anxiety and rely more on guidance from the examiner on a task in which their performance is criticised.

In a real life situation, Fliegel (1955) found that women who had left home were more field independent after a three year interval than those who remained with their parents. Gordon's (1953) study indicated that field dependents tend to view themselves, and to be viewed by others, as socially dependent. Witkin et al. stated:

> "The need for support and guidance felt by people who lack a developed sense of identity, and their reliance on others for a definition of their judgements and self-view, may make such people especially alert to the moods and attitudes of those around them." (Witkin et al., 1962, p. 147).

Beller (1958) found that dependency correlated positively with greater attention to those on whom a subject was dependent. He also found a tendency for girls to be more visually orientated towards the human environment and less towards the physical environment than boys. This is consistent with Witkin's findings of consistent sex differences in field approach.

In line with the overall differentiation concept, Witkin felt that the field dependent would be more susceptible to being influenced by external standards in the formation and maintenance of his attitudes and judgements. Linton (1955) offered support for this, as she found that people with a global field approach tend to adapt their view to conform with the views of others. Feinberg (1951) discovered that women show consistently greater conformity than do men. Rudin and Stagner (1958) and Konstadt and Forman (1965) demonstrated that in experimental situations, field independents are able to maintain a

consistent view of themselves, while field dependents tend to be influenced by the examiner's attitude towards them.

4.35 Nature of Controls and Defences

In a brief review of the relationship of differentiation to problems of pathology, Witkin (1965) cited data which indicated that among people with a global cognitive style were found problems of identity, symptoms associated with dependency, and inadequately-developed controls which resulted in chaotic functioning, passivity and helplessness. This was so with alcholics, ulcer and asthma patients. Taylor (1964) has shown that psychotics who hallucinated were more likely to be field dependent, while delusional psychotics were more likely to be field independent. This finding supported the differentiation hypothesis as delusions have a more logical structure than have hallucinations.

4.36 Activity

Witkin et al. (1962) admitted that the evidence which they presented in support of the hypothesis that an analytical field approach will correlate positively with an "active attitude" of assertiveness or striving was inconclusive. Although there is an overlap in the introversion/extraversion and the field dependent/independent dimensions (Taft, 1958; Petrie, Collins and Solomons, 1960), simply observing the amount of energy output of a given individual over a period of time, or measuring the amount of activity in dream content, as did Eagle (1959), has proved relatively fruitless. Further investigation may attempt to get at the situations in which subjects actually do or change things, or affect people. If activity is defined in terms of actual manipulation of the human or material environment, and not merely a show of doing so, qualitative differences which cannot be measured in quantitative energy output terms may prove enlightening.

4.37 Sex Differences

Witkin et al. (1962, pp. 214-216) reviewed a number of studies with the RFT and EFT which confirm their findings of sex differences for both adults and children, with females being more field dependent than males. Witkin, Goodenough and Karp (1959) demonstrated these differences down to the eight-year-old level. The differences were

also found to apply to groups of English, French, Dutch and Chinese (Hong Kong) subjects as well as to varied socio-economic groups in America.

Sex differences in intellectual tasks requiring the separation of items from embedding contexts, such as Einstellung problems, have also been established. (Witkin et al., 1962). However, differences between the sexes were small compared to the range of individual differences within each sex. This consideration also weakened Hustmyer's (1964) claims regarding genetic differences between males and females which accounted for inter-sex differences in mode of field approach.

4.4 Cross-cultural Differences in Mode of Field Approach

Dawson (1963, 1967a, 1967b) was the first to conduct research into the differentiation hypothesis among unacculturated peoples. He noted several factors among the Temne of Sierra Leone which would encourage the development of the global perceptual style of the field dependent. In particular, he commented on:

(i) The tribal social organisation, which emphasises the values of conformity, authority, harsh discipline, and group reliance. Individual competition is discouraged and deviants from these group norms may be subjected to accusations of witchcraft. Intelligent and outspoken children are subject to the same accusations, and are punished. The individual is thus made to conform to group standards; to be "other-directed" in Riesman, Glazer and Denney's (1963) nomenclature rather than individualistic or "inner-directed". These social processes are likely to develop a global field approach.

(ii) The existence of the polygamous family group, because of which the tribal mother plays a dominant role in the rearing of her children. Dawson felt that the father tends to be an inadequate role model because his numerous wives and children preclude his spending much time with any one "family" group. It is also possible that the role of a man in such a tribal society renders close contact with wife and children impossible. Also, the tribe may be a source of migrant labourers with resultant paternal deprivation. Whatever the reason may be, however, the disciplinary patterns within the tribal Temne family groups are in line with those which, according to Witkin's hypothesis, would produce field dependent individuals.

(iii) The presence of a physiological variable most relevant to research into differentiation among unacculturated peoples:

> " . . . it was thought that the protein deficiency disease Kwashiorkor with its accompanying endocrinal disturbance might be associated with the development in males of a more field-dependent approach. Trowell et al. (1954) has (sic) noted that Kwashiorkor affects the liver which in turn results in a hormonal disturbance involving in males Gynaecomastia (a swelling of the male mammary gland), testicular atrophy, and feminisation. It was also considered possible that male Ss manifesting these endocrinal disturbances might, because of their more feminine traits, tend to develop a field-dependent perceptual style." (Dawson, 1967a, p. 117).

Dawson also commented that there may be a certain amount of interaction between these cultural and physiological variables, as the more feminine Gynaecomastia sufferers may be more susceptible to maternal and social influences.

In contrast to the Temne, the other major tribe of Sierra Leone, the Mende, does not have tribal socialisation processes which predispose its members to field dependence. Mende mothers are not as dominating as Temne ones, nor is individual initiative frowned upon. Because of these known differences in severity of socialisation practices among the Temne and the Mende, Dawson hypothesised that Temne males would be more field dependent than Mende males. He matched two tribal groups, each numbering 49, in terms of age, occupation, education, and intelligence; whilst ocular bias and visual deficiency were controlled. Degree of field dependence was measured by both the EFT (in modified form) and the Kohs blocks, the latter also recognised by Witkin as a valid measure of the field dependence dimension. The hypothesis was confirmed on the EFT, on which Temne males were significantly more field dependent than Mende males. Although the results were markedly in the expected direction on the Kohs Blocks, the difference was not significant. There was, however, a high correlation between the two field dependence tests.

Dawson also found that gynaecomastia sufferers were significantly more field dependent than a normal male Temne group. The former group, however, was rather limited in number (N=10), thus precluding definite statements about the effects of physiological

variables on style of field approach. Another of Dawson's (1967b) findings which is of particular interest at this point is that no relationship was found between performance on the EFT and Kohs Blocks and susceptibility to the Sander Parallelogram illusion.

Dawson's work, however, does not provide any real indication of the degree of field dependence of the Temne and Mende as compared with non-African groups, although the latter would appear more field independent. This is not true of the research of Berry (1966), who compared the performance of unacculturated (traditional) and relatively acculturated (transitional) Temne and Eskimo and urban and rural Scots on the EFT and Kohs Blocks among other spatial tests.

These groups were chosen because the great freedom of Eskimo rearing and socialisation practices are in direct contrast to the severity of those of the Temne, which have already been described. The ecological characteristics of the Eskimo environment, too, differ considerably from those of the Temne. The Scots groups were tested " ... so that the cross-cultural data might be related, through the Scots, to the accumulated mass of Western psychological findings." (Berry, 1966, p. 208). To explore the effects of acculturation, two samples from each society were selected. The traditional Temne and Eskimo groups (N=90 in each) lived in small settlements and had little contact with European culture, whilst the transitional groups (N=30 in each) lived in communities in the process of acculturation. In order to continue the traditional/transitional comparison, the Scots samples consisted of an unsophisticated rural group (N=62) and a sophisticated urban group (N=60). The non-Western groups were matched in terms of age, sex, education and degree of Westernisation.

Berry, using four standard tests of spatial ability, the EFT, Kohs Blocks, Raven Matrices and Morrisby Shapes,[9] investigated five hypotheses concerning spatial skills. He found a large number of significant correlations among these four tests, (all of Western origin), suggesting that they were measuring some characteristic fairly consistently. Each of the five hypotheses, and Berry's findings in relation to it, will be dealt with in turn.

Hypotheses 1: "The Eskimo will score significantly higher than the Temne for comparable degrees of Westernization." (Berry, 1966, p. 215).

9. The Morrisby Shapes Test measures "spatial visualization"; the ability to manipulate perceptual figures mentally. (See Buros, 1959).

The reasons for this prediction lay in the richness of the Eskimo language in geometrical-spatial terms, which aid in the analysis of, and communication about, surrounding space; the advanced arts and crafts of the Eskimo, which are thought to develop observational and spatial skills; and the socialization practices of the Eskimo, which produce individualistic, assertive and venturesome (and, presumably, field independent) adults.

Berry found that "the eight tests of significance which were applied to test this hypothesis were really unnecessary, a great gulf exists between Temne and Eskimo spatial ability . . .". (p. 223). As expected, the performance of the Eskimo group was significantly better than that of the Temne on all four tests.

Hypothesis 2: "Furthermore, the Eskimo scores will more closely approximate the Scottish scores than the scores of the Temne samples of equivalent westernization." (Berry, 1966, p. 215).

This prediction was also confirmed. The Eskimo results more closely approximated the scores of the educated and literate Scots than the scores of the Temne. In fact, the Scots' scores were only significantly better than those of the Eskimo on one of the tests, the Ravens Matrices. Although Berry considered this result to be remarkable, he pointed out that it had been predicted in terms of linguistics, artistic and socialisation practices, and environmental requirements. Witkin (1967, pp. 247-248) feels that adaptive selection may play a role in causing such results. In the case of the Eskimo, " . . . it is conceivable that the highly adaptive value of analytical competence in coping with the world in which they live may have caused selection for this attribute."

Hypothesis 3: "As a result of contact with Western peoples and institutions, the Temne and Eskimo transitional samples will score higher than the respective traditional samples." (Berry, 1966, p. 215).

This hypothesis was confirmed. The transitional, more Westernised groups scored significantly higher than their traditional counterparts on all tests except, in the case of the Temne, the Morrisby Shapes. This was consistent with the expectation that contact with Western life, especially literature, education and cinemas, would tend to change traditional perceptual characteristics and improve spatial skills. Du Preez (1963) raised the possibility that the more psychologically aggressive and hence field independent unacculturated peoples would seek Western contact in order to earn money. His postulate, however, may only hold true for his Xhosa sample.

Hypothesis 4: "Within the six samples, these scores will be significantly related to the level of education." (Berry, 1966, p. 215).

A strong positive relationship between education and spatial test scores was found. These correlations were strongest in the Scots groups and the transitional Eskimo and Temne samples. The traditional Temne group revealed a strong correlation between amount of (Arabic) education and EFT score, while the unacculturated Eskimo group produced consistent negative correlations. This was attributed to the then very recent provision of schooling facilities for the Eskimo, which meant that the youngest subjects, who were less perceptually developed, were the only ones who had attended school.

Hypothesis 5: "Within each sample, those rating themselves as more severely disciplined will score lower than those less severely disciplined." (Berry, 1966, p. 215).

Each subject was asked to rate his treatment while young by his parents as either very strict, fairly strict, or not so strict. Very pronounced differences were found between the Temne, almost all of whom replied "very strict", and the Eskimo, almost all of whom plumped for "not so strict". A more even distribution was obtained for the Scots, the majority of whom chose "fairly strict". It would appear to be true to note that, even if the self-ratings of individual subjects were incorrect, Berry's method did succeed in revealing the most favoured rearing method in each of the three societies. In general, the hypothesis was confirmed.

Berry's results also allowed analysis of sex and age differences. He found that, in the Temne and Scottish samples, men were significantly more field independent than the women, but that there were no significant differences between Eskimo male and female scores. Witkin et al. (1962) attributed the consistent sex differences which they found to the dependent role of women in the Western culture, as well as differences in biological role. Temne men, too, exercise harsh control over their women, but, in direct contrast, great freedom is enjoyed by Eskimo women. This suggests that, in societies in which women are allowed independence, sex differences in mode of field approach will disappear. Analysis of the data for age trends suggested that:

> "... in societies where spatial skills are required, maximum ability is attained between 20 and 30 years of age, but where these skills are not needed, the minimum level of ability already possessed at an early age remains fairly constant and undeveloped throughout life." (Berry, 1966, p. 228).

Berry's study is important because it both successfully related cultural and ecological characteristics to mode of field approach and general spatial skills, and also compared the performances of two individual non-Western cultures and a Western group on tests of field dependence. The Eskimo and Scots results show that certain skills may be developed to similar extents by distinctly divergent societies, and the Eskimo performance gives lie to the oft-held belief that members of non-Western cultures inevitably perform poorly on Western tests. It also confirmed Dawson's (1963, 1967a, 1967b) findings that the socialisation practices of the Temne, which are similar to those of many African tribes, encourage the development of a global mode of field approach.

Wober (1966) noted that some African cultures, including that of the Temne, placed considerable stress on sensory modalities other than the visual:

> "To begin with, among the peoples studied (Nigerians), babies are early in life strapped to their mothers' backs and spend much of their time upright, they learn to walk and even dance extremely early, and dancing and physical expressiveness remain extremely important elements in the activity of the culture. Many West African languages, including those of all the subjects studied, are tonal, and rhythm and tone direction are subjects of elaborated attention, that is, knowledge of subtleties and vigilance over confusions in this field of perception are likely to be well developed. While these are not proprioceived activities, yet they are not visual, and argue for directions of psychological elaboration apart from the visual world." (Wober, 1966, p. 182).

Wober coined the term "sensotype" to refer to the differing importance of sense modalities, by which the child perceives the world and develops his abilities, in different cultures. Because of differing sensotypes among American and African cultures, Wober suspected that a given degree of psychological differentiation might not be so generalised throughout all aspects of an individual's functioning as Witkin's theory suggests. In other words, analytic style in one sense modality may not correlate highly with analytic style in another sense modality. In particular, he felt that the RFT, because it contains a proprioceptive element, was more suitable for testing Africans' degree of field dependence than were the EFT and Kohs Blocks, which

are purely visual tests.

Wober administered the RFT, EFT, Kohs Blocks, Ravens Matrices and certain other tests to 173 Nigerian industrial workers. He found that while there were significant relationships between the scores on the EFT, Kohs Blocks, Ravens Matrices and amount of Western schooling, all of which stress visual analytic ability, there were no significant correlations between any of these test and the RFT results.

In a further study, Wober (1967) administered the RFT and the EFT to 86 Nigerian industrial workers, to test further his argument that the RFT " . . . contains a proprioceptive component which makes it essentially different from tests involving purely visually mediated transactions." His results suggested that this was the case, and that the RFT does not measure the same skills or analytic style as the EFT. Gruen (1955) had produced similar results in her study of American dancers, who, of course, were trained in proprioceptive sensitivity. Wober also found that the Nigerians' performance was below American norms when the task demanded purely visual skills; i. e., when the subject's body was vertical and the display was tilted. When the subject's body was tilted, however, and proprioceptive information became important, the performance of the Nigerians was significantly better than that of Americans. This finding was taken to mean that this was an area of analytic functioning in which African performance equals or excels that of Americans, and Wober points to Beveridge's (1939) finding that West Africans' perception " . . . is guided less by visual and more by other cues than is that of the European."

Because of the conditions under which the RFT was administered, however, if on no other grounds, Wober's findings are suspect. So, for example, light was admitted twice during each testing session when the door of the small hut in which the testing was carried out was opened for ventilation purposes. More important, perhaps, was that when the chair was tilted by placing blocks under two of its legs, according to Wober's sketch, no steps were taken to ensure that the subject's body assumed the same angle as the chair. It may therefore be quite possible that the Nigerians performed better than Americans under conditions of chair tilt simply because their bodies remained relatively vertical. Witkin (1967), although recognising that Wober's hypothesis merits further enquiry, was unwilling to pass judgement on its findings until a validation study had been performed.

He also detailed age and sex biases in Beveridge's (1939) group which could have accounted for the results obtained.

Other evidence comes from Schwitzgrebel (1962), who found that a Zulu sample were more field dependent than a Dutch sample on the Gottschaldt Hidden Figures. Vernon (1965) found that a West Indian sample was more field dependent than an English one on the EFT and Kohs Blocks, and MacArthur (1967) replicated Berry's findings.

The studies by Dawson, Berry, Wober and others, which are discussed above, constitute the direct evidence concerning the mode of field approach of Africans. The general conclusion to be drawn from this evidence is that, given cultural and ecological factors similar to those prevailing in West Africa — which would not appear to be uncommon — the African tends to be more field dependent than the European, although the gap lessens with the African's increasing acculturation. This conclusion, however, must be recognised as being based on fairly limited evidence, and may not be valid for many tribal or sub-tribal African groups. The finding, however, is not unexpected — in the most comprehensive of reviews of African intellectual ability, Cryns (1962) comments that there is general agreement as to the African's weakness in perceptual analysis and manipulation of spatial relations. Cryns' conclusions on the qualitative aspects of African intelligence would seem relevant to the present discussion:

> "White intelligence would be based predominantly on abilities like analytic perception, conceptualization and the manipulation of mathematical and spatial relations. African intelligence, on the other hand, would be of a more concrete and global nature, characterized by syncretic perception and a general lack of abstractive ability." (Cryns, 1962, p. 292).

In a review of research into the traditional personality traits of Africans, Doob (1965a, pp. 388-393) questioned the validity of certain personality tests for use among Africans and commented upon apparent great individual differences, yet the overall picture is one of strong conformity and "tradition-directedness", which would encourage field dependent personalities.

In general, therefore, it would seem justified to conclude that unacculturated Africans are more field dependent than acculturated

peoples. Segall et al. have shown that such Africans are also less susceptible than Europeans to the Müller-Lyer illusion. However, current theory purporting to explain individual differences in susceptibility to the Müller-Lyer illusion in terms of field approach relates illusion-responses to field dependence. A grave anomaly would appear to exist.

5. The Present Study

If the specific is made general, the following statements are supported by the research which has been discussed:

(i) Africans' ability to perceive perspective in pictures increases with degree of acculturation and exposure to Western-type pictorial material.

(ii) Africans are less susceptible than Europeans to the Müller-Lyer illusion.

(iii) Africans do not differ from Europeans in susceptibility to the Perspective Drawing illusion of Segall et al., which is a modified Ponzo illusion.

(iv) The Müller-Lyer and Ponzo illusions are related both in terms of possible perspective interpretations and in terms of the apparent distortion-generating contours.

(v) Susceptibility to the Müller-Lyer illusion is related to field dependence, and lack of susceptibility to the illusion to field independence.

(vi) Africans are more field dependent than Europeans when measured on purely visual tests of mode of field approach.

These statements serve to illustrate an example of the major raison d'être of cross-cultural studies — the testing of the generality of otherwise culturally-bound theories of human behaviour. (Biesheuvel, 1958; Strodtbeck, 1964).

The statements above indicate that the relationship between field dependence and susceptibility to illusion is not universal, and that the Müller-Lyer and Ponzo illusions may not be generated by the same factors. The statements also suggest that, in terms of the perspective-based explanation of the Ponzo illusion, susceptibility to the illusion will increase with the ability to perceive depth in pictures; and, should a mental set be introduced to facilitate a perspective response, susceptibility will increase only among subjects skilled in the interpretation of two-dimensional representations of three-dimensional scenes. The present study is devoted primarily to a consideration of these premises.

5.1 The Method of Study

This study demanded careful attention to metho-logical considerations and selection of groups of subjects. In essence, it involved exposing White and Xhosa groups to measures of field dependence and susceptibility to the Müller-Lyer and Ponzo illusions.

The essential requirement of any subject on a Müller-Lyer or Ponzo illusion task is that he make a judgement of the relative length of two lines. On the Rod-and-Frame Test, the popularly-used measure of field dependence (Immergluck, 1968a), the task is to set a rod to the true vertical. Both of these tasks demand that the subject have an elementary grasp of geometrical spatial concepts, yet investigators such as Biesheuvel (1958) have commented upon the difficulties Africans experience in manipulating spatial relations. Page (1965), after testing 133 Zulu youths from urban and rural locations on Paiget-type tests, suggested that not only was their acquisition of spatial concepts considerably slower than the European norms, but that "merely getting older (did) not guarantee the acquisition of seemingly elementary notions of space." Whereas education had an initial stimulating effect, there was little further development, and urban residents did not perform very much better than rural Zulus.

A prime task in the present study, therefore, was that of ensuring that every subject understood the concepts which underlay the experimental tasks.

It has been noted that Segall et al. took stringent measures to prevent failures of communication with their subjects, and to detect cases in which it had occurred despite their precautions. In the present study, the comprehension checks, the task worksheets,[10] and the experimental tasks and apparati were designed in such a way that inadequacies in communication became apparent immediately.

As far as possible, the tasks were developed to meet Reuning's (1963) ideal conditions of cross-cultural testing, which indicated that

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10. The Task Worksheets in Appendix Three follow those developed by Page (1965), which are based on the Branching Programmes or "Teaching Machine" education. Instructions are given to the subject, and his responses determine the next in a series of instructions. Each comprehension and experimental task has a worksheet, thus standardised instruction for all subjects is assured.

tests should be understandable without verbal explanation and should invite action; and that the subject's whole response should be in terms of that action, rather than in terms of verbalisation which has to be back-interpreted. For this reason, subject-adjustable apparati were preferred to the Herskovits-type format. Apart from the former type of apparatus providing easily-measurable quantitative data, it also renders it simple to detect and counter lack of understanding, lack of motivation, and guessing. Another important advantage which this type of equipment has is that it demands attention to the visual display for some time while settings are made, and this serves to counter the tendency of certain groups, as noted by Morgan (1959) and others, to glance at the Herskovits et al. figures and make "snap" judgements.

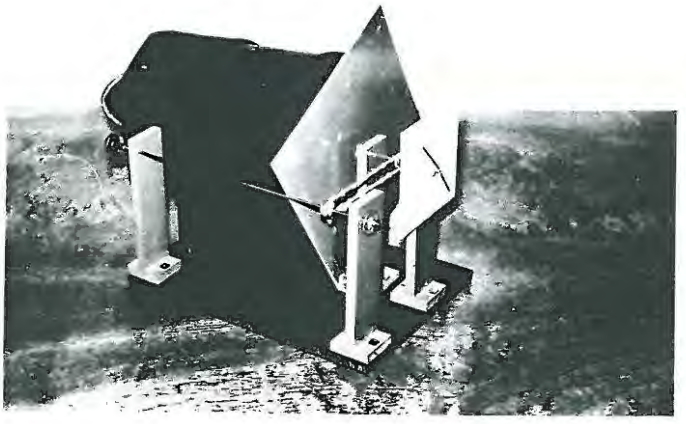
5.11 The Rod-and-Frame Test

The Rod-and-Frame Test (RFT) was chosen as the measure of mode of field approach since it would seem to be the most suitable of such measures for use among unacculturated African groups. The only practical alternative measure is the Embedded Figures Test (EFT), which in its standard form, incorporates culture-specific geometrical shapes.

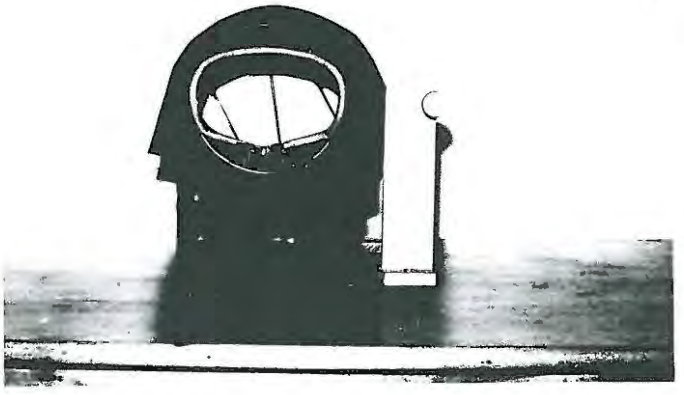
The RFT measures the subject's ability to perceive the true vertical within a limited and distracting visual field. As used by Witkin and his associates, the apparatus consisted of a luminous square frame and a luminous rod, both pivoted at the same centre but each capable of moving independently of the other. The test was administered in a dark room, so that only the frame and rod were visible. Three series, each of eight trials, comprised the standard test. These series involved the subject being asked to set the rod to the true vertical when (i) he (in a special chair) and the frame were tilted 28° to the same side; (ii) he and the frame were each tilted 28° to opposite sides; and (iii) he remained erect but the frame was tilted 28° to right or left. Witkin found that in a relatively field dependent performance, the rod was adjusted close to the axes of the tilted frame, while the field independent performance was relatively unaffected by the frame tilt and therefore more accurate.

Witkin (1967, p. 247) noted that " ... the size of the apparatus needed and the requirement that it be conducted in a light-proofed dark room have made it difficult to use the rod-and-frame test, one of the best tests of field dependence, in the kinds of settings in which cross-cultural research must often be done." Because of this, a portable

(a) Three-quarter rear view of RFT apparatus, showing adjustment mechanism and deviation indicator (on white square).



(b) Front view of RFT apparatus, with parts of the Rod and Frame visible through the viewer.



(c) Side view of RFT apparatus, showing the gap between the display and the tubes which allowed illumination of the Rod and Frame.

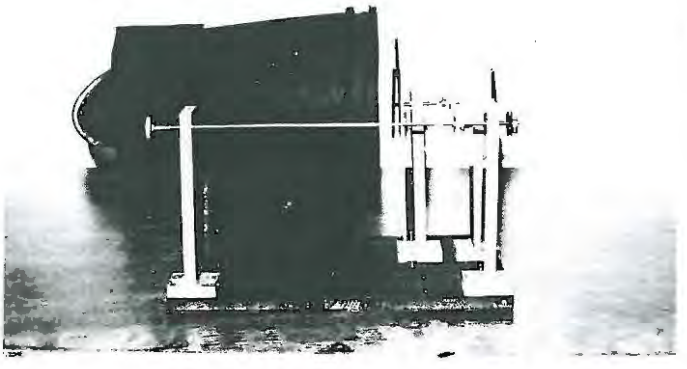


Figure 14 (a), (b) and (c). The Portable RFT Apparatus

unit which could be used under ordinary daylight conditions was developed in Witkin's laboratory. The reliability and validity of this piece of apparatus were found to be highly satisfactory. Morris (1967) developed a similar portable RFT, also found to be valid and reliable, which she described fully. The dimensions of this "Rod-and Frame Box", which are fully detailed in available sources, were used in the development of the portable RFT apparatus employed in the present study. Morris' complicated apparatus for illumination was avoided in the present apparatus by positioning the rod and the frame at the end of a tapered circular tube which did not provide verticality cues, but which permitted natural lighting to be used.

Figure 14 illustrates the RFT apparatus, while Appendix Nine provides full details of its dimensions and construction. The subject, with his head positioned in the viewer, could see only the circular interior of the instrument and the rod and frame. He adjusted the rod to a position which he judged to be vertical by turning a round adjustment knob with his right hand. As is detailed in the Worksheet for Task 2 and the Individual Record Form (Appendix Four), each subject performed 20 trials, 10 with the frame tilted 28° to the right and 10 with the frame 28° to the left. The method employed by Witkin was used, the rod being set between 41° and 50° to the right and left of the true vertical by the experimenter before each trial. (See Appendix Four.)

Prior to starting the 20 experimental trials, each subject performed two "practice" trials; the purpose of which was to test whether the subject had fully understood the task requirements. In addition, relatively unacculturated subjects performed a comprehension task before the experimental one. (See Worksheet for Task 1, Appendix Three). By successfully setting a rod pivoted in the centre of a plywood square to the vertical in various conditions of square tilt, the subject indicated that he understood the concept of verticality, or "straight up to the sky".

The subject's score for the RFT was his mean absolute error in degrees, read off a protractor at the rear of the apparatus, for the 20 trials. Witkin et al. (1962) noted:

> "There are a number of possible alternative scoring methods for the RFT .... For example, the mean error in the direction of the tilt of the frame has been used by some workers instead of the absolute error. These alternatives may be useful for specific

> research problems, but we have not found a scoring method that has greater construct validity as a measure of field dependence than does the absolute error." (Witkin et al., 1962, p. 37).

5.12 The Müller-Lyer Illusion Apparatus

The subject-adjustable form of the Müller-Lyer illusion apparatus, used in this study to measure susceptibility to the illusion, was housed in a rectangular box. (See Figure 15 and Appendix Ten for full details of its dimensions and construction.)

The composite form of the Müller-Lyer figure was used, with 1mm. gaps at the junctions of the standard and variable lines and the context lines. As the standard instruction was "make the lines the same length" (See Worksheet for Task 4), these measures facilitated communication of the task. The method of average error was used in the way detailed by Guilford (1954), 10 trials being performed on each of two lengths of the standard line, 8cm. and 12cm. Before each trial, the experimenter set the variable line to a predetermined length (See Appendix Four), and the subject matched it with the standard line by rotating the adjustment knob to the right of the box. Readings were taken to the nearest millimetre from a measure on the back of the variable slide.

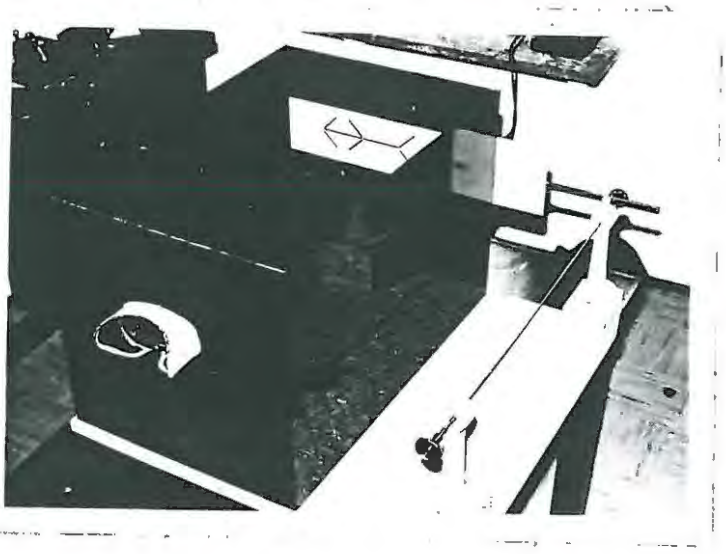
The subject's mean deviation from the length of the standard line served as his score for each of the two series of 10 trials. The mean absolute error was not used as the task was not one of measuring the subject's ability to judge the length of two lines, but rather one of ascertaining the extent to which the illusion-generating contours caused him to exhibit illusion-produced responses.

The comprehension check for the Müller-Lyer task was designed to reveal whether the individual understood the concept of equal length, and involved matching plywood rods of varying lengths. (See Worksheet for Task 3). It was administered only to the relatively unacculturated groups of subjects.

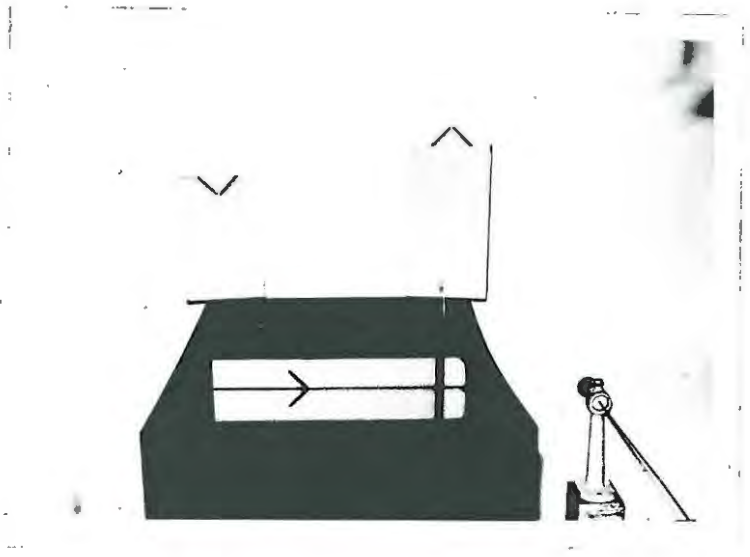
5.13 The Ponzo Illusion Apparatus

The Ponzo illusion apparatus was designed as a means of measuring both susceptibility to the illusion and the effect of the introduction of a "perspective set" on susceptibility to the illusion. The

(a) Three-quarter front view of the M-L apparatus, showing the stimulus figure at the 8cm. standard setting, the viewer, and the adjustment mechanism.



(b) Front view of the display, with the slides used to vary the lengths of the standard and variable lines removed and resting on the top of the M-L apparatus. Their shapes and arrowheads are clearly visible.



(c) Three-quarter rear view of the M-L apparatus, showing the measure on the variable slide.

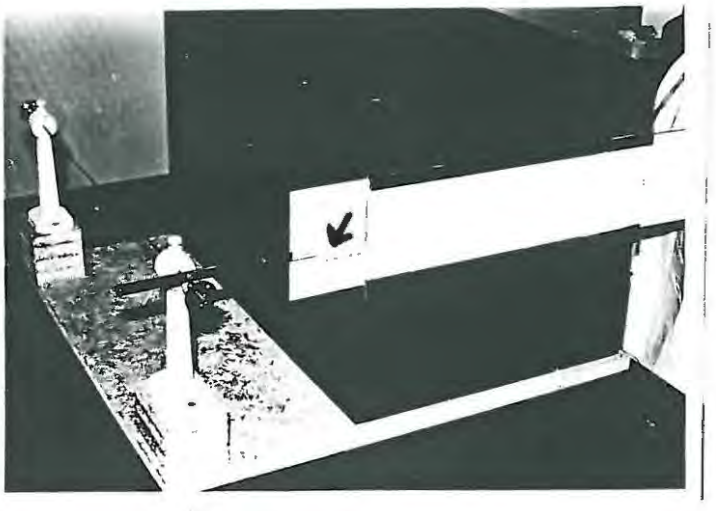


Figure 15 (a), (b) and (c). The Müller-Lyer Illusion Apparatus

apparatus consisted of an oblong box, with a viewer and adjustment knob at one end and a slide holder at the other. (See Figure 16 and Appendix Eight for details of construction and dimensions).

The contrast lines of the Ponzo illusion were embodied in three forms, each of which was mounted on a perspex slide. The conventional Ponzo diagram was drawn in black ink on white paper, while the other two slides represented a bridge viewed in perspective. (See Figure 16). One was a photograph of the bridge, the other a black-on-white line-drawing emphasising perspective cues and the similar inverted-V shape of the Ponzo figure and the edges of the bridge. In all three slides, the standard upper horizontal line was 2cm. long and 2mm. wide, while the length of the lower one, which was also 2mm. wide, could be varied from zero to four cm. by turning the adjustment knob positioned under the viewer.

Subjects performed either two or four series of 10 trials, depending on whether the "perspective set" was introduced or not. (See 5. 15 for procedure). The method of average error was used, and, as for the Müller-Lyer task, a subject's score for each series was his mean deviation from the length of the standard line. The experimenter set the variable line to a position between 0cm. and 4cm. before each trial. (See Appendix Four).

The comprehension check for the Ponzo task was the same as that for the Müller-Lyer one. The relatively unacculturated subjects matched rods of varying lengths, thereby demonstrating that they understood the concept of equal length. (See Worksheet for Task 3).

5. 14 The Pilot Study

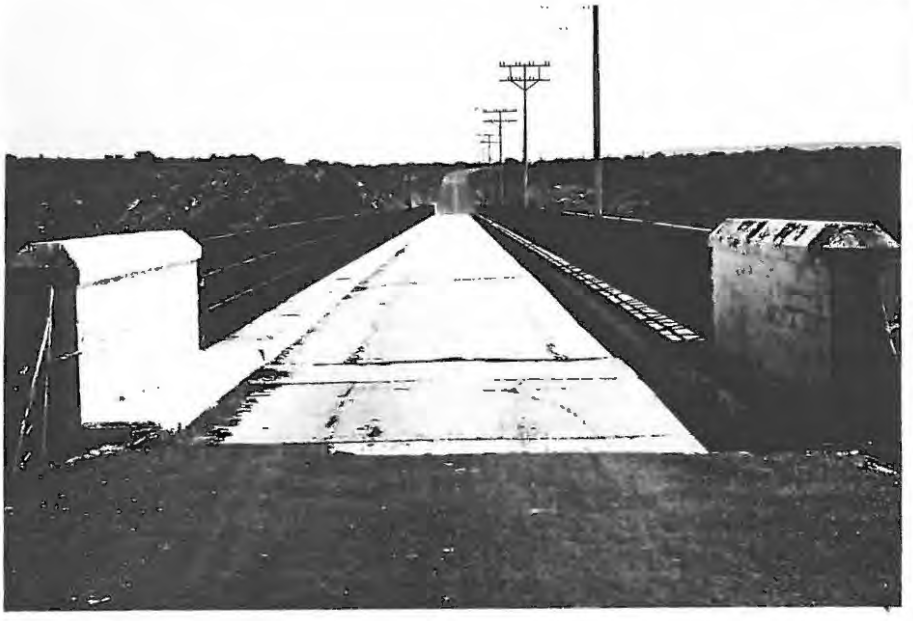
The designs of the RFT, Müller-Lyer, and Ponzo apparati and worksheets were evaluated in a study of the responses of three small groups of scholars.[11] The groups (European primary scholars aged 10 to 12, Xhosa primary scholars aged 12 to 14, and Xhosa secondary scholars aged 17 to 19) each numbered eight, and were selected to reveal both cross-cultural and possible age trends.

Prior to the study, two trained Xhosa interpreters developed suitable Xhosa translations of the English-worded worksheets. The

11. The effects of two "movement" illusions, the Rotating Trapezoidal Window (See Appendix Two) and the Kinetic Visual Display (See Appendix Six) were also investigated in the pilot study, but were excluded in the present study for technical reasons.

(a) Three-quarter front view of Ponzo apparatus, without a stimulus slide.

(b) The photograph which was used as a stimulus slide to embody the Ponzo horizontal contrast lines and introduce the "perspective set".



(c) The "perspective" photograph stimulus slide in position in the Ponzo apparatus.

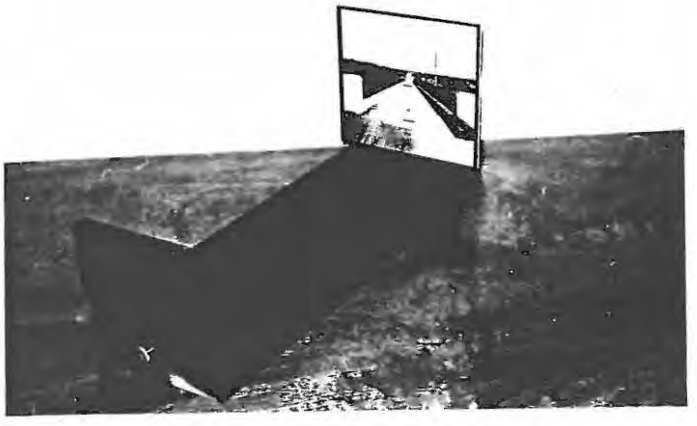


Figure 16 (a), (b) and (c). The Ponzo Illusion Apparatus

experimenter also acquainted himself with the standard Xhosa instructions. The subjects' visual acuity and stereoscopic vision were tested by means of the Bausch and Lomb Master Ortho-Rater. (See Appendix Five).

The administration and results of the pilot study suggested that:

(i) Field dependence scores were influenced by age and level of education, as the secondary Xhosa scholars recorded the lowest RFT scores. This is consistent with Witkin's hypothesis. However, the European primary group was less field dependent than the older Xhosa primary group of equivalent educational level. The intergroup differences were not statistically significant.

(ii) Field dependence was related to susceptibility to the Ponzo illusion ($r_s = \cdot 56$, $p = \cdot 01$), but not to the other illusions. There was, however, a strong positive relationship between the Ponzo and Müller-Lyer illusions.

(iii) There were no significant inter-group differences in susceptibility to any of the illusions.

(iv) Although the small number of subjects precluded statistical analysis, the introduction of the perspective set increased susceptibility to the Ponzo illusion considerably, while non-exposure to the "perspective" slides resulted in decreased susceptibility to the illusion on the second set of 10 trials.

(v) Because communication of the RFT task proved difficult in some cases, this task should be performed last of all. By the time they attempted it, subjects were at ease and familiar with the general operational principles of the experimental equipment. Since the Müller-Lyer task had to be done either immediately before or immediately after the second set of Ponzo diagram trials, it was considered that the experimental tasks were best administered in the following order:

Ponzo diagram (10 trials)
Ponzo photograph (10 trials)
Ponzo drawing (10 trials)
Ponzo diagram (10 trials)
Müller-Lyer (2 series of 10 trials)
RFT (2 series of 10 trials)

Those subjects who were not exposed to the perspective set of the photograph and drawing forms of the Ponzo performed the Müller-Lyer task in the place of these. As pre-selection and matching of experimental and control groups for this part of the study would be impracticable under field conditions, every alternate subject was exposed to the set-facilitating Ponzo slides.

(vi) It was necessary to keep the number of trials and series to a minimum. As Jahoda (1966, p. 194) noted, "the tolerance of illiterates for a strange task, whose purpose is obscure, is limited; unless one has some special claim on their co-operation, fatigue and boredom set in fairly soon and the performance then becomes perfunctory." While the initial number of trials on the RFT was 40, and 50 were used on the Müller-Lyer, 20 trials for each of these tasks were adopted during the course of the pilot study to combat the obvious boredom of the subjects.

(vii) The Ortho-Rater, while providing accurate measures of visual skills, was extremely difficult and time-consuming to use with semi-literate subjects. Accordingly, it was decided to use a wall-chart with E-shaped figures to test visual acuity in the present study.

These considerations shaped the final form of the study. The equipment and administration, recording and scoring procedures for the RFT, Müller-Lyer and Ponzo tasks, and the order of their presentation, were employed as described.

5.2 The Subjects

The study involved using suitable groups as organismic independent variables, in order to assess the influence of acculturation on the responses to certain tasks. This necessitated that groups at relatively distinct stages of the acculturated/unacculturated continuum be used as subjects. As the investigation was a cross-cultural one, the performance of a sophisticated European undergraduate group served as a standard, relative to which the performances of three groups of Xhosa at differing levels of acculturation could be evaluated. The relative acculturation levels of the Xhosa groups were judged by two major criteria; level of education and amount of contact with Western urban life. This resulted in the selection of three Xhosa

groups; undergraduates, urban dwellers, and rural dwellers, who ranged from acculturated to relatively unacculturated respectively. Since the visual environment of the Ss is another important consideration in research concerning illusions, a certain amount of comment on ecological factors is included in the description of these groups below.

5.21 The Xhosa Rural Group

The 30 male subjects comprising the Xhosa Rural (XR) Group were all members of the Xhosa ethnic group and hailed from the village of Tyamara (See Figure 17), which is situated in the Ciskei area approximately five miles north-east of the small town of Alice. Tyamara is in most respects a typical Ciskei village, sprawling along the crest of a hill overlooking the undulating countryside which is characterised by sparse thorn trees and scattered hill-top villages. (See Figure 17a). Approximately 15 miles to the north and west relatively high and well-wooded mountain ranges are visible. There are no stretches of open water. There are few roads in the area, and they are narrow, winding and often ill-defined.

The inhabitants of the village, estimated by a Government-appointed enumerator to number approximately 1,000, live for the most part in the traditional thatched-roofed, earthen-walled circular huts with roughly rectangular openings to serve as doorways and windows. These huts are often sketchily ornamented with white paint or clay. It was noteworthy, however, that the majority of the newer huts and of those in the process of being erected were rectangular in shape and constructed of sun-baked clay bricks and galvanised-iron sheeting. (See Figure 17b). European-style furniture seemed limited in most cases to rudimentary benches, tables and beds.

The internal affairs of the village are administered by an elected Headman and the older men sitting in council. The majority of the villagers engage in animal husbandry and the cultivation of root and cereal crops. A fair proportion of the men and a small number of the women are employed as labourers and domestic servants on surrounding farms and in the town of Alice itself.

Perhaps due to the very active early nineteenth-century missionary influence, which is still strong in this area, most of the inhabitants would be classified as "School" rather than "Red" Xhosa according to Mayer's (1961) dichotomy. Indeed, Tyamara boasts a

(a) The village of Tyamara and the countryside around it.

(b) Huts in Tyamara. Note the rectangular iron-roofed hut among the traditional thatch-roofed circular ones.

(c) The rondawel at the A.I.C.A. seminary in which the XR subjects were tested.

Figure 17 (a), (b) and (c). The Village of Tyamara and the testing location for the XR Group

European-type higher primary (up to 10 years of schooling) school, and is by no means unique among the area's villages in this respect. Somewhat to the experimenter's surprise, the mean scholastic standard attained by the Tyamara subjects (5.3 years of schooling) was approximately the same as that of the urban Xhosa group. In terms of visual environment and degree of acculturation, however, an obvious distinction was apparent between the two groups.

As the initial arrival of the experimenter in the village occasioned the disappearance of most of the inhabitants, the Headman agreed to appoint a "recruiting officer" who assembled the required number of Ss at the required times. Of these Ss, 19 had never been employed outside the village, 3 were scholars at the local school; 7, although unemployed at the time at which they were tested, had worked at some time as labourers and handymen in Alice; and 1 subject had been a driver in Port Elizabeth, a large city some 140 miles from Tyamara. The Ss were told that the aim of the study was to compare the visual acuity of town- and country- dwellers, and that it was expected that their vision would be superior to that of townfolk. The ages of the Ss ranged from 17 to 48 years, their mean age being 23 years. All were paid R1 after they had been tested.

These Ss were tested in a rondawel at the African Independent Churches Association (AICA) Seminary in Alice. This rondawel, one of a number of similar structures constituting the living quarters of the Seminary students, was built in the traditional circular shape of Xhosa huts and had a thatched conical roof, but was constructed of brick and mortar, had rectangular windows and door, and was supplied with electricity. (See Figure 17c). Interior furnishings included steel lockers, tables, chairs and a bed. The interpreter for this group, all of whom were instructed in Xhosa, also interpreted for the urban Xhosa Group. All testing was carried out between the hours of 8.00 a.m. and 5.00 p.m., which meant that adequate natural illumination was available, although an electric light was positioned to provide supplementary lighting.

5.22 The Xhosa Urban Group

The 30 male Ss comprising the Xhosa Urban (XU) Group were all members of the Xhosa ethnic group who had been either born and raised or had spent most of their lives in the Grahamstown area. This small city lies in a hollow surrounded by hills.

The African inhabitants live chiefly in townships in dwellings which are for the most part crudely constructed of galvanised-iron sheeting and earth, although many newer houses are built of brick-and-mortar. With few exceptions all the houses are rectangular and furnished with European-style furniture. The layout of the townships is predominantly rectangular, and there are wide, long streets despite the overcrowded slum conditions.

As there is little industrial activity in Grahamstown, unemployment is rife among the African inhabitants, and their socio-economic status compares unfavourably with that of Africans in more industrialised centres. In terms of Mayer's (1961) perhaps over-simplified classification, the Xhosa in Grahamstown fall into the "School" rather than the "Red" category. Although observation suggests that the schools in the locations are overcrowded and lack adequate facilities, education up to the university entrance level is available. As Grahamstown is also a centre of religious education, certain Churches also have a strong influence. Traditional practices, however, such as the circumcision ceremonies which initiate the youths into manhood, are still widely observed. In short, while the XU Group of Xhosa were distinctly more acculturated than the XR Group, they did not display the effects of acculturation to more than a moderate degree.

The Ss comprising this group were obtained from two sources. Eighteen of the Ss were unemployed, and were recruited at the Municipal Unemployment Office which is supervised by the Assistant Location Superintendent. A measure of pre-selection was applied in terms of age and obvious visual and bodily infirmity, otherwise these Ss were selected on a "first-come, first-served" basis. Of these 18, 12 had been employed in unskilled jobs, such as labourers and gardeners, while 6 had worked in semi-skilled-type positions, such as drivers and waiters. The remaining 12 Ss in the XU Group were employed by Rhodes University as messengers. It was considered that their inclusion served to complement the unemployed group so that the XU Group as a whole would constitute a sample not atypical of the male Xhosa inhabitants of Grahamstown in terms of education, experience and socio-economic status. The ages of these Ss ranged from 20 to 48 years, the mean age being 29 years. Years of schooling ranged from zero to ten, the mean being 5.5 years.

This Group was tested between 9.00 a.m. and 6 p.m. in a small room in the Department of Psychology at Rhodes University. Adequate illumination was provided by artificial sources. Those 12

Ss employed by the University were instructed in English by the experimenter, while the remaining 18 were instructed in Xhosa by the interpreter who also assisted with the XR Group.

5.23 The Xhosa Student Group

The 30 male Ss comprising the Xhosa Student (XS) Group were members of the first-year Psychology class at the University of Fort Hare, which is situated in Alice. Students at this University are all of the Xhosa ethnic group, although the language of instruction is English.

It was not intended that this group be matched with the group of White students, for as Biesheuvel (1952) has pointed out, such an attempt, if not impossible, would be equivocal. The Fort Hare students, however, constituted a readily accessible acculturated Xhosa group.

Twenty-five Ss of this group came from major cities or large towns in South Africa, chiefly Port Elizabeth, Kimberley, East London and Johannesburg. Although it is expected that they would live in the African townships in these cities, they would have been thoroughly exposed to the visual environments of large urban communities. This would also be true, although to a lesser extent, of the remaining 5 Ss, four of whom hailed from the Transkei and 1 from the Ciskei. Although the tertiary education of most of these Ss is subsidised by scholarships from various funds and official bodies, the very fact that they are at university places them in an above-average socio-economic category relative to the majority of other Africans.

Of the 32 first-year Psychology students, 30 took part in the study, while one opted out of participating and one acted as a reserve S. The 31 students who volunteered to be tested were all paid R1.00. The ages of these Ss ranged from 19 to 28 years; the mean age being 22. None of them had prior knowledge of the visual illusions.

Testing was conducted between 8 a.m. and 5 p.m. in a small room in the Department of Psychology at the University of Fort Hare. Natural and artificial illumination provided satisfactory lighting. Instructions were given by the experimenter in English; in which all the Ss were fluent.

5.24 The White Student Group

The 30 male Ss comprising the White Student (WS) Group were

members of the first-year Psychology class at Rhodes University, Grahamstown. They were arbitrarily selected from a large number of volunteers, none of whom had prior knowledge of the visual illusions.

Nineteen Ss in this Group came from major cities in South Africa and Rhodesia, chiefly Port Elizabeth, East London, Salisbury and Bulawayo, whereas eleven hailed from smaller towns and cities in these two countries, including two from Grahamstown itself. Although all these subjects were in their first year at university, their mean age was 20, indicating that many had completed their military service or had been in employment before embarking on their tertiary education.

These subjects were tested in the Department of Psychology, Rhodes University, under the same conditions as the XU Group. They were instructed in English by the experimenter, and paid R1.00 for their participation.

5.25 Summary of Experimental Groups

A summary of the most important considerations for the four groups of subjects follows in tabular form:

Group	XR	XU	XS	WS
n	30	30	30	30
Sex	Male	Male	Male	Male
Ethnic Group	Xhosa	Xhosa	Xhosa	European
Mean Age (Yrs.)	28	29	22	20
Age Range (Yrs.)	17-48	20-48	19-28	18-23
Mean Schooling (Yrs.)	5.3	5.5	12.5	12.5
Schooling Range (Yrs.)	0-10	0-10	-	-
Domicile	Tyamara	Grahamstown	Various	Various
Place of Testing	AICA Seminary	Rhodes University	University of Fort Hare	Rhodes University
Language of Instruction	Xhosa	Xhosa/ English	English	English
"Carpenteredness" of Environment	Low	Moderate	High	High
Degree of Acculturation	Low to Moderate	Moderate	Moderate to High	High

5.3 The Analysis of The Results

The manner in which the RFT, Müller-Lyer and Ponzo tasks were scored has been described. The raw data which were used in the compilation of group scores is provided in the tables in Appendix Eleven.

The raw scores in all series of each experimental task were used in the analysis of results, as there were no differential weightings or other considerations requiring the use of standard scores. Group results are expressed as the arithmetic means of the individual scores, and variability measured by their standard deviations.[12] Means were preferred to medians since extreme responses were rare.

The possible significances of intergroup differences in the performances of three or four groups on particular experimental tasks were assessed by one-way analyses of variance. If the intergroup variance was significant at the five percent level, *t*- tests were used to determine between which groups the significant differences lay. McGuigan (1968), while owning that the above method is satisfactory for the statistical analysis of a multi-group design, prefers the use of Duncan's Range Test. As computer facilities were available for the one-way analysis of variance procedure, however, its application was the easier and less time-consuming of the two. *t* was calculated from the standard formulae for dependent or independent observations.

These methods of analysis were used to determine the possible significance of inter-group differences on the experimental tasks or the performance of a particular group on two series of the same task. The Ponzo illusion task concerned the effect of the introduction of a "perspective set" on susceptibility to the illusion, thus pre-set and post-set scores were obtained. Although one is tempted to use a raw change score with readings of the "before and after" kind, Cronbach and Furby (1969) have shown that if such scores are obtained by subtracting one of these pre- and post-set scores from the other, fallacious conclusions may result, and that there is no need to use change scores. If one is testing the null hypothesis that the "perspective set" treatment has no effect on susceptibility to the Ponzo illusion, the essential question is whether the pre-set and post-set

12. See Appendix Seven for the statistical models underlying the programmes of the Hewlett-Packard 9100 B computer used to calculate means and standard deviations, one-way analyses of variance, and regression analyses.

scores vary significantly.

To ascertain the possible significance of relationships between two variables, such as mode of field approach and susceptibility to the Müller-Lyer illusion, Chi square was used in 2 x 2 contingency tables with one degree of freedom. As conditions precluded the prior setting of criteria to provide discrete groups of field dependents and field independents, or subjects who were susceptible to illusion and those who were not, or groups based on age or education, the medians for ungrouped data were used in all such cases to provide suitable dichotomies.

The standard formula for Chi square was used, with attention being given to the precautions laid down in Chapter 12 of Spiegel (1961). Since 2 x 2 contingency tables were used, the tetrachoric correlation (r) was employed to describe the correlation of the attributes.

6. Results, Discussion, and Conclusions

In discussing the results of the present study, each separate experimental task is analysed before the evaluation of the intertask associations. The tables of the raw scores of the subjects in each of the Xhosa Rural (XR), Xhosa Urban (XU), Xhosa Student (XS), and White Student (WS) groups are contained in Appendix Eleven. The statistic used to indicate group performances is the average mean deviation, as a subject's raw score on the RFT and the illusion tasks was his mean deviation in 10 or 20 trials from the vertical (on the RFT) or the length of a standard stimulus line (on the illusion tasks).

6.1 The Ponzo Illusion Tasks

6.11 The Ponzo Illusion Diagram

Intergroup comparisons of the average mean deviations on the conventional Ponzo figure reveal a trend towards susceptibility to the illusion increasing with degree of acculturation. The data in Table 1 illustrate this trend, but reveal a minor discrepancy in that the XS group were slightly more susceptible to the illusion than the WS group.

TABLE 1

Susceptibility to the Ponzo illusion:
average mean deviations[+] from 2cm. standard.

Group	Xhosa Rural	Xhosa Urban	Xhosa Student	White Student
Mean	.051	.075	.122	.111
S. D.	.110	.105	.110	.123

[+] Expressed in cm., $n_i = 30$

A one-way analysis of variance of the scores of the three Xhosa groups revealed a significant intergroup variance ($F = 3.22$, $p < .05$), which Table 2 shows lay between the most and least acculturated Xhosa groups.

TABLE 2

Group-to-group comparison[+] of average mean deviations from 2cm. standard of Ponzo illusion.

Group	Xhosa Rural	Xhosa Urban	Xhosa Student	White Student
Xhosa Rural	-			
Xhosa Urban	1.046	-		
Xhosa Student	2.491*	1.498	-	
White Student	1.981	1.045	0.340	-

*$p < .05$

[+] t's

These results fit the Perspective theory of illusions and the Carpentered World hypothesis.[13] As the extent of exposure to the materials and informal training which are thought to facilitate the acquisition of depth-perception skills in a Westernised environment grew, so did the groups' susceptibility to the illusion. Hudson (1962a) noted that 87% to 95% of the African subjects whom he tested on his depth perception test failed to identify two converging lines, similar to the Ponzo context lines, as representing a road extending into the distance, and it may be assumed that a large preportion of the unacculturated Xhosa subjects had not developed this inference habit. In terms of ecological cue validity, the visual environment of the least acculturated (XR) group, as it was almost completely lacking in well-defined straight roads, etc., would not demand the acquisition of such a perceptual habit.

This explanation is supported by a marked but not significant tendency for the better-educated subjects in the XR group to be more susceptible to the illusion than their less-educated counterparts. This was not found among the XU subjects, although there was a slight tendency for susceptibility to the illusion to be related to increased age in this group. (See Table 3). (The limited age ranges and uniformity of educational level of the two student groups precludes analysis of age and education trends.)

13. Although, in fact, Segall et al. did not find significant intergroup differences in susceptibility to their "perspective drawing" illusion, this has been attributed to its physical construction. (Doob, 1965a).

TABLE 3

Associations[+] of age and level of education with susceptibility to the Ponzo illusion in non-student groups.

Group	Xhosa Rural	Xhosa Urban
Age	.000	.134
Level of Education	.267	.077

[+] Tetrachoric correlation

The associations of age and level of education with susceptibility to the illusion may have been more marked had there not been a tendency for the younger subjects to be the better-educated. If education increases susceptibility to the illusion by exposing individuals to printed materials, so may simple informal exposure to man-made artifacts. While the younger subjects were more educated than the older ones, the latter would obviously have had greater and longer exposure to man-made environments. Age and level of education would therefore operate against each other and possible relationships would be obscured.

6.12 The Photograph and Drawing embodying the Ponzo Illusion

To ascertain whether susceptibility to the Ponzo illusion would be influenced by the introduction of a mental set which facilitated the perception of perspective in the Ponzo figure, a photograph and line-drawing of a bridge, which embodied the Ponzo contrast lines in strong perspective elements, were introduced to half the subjects in each group. While the investigation was aimed primarily at a comparison of their pre- and post-set scores, the photograph and drawing tasks in themselves produced some interesting results.

An inter-group comparison of the mean average deviations on the Ponzo photograph task reveals one rather discrepant result.

TABLE 4

Susceptibility to the Ponzo illusion diagram and photograph: average mean deviations from 2cm. standard.

Group	Xhosa Rural	Xhosa Urban	Xhosa Student	White Student
Diagram	.057	.105	.095	.087
Photograph	.019	.272	.104	.127

[+] Expressed in cm., $\underline{n}i = 15$

As shown in Table 4, the susceptibility of the XU group to the photograph form of the Ponzo illusion was considerably more than that of the other groups. During the course of testing, it was found that approximately one-third of the XU subjects exhibited indecision when required to perform the photograph task, despite its similarity to the diagram one. Typically, these few subjects, on the first trial, adjusted the length of the variable line back and forth in an apparently aimless manner, until suddenly making a judgement and indicating that the contrast lines were the same length. Although this judgement was fairly constant for the remaining nine trials, it invariably involved the variable line being made considerably longer than the standard one. These subjects were questioned to ensure that they were not attempting some sort of size-constancy judgement, but were adamant that their matching was correct and that the actual lengths of the contrast lines were the same.

This response pattern was not encountered in any other group or task. It may have resulted from an inadequate grasp of pictorial depth perception principles, in that the perspective elements in the photograph were recognised and responded to, but in an exaggerated way since skill in interpreting pictures was not fully developed. A more simple explanation would be that the task instructions were inadequate, but this does not explain the reason for this response pattern occurring only in one group and on one task. Whatever the reason, the high XU average mean deviation meant that this group was significantly more susceptible to this form of the illusion than both the XR group ($\underline{t} = 3.398$, $\underline{p} < .01$) and the XS group ($\underline{t} = 2.199$, $\underline{p} < .05$). There was no other significant intergroup variance.

If the XU results are excluded, Table 4 shows that the acculturated groups were more, and the unacculturated group was less, susceptible to the photograph than to the Ponzo diagram. These results are explicable in terms of pictorial depth perception, particularly since, in the development of the Ponzo apparatus, it was found that a Ponzo diagram with context lines angled at 110° (the angle between the edges of the bridge in the photograph) generated very little illusory effect, thus a 55° angle was used for the diagram in the present study. If they lacked depth perception skills, as would seem probable, the XR subjects' sharp drop in susceptibility may have been caused by their perceiving the edges of the bridge simply as context lines angled at 110°. The acculturated groups, however, were susceptible to the perspective cues of the photograph.

In general, the average mean deviations on the Ponzo line-drawing task followed a pattern similar to that of the photograph task. The general tendency was for susceptibility to this form of the illusion to increase with acculturation. As shown in Table 5, however, the major intergroup difference lay between the two groups on the extremes of the acculturated/unacculturated continuum ($t = 2.831$, $p < .01$).

TABLE 5

Susceptibility to the drawing form of the Ponzo illusion: average mean deviations[+] from 2cm. standard.

Group	Xhosa Rural	Xhosa Urban	Xhosa Student	White Student
Mean	.141	.294	.242	.342

[+] Expressed in cm., $n_i = 15$

However, the data in Table 6 show significant differences in the responses to the photograph and to the drawing, with susceptibility greatly increased for the latter task for all but the XU group, whose results, as has been noted, are suspect.

TABLE 6

Susceptibility to the photograph and line-drawing forms of the Ponzo illusion: average mean deviations[+] from 2cm. standard.

Group	Xhosa Rural	Xhosa Urban	Xhosa Student	White Student
Photo	.019	.272	.104	.127
Drawing	.141	.294	.242	.342
t	4.309**	0.241	5.704**	9.142*

+ Expressed in cm., $n_i = 15$

* $p < .01$

** $p < .05$

Smith, Smith and Hubbard (1958) found no evidence that depth perceived in line-drawings differed from that in photographs, but two explanations can be advanced for the findings of the present study.

The first is that the bridge drawing was used to emphasise perspective cues, thus detail was monitored to this end. This stressing of perspective cues may have increased susceptibility to this form of the illusion, yet, since it has been remarked that the XR subjects were unlikely to have had fully-developed pictorial depth perception skills, it may be argued that increased perspective cues cannot explain their significant increase in susceptibility. The second explanation avoids this complication — the increases in susceptibility may have resulted from the physical properties of the drawing, as it was executed in heavy black lines. In view of Fisher's (1969) contour proximity theory of illusions, one would expect these heavily-accented contours to increase susceptibility to the illusion effect.

6.13 The Effects of the Introduction of the "Perspective Set"

The effects of the perspective set, introduced by the photograph and drawing tasks, to susceptibility to the diagram form of the Ponzo illusion was evaluated by comparing the pre- and post-set scores, the manner advocated by Cronbach and Furby (1970). Half of the subjects in each group were exposed to the perspective set, while the other half acted as a control group. In Table 7, the scores on the first and second sets of Ponzo diagram trials of those subjects who underwent the perspective therapy are shown.

TABLE 7

Pre- and post-set average mean deviations[+] on the Ponzo illusion diagram of those Ss exposed to the photograph and drawing.

Group	Xhosa Rural	Xhosa Urban	Xhosa Student	White Student
Pre-set Mean	.057	.105	.095	.087
Post-set Mean	.058	.201	.190	.211
t	0.032	1.435	3.862*	3.594*

+ Expressed in cm., $n_i = 15$

* $p < .01$

The proportions of increase in susceptibility to the Ponzo illusion which result from the introduction of the perspective set are related to extent of acculturation. The susceptibility of the two most acculturated groups increased significantly; there was a marked but not

significant increase in the susceptibility of the moderately-acculturated XU group; while the scores of the unacculturated XR group were practically unchanged.

There were no significant changes in the susceptibility of those subjects who were not exposed to the perspective therapy.

TABLE 8

Susceptibility to the first and second Ponzo diagram series of those Ss not exposed to the photograph and drawing: average mean deviations[+] from 2cm. standard.

Group	Xhosa Rural	Xhosa Urban	Xhosa Student	White Student
1st series	.045	.045	.149	.136
2nd series	.027	.105	.155	.143
t	0.391	1.101	0.164	0.114

+ Expressed in cm., $n_i = 15$

As shown in Table 8, the XR group showed a decrease in susceptibility, probably due to increased familiarity with the task and equipment, while the susceptibility of the XS and WS groups remained at approximately the same level. The XU group, however, showed an increase in susceptibility, but this was not significant.

Dawson (1967a) found that, for a Temne group, field independent subjects acquired three-dimensional perception skills more readily than did field dependent subjects. Table 9 shows the results of analyses aimed at ascertaining whether the susceptibility to the Ponzo illusion of the more field independent subjects[14] in the XR and XU groups was influenced by the perspective set to a greater extent than that of the field dependent subjects because of possibly better-developed depth perception skills in the former group.

TABLE 9

Association[+] of RFT scores and increase in susceptibility to the Ponzo illusion after the introduction of the perspective set in two non-student groups.

Group	Xhosa Rural	Xhosa Urban
Y	.081	.445*

+ Tetrachoric correlation
* $\chi^2 = 2.977$, $df = 1$, $p > .10 < .05$

14. The results of the RFT task are discussed below.

It was found that a significant correlation between field independence and increased susceptibility was approached in the case of the XU group, providing some support for Dawson's finding. This tendency was not found in the two acculturated groups ($\underline{r}$ = .063 in both cases), since, field independent or not, all of these subjects would have well-developed pictorial interpretation skills.

Degree of acculturation, and the attendant amount of exposure to printed material and informal training, would appear to be the primary determinant of the amount of increase in susceptibility to the Ponzo illusion generated by the introduction of a perspective set. If, through acculturation, the subjects had acquired certain depth perception skills and inference habits, as had the two student groups, there was a significant increase in their susceptibility.

These results are supported by a study by Mackavy (1970), who found that if a modified Ponzo figure was described to subjects as a pennant, thus minimising perspective interpretations, they made little illusory error. However, if the Ponzo was described simply as a figure, which was "perspective-neutral", there was an increase in illusory error.

6.2 The Müller-Lyer Tasks

6.21 Intergroup Comparison of Müller-Lyer Scores

Comparison of the average mean deviations of the four groups on the 12cm. and 8cm. standard settings [15] of the Müller-Lyer illusion apparatus shows that the more acculturated (XS and WS) groups were more susceptible to the illusion figure than were the relatively unacculturated (XR and XU) groups. (See Table 10).

TABLE 10

Susceptibility to the Müller-Lyer illusion: average mean deviations+ from 12cm. and 8cm. standards.

Group		Xhosa Rural	Xhosa Urban	Xhosa Student	White Student
12cm. standard setting	Mean	1.645	1.359	1.653	1.847
	S. D.	0.596	0.767	0.677	0.758
8cm. standard setting	Mean	1.016	0.757	1.225	1.152
	S. D.	0.369	0.629	0.553	0.534

\+ Expressed in cm., $\underline{n}_i$ = 30

15. The reason for having two standard settings is discussed below.

One-way analyses of variance of the scores of the four groups of subjects revealed significant intergroup variance on the 8cm. standard ($F = 4.389$, $p < .01$), but not on the 12cm. ($F = 2.385$).

TABLE 11

Group-to-group comparison[+] of average mean deviations from 12cm. and 8cm. standards of the Müller-Lyer illusion.

Group		Xhosa Rural	Xhosa Urban	Xhosa Student	White Student	
Xhosa Rural			1.908	1.698	1.131	8cm. standard
Xhosa Urban	12cm. standard	1.584		3.009*	2.577**	
Xhosa Student		0.050	1.548		1.625	
White Student		1.136	2.442**	1.033		

+ t's : $n_i = 30$.

* $p < .01$

** $p < .05$

As shown in Table 11, significant differences existed only between the XU and the WS groups on the 12cm. standard setting, and between the XU and both the XS and WS groups on the 8cm. standard setting. On both settings, the XR group were more susceptible to the illusion than the XU group, and not very much less susceptible than the two student groups.

These results are contrary to those expected in terms of the Carpentered World type of explanation because the relative absence of carpentered artifacts in the environment of the XR group should have resulted in their being the least susceptible. While it is tempting to attempt to explain this apparent discrepancy in terms of the XU group's lack of familiarity with tasks of the Müller-Lyer type, this group was the most accurate of all on the Ponzo diagram task, which was similar in nature to the Müller-Lyer task and which was performed immediately prior to it.

In addition, analyses of practice effects which compared the average mean deviations on first and second sets of five trials on each of the 12cm. and 8cm. standard settings show that practice did not influence the performance of the XU group much more than that of other

groups on the 12cm. setting, and least of all the groups on the 8cm. setting. (See Table 12).

TABLE 12

Deviations from mean deviations[+] on the first and second sets of five trials on the 12cm. and 8cm. standard settings of the Müller-Lyer apparatus.

	Group		Xhosa Rural	Xhosa Urban	Xhosa Student	White Student
12cm. standard		Mean	1.645	1.359	1.653	1.847
	Deviation from Mean	1st 5 trials	.062	.042	.072	.053
		2nd 5 trials	-.062	-.042	-.072	-.053
8cm. standard		Mean	1.016	0.757	1.225	1.152
	Deviation from Mean	1st 5 trials	.029	.070	.105	.066
		2nd 5 trials	-.029	-.070	-.105	-.066

+ Expressed in cm., $n_j = 30$

The effects of practice may also be evaluated by comparing the scores on the 12cm. and 8cm. settings as performed as first or second Müller-Lyer tasks. Half the subjects in each group were exposed first to the 12cm. standard setting figure, and then to the figure with the 8cm. standard setting, while the other subjects performed first the 8cm., then the 12cm. task. If practice or exposure to the illusion figure were causing decrements in susceptibility, the "second task" scores should be consistently lower than the "first task" scores. However, Table 13 indicates that there were no significant instances of this, and that the opposite occurred on either the 12cm. or 8cm. task for each of the Xhosa groups.

TABLE 13

Mean average deviations[+] on 12cm. and 8cm. standard settings tasks on the Müller-Lyer apparatus when performed as first or second Müller-Lyer tasks.

	Group	Xhosa Rural	Xhosa Urban	Xhosa Student	White Student
12cm. standard	1st task	1.617	1.611	1.613	1.962
	2nd task	1.673	1.107	1.693	1.734
	t	0.249	1.839	0.311	0.805
8cm. standard	1st task	1.077	0.633	1.306	1.220
	2nd task	0.954	0.881	1.145	1.084
	t	0.896	1.060	0.780	0.680

+ Expressed in cm., $n_j = 15$.

6.22 Age and Education Trends

No significant correlations were found between level of education and susceptibility to the Müller-Lyer figure in the XR and XU groups. (See Table 14).

TABLE 14

Associations[+] of level of education with susceptibility to the Müller-Lyer illusion in two non-student groups.

Group	Xhosa Rural	Xhosa Urban
12cm. standard	.267	.029
8cm. standard	.000	.044

+ Tetrachoric correlation

As shown in Table 15, there was, however, one significant association of increase in age with susceptibility to the illusion.

TABLE 15

Association[+] of increase in age with increase in susceptibility to the Müller-Lyer illusion in two non-student groups.

Group	Xhosa Rural	Xhosa Urban
12cm. standard	.000	.000
8cm. standard	.400*	.134

+ Techrachoric correlation
* $\chi^2 = 4.800$, $df = 1$, $p < .05$

This single significant r is suspect. Performances on the 12cm. and 8cm. standard settings of the Müller-Lyer were highly correlated, indicating that they cannot be regarded as different tasks. (See Table 16). However, Table 15 reveals no consistent relationships between age and level of education and susceptibility to the illusion, as $r = .000$ for both groups on the 12cm. standard setting task. task.

TABLE 16

Associations[+] between degrees of susceptibility to the 12cm. and the 8cm. standard settings of the Müller-Lyer apparatus.

Group	Xhosa Rural	Xhosa Urban	Xhosa Student	White Student
r	.400**	.400**	.534*	.400**

+ Tetrachoric correlation
* $\chi^2 = 8.5$, $df = 1$, $p > .01$
** $\chi^2 = 4.8$, $df = 1$, $p < .05$

It may be conjectured that the lack of associations of age and level of education with susceptibility resulted from the conflicting influences of the two variables, as may have occurred on the Ponzo illusion task.

6.3 Variability of Responses to the Müller-Lyer and Ponzo Illusion Figures

Investigators from Rivers (1901) to Jahoda (1966) have noted that unacculturated groups show great variability on illusion tasks in spite of their relatively accurate scores on these tasks. A possible cause of this great variability was noted during the testing of the XR and XU groups for the present study. It was noticeable that, while their responses on the Müller-Lyer and Ponzo tasks were generally more accurate than those of the acculturated groups, most of the XR and XU subjects exhibited a modal tendency to exaggerate the typical method of average error response pattern. When the variable line was adjusted from a too-short setting, these subjects tended to make their matchings much shorter than their overall mean deviation, while the matchings were much longer when the variable line was adjusted from a too-long setting. Table 17 shows that, for the Müller-Lyer tasks, this tendency, with a single exception (the XR group on the 8cm. standard setting), increased with degree of unacculturation.

TABLE 17

Deviations from means[+] when the initial variable settings (v) of the Muller-Lyer were greater and smaller than the standard settings (s).

Group		Xhosa Rural	Xhosa Urban	Xhosa Student	White Student
12cm. standard setting	Mean	1.645	1.359	1.653	1.847
	V > S	.143	.117	.086	.080
	V < S	- .143	- .117	- .086	- .080
8cm. standard setting	Mean	1.016	0.757	1.225	1.152
	V > S	.055	.102	.077	.072
	V < S	- .055	- .102	- .077	- .072

+ Expressed in cm. : $n_i = 30$

The accurate scores of the unacculturated groups preclude explanations in terms of task-familiarity or understanding. While

differing degrees of concentration on the tasks might provide a possible explanation, it was considered that, if anything, the unacculturated groups, and particularly the XR subjects, were more painstaking than the student groups.

This response pattern was also evident in the Ponzo illusion task. Table 18 shows the great difference between the deviations of the XR and WS groups, but, in this case, little difference between the XU and XS groups.

TABLE 18

Deviations from means[+] when the variable setting (v) of the Ponzo illusion apparatus was greater and smaller than the standard setting (s).

Group	Xhosa Rural	Xhosa Urban	Xhosa Student	White Student
Mean	.051	.075	.122	.111
V > S	.064	.047	.051	.023
V < S	-.064	-.047	-.051	-.023

+ Expressed in cm. : $n_i = 30$

It is obvious that, should this be a modal response pattern among unacculturated peoples, apparati which allow adjustment of the variable setting from only a too-short or too-long position, as did Jahoda's (1966) Horizontal-vertical illusion apparatus, will provide greatly biased results.

6.4 The Rod-and-Frame Test Task

Intergroup comparison of the RFT average mean deviations suggests that degree of field independence increases with extent of acculturation.[16] (See Table 19).

16. Although there is no justification for assuming that the four groups were evenly spaced on some "acculturation scale", a regression analysis was performed on the RFT scores. An almost perfect negative relationship ($r = -.98$) was found between these scores and degree of acculturation.

TABLE 19

Average mean deviations[+] from vertical on the RFT

Group	Xhosa Rural	Xhosa Urban	Xhosa Student	White Student
Mean	4.322	3.655	2.289	2.089
S. D.	2.327	2.577	1.107	0.957

+ Expressed in degrees

A one-way analysis of variance revealed significant intergroup variance (F = 9.474, $p < .01$), and t - tests showed that the differences lay between the two acculturated student groups on the one hand, and the two unacculturated groups on the other. (See Table 20).

TABLE 20

Group-to-group comparison[+] of average mean deviations from vertical on the RFT

Group	Xhosa Rural	Xhosa Urban	Xhosa Student	White Student
Xhosa Rural	-			
Xhosa Urban	1.034	-		
Xhosa Student	2.480**	2.622**	-	
White Student	4.788*	3.067*	0.736	-

+ t's

* $p < .01$

** $p < .05$

Each student group was significantly less field dependent than each relatively unacculturated group, while there was very little difference between the two student groups results. These findings are consistent with those of Berry (1966) and Dawson (1967a, 1967b), who demonstrated that field independence increased with acculturation and the attendant freedom from the forced conformity of tribal life — and with the acquisition of the habits of visual analysis necessary in Western life.

The portable RFT used in this study was not standardised, and generated deviations from the vertical of approximately half the magnitude of the conventional RFT. However, it did produce a deviation range of some 16°, and intergroup differences were clear.

Perhaps surprisingly in view of the significant relationship between acculturation and field independence, there were no marked tendencies for field independence to be associated with either age or level of education in the XR and XU groups. Table 21 shows that only in the XU group there was a slight association between low RFT scores and higher education level.

TABLE 21

Associations+ of RFT scores with age and higher level of education in the two non-student groups

Group	Xhosa Rural	Xhosa Urban
Age	.000	.000
Education	.000	.207

+ Tetrachoric correlation

As occurred in the illusion tasks, age and education trends may have been obscured by the conflicting influences of the two variables. In addition, the age range of approximately 20 years (20 to 40 years of age) in both the XR and XU groups was possibly too limited to reveal trends.

The successful communication of the RFT task requirements and sustained concentration of all the groups (this was the final task) is shown by the consistency shown under different conditions of rod movement and frame tilt. Table 22 shows that there were no marked differences between clockwise and anti-clockwise settings of the rod in any group.

TABLE 22

Average Mean Deviations+ on RFT with clockwise and anti-clockwise settings of the rod

Group	Xhosa Rural	Xhosa Urban	Xhosa Student	White Student
Clockwise	4.343	3.547	2.377	2.121
Anti-clockwise	4.300	3.763	2.202	2.056
$\underline{t}$	0.070	0.318	0.572	0.254

+ Expressed in degrees.

There were also no marked differences between the series with the frame tilted 28° to the right and that with the tilt being 28° to the left. (See Table 23).

TABLE 23

Average mean deviations+on RFT with frame tilted 28° to the left and right.

Group	Xhosa Rural	Xhosa Urban	Xhosa Student	White Student
Frame Left 28°	4.120	3.520	2.230	2.092
Frame Right 28°	4.523	3.790	2.348	2.087
t	.567	.306	.280	.000

+ Expressed in degrees.

There was an interesting tendency for the unacculturated subjects' judgements to become less accurate on the second series of 10 trials on the RFT, while those of the two student groups became slightly more accurate. This is shown in the data in Table 24.

TABLE 24

Average mean deviations+ on the first and second series of 10 trials on the RFT

Group	Xhosa Rural	Xhosa Urban	Xhosa Student	White Student
1st series	4.122	3.343	2.582	2.175
2nd series	4.522	3.967	1.997	2.003
t	0.563	0.710	1.409	0.533

+ Expressed in degrees.

The two student groups, who would be expected to be intellectually superior to the XU and XR groups, appear to have been able to analyse and counter the effect of the tilt of the frame, and even improve their performance as familiarity with the task increased. The two relatively unacculturated Xhosa groups, however, became more and more affected by the tilt of the frame as the period of their deprivation of verticality cues lengthened. This is the more typical response pattern to the RFT. However, in no cases were

the differences between the scores on the first and second series of trials significant.

6.5 Inter-task Associations

6.51 Ponzo/Müller-Lyer Tasks

As is shown in Table 25, there were no significant or even marked associations of the Ponzo with the Müller-Lyer tasks[17] on intra-group comparison.

TABLE 25

Associations[+] of the Ponzo with the two Müller-Lyer tasks

Group	Xhosa Rural	Xhosa Urban	Xhosa Student	White Student
Ponzo/M-L 12cm.	.134*	.000	.000	.000
Ponzo/M-L 8cm.	.134*	.000	.000	.134

\+ Tetrachoric correlation

* Negative association

There were negative associations between performances on the Ponzo and on the two Müller-Lyer tasks by the XR group, indicating that those susceptible to the Müller-Lyer were resistant to the Ponzo, and vice versa. Among the other groups, there was little or no tendency for those who were susceptible to the one illusion to be susceptible to the other. These results cast some doubt on the postulate of Segall et al. that the two illusions are generated by similar inference habits, and upon Fisher's (1968a) observation that similar contour properties generate the two illusions.

6.52 RFT / Illusion Tasks

Furthermore, this study offers no evidence of a relationship between high scores on the RFT and the Ponzo and Müller-Lyer tasks, and therefore provides no support for a universal relationship between field dependence and susceptibility to illusion. The most field dependent groups, XR and XU, were the least susceptible to both illusions.

17. Table 14 has shown that the two Müller-Lyer tasks were significantly related.

As was found in the pilot study, however, there were slight intra-group associations between field dependency and susceptibility to the Ponzo illusion. These are shown in Table 26, which also reveals that there were several negative associations between field dependency and susceptibility to the Müller-Lyer illusion.

TABLE 26

Associations+ of the RFT with the Müller-Lyer and Ponzo tasks

Group	Xhosa Rural	Xhosa Urban	Xhosa Student	White Student
RFT/M-L 12cm.	.134*	.400**	.267*	.134*
RFT/M-L 8cm.	.000	.000	.000	.000
RFT/Ponzo	.000	.267	.000	.267

\+ Expressed as r's

* Negative association

** Significant negative association ($\chi^2 = 4.8$, $df = 1$, $p < .05$)

Further evidence that susceptibility to the Müller-Lyer illusion is not related to mode of field approach comes from the percentage of illusory distortion exhibited by each group on each of the 12cm. and 8cm. standard settings of the Müller-Lyer apparatus. These two settings were used since the ingoing arrowheads on the standard line of the illusion figure were practically joined at their tips on the 8cm. setting, while they were well-separated on the 12cm. setting. It was expected, therefore, that the 8cm. setting would generate strong field effects, and that it would affect the field dependent subjects relatively more than would the 12cm. setting. However, Table 27 shows that the reverse obtained for all but the XS group.

TABLE 27

Percentages of illusory distortion generated by the 12cm. and 8cm. standard settings of the Müller-Lyer apparatus

Group	Xhosa Rural	Xhosa Urban	Xhosa Student	White Student
12cm. standard	13.7	11.3	13.8	15.4
8cm. standard	12.7	9.5	15.3	14.4

Apart from casting doubt upon the universality of the relationship between mode of field approach and susceptibility to illusion, the finding that performances on the RFT and illusion tasks were not associated refutes an alternative explanation to the Carpentered World hypothesis of cross-cultural differences in illusion-produced responses. As has been quoted on pages 16 and 19 of the present study, Rivers (1901, 1905) considered that differential responses to the Müller-Lyer illusion were caused by his unacculturated subjects disregarding the context lines while the "civilized man" tended to regard the figure as a whole. Rivers' observation may be taken to mean that unacculturated subjects "blanked out" the context lines — they did not, as a field independent individual is presumed to do, analyse and then attempt to counter the distracting effect of the field. There is some evidence that this "perceptual atomisation" is a modal tendency among unacculturated subjects on pictorial interpretation tasks. Doob (1965a) noted that Shapiro (1961) explained a Nyasa group's inability to interpret drawings in terms of their failure to integrate the elements of the drawing. Reader (1963) commented upon this tendency in relation to African industrial workers' perception of safety posters.

However, if atomised perception is modal among unacculturated groups and renders them resistant to illusions having distracting context lines, they should record low errors on the RFT, as they would be able to "blank out" the distracting tilted frame. It is clear, however, that unacculturated subjects in the present study were more influenced by the frame tilt than were the acculturated subjects.

6.6 Summary and Conclusions

In order to investigate certain anomalies evident in the literature, the performances of three Xhosa groups (rural dwellers, urban dwellers, and undergraduates) of varying degrees of acculturation and a White undergraduate group, each group consisting of 30 subjects, were measured on tests of mode of field approach and susceptibility to the Müller-Lyer and Ponzo illusions. In addition, the effect of the introduction of a mental set, which facilitated the perception of perspective in the Ponzo figure, on susceptibility to the illusion was ascertained.

Mode of field approach was measured by a portable version of the Rod-and-Frame Test. Susceptibility to the Müller-Lyer illusion was measured by a conventional movable-slide, subject-adjustable device, while a piece of apparatus which also worked on the movable-

slide principle and was subject-adjustable was developed to measure susceptibility to the Ponzo illusion. The set to facilitate the perception of perspective in the Ponzo figure was introduced by having subjects match the length of Ponzo contrast lines embodied in a photograph and a line-drawing of a bridge, both of these pictures having strong perspective cues.

The subjects were required to perform the tasks in prescribed order. Standardised English or Xhosa instructions were ensured by the use of "programmed" worksheets for each task. Prior to each experimental task, the more unacculturated subjects performed comprehension checks to ensure that they understood the concepts of equal length and verticality.

The results of the study suggested that :

(i) When groups of differing acculturation levels are tested, there may be a pronounced negative association of field dependence with susceptibility to the Müller-Lyer and Ponzo illusions. In general, the more unacculturated the subject, the more field dependent and the less susceptible to illusions he was. However, there was no evidence which either strongly supported or refuted the relationship between these attributes at the intra-group level.

(ii) There is no intra-group association between susceptibility to the Müller-Lyer and to the Ponzo illusions. This would indicate that they are not necessarily generated by similar inference habits or by similar contour properties.

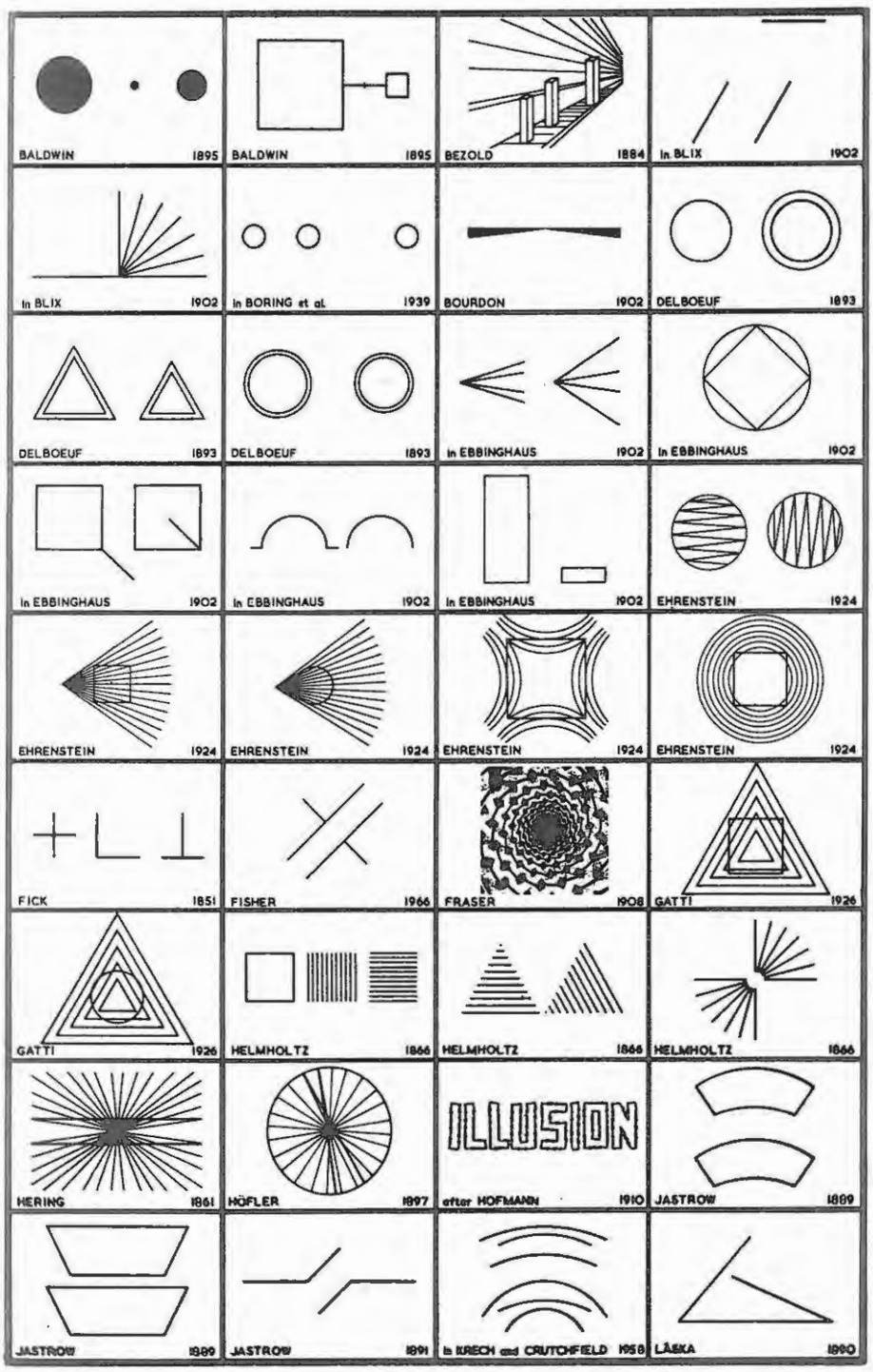
(iii) The introduction of a "perspective set" increases susceptibility to the Ponzo illusion only among acculturated subjects, who have well-developed pictorial depth perception skills and who habitually infer depth in inverted – V configurations.

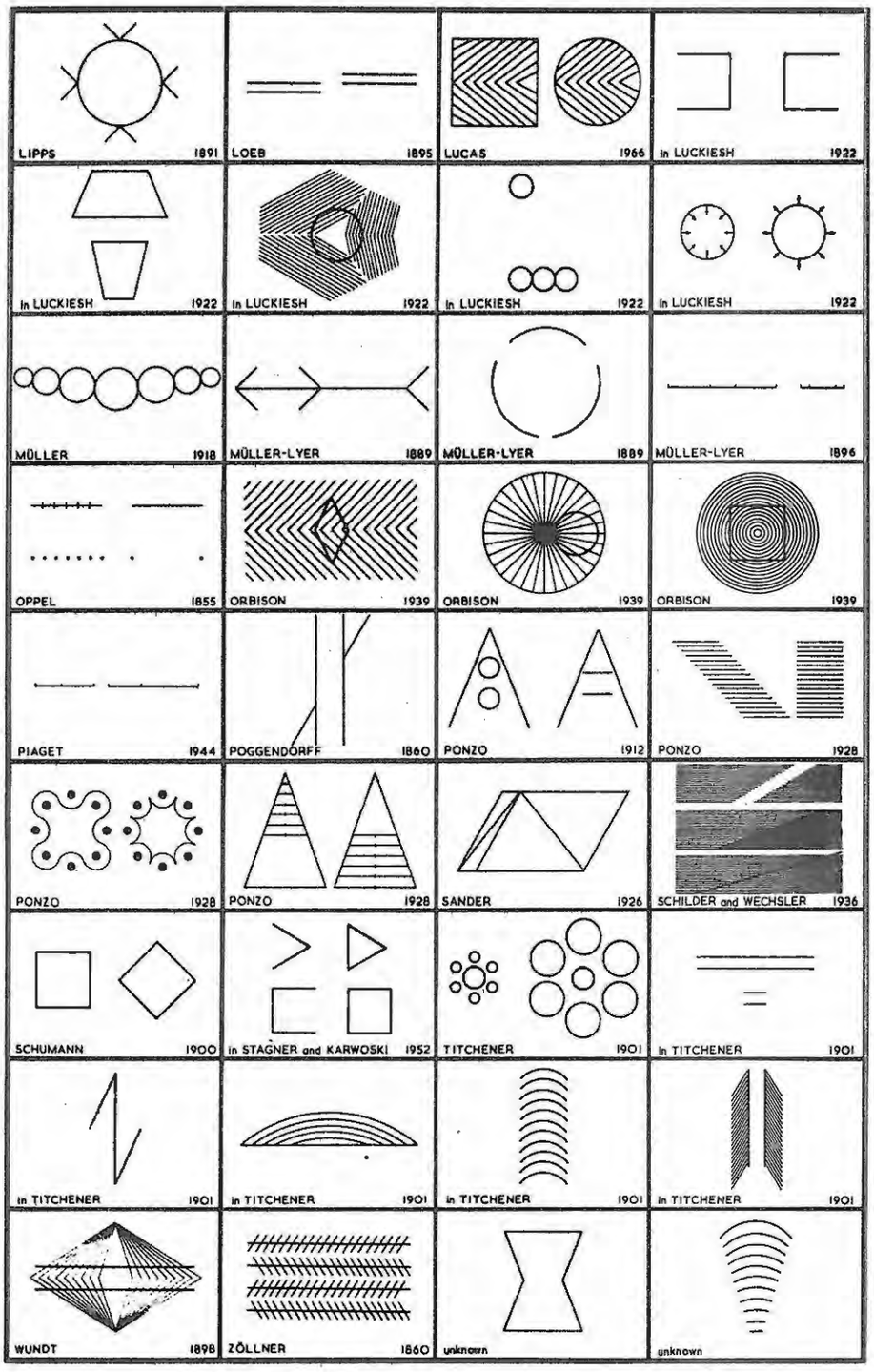
(iv) There is a significant association between acculturation and field independence. The unacculturated subjects, presumably because they lack the skills of visual analysis which are engendered by Western culture, were more field dependent than the acculturated subjects.

(v) Provided that their degrees of acculturation are more-or-less equivalent, as were those of the two undergraduate groups, there are no differences in mode of field approach or susceptibility to the Müller-Lyer and Ponzo illusion among Xhosa and White subjects.

APPENDIX ONE

72 Geometrical Visual Illusions



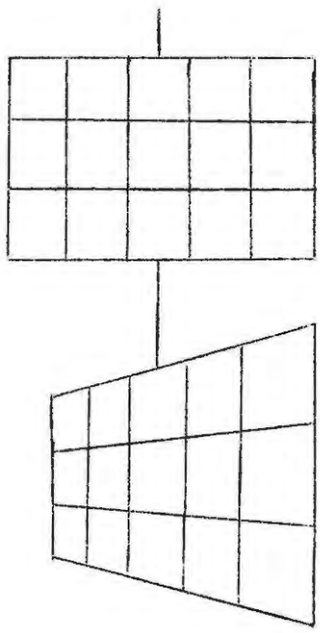


Reproduced from Fisher (1968a), with the permission of G. H. Fisher.

APPENDIX TWO

The Rotating Trapezoidal Window

The Rotating Trapezoidal Window was designed by Adelbert Ames (1951) of the Hanover Institute Division of the Institute for Associated Research to be used as one of a series of demonstrations of phenomena related to the perception of motion. It was used in conjunction with a rectangular window and various cubes and tubes to demonstrate empirically the alterations in visual phenomena that are related to the variation of the trapezoidal form of a window.



Diagrammatic Representation of Ames' Apparatus.

The apparatus consists of an electric motor attached to the ceiling, which drives a vertical shaft to which the rectangular window is connected. The trapezoidal window is suspected from another vertical shaft extending from the bottom of the rectangular window. The dimensions of the rectangular window are (inches) : length, $23\frac{1}{2}$; height, $16\frac{1}{2}$. thickness, $^1/_4$; width of outside frame, $\frac{1}{2}$; width of mullions, $^1/_4$. The dimensions of the trapezoidal window which differ from those of the rectangular one are (inches) : length, $19\frac{1}{2}$; height of long side, $23\ ^5/_8$; height of short side, $12\frac{1}{2}$; thickness, $^1/_8$. The motor rotates the two windows about a common vertical axis at the required speed, usually 3 to 6 rpm.

The major observed phenomenon is that, when in motion, the rectangular window is seen to rotate, while the trapezoidal one often appears to oscillate back and forth through 90 to 180 degrees. This finding is explained in terms of stimulus characteristics and their translations in terms of assumptions generated by past experience. The subject is thought to assume that the trapezoidal window is a rectangular one, the trapezoidal shape and retinal pattern resulting from the particular angle of regard. As the longer edge of the trapezoidal window is always longer on the retina than the shorter edge, even when the latter is nearer to the subject, the window appears to oscillate rather than rotate. Ames' explanation is thus of an empiricistic nature.

APPENDIX THREE

Task Worksheets

Worksheet for Task 1 : M - L and Ponzo Communication Check.

Preparation Seat S between E and I on one side of a table.

Set up Apparatus Place 5 plywood rods on table in front of S, in following order away from S : 9cm, 12cm, 8cm, 11cm, & 10cm. I holds spare 8cm, 10cm, and 12cm rods.

Instruct the Subject

No.	Instruction	Response
1.	"We want to see how good you are at seeing when sticks are the same length. You see that there are sticks on the table. They are all of different lengths." (Demonstrate by squaring ends on table, then re-arranging in above order) "Do you see they are different lengths?"	Yes ..... 2 No 1
2.	(Show spare 8cm rod) "Now I want to know which stick is the same length as this one I hold. So I look at the sticks and put it next to the stick I think is the same length" (Place spare next to 8cm rod) "I can measure they are the same length by putting them like this." (Align spare rod on top of the other on table top, then replace them flat next to each other on table. Indicate them:) "Are you sure these two sticks are the same length?"	Yes ..... 4 No 3
3.	"Here are the sticks." (Hand to S) "Hold them together. Do you still think they are of different lengths?" (Replace 8cm rod on table and retain spare 8cm rod).	Yes ..... End No. 4
4.	(Hand S spare 10cm rod) "You find the stick that is the same length as this one. You can measure like this, then put the stick you are holding next to the one that is the same length like this." (Demonstrate with spare 8cm rod.)	Succeeds. 6 Fails.... 5

5.	(Take spare 10cm rod from S) "No, they are not the same length. Look, they are different." (Align two rods upright). "This one is longer/ shorter" (Demonstrate) "Now try again to find the stick that is the same."	Succeeds. 6 Fails .... End
6.	(Remove spare 10cm rod and hand S 12cm spare rod). "Now find the stick that is the same length as this stick. Measure it and put it next to the one which is the same length."	Succeeds. End Fails ... 5

Worksheet for Task 2 : Ponzo Diagram (1)

Preparation Seat S at ease in front of Ponzo apparatus. I stands on left next to S, while E sits behind apparatus to take readings and set variable line.

Set up Apparatus Apparatus is placed on table which permits easy viewing. Diagram slide is in position, and variable line is set to maximum (4cm).

Instruct the Subject

No.	Instruction	Response
1.	"You remember how you found sticks of the same length and how you made the lines in that box (indicate M - L apparatus) the same length. Now I want you to make more lines the same length."	2
2.	(Put S's eyes to viewer and indicate standard line) "Do you see this top red line here?"	3
3.	(Indicate variable line) "Do you see this bottom red line here?"	4

4.	(Indicate variable line) "Is this bottom line longer or shorter than the top line?" (Indicate standard line)	"Longer". 5 "Shorter" End
5.	(Place S's left or right hand on adjusting knob and guide it to turn knob to the left) "See how if you move this knob this way the line gets shorter."	6
6.	(Guide S's fingers to turn knob to the right) "If you move the knob this way the line gets longer."	7
7.	(Cease guidance) "Make the line short."	Succeeds. 8 Fails . . . 5
8.	"Make the line long."	Succeeds. 9 Fails. 6
9.	"Now make the bottom line that you can move the same length as the top line."	10
10.	(Ensure S sits at ease with hand off adjusting knob) "Sit back with your hands in your lap."	11
11.	(E sets variable line for first trial) "Make the lines the same again. You are going to make them the same a lot of (10) times".	12
12.	Instructions 10 and 11 continue until testing completed.	End

Worksheet for Task 3 : Müller-Lyer

Preparation — Seat S at ease in front of M - L apparatus. I stands on right next to S, while E sits behind apparatus to take readings and set standard and variable slides.

Set up Apparatus — Apparatus is placed on table in front of S. Standard slide is set to 12cm; variable slide to 2cm. Lid is in position.

Instruct the Subject

No.	Instruction	Response
1.	"You remember how you have found sticks of the same length. Now I want you to make lines in this box the same length."	2
2.	(Put S's eyes to viewer and indicate standard line from right to left.) "Do you see this line here? You see it goes from here to here." (Indicate twice).	3
3.	(Indicate variable line). "Do you see this other line here? It goes from here to here." (Indicate twice).	4
4.	(Indicate variable line) "Is this line longer or shorter than this line?" (Indicate standard line.)	"Longer". End "Shorter". 5
5.	(Place S's right hand on adjusting knob and guide it to turn knob to the right.) "See how if you move this knob this way the line gets longer."	6
6.	(Guide S's fingers to turn knob to the left.) "If you move the knob this way, the line gets shorter."	7

7.	(Cease guidance) "Make the line longer."	Succeeds. 8 Fails.... 5
8.	"Make the line shorter."	Succeeds. 9 Fails.... 6
9.	"Now make the line that you can move the same length as the other line."	10
10.	(Ensure S sits at ease with hand off adjusting knob) "Sit back with your hands in your lap."	11
11.	(E sets standard and variable lines for first trial) "Make the lines the same again. You are going to make them the same a lot of (10) times."	12
12.	Instructions 10 and 11 continue until testing completed.	End

Worksheet for Task 4 : Ponzo Photograph

Preparation — Seat S at table, flanked by E and I.

Set up Apparatus — Ponzo apparatus is on floor next to E. Photo and diagram slides are on table in front of I. I has rod on table in front of him.

Instruct Subject

No.	Instruction	Response
1.	(Hold diagram slide in front of S) "You have just made the red lines inside this (indicate) the same length." (Place on table in front of S and hold photo slide in front of him.) "In a moment I want you to make lines inside this picture the same length. This is a picture of a bridge, with telephone poles and the road on the other side of the bridge and veld behind the bridge." (Indicate)	2

2.	"You see this end of the bridge nearest to you (indicate) looks longer than the edge of the bridge far away from you. (Indicate) Is this end near to you really bigger than the other end, or is it the same?"	Bigger... 3 Same.... 4
3.	"No, it just looks bigger. It is really the same. When things are far away from you, they look smaller than things which are near to you." (Place rod on table in front of S) "If I put this stick there and measure it with my fingers like this (measure between thumb and forefinger) the stick looks this big." (Show S fingers) "If I hold it near to me like this, (hold near eyes), it looks this big." (Indicate) "Here, you try it." (Guide S through procedure) "Now look at this telephone pole and this telephone pole." (Indicate 1st and 3rd poles) "This one (1st) looks bigger than this one (3rd). Is it really bigger or is it the same?"	Bigger... 3 Same.... 4
4.	"Yes, that is right. It is the same, but why does it look bigger?"	Further away 5 Do not know.. 3
5.	"Yes, it looks biggerbecause it is near to you." (Place slide in Ponzo apparatus) "Now make the lines the same again. Once again you are going to make them the same a lot of (10) times."	6
6.	Readings taken as in Task 5.	End

Worksheet for Task 5 : Ponzo Drawing

Preparation S, E and I seated as for Task 6.

Set up Apparatus As for Task 6, with addition of drawing slide.

Instruct Subject

No.	Instruction	Response
1.	(Hold photo and drawing slides in front of S) "You see that this (indicate drawing) is a drawing of this (indicate) photograph. Here is the bridge and here are the telephone poles. As the bridge gets further away from you, it looks as though it gets narrower. As the telephone poles get further away from you, they seem to get smaller. Remember, the bridge is really the same width at that end (indicate far end) as at this end. (indicate near end). Also, all the telephone poles are the same length. They only look smaller when they are far away from you."	2
2.	(Place drawing slide in Ponzo apparatus, and position S in front) "Now make the lines the same again. Again, you are going to make them the same a lot of (10) times."	3
3.	Take readings as in Tasks 5 and 6.	End

Worksheet for Task 6 : Ponzo Diagram (11)

Preparation As for task 7

Set up Apparatus As for Task 7.

Instruct Subject

No.	Instruction	Response
1.	(Hold diagram slide in front of S) "Now we want you to make the lines inside this the same length again." FOR EXPERIMENTAL GROUP ONLY. "You see how this (indicate inverted - V) looks like the sides of the bridge in this photo and this drawing" (Trace V's on both).	2

2.	Place diagram slide in Ponzo apparatus and take readings as in Tasks 5, 6 and 7.	End

Worksheet for Task 7 : RFT Communication Check

Preparation Seat S between E and I on one side of a table

Set up Apparatus Place RFT model and spare rod on table in front of I

Instruct the Subject

No.	Instruction	Response
1.	"We want to see how good you are at making a stick point straight up to the sky. You must make it point straight up, like you are when you stand up". (Stand up, indicate verticality by pointing hand from feet through head to roof) "Do you understand what 'straight up' means?"	"Yes" ... 2 "No" ... 1
2.	(Hold RFT model, frame square, rod 45° left, in front of S. Indicate rod.) "Is this stick straight up?"	"Yes" ... 1 "No" ... 3
3.	"Make it straight up."	Does ... 6 Does not 4
4.	(Hold spare rod vertical) "Is it straight up like this stick?"	"Yes" ... End "No" ... 5
5.	(Remove spare rod) "Then make it straight up to the sky like that stick was."	Does ... 6 Does not End
6.	(Hold RFT model 45° left. rod 45° right) "Make it straight up again."	Does ... 8 Does not 7

7.	"No, that is not straight up. This piece of wood is crooked, but you must still make the stick straight up like this" (Show spare rod vertical). Now make it straight up."	Does ... 8 Does not End
8.	(Hold RFT model 45° Right, rod 45° left.) "Make it straight up again."	Does... End Does not 7

Worksheet for Task 8 : Rod-and-Frame Test

Preparation — Seat S at ease in front of RFT apparatus. I sits on S's right, while E sits behind apparatus to take readings and set the rod and frame.

Set up Apparatus — Place RFT apparatus with viewer at appropriate height in front of S. Set frame to 28° right, rod to 45° left:

Instruct the Subject

No.	Instruction	Response
1.	"You have just shown me that you are good at making a stick point straight up to the sky. Now I want you to make the stick in here (indicate apparatus) point straight up too. I have made the lines in the box not straight up to try and trick you."	2
2.	(Put S's eyes to viewer and move rod to and fro) "Can you see the stick moving in the box?"	"Yes"... 3 "No" ... 2
3.	(Put S's right hand on adjusting knob and guide it to turn knob to and fro) "You can move the stick by turning this knob. Move it for me." (Cease guidance)	Succeeds. 4 Fails.... 3

4.	"Now make the stick point straight up. You can take as long as you like."	Succeeds. 6 Fails 5
5.	(Withdraw S's head from viewer and use RFT model) "No, that is not straight up. Remember how you made this stick straight up even when this piece of wood was not straight up? Like this.(Demonstrate). Now make that stick point straight up".	Succeeds. 6 Fails . . . End
6.	(E sets frame to 28° left, rod to 48° left) "Now I want you to make that stick point straight up some more times." (Guide S's eyes to viewer) "Keep your eyes in here until I tell you we have finished everything. Now make the stick point straight up."	7
7.	Final intruction of Instruction 6 repeated for each trial until testing completed.	End

APPENDIX FOUR

INDIVIDUAL RECORD FORM

S No.	Name	Date of birth
Race	Handedness	Occupation
Schooling	Area of habitat	Test area
Date tested	Time tested	Interpreter
Visual acuity	Testing Record	

ROD-AND-FRAME TEST

ROD START POSITION (N° L+R)	FRAME 28° LEFT			FRAME 28° RIGHT			Mean Error of start Positions
	Rod c-w	Rod a-c	Mean Error	Rod c-w	Rod a-c	Mean Error	
48							
43							
46							
41							
50							
Mean Error							

Mean Error Clockwise ____ Mean Error Anticlockwise ____ Overall Mean Error ____

MÜLLER-LYER

Settings (CM)		VARIABLE										Mean Error
		3.5	17.5	2	16.5	3	18.5	1.5	17	2.5	18	
Standard	12											
	Error											
	8											
	Error											
Mean Error												

PONZO

Set-ting (cm)	DIAGRAM (1)			PHOTO			DRAWING			DIAGRAM (2)		
	Set 1	Set 2	Mean Error	Set 1	Set 2	Mean Error	Set 1	Set 2	Mean Error	Set 1	Set 2	Mean Error
4												
1												
3												
0												
2												
M. E.												

Remarks

Experimenter .....

APPENDIX FIVE

The Bausch and Lomb Master Ortho-Rater

The Master Ortho-Rater, developed between 1940 and 1943 by Tiffin, Wirt, Kuhn and Shephard in conjunction with Bausch and Lomb Inc., incorporates a battery of twelve visual tests. Its major professional and industrial use is to screen visual skills and reveal for referral to an optometrist those persons who may benefit from a closer eye examination. Essentially, the Ortho-Rater is a specialised stereoscope containing twelve test slides, seven of which test "distance" vision and five of which test "near" vision. The visual skills tested are:

1. For distance and near vision:
   (i) Heterophoria, vertical and horizontal
   (ii) Visual acuity, monocular and binocular
   (iii) Stereoscopic vision

2. Colour vision is tested in the "distance" condition only.

The instrument and the standard testing procedure enable the control of all variables except the one being tested to be realised, and has been shown to be highly valid in terms of the factor being tested and highly reliable as regards repeatability of results. (Sulżman, Cook and Bartlett, 1947; Gordon, Zeidner, Zagorski and Uhlaner, 1954.)

In the present study, a Master Ortho-Rater was used in the "near" condition to test binocular visual acuity and stereoscopic acuity.

The visual acuity test objects consist of large squares with diagonals at 90 degrees and 180 degrees respectively. Division into nine smaller squares enables the small square in each of the four corners to be used as the testing target. The target square is checkerboard-patterned, while the remaining corner and central squares are filled with half-tone dots. The subject's task is simply to indicate the corner in which the checkerboard is situated (upper, lower, left or right). Gradations in the sizes of the squares give acuity targets in twelve steps of progressive difficulty. As this is a non-letter test, no language or educational requirements are important in its administration.

The stereoscopic vision test consists of a slide with nine rows of numbers, each of the test rows having six (1, 2, 3, 4, 5, 6.). In each row, one number is located optically closer to the eyes of the subject. His task, which grows progressively more difficult, is to indicate the outstanding number. Obviously, this test involves certain educational skills as well as depth perception.

Both the above tests are scored in accordance with the Scoring Key and Manual provided by Bausch and Lomb Inc.

APPENDIX SIX

The Kinetic Visual Display Apparatus

The Kinetic Visual Display Apparatus produced by the Marietta Apparatus Company was used in the pilot study. The apparatus consists of a continuous plastic belt of black and white 3cm-wide stripes mounted on electrically-powered rollers, and controlled by a control box which has on/off, forward/reverse, and run/stop switches. The desired speed of rotation of the belt can be varied by setting a pointer on a calibrated dial on the control box.(30rpm were employed in the pilot study.)

A heavy wooden base and a plywood frame, both painted medium grey, were constructed to support the apparatus and impart a "television screen" effect to the moving belt. The dimensions of the actual stimulus were : vertical, 30cm; and horizontal, 50cm.

This apparatus is used to study illusions of movement due to disturbances of the image/retina system, the most marked of which is known as the "waterfall effect". This is exemplified by phenomena such as the apparent "backward" rotation when the turntable of a record-player is stopped after its central pivot has been fixated for approximately half a minute. Gregory (1966) points out that this illusory effect cannot be due to eyemovements, and this can be shown by using the Kinetic Visual Display Apparatus.

If the moving belt is followed across the screen, then the eyes rapidly returned to the beginning of the screen when the end is reached, this being done several times, there is no illusory after-effect when the belt is stopped. If the head and eyes are held steady, however, the belt appears to move backwards for an instant after it has been stopped. This suggests that the illusory effect is generated by the image/retina system.(Anstis and Gregory, 1964).

A review of literature on the autokinetic effect is provided by Gregory and Zangwill (1963).

APPENDIX SEVEN

Hewlett-Packard 9100B Statistical Models

One Way Analysis of Variance m x n

This programme separates the total variance in a table of data into a portion due to chance and a portion due to differences between and population means underlying each column of sample data. It then calculates the variance ratio.

$$F = \frac{nm(m-1) \sum_{j=1}^{n} (X_j - \bar{\bar{X}})}{(n-1) \sum_{i=1}^{m} \sum_{j=1}^{n} (X_{ij} - \bar{X}_j)}$$

with $\nu_1 =$ n - 1 degrees of freedom

$\nu_2 =$ n (m - 1) degrees of freedom

where

$$\bar{\bar{X}} = \frac{1}{mn} \sum_{i=1}^{m} \sum_{j=1}^{n} X_{ij}$$

$$\bar{X}_j = \frac{1}{n} \sum_{j=1}^{n} X_{ij}$$

The equation used by the programme is:

$$F = \frac{nm(m-1) \left\{ \sum_{j=1}^{n} \left[\sum_{i=1}^{m} X_{ij} \right]^2 - \frac{1}{mn} \left[\sum_{j=1}^{n} \sum_{i=1}^{m} X_{ij} \right]^2 \right\}}{(n-1) \left\{ \sum_{j=1}^{n} \sum_{i=1}^{m} X_{ij}^2 - \frac{1}{mn} \left[\sum_{j=1}^{n} \sum_{i=1}^{m} X_{ij} \right]^2 - \frac{1}{m} \sum_{j=1}^{n} \left[\sum_{i=1}^{m} X_{ij} \right]^2 + \frac{1}{mn} \left[\sum_{j=1}^{n} \sum_{i=1}^{m} X_{ij} \right]^2 \right\}}$$

Reference: Freund, John E., Mathematical Statistics, Prentice Hall (1962)

Mean and Standard Deviation

This programme calculates the mean, $\bar{X}$, and standard deviation, S, of a set of data points by the equations

$$\bar{X} = \frac{\sum_{i=1}^{n} X_i}{n} \qquad \text{and} \qquad S = \sqrt{\frac{\sum_{i=1}^{n} (X_i - \bar{X})^2}{n-1}}$$

Reference: Introduction to the Theory of Statistics
by Mood and Graybill
McGraw-Hill 1963

Linear Regression and Correlation Coefficient

This programme calculates the equation of the straight line of best fit of a set of data points. The best fit is determined by minimizing the sum of the squares of the deviations of the data points from the line.

The programme calculates m and b for the equation

$$Y = mX + b.$$

The programme also calculates a correlation coefficient r, an indication of goodness of fit. Note $-1 \leq r \leq 1$ where the sign corresponds to the slope m. If $r = 0$ there is no correlation, and if $r = \pm 1$ there is perfect correlation or a perfect fit.

The defining equations are

$$m = \frac{\sum_{i=1}^{n} (X_i - \bar{X})(Y_i - \bar{Y})}{\sum_{i=1}^{n} (X_i - \bar{X})^2}$$

$$b = \bar{Y} - m\bar{X}$$

where $\bar{Y} = \frac{\sum_{i=1}^{n} Y_i}{n}$ and $\bar{X} = \frac{\sum_{i=1}^{n} X_i}{n}$

$$r = \frac{\sum_{i=1}^{n} (X_i - \bar{X})(Y_i - \bar{Y})}{\sqrt{\sum_{i=1}^{n} (X_i - \bar{X})^2 \; \Sigma \; (Y_i - \bar{Y})^2}}$$

Reference: Mathematical Statistics
by John E. Freund
Prentice-Hall 1962

APPENDIX EIGHT

The Ponzo Apparatus

The Ponzo apparatus illustrated in Figure 16 consisted of an oblong hollow box, with a viewer positioned at one end and a stimulus figure slide holder at the other. Through the hollow box ran a steel shaft to which were attached the knob and pinion gear which rendered the apparatus subject-adjustable.

The Oblong Box and Viewer

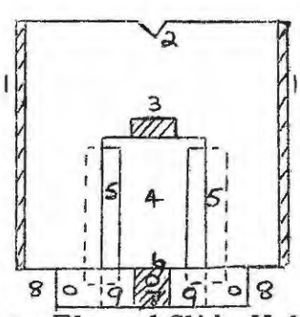
The box was constructed of plywood, 5mm. thick. It measured 65cm. long 7cm. high, and 21cm. wide. The width of the box provided a stable base for the apparatus; the height allowed for the required vertical movement of the variable slide; and the length of the box approximated the arm's-reach of an adult male. (These dimensions were arrived at after experimentation with cardboard mock-ups).

The Viewer, constructed of wood, served to position the subject's eyes at a level midway between the standard and variable lines of the stimulus figures.

The Slide Holder

The Slide Holder, which held the stimulus figure slides, was constructed of white perspex, 3mm. thick. It was secured by two wingnuts to the rear end of the Box, and was detachable.

1. L-mountings
2. Notch
3. Standard line background
4. Rectangular aperture
5. Variable line slide supports



Rear Eln. of Slide Holder

6. Hole for shaft
7. Block
8. Holes for bolts
9. Front support

Not to scale

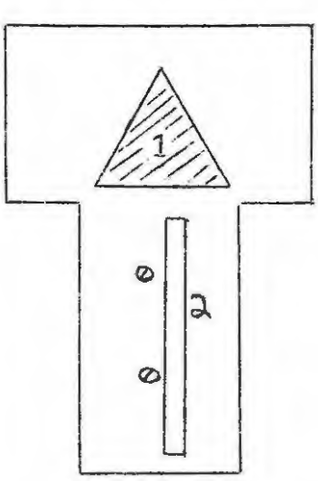
The L-mountings held the stimulus figure slides in position, and were constructed of 5mm. x 3mm. black perspex.

The notch at the top of the slide holder allowed for easy

extraction of the stimulus figure slides. The red background for the standard line was painted above the rectangular aperture into which the variable line slide fitted. The support shown, plus spacers and minor supports which are not shown, ensured free vertical movement of the variable line slide. The perspex block bonded to the front support acted as a mounting for the adjustment shaft, which passed through a hole drilled through the block. To the rear of one of the back supports was pasted a paper measure, which together with the pointer on the variable line slide, allowed readings to 0.5mm. to be taken.

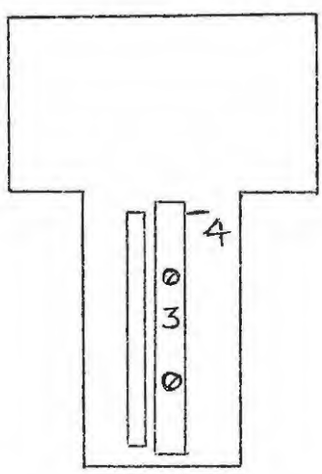
The Variable Line Slide

The variable line slide, which, when moved up and down vertically, served to vary the length of the variable line, fitted into the rectangular aperture of the stimulus figure slide holder. It was constructed of perspex, 3mm. thick.



Front Eln.

1. Variable line background
2. Aperture for shaft
3. Rack gear mounting
4. Pointer



Rear Eln.

Variable Line Slide

The triangular red-painted variable line background served to vary the length of the lower line as the slide was moved. The aperture accommodated the adjustment shaft, while the rack gear mounting, a strip of perspex extending past the teeth of the rack gear, ensured that the pinion gear meshed correctly. The pointer attached to this

mounting indicated the length of the variable line.

The Adjustment Mechanism

The adjustment mechanism consisted of a 3mm. diameter steel shaft, 68cm. long, extending from the adjustment knob at the "viewer" end of the Box to the control knob behind the stimulus figure slide holder.

The small spring behind the adjustment knob prevented undue backward/forward movement of the shaft. Items 5, 6, and 7 were bonded together, thus they moved as a unit.

The pinion gear fixed to the shaft was 1.5cm. in diameter, and had 24 teeth.

The Stimulus Slides

There were three stimulus slides, each measuring 24cm. high and 25cm. wide. The slides were made of black perspex, 1.5mm. thick, and on them were pasted the stimulus figures. The figures consisted of a conventional Ponzo figure, a photograph of a bridge and its surroundings, and a line drawing of the same scene. (See Figure 16).

The standard line in each slide was 2cm. long and 2mm. wide and was produced by an aperture being cut in the slide, thus rendering the red background painted on the stimulus figure slide holder visible. An aperture 4cm. long and 2mm. wide was cut in each slide to allow the variable line to be visible. The two lines were 6cm. apart.

The Ponzo Diagram consisted of the conventional Ponzo figure drawn in black on a white background. The context lines were 13cm. long, and were angled at 55° from each other. Initially, the lines were at the same angle to each other as are those of the slides of the bridge shown on the other two slides. However, trials indicated that this angle — 110° — when used in the diagram produced no illusory effect.

The Bridge Photograph was taken in the Albany district. The bridge shown on chosen because the adjacent telephone poles added to the perspective effect and it did not have the heavy white lines, which are found on modern tarred bridges, down its centre. In this photograph, the roadway edges were at an angle of 110°.

The Bridge Drawing was produced from a tracing of the photograph, although detail was monitored to enhance the effect of perspective. It was drawn in black ink on white paper.

Ponzo and Müller-Lyer Comprehension Check

To ensure that unacculturated subjects were familiar with the concept of equal length before being exposed to the Ponzo and Müller-Lyer experimental tasks, they were required to match plywood rods, 5mm. thick and 5mm. wide. There were eight such rods, 8cm. (2), 9cm., 10cm. (2), 11cm. and 12cm. (2) in length.

APPENDIX NINE

The Portable Rod-and-Frame Test

The portable RFT illustrated in Figure 14 consisted of a base on which were mounted the tapered circular tubes through which the rod-and-frame display was viewed, a rod adjustment mechanism which could be operated by the subject and by the experimenter, and a pointer on a protractor, from which readings were taken. Many of its dimensions were based on those of Morris' (1967) Rod-and-Frame Box.

Base and Mountings

The base was constructed of wood 1.6cm. thick and measured 35cm. x 25cm. To this black-painted base were bolted four mountings, constructed of 1.1cm. thick perspex, two of which held the adjustment shaft and two the rod control shaft. These mountings were 19cm. long with holes drilled at a height of 17.5cm. to accommodate the two shafts.

The tube mounting was constructed of wood and formed a cradle onto which the exterior tube was nailed.

Exterior and Interior Tubes and Viewer

The exterior tube, 22cm. long, held the interior tube, which was glued into position. Both tubes were made of plastic. The exterior tube tapered from a diameter of 22cm. at the open ("rod-and-frame") end to a diameter of 16cm. at the end into which the viewer was fitted. It was 25.5cm. long, and was spray-painted matt black, both inside and out.

The viewer was constructed of tin, with a soft rubber lining. It was shaped to ensure that once the subject was positioned to look through the viewer, external cues were not visible.

Rod and Frame

The Rod was 11.3cm. long and 3mm. in diameter. It was constructed of steel shafting which was painted black and welded to the rod control shaft.

The Frame, which measured 11.5cm. square with lines 3mm.

thick, was painted in gloss black on opaque white perspex, 25cm. square and 3mm. thick, which had been rubbed with a mild abrasive substance to obviate any reflection. The rear surface of the perspex was spray-painted light grey to prevent any show-through of light or mechanism.

The Rod-and-Frame dimensions follow those used by Morris for her Rod-and-Frame Box.

The Frame was centered 2.5mm. from the end of the interior tube, thus allowing light entry to render the Rod-and-Frame clearly visible at 28cm. from the viewer, the distance used by Morris. When suitably positioned to the source of light, a bright but diffused illumination, casting no shadows, was obtained.

The perspex square upon which the Frame was painted was mounted on a steel collar which was connected to a mounting and allowed the rod control shaft to revolve freely within it. The perspex square was held at the 28° right and left positions by shafts, 5cm. long, which extended through brackets fixed to the perspex square into holes drilled into the wooden base.

Rod Control Shaft

The steel rod control shaft was 19.5cm. and 3mm. in diameter. To one end was welded the Rod, to the other the deviation pointer. It was supported by two mountings; a protractor, 12.5cm. in diameter and mounted on perspex being affixed to the rear mounting. This enabled readings to 0.5° to be taken from the deviation pointer.

A pulley, 2cm. in diameter was fixed to the middle of the shaft.

Adjustment Mechanism

The adjustment mechanism consisted of a round brass knob, 2.5cm. in diameter, on one end of a 3mm. diameter steel shaft, 37cm. long, with the experimenter's control knob fixed to the other end. Springs positioned between the knobs and two mountings prevented undue backward/forward movement of the shaft.

The pulley, 2cm. in diameter, was fixed to the adjustment shaft directly opposite the pulley on the rod control shaft. A length of knotted cord connected to two pulleys, which were 13cm. apart, and enabled accurate and slip-free adjustments of the Rod to be made.

The Comprehension Check

The RFT comprehension check was used to ensure that the unacculturated subjects were familiar with the concept of the true and unchanging vertical before they were exposed to the RFT experimental task. It was a 18cm. plywood square, painted white, with a 1cm. wide border imparting a "frame" effect. A black-painted plywood rod, 1cm. wide and 16cm. long, was fixed by a small bolt through its centre to the centre of the square. The rod could be revolved freely by hand.

APPENDIX TEN

The Müller-Lyer Illusion Apparatus

The Müller-Lyer figure (See Figure 15) was housed in a box of the same dimensions as that of Day (1962) — it was 65.5cm. long, 41.5cm. wide, and 41.0cm. deep.

Box Viewer, Lid and Base

The box was constructed of black perspex, 5mm. thick, with apertures in the front and rear ends for the viewer and Müller-Lyer figure slides respectively. The latter aperture measured 41.5cm. long and 11cm. high. The interior of the box was spray-painted matt black to avoid reflection.

The viewer was constructed of wood and was centered with the horizontal line of the Müller-Lyer figure, which was 25cm. from the bottom of the box.

The lid of the box was detachable and extended from the viewer end to within 17cm. of the rear end, thus allowing natural illumination of the Müller-Lyer figure.

The box was fixed by wingnuts to a 67cm. square wooden base, 2cm. thick, thus enabling it to be detached for transport when necessary. Two platforms on the base were fixed to the mountings for the adjustment shaft.

Adjustment Mechanism

The adjustment mechanism for the variable slide consisted of a steel shaft 72cm. long and 3mm. in diameter supported between two metal mountings. Two springs prevented undue backward/forward movement of the shaft, which had an adjustment knob and a control knob fixed to its ends.

A 36-teeth pinion gear, 2cm. in diameter, was fixed to the shaft and meshed with the rack gear fixed to the variable slide. The rack gear was 23cm. long and allowed the variable slide to move freely through a range of 20cm. Strips of perspex 1.5mm. thick were bolted to the sides of the rack gear. These extended 3mm. past the teeth, and ensured that the rack and pinion gears engaged squarely.

The Müller-Lyer Figure

The conventional composite version of the Müller-Lyer figure, with horizontal lines between the "arrowhead" obliques, was used.

All obliques were 4cm. long and 2mm. wide, angled at 45° degrees from the horizontal line, which was also 2mm. wide, but extended along the length of the fixed centre slide, i. e. 41. 5cm. The obliques and horizontal line were black-painted in precut grooves in the slides.

The obliques did not touch the horizontal line, but were positioned 1mm. above and below it. There was a gap of 2mm. in the horizontal line at the intersection of the middle diagonals.

These measures made the communication of the task, i. e. "make the lines the same length", extremely simple.

The Slides

The standard, variable and fixed centre slides were constructed of white perspex, 3mm. thick. The backs of these slides were spray-painted light grey to prevent the show-through of shadows and of those portions of the black horizontal line painted on the fixed centre slide which were concealed behind the standard and variable slides. (See Figure 15b).

The fixed centre slide, with the horizontal line and the middle pair of obliques painted on it, was bonded to mountings at the rear of the box. The mountings allowed the two movable slides to move freely in front of the centre slide.

The standard slide, always positioned to the subject's left, was moved manually by the experimenter to obtain the required standard settings. The slide was 20cm. long and 13cm. wide, with obliques painted on the edges of triangular cut-out. The centre notch served to extend the horizontal line to the intersection of the obliques.

A paper measure, marked in millimetres, was glued to the back of the slide. This measure enabled the standard horizontal line to be set at the required length for each set of trials. The end of the fixed centre slide was used as the length indicator.

The variable slide was adjusted by the subject activating the rack and pinion gear mechanism. The rack-gear was bonded and bolted to the slide, which was always positioned to the viewer's right.

The slide was 24.5cm. long with the notched triangular section, on the edges of which are painted the obliques, extending a further 2.8cm.; and 13cm. wide. As in the standard slide, the notch served to extend the horizontal line to the intersection of the obliques.

A paper measure glued to the rear of the slide measured the exposed length of horizontal line in the same way as does the measure on the standard slide. Readings to 0.5mm. could be taken.

The comprehension check for this task was the same as that for the Ponzo task. (See Appendix Eight).

APPENDIX ELEVEN

Individual and Group Results on the
RFT and Müller-Lyer and Ponzo Illusion Tasks*
Xhosa Rural, Xhosa Urban, Xhosa Student
and White Student Groups

* RFT results expressed as $\underline{n}^{o}$ deviation from vertical, mean of 20 trials. Müller-Lyer and Ponzo illusion results expressed as $\underline{n}^{cm.}$ deviation from length of standard stimulus, mean of 10 trials. Individual results are thus expressed as mean deviations, and group results as average mean deviations. Minus signs identify non-illusion-produced responses on the Müller-Lyer and Ponzo tasks.

Xhosa Rural (XR) Group

S No.	Age (Yrs)	Education (Yrs)	RFT	Müller-Lyer		Ponzo			
				12cm.	8cm.	Diagram	Photo	Drawing	Diagram
1	18	4	2.625	1.18	0.99	.060	-.095	-.035	.050
2	42	0	4.800	1.16	1.09	-.115	-.025	-.060	-.165
3	18	8	4.625	2.62	1.20	.110	.010	.325	.050
4	17	5	4.825	1.47	0.67	.120	.305	.415	.260
5	40	5	5.300	1.34	0.44	.005	.065	.070	-.030
6	28	4	1.175	1.69	1.20	.040	.165	.135	.205
7	35	7	9.600	1.04	1.14	.175	.040	.125	.020
8	26	0	4.625	1.38	1.30	.015	.115	.160	.080
9	34	7	4.125	0.87	1.08	.185	.055	.210	.235
10	24	6	9.300	1.80	0.64	.105	.030	.380	.200
11	29	6	3.450	2.30	1.15	.005	-.240	-.005	-.060
12	34	10	3.125	1.20	0.10	.165	.135	.330	.130
13	20	4	3.850	1.62	0.34	-.050	-.215	-.085	.030
14	20	8	2.975	1.44	0.79	.070	.075	.255	.075
15	18	10	4.100	2.08	1.05	-.040	-.130	-.105	-.210
Means	-	-	-	-	-	.057	.019	.141	.058
16	47	6	3.800	2.94	1.59	-.085	-	-	-.100
17	38	3	11.600	1.23	1.00	-.150	-	-	-.150
18	23	6	6.800	1.74	1.63	.120	-	-	.130
19	41	3	3.275	1.60	1.35	.175	-	-	-.080
20	26	6	4.250	1.91	1.25	.010	-	-	.065
21	36	5	2.100	1.89	1.28	.050	-	-	.085
22	23	0	4.600	1.00	0.75	-.005	-	-	.010
23	42	0	4.600	2.81	1.23	.105	-	-	-.025
24	25	3	2.975	0.88	0.72	-.175	-	-	-.060
25	25	8	3.100	1.87	1.04	.255	-	-	.225
26	40	8	3.200	2.14	1.62	.155	-	-	-.035
27	21	5	3.825	2.27	1.11	-.040	-	-	.065
28	19	5	1.500	0.93	0.60	.235	-	-	.280
29	17	6	4.750	0.58	0.70	.095	-	-	.030
30	19	10	0.775	2.36	1.42	-.070	-	-	-.035
Means	-	-	-	-	-	.045	-	-	.027
Group Means	28	5.3	4.322	1.645	1.016	.051	-	-	-

Xhosa Urban (XU) Group

S No.	Age (Yrs.)	Education (Yrs.)	RFT	Müller-Lyer		Ponzo			
				12cm.	8cm.	Diagram	Photo	Drawing	Diagram
1	24	0	3.900	0.16	0.05	.145	.800	.260	.275
2	22	3	1.800	2.42	1.27	.080	- .105	.130	.050
3	27	6	3.225	1.54	0.44	.040	.050	.185	.035
4	32	7	3.900	0.92	0.99	.185	.090	.195	.270
5	20	7	1.700	1.63	1.66	.295	.200	.375	.405
6	21	5	7.075	0.81	1.05	- .010	.330	.170	.170
7	26	8	6.300	0.68	0.31	.025	.310	.470	.495
8	21	6	4.650	0.51	0.52	.080	.600	.930	.155
9	34	10	1.550	1.82	0.77	.055	.260	.095	- .140
10	36	7	3.350	1.11	0.76	- .035	.385	.095	.010
11	48	6	7.775	2.32	0.60	.115	.410	.460	.120
12	36	6	1.325	1.69	1.80	.090	- .110	.045	.120
13	34	7	3.300	0.52	0.90	.095	.130	.160	.165
14	23	10	1.825	0.58	-0.02	.050	.235	.205	.060
15	20	7	4.875	2.56	2.00	.370	.500	.635	.820
Means	-	-	-	-	-	.105	.272	.294	.201
16	25	1	1.675	0.00	-0.37	.035	-	-	.125
17	30	4	3.175	1.54	0.64	.125	-	-	.030
18	40	0	3.775	1.17	0.41	.125	-	-	.245
19	26	7	1.400	2.20	0.61	.025	-	-	- .035
20	27	0	3.250	0.80	0.06	- .115	-	-	.115
21	26	5	3.375	1.77	1.16	- .130	-	-	- .155
22	42	0	2.625	0.37	0.19	- .040	-	-	- .020
23	25	6	1.075	2.56	1.86	.235	-	-	.210
24	34	3	2.600	2.16	1.56	- .015	-	-	- .010
25	30	4	6.075	0.62	0.16	.115	-	-	.260
26	25	8	0.900	0.80	0.04	.105	-	-	.035
27	31	6	13.525	1.98	1.63	.155	-	-	.275
28	29	10	5.600	0.98	0.12	.115	-	-	.380
29	36	7	2.975	2.26	0.42	.025	-	-	.085
30	34	7	1.075	2.29	1.12	.065	-	-	.035
Means	-	-	-	-	-	.045	-	-	.105
Group Means	29	5.5	3.655	1.359	0.757	.075	-	-	-

Xhosa Student (XS) Group

S No.	RFT	Müller-Lyer		Ponzo			
		12cm.	8cm.	Diagram	Photo	Drawing	Diagram
1	1.650	0.45	-0.19	-.055	-.040	.085	.185
2	3.025	1.71	0.93	.125	.135	.320	.195
3	1.500	1.58	1.50	.190	.235	.135	.310
4	1.675	1.79	1.65	.120	.065	.155	.175
5	1.675	2.37	1.40	.100	.020	.260	.235
6	3.200	2.10	1.82	.110	.360	.425	.205
7	1.850	1.28	0.82	.150	.175	.190	.270
8	3.850	0.43	0.68	.220	.155	.220	.125
9	1.825	0.38	0.29	-.030	-.165	.035	.010
10	1.225	1.52	0.77	.065	.290	.430	.275
11	3.525	2.42	1.69	-.155	-.150	.160	.045
12	1.800	2.65	2.40	.210	-.065	.085	.160
13	1.750	2.26	0.73	.070	.085	.165	.095
14	2.125	0.79	0.79	.070	.280	.600	.270
15	1.525	2.32	1.50	.230	.180	.370	.300
Means	-	-	-	.095	.104	.242	.190
16	0.975	1.78	1.02	.065	-	-	.060
17	1.125	0.92	0.89	.075	-	-	.070
18	1.675	1.90	1.89	.415	-	-	.370
19	4.475	2.22	2.18	.075	-	-	.060
20	4.725	1.31	1.45	.045	-	-	.170
21	1.150	2.20	1.55	.225	-	-	.160
22	1.525	2.16	1.05	.110	-	-	.050
23	3.250	0.69	1.46	.095	-	-	.080
24	1.375	2.14	1.38	.265	-	-	.245
25	2.625	1.51	1.08	-.005	-	-	-.005
26	2.275	1.22	1.19	.210	-	-	.280
27	2.750	2.19	1.45	.160	-	-	.225
28	2.925	2.85	1.91	.250	-	-	.230
29	4.800	1.41	0.82	.125	-	-	.190
30	0.825	1.04	0.66	.125	-	-	.145
Means	-	-	-	.149	-	-	.155
Group Means	2.289	1.653	1.225	.122	-	-	-

White Student (WS) Group

S No.	RFT	Müller-Lyer		Ponzo			
		12cm.	8cm.	Diagram	Photo	Drawing	Diagram
1	3.550	2.72	1.39	.110	.313	.690	.580
2	1.375	1.34	0.79	.090	.105	.415	.250
3	1.250	2.95	1.68	-.010	.095	.320	.225
4	4.475	1.00	0.91	.145	-.035	.370	.385
5	0.800	2.70	1.43	.060	.335	.460	.065
6	1.175	1.98	1.02	.070	-.020	.200	.105
7	2.275	1.52	1.53	-.055	.035	.215	.090
8	1.625	1.65	1.04	.205	.470	.300	.295
9	1.725	1.65	1.17	-.075	-.090	.025	.075
10	0.975	2.31	1.26	.175	.325	.403	.155
11	0.975	1.69	0.92	.130	.135	.355	.140
12	3.350	3.01	0.64	-.045	.100	.165	.200
13	2.000	1.91	1.98	.165	.290	.615	.260
14	3.375	2.05	1.45	.110	.005	.110	.110
15	3.425	1.77	1.86	.225	.050	.225	.230
Means	-	-	-	.087	.127	.324	.211
16	2.550	3.70	2.75	.215	-	-	.190
17	2.925	1.81	0.75	.090	-	-	-.050
18	2.025	1.79	1.09	.030	-	-	.100
19	1.175	1.47	1.10	.030	-	-	-.080
20	2.150	2.22	1.45	.200	-	-	.135
21	2.225	2.72	1.43	.035	-	-	.040
22	0.325	0.93	0.95	.020	-	-	.250
23	2.125	0.92	0.33	.180	-	-	.280
24	1.175	2.31	1.54	.260	-	-	.310
25	2.000	1.51	0.89	.060	-	-	-.010
26	3.550	1.92	1.21	.390	-	-	.355
27	2.225	2.08	0.82	.090	-	-	.145
28	2.100	0.28	-0.06	.475	-	-	.540
29	2.100	1.18	0.31	.020	-	-	.025
30	1.675	0.35	0.93	-.050	-	-	.080
Means	-	-	-	.136	-	-	.143
Group Means	2.089	1.847	1.152	.111	-	-	-

REFERENCES

ALLPORT, F.H. (1955) Theories of perception and the concept of structure. New York : Wiley.

ALLPORT, G.W. (1928) The eidetic image and the after image. Am. J. Psychol., 40, 1, 418-425.

ALLPORT, G.W., and PETTIGREW, T.F. (1957) Cultural influence on the perception of movement : the trapezoidal illusion among Zulus. J. Abn. Soc. Psychol., 55, 104-113.

AMES, A. (1951) Visual perception and the rotating trapezoidal window. Psychol. Monogr., 65, No7. (Whole No. 324).

ANSTIS, S.M., and GREGORY, R.L. (1964) The after-effect of seen motion : the role of retinal stimulation and eye movements. Quart. J. Exp. Psychol. Cited by Gregory (1966).

ASCH, S.E., and WITKIN, H.A. (1948a) Studies in space orientation: 1. Perception of the upright with displaced visual fields. J. Exp. Psychol., 38, 325-337.

ASCH, S.E., and WITKIN, H.A. (1948b) Studies in space orientation: 2. Perception of the upright with displaced visual fields and with body tilted. J. Exp. Psychol., 38, 455-477.

BAGBY, J.W. (1957) A cross-cultural study of perceptual predominance in binocular rivalry. J. Abn. Soc. Psychol., 54, 331-334.

BELLER, E. (1958) A study of dependency and perceptual orientation. Paper read at Amer. Psychol. Assn., Washington. Cited by Witkin et al. (1962).

BERRY, J.W. (1966) Temne and Eskimo perceptual skills. Int. J. Psychol., 1, 3, 207-229.

BERRY, J.W. (1968) Ecology, perceptual development and the Muller-Lyer illusion. Brit. J. Psychol., 59, 3, 205-210.

BEVERIDGE, W.M. (1935) Racial differences in phenomenal regression. Brit. J. Psychol., 26, 59-62.

BEVERIDGE, W.M. (1939) Some racial differences in perception. Brit. J. Psychol., 30, 57-64.

BIERI, J. (1960) Parental identification, acceptance of authority and within-sex differences in cognitive behaviour. J. Abn. Soc. Psychol., 60, 76-79.

BIERI, J., BRADBURN, W.M., and GALINSKY, M.D. (1958) Sex differences in perceptual behaviour. J. Pers., 27, 74-86.

BIESHEUVEL, S. (1952) The study of African ability: Part 1. The intellectual potentialities of Africans. Afr. Stud., 11, 2, 45-58.

BIESHEUVEL, S. (1958) Objectives and methods of African psychological research. J. Soc. Psychol., 47, 161-168.

BING, E. (1963) Effects of child-rearing practices on development of differential cognitive abilities. Child Devlm., 34, 631-648.

BONTE, M. (1962) The reaction of two African societies to the Müller-Lyer illusion. J. Soc. Psychol., 58, 265-268.

BROWN, L.B. and HOUSSIADAS, L. (1964) Illusiory perception as a constancy phenomenon. Nature, 204, 302.

BROWN, L.B., and HOUSSIADAS, L. (1965) The perception of illusions as a constancy phenomenon. Brit. J. Psychol., 56, 2 and 3, 135-141.

BROWN, R.W. (1958) Words and things. Glencoe: Free Press. Cited by Doob (1960).

BROWN, R.W., and LENNEBERG, E.H. (1954) A study in language and cognition. J.Abn. Soc. Psychol., 49, 454-462.

BRUNSWIK, E., and KAMIYA, J. (1953) Ecological cue-validity of 'proximity' and of other Gestalt factors. Am. J. Psychol., 66, 20-32.

BUROS, O.K. (1959) (Ed.) The Fifth Mental Measurements Yearbook. New York: Gryphon Press.

CAMPBELL, D.T. (1964) Distinguishing differences of perception from failures of communication in cross-cultural studies. Chapt. 18 in Cross-cultural understanding: Epistomology in Anthropology, ed. by F.S.C. Northrop and H.H. Livingstone; New York: Harper and Row.

CRONBACH, L.J., and FURBY, L. (1970) How should we measure "change" — or should we? Psychol. Bull., 74, 1, 68-80.

CRUTCHFIELD, R.S. (1963) Independent thought in a conformist world. In S.M. Farber and R.H.L. Wilson (Eds.), Conflict and creativity: control of the mind; New York: McGraw Hill.

CRYNS, A.G.J. (1962) African intelligence: a critical survey of cross-cultural intelligence research in Africa south of the Sahara. J. Soc. Psychol., 57, 283-301.

DAWSON, J.L.M. (1963) Psychological effects of social change in a West African community. Unpub. Doctoral dissertation, Oxford University.

DAWSON, J.L.M. (1967a) Cultural and physiological influences upon spatial - perceptual processes in West Africa. Part I. Int. J. Psychol., 2, 2, 115-128.

DAWSON, J.L.M. (1967b) Cultural and physiological influences upon spatial - perceptual processes in West Africa. Part II. Int. J. Psychol., 2, 3, 171-185.

DAY, R.H. (1962) The effect of repeated trials and prolonged fixation on error in the Muller-Lyer figure. Psychol. Monogr., 76, 14. (Whole No. 533).

DEREGOWSKI, J.B. (1967) The Horizontal-vertical illusion and the ecological hypothesis. Int. J. Psychol., 2, 4, 269-273.

DEREGOWSKI, J.B. (1968a) On perception of depicted orientation. Int. J. Psychol., 3, 3, 149-156.

DEREGOWSKI, J.B. (1968b) Difficulties in pictorial depth perception in Africa. Brit. J. Psychol., 59, 3, 195-204.

DEUTSCH, C.P. (1968) Environment and perception. Chapt. 2 in M. Deutsch, I. Katz, and A.R. Jensen (Eds.): Social class, race, and psychological development. New York: Holt, Rinehart and Winston.

DOOB, L.W. (1957) The use of different test items in non-literate societies. Publ. Opinion Quart., 21, 499-504.

DOOB, L.W. (1960) The effect of codability upon the afferent and efferent functioning of language. J. Soc. Psychol., 52, 3-15.

DOOB, L.W. (1964) Eidetic images among the Ibo. Ethnology, 3, 357-363.

DOOB, L.W. (1965a) Psychology. Chapt. 14 in R.A. Lystad (Ed.): The African World. London: Pall Mall Press.

DOOB, L.W. (1965b) Exploring eidetic imagery among the Kamba of Central Kenya. J. Soc. Psychol., 67, 3-22.

DU PREEZ, P.D. (1968) Social change and field dependence in South Africa. J. Soc. Psychol., 76, 265-266.

DU TOIT, B.M. (1966) Pictorial depth perception and linguistic relativity. Psychol. Afr., 11, 51-63.

EAGLE, C.J. (1959) Personal communication to Witkin. Cited by Witkin. Cited by Witkin et al. (1962).

ELLIOT, R. (1961) Interrelationships among measures of field dependency, ability and personality traits. J. Abn. Soc. Psychol., 63, 27-32.

ENGLISH, H.B., and ENGLISH, A.C. (1959) A comprehensive dictionary of psychological and psychoanalytical terms. Longmans, Green & Co.

EPSTEIN, L. (1957) The relationship of certain aspects of the body image to the perception of the upright. Unpub. Doctoral dissertation, N.Y.U. Cited by Witkin et al. (1962).

FEINBERG, J.R. (1951) Sex differences in resistance to group pressure. Unpub. Master's dissertation, Swarthmore College. Cited by Witkin et al. (1962).

FENCHEL, G.H. (1958) Cognitive rigidity as a behavioural variable manifested in intellectual and perceptual tasks by an outpatient population. Unpub. Doctoral dissertation, N.Y.U. Cited by Witkin et al. (1962).

FERENCZI, V. (1966) La perception de l'espace projectif. Paris: Didier. Cited by Hudson (1967).

FISHER, G.H. (1968a) The frameworks for perceptual localization. Newcastle : G.H. Fisher.

FISHER, G.H. (1968b) An experimental and theoretical appraisal of the inappropriate size-depth theories of illusions. Brit. J. Psychol., 59, 4, 373-383.

FISHER, G.H. (1968c) An experimental comparison of rectilinear and curvilinear illusions. Brit. J. Psychol., 59, 1, 23-28.

FISHER, G.H. (1968d) Illusions and size-constancy. Am. J. Psychol., 81, 2-20.

FISHER, G.H. (1969) Towards a new explanation for the geometrical illusions. I. The properties of contours which introduce illusory distortion. Brit. J. Psychol., 60, 2, 179-185.

FISHER, S. (1964) Personal communication to Witkin. Cited by Witkin et al. (1962).

FLIEGEL, Z.O. (1955) Stability and change in perceptual performance of a late adelescent group in relation to personality variables. Unpub. Doctoral dissertation, N.Y. School for Soc. Res. Cited by Witkin et al. (1962).

GANZ, L. (1966) Mechanism of the figural aftereffects. Psychol. Rev., 73, 2, 128-150.

GARDNER, R.W. (1957) Field dependence as a determinant of susceptibility to certain illusions. Am. Psychol., 12, 397. (Abstract).

GARDNER, R.W. (1961) Cognitive controls of attention deployment as determinants of visual illusions. J. Abn. Soc. Psychol., 62, 1, 120-127.

GARDNER, R.W., and LONG, R.I. (1960a) Errors of the standard and illusional effects with the inverted - T. Perc. Mot. Skills, 10, 47-54.

GARDNER, R.W., and LONG, R.I. (1960b) Errors of the standard and illusional effects with L - shaped figures. Perc. Mot. Skills, 10, 107-109.

GOODMAN, B. (1960) Field dependence and the closure factors. Unpub. study. Cited by Witkin et al. (1962).

GORDON, B. (1953) An experimental study of dependence - independence in a social and laboratory setting. Unpub. Doctoral dissertation, U.S.C. Cited by Witkin et al. (1962).

GORDON, D.A., ZEIDNER, J., ZAGORSKI, H.J., and UHLANER, J.E. (1954) A psychometric evaluation of Ortho-Rater and Wall-Chart Tests. Am. J. Ophthalmology, May 1954.

GREENBERG, J.H. (1965) Linguistics. Chapt. 15 in R.A. Lystad (Ed.): The African World. London: Pall Mall.

GREGOR, A.J., and McPHERSON, D.A. (1965) A study of susceptibility to geometric illusion among cultural subgroups of Australian Aborigines. Psychol. Afr., 11, 1-13.

GREGORY, R.L. (1963) Distortion of visual space as inappropriate constancy scaling. Nature, 199, 678-680.

GREGORY, R.L. (1966) Eye and brain : the psychology of seeing. London : World University Library.

GREGORY, R.L. (1968) Visual illusions. Scient. Am., 219, 5, 66-76.

GREGORY, R.L. (1970) The intelligent eye. London: Weidenfeld & Nicholson.

GREGORY, R.L., and WALLACE, J.G. (1963) Recovery from early blindness. Exp. Psychol. Monogr., (Whole No. 2.)

GREGORY, R.L., and ZANGWILL, O.L. (1963) The origin of the autokinetic effect. Quart. J. Exp. Psychol., 15, 4.

GRUEN, A. (1955) Dancing experience and personality in relation to perception. Psychol. Monogr., 69. (Whole No. 399).

GUILFORD, J.P. (1954) Psychometric methods. New York: McGraw-Hill.

GUILFORD, J.P. (1965) Fundamental statistics in psychology and education. Tokyo: McGraw-Hill.

GUILFORD, J.P., BERGER, R.M., and CHRISTENSEN, P.R. (1955a) A factor-analytic study of planning. Rep. Psychol. Lab., No. 12, Los Angeles, U.S.C. Cited by Witkin et al. (1962).

GUILFORD, J.P., FRICK, J.W., CHRISTENSEN, P.R., and MERRIFIELD, P.R. (1957) A factor-analytic study of flexibility in thinking. Rep. Psychol. Lab., No. 18, Los Angeles, U.S.C. Cited by Witkin et al. (1962).

GUILFORD, J.P., KETTNER, N.W., and CHRISTENSEN, P.R. (1955b) The relation of certain thinking factors to training criteria in the U.S. Coast Guard Academy. Rep. Psychol. Lab., No. 13, Los Angeles, U.S.C. Cited by Witkin et al. (1962).

GUILFORD, J.P., WILSON, R.C., and CHRISTENSEN, P.R. (1952) A factor-analytic study of creative thinking. Rep. Psychol. Lab., No. 8, Los Angeles, U.S.C. Cited by Witkin et al. (1962).

HABER, R.N., and HABER, R.B. (1964) Eidetic imagery. I: Frequency. Perc. Mot. Skills, 19, 131-138.

HAMILTON, V. (1966) Susceptibility to the Müller-Lyer illusion and its relationship to differences in size constancy. Quart. J. Exp. Psychol., 18, 63-72.

HERSKOVITS, M.J., CAMPBELL, D.T., and SEGALL, M.H. (1956) Materials for a cross-cultural study of perception. Prog. of Af. Stud., Northwestern U., Evanston, Ill.

HEUSE, G.A. (1957) Etudes psychologiques sur les Noirs Soudanais et Guineens. Rev. Psychol. Peuples, 12, 35-68. Cited by Pettigrew and Nuttall (1963).

HOTOPF, W.H.N. (1966) The size-constancy theory of visual illusions. Brit. J. Psychol., 57, 344, 307-318.

HUDSON, W. (1960) Pictorial depth perception in sub-cultural groups in Africa. J. Soc. Psychol., 52, 183-208.

HUDSON, W. (1962a) Pictorial perception and educational adaptation in Africa. Psychol. Afr., 9, 226-239.

HUDSON, W. (1962b) Cultural problems in pictorial perception. S.A.J. Sci., 58, 7, 189-196.

HUDSON, W. (1967) The study of the problem of pictorial perception among unacculturated groups. Int. J. Psychol., 2, 2, 89-107.

HUSTMYER, F.L. (1964) Background autonomic activity and analytic perception. J. Abn. Soc. Psychol., 68, 4, 467-468.

IMMERGLUCK, L. (1966a) Visual figural after-effects and field dependence. Psychon. Sci., 4, 6, 219-220.

IMMERGLUCK, L. (1966b) Figural after-effects, rate of "figure-ground" reversal, and field dependence. Psychon. Sci., 6, 2, 45-46.

IMMERGLUCK, L. (1966c) Resistance to an optical illusion, figural after-effects, and field dependence. Psychon. Sci., 6, 6, 281-282.

IMMERGLUCK, L. (1968a) Comment on "Figural aftereffects, illusions and the dimension of field dependence". Psychon. Sci., 11, 10, 363.

IMMERGLUCK, L. (1968b) Further comments on "Is the figural aftereffect an aftereffect?" Psychol. Bull., 70, 3, 198-200

IMMERGLUCK, L. (1970) Figural aftereffects potency: a function of sex or field-dependence? Psychon, Sci., 18, 6, 317-318.

JAHODA, G. (1966) Geometric illusions and environment: a study in Ghana. Brit. J. Psychol., 51, 142, 193-199.

JENSEN, A.R. (1969) How much can we boost I.Q. and scholastic achievement? Harv. Educ. Rev., 39, 1, 1-123.

KARP, S.A. (1963) Field dependence and overcoming embeddedness. J. Consult. Psychol., 27, 294-302.

KILBRIDE, P.L., and ROBBINS, M.C. (1968) Linear perspective, pictorial depth perception and education among the Baganda. Perc. Mot. Skills, 27, 601-602.

KILBRIDE, P.L., ROBBINS, M.C., and FREEMAN, R.B. (1968) Pictorial depth perception and education among Baganda school children. Perc. Mot. Skills, 26, 1116-1118.

KLUCKHOHN, C., and LEIGHTON, D. (1946) The Navaho. Cambridge: Harvard U. Press. Cited by Michael (1953).

KÖHLER, W., and FISHBACK, J. (1950a) The destruction of the Müller-Lyer illusion in repeated trials: 1. An examination of two theories. J. Exp. Psychol., 40, 267-281.

KÖHLER, W., and FISHBACK, J. (1950b) The destruction of the Müller-Lyer illusion in repeated trials: II. Satiation patterns and memory traces. J. Exp. Psychol., 40, 398-410.

KONSTADT, N., and FORMAN, E. (1965) Field dependence and external directedness. J. Pers. Soc. Psychol., 1, 490-493.

KÜNNAPAS, T.M. (1955) An analysis of the "vertical-horizontal illusion". J. Exp. Psychol., 49, 2, 134-140.

KÜNNAPAS, T.M. (1958) Measurement of subjective length in the vertical-horizontal illusion. Acta Psychologica, 14, 371-374.

KÜNNAPAS, T.M. (1959) The vertical-horizontal illusion in artificial visual fields. J. Psychol., 47, 41-48.

LINTON, H.B. (1952) Relations between mode of perception and tendency to conform. Unpub. Doctoral dissertation, Yale U. Cited by Witkin et al. (1962).

MacARTHUR, R. (1967) Sex differences in field dependence for the Eskimo. Int. J. Psychol., 2, 2, 139-140.

MACHOVER, K. (1954) Personal communication to Witkin. Cited by Witkin et al. (1962).

MACKAVY, W.R. (1970) Effects of instructions upon a perspective illusion. Psychon. Sci., 18, 2, 105-106.

MAYER, P. (1961) Townsmen or tribesmen: conservatism and the process of urbanization in a South African city. Cape Town: Oxford Univ. Press.

McGUIGAN, F.J. (1968) Experimental psychology: a methodological approach. Englewood Cliffs, New Jersey: Prentice-Hall.

McGURK, E. (1965) Susceptibility to visual illusions. J. Psychol., 61, 127-143.

MICHAEL, D.N. (1953) A cross-cultural investigation of closure. J. Abn. Soc. Psychol., 48, 225-230.

MOED, G. (1959) Satiation-theory and the Müller-Lyer illusion. Am. J. Psychol., 72, 609-611.

MORGAN, P. (1959) A study in perceptual differences among cultural groups in Southern Africa, using tests of geometric illusion. J.N.I.P.R., 8, 39-43.

MORRIS, J.B. (1967) The Rod-and-Frame Box: a portable version of the Rod-and-Frame Test. Perc. Mot. Skills, 25, 152.

MOUNTJOY, P.T. (1958) Effects of exposure time and internal interval upon decrement to the Müller-Lyer illusion. J. Exp. Psychol., 56, 2, 97-102.

MUNDY-CASTLE, A.C. (1966) Pictorial depth perception in Ghanaian children. Int. J. Psychol., 1, 4, 289-300.

MUNDY-CASTLE, A.C., and NELSON, G.K. (1962) A neurophysiological study of the Knysna forest workers. Psychol. Afr., 9, 240-272.

MUSSEN, P.H., and KAGAN, J. (1958) Group conformity and perception of parents. Child Devlm., 29, 57-60.

OVER, R. (1966) A comparison of haptic and visual judgements of some illusions. Am. J. Psychol., 79, 590-595.

PAGE, H.W. (1965) The African's concept of geometrical space: a rural-urban comparison. Unpub. report, U. of Natal.

PAGE, H.W. (1970) Pictorial depth perception: a note. S.A.J. Psychol., 1, 45-48.

PETRIE, A., COLLINS, M., and SOLOMON, P. (1960) The tolerance for pain and for sensory deprivation. Am. J. Psychol., 73, 80-90.

PETTIGREW, T.F., ALLPORT, G.W., and BARNETT, E.O. (1958) Binocular resolution and perception of race in South Africa. Brit. J. Psychol., 49, 4, 265-278.

PETTIGREW, T.F., and NUTTALL, R.L. (1963) Negro American perception of the irradiation illusion. Perc. Mot. Skills, 17, 98.

POLLACK, R.H., and CHAPLIN, M.R. (1964) Effects of prolonged stimulation by components of the Müller-Lyer figure upon the magnitude of illusion. Perc. Mot. Skills, 18, 377-382.

POSTMAN, L., and BRUNER, J.S. (1952) Hypothesis and the principle of closure: the effect of frequency and recency. J. Psychol., 33, 113-125.

READER, D.H. (1963) African and Afro-European research: a summary of previously unpublished findings in the National Institute for Personnel Research. Psychol. Afr., 10, 1-18.

REUNING, H. (1963) Conditions for cross-cultural testing. In D.H. Reader: African and Afro-European research: a summary of previously unpublished findings in the N.I.P.R. Psychol. Afr., 10, 1-18.

RIESMAN, D., GLAZER, N., and DENNY, R. (1953) The lonely crowd: a study of the changing American character. New York: Doubleday.

RIVERS, W.H.R. (1901) Vision. In A.C. Haddon (Ed.), Reports of the Cambridge Anthropological Expedition to the Torres Straits, Vol. 2, Part 1. London: Cambridge Univ. Press.

RIVERS, W.H.R. (1905) Observations on the senses of the Todas. Brit. J. Psychol., 1, 4, 321-396.

ROBINSON, J.O. (1968) Retinal inhibition in visual distortion. Brit. J. Psychol., 59, 1, 29-36.

RUDEL, R.G., and TEUBER, H.L. (1963) Decrement of visual and haptic Müller-Lyer illusion on repeated trials: a study of crossmodal transfer. Quart. J. Exp. Psychol., 15, 125-131.

RUDIN, S.A., and STAGNER, R. (1958) Figure ground phenomena in the perception of physical and social stimuli. J. Psychol., 45, 213-225.

SCHWITZGREBEL R. (1962) The performance of Dutch and Zulu adults on selected perceptual tasks. J. Soc. Psychol., 57, 73-77.

SEDER, J.A. (1957) The origin of differences in extent of independence in children. Unpub. report. Cited by Witkin et al. (1962).

SEGALL, M.H., and CAMPBELL, D.T. (1963) A reply to Spitz. Science, 140, 422-424.

SEGALL, M.H., CAMPBELL, D.T., and HERSKOVITS, M.J. (1963) Cultural differences in the perception of geometric illusions. Science, 139, 769-771.

SEGALL, M.H., CAMPBELL, D.T., and HERSKOVITS, M.J. (1966) The influence of culture on visual perception. New York: Bobbs-Merrill.

SHAPIRO, M.B. (1961) The influence of social environment upon the rotation of drawings. Unpub. paper., 1961. Cited by Doob (1965a).

SMITH, O.W., SMITH, P.C., and HUBBARD, D. (1958) Perceived distance as a function of the method of representing perspective. Am. J. Psychol., 71, 662-674.

SPIEGEL, M.R. (1961) Theory and problems of statistics. New York: Schaum Publ. Co.

SPITZ, H.H. (1963) Cross-cultural differences: a critical letter. Science, 140, 422.

SPUHLER, J.N., and LINDZEY, G. (1967) Racial differences in behaviour. Chapt. 19 in J. Hirsch (Ed.): Behaviour-genetic analysis. New York: McGraw-Hill.

STRODTBECK, F. (1964) Considerations of meta-method in cross-cultural studies, Am. Anthro., 66, 223-229.

SULZMAN, J.H., COOK, E.S., and BARTLETT, N.R. (1947) The reliability of visual acuity scores yielded by three commercial devices. J. Appl. Psychol., 31, 236-240.

TAFT, R. (1958) Neuroticism, extraversion and the perception of the vertical. J. Abn. Psychol., 56, 139-141.

TAUSCH, R. (1954) Optische Täuschungen als artifizielle Effekte der Gestaltungsprozesse von Grössen - und Formenkonstanz in der naturlichen Raumwahmehmung. Psychol. Forsh., 24, 199-248. Cited by Fisher (1968a).

TAYLOR, J.M. (1964) A comparison of delusional and hallucinatory individuals using field dependency as a measure. Unpub. Doctoral dissertation, Purdue U. Cited by Witkin (1965).

THIERY, A. (1896) Über geometrisch optische Tauschungen. Phil. Stud., 12, 67-126. Cited by Fisher (1968a).

THOMPSON, W.R. (1967) Some problems in the genetic study of personality and intelligence. Chapt. 18 in J. Hirsch (Ed.): Behaviour-genetic analysis. New York : McGraw-Hill.

THOULESS, R.H. (1932) Individual differences in phenomenal regression. Brit. J. Psychol., 22, 216-241.

THOULESS, R.H. (1933) A racial difference in perception. J. Soc. Psychol., 4, 330-339.

THURSTONE, L.L. (1944) A factorial study of perception. Chicago. Cited by Hamilton (1966).

VERNON, P.E. (1965a) Environmental handicaps and intellectual development : Part 1. Brit. J. Educ. Psychol., 35, 9-20.

VERNON, P.E. (1965b) Environmental handicaps and intellectual development : Part 2. Brit. J. Educ. Psychol., 35, 117-126.

WAGNER, H.L. (1968) The illusions and Ganz's theory of contour displacements. Brit. J. Psychol., 59, 4, 361-367.

WAPNER, S., and WITKIN, H.A. (1950) The role of visual factors in the maintenance of body-balance. Am. J. Psychol., 63, 385-408.

WHORF, B.L. (1956) Language, thought and reality. Cambridge, Mass. : Technology Press.

WINTER, W.L. (1963) The perception of safety posters by Bantu industrial workers. Psychol. Afr., 10, 127-135.

WINTER, W.L. (1967) Size constancy, relative size estimation and background : a cross-cultural study. Psychol. Afr., 12, 42-58.

WITKIN, H.A. (1949a) Perception of body position and the position of the visual field. Psychol. Monogr., 63.

WITKIN, H.A. (1949b) Sex differences in perception. Science, 72, 22-26.

WITKIN, H.A. (1949c) The nature and importance of individual differences in perception. J. Pers., 18, 145-170.

WITKIN, H.A. (1950a) Perception of the upright when the direction of force acting on the body is changed. J. Exp. Psychol., 40, 93-106.

WITKIN, H.A. (1950b) Individual differences in ease of perception of embedded figures. J. Pers., 19, 1-15.

WITKIN, H.A. (1952) Further studies of perception of the upright when the direction of the force acting on the body is changed. J. Exp. Psychol., 43, 9-20.

WITKIN, H.A. (1965) Psychological differentiation and forms of pathology. J. Exp. Psychol., 70, 5, 317-336.

WITKIN, H.A. (1967) A cognitive-style approach to cross-cultural research. Int. J. Psychol., 2, 4, 233-250.

WITKIN, H.A., and ASCH, S.E. (1948a) Studies in space orientation : 3. Perception of the upright in the absence of a visual field. J. Exp. Psychcl., 38, 603-614.

WITKIN, H.A., and ASCH, S.E. (1948b) Studies in space orientation: 4. Further experiments on perception of the upright with displaced visual fields. J. Exp. Psychol., 38, 762-782.

WITKIN, H.A., DYK, R.B., FATERSON, H.F., GOODENOUGH, H.D.R., and KARP, S.A. (1962) Psychological differentiation. New York: Wiley.

WITKIN, H.A., GOODENOUGH, D.R., and KARP, S.A. (1959) Developmental changes in perception. Unpub. report. Cited by Witkin et al. (1962).

WITKIN, H.A., LEWIS, H.B., HERTZMAN, M., MACHOVER, K., MEISSNER, P.B., and WAPNER, S. (1954) Personality through perception. New York: Harper.

WITKIN, H.A., and WAPNER, S. (1950) Visual factors in the maintenance of posture. Am. J. Psychol., 63, 31-50.

WOBER, M. (1966) Sensotypes. J. Soc. Psychol., 70, 181-189.

WOBER, M. (1967) Adapting Witkin's field independence theory to accommodate new evidence from Africa. Brit. J. Psychol., 58, 142, 29-38.

WOHLWILL, J.F. (1960) Developmental studies of perception. Psychol. Bull., 57, 4, 249-288.

ZAKS, M.S. (1954) Perseveration of set, a determinant in problem-solving rigidity. Unpub. Master's dissertation, Roosevelt College, Chicago. Cited by Witkin et al. (1962).

ZIGLER, E. (1963) A measure in search of a theory. Contemp. Psychol., April 1963.