The relationship between rft performance and inter-and intra modal matching tasks

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by

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Contents

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Summary

This study attempted to relate a field dependence measure viz. rod and frame test performance to scores on inter-and intra-modal matching tasks. The view taken is that since in the rod and frame test situation two sets of sensory data, viz. vision and kinaesthesia seem significant for good performance, rod and frame test ability must somehow be related to the efficiency with which the two sets of data are processed. The study was based on the observation of Vaugh and Ellinger (1966) that the field independent subject is better at a form discrimination task than the field dependent. Form discrimination is in fact a type of crossmodal matching task between the kinaesthetic modality and vision. In the present study lines and widths of solid objects instead of forms were used in order to facilitate measurement.

An attempt was also made to construct a rod and frame test that is performed only in the kinaesthetic modality in order to determined whether the rod and frame test must of necessity be crossmodal in nature and whether this kinaesthetic rod and frame test is related to the efficiency of intramodal matching in the kinaesthetic modality.

Fourty-six male subjects were used in the non-visual rod and frame test study and sixty-six male subjects were used in the study to determine whether rod and frame test performance is related crossmodal matching ability. A portable version of the rod and frame test as described by Morris (1967) was used.

No correlation was found between the rod and frame test and the non-visual rod and frame test (called the somaesthetic rod and frame test). The implication of the results for the differential hypothesis are briefly discussed.

A moderate correlation (-0,28) was found between the rod and frame test and the kinaesthetic to visual matching task. This correlation is opposite in sign to Vaugh and Ellinger's. No correlation between the rod and frame test and the visual to kinaesthetic matching condition could be obtained. The results are discussed in terms of implications it may have for understanding the phenomenon of motion sickness. The findings of the study are then interpreted in terms of cerebral hemisphere lateralization.

1

Introduction

The study of personality is an important branch of the Science of Psychology. In the earlier years psychologists developed various typologies and descriptive constructs in an attempt to describe personality. For a Science to develop, however, it must move from the stage of description to measurement. The description of personality was, therefore, only a step in the evolution of Psychology. To deepen understanding, to verify hypotheses about its origins, and to study personality changes and development, devices for measuring personality become essential. Instruments that have been developed to assess personality include the various inventories, rating scales, interview techniques and projection tests, all with varying degrees of subjective elements in their method of scoring. These tests further depend on or utilize the verbal ability of the subject.

Another sign of the development of a Science is the constant endeavour to improve its measuring instruments in order to achieve greater reliability and precision in its measurements. Techniques for measuring personality are constantly being designed. Witkin et al. (1962) believe that the techniques they have developed are capable of assessing personality objectively and with laboratory precision. Their approach is based on the assumption that since

factors such as interest, experience and motives are known to affect perception, motives interest and personality must in turn be reflected in the perceptual processes of the individual. The manner in which the individual perceives the world must also somehow reflect his past experience and how he has learnt to cope with the various life situations he may meet. Some projection tests (e.g. the Rorschach) have similar assumptions. In the projection test the subject is assessed according the manner in which he chooses to respond (he perceives what he is disposed to see) whereas in the Witkin test the subject's ability to respond is tested. Since Witkin et al. use cognitive tests as indicators of personality functioning, and since cognitive functioning can be assessed by laboratory procedures, Witkin et al. claim that their personality tests are more objective than the standard instruments.

The measure of Witkin et al. (1954; 1962) has its origin in the discovery of Asch and Witkin (1948) that there are individual differences in responses in a cue conflict situation between vision and somasthesia. Witkin et al. (1954) subsequently tried to link this to various aspects of personality functioning through (mostly) correlational studies. Witkin's theory thus started with a measure and because of the changes between Witkin's 1954

and Witkin's 1962 work, Zigler (1963) has called Witkin's test "a measure in search of a theory" (p.133). Witkin et al. (1977) do not mention the differentiation concept.

The aim of the present study is not so much concerned with the status of Witkin et al.'s test as measures of personality but rather with the substrates of the test behaviour of the subjects. A better understanding of the substrates can enhance the understanding of test behaviour. Such an understanding may also indicate constraints to which future theorising about the function of the test and what it measures must conform.

Witkin et al. themselves suggest that the individual differences shown on their test performance may be related to identifiable differences in neural functioning. Attempts have been reported in the literature relating test performances to factors such as somatic sensitivity, cerebral hemisphere lateralization, endocrinal function, and individual differences in the speed of maturation. The present study attempts to relate the rod and frame test (one of Witkin et al.'s tests) to efficiency of information transfer or exchange between vision and somaesthesia. Witkin et al.'s tests assess the individual's sensory preference in a cue conflict

situation between vision and somaesthesia. In the present study an attempt is also made to design a Witkin type test that is performed in only the somaesthetic modality in order to determine whether a Witkin test must of necessity be cross modal in nature, i.e. whether the cue conflict test situation must necessarily be between two different sensory systems. If the test designed in the present study correlates well with the usual Witkin test then this new test would be a useful tool for assessing the cognitive make-up (as well as personality functioning) of the blind. As it is, the present methods of assessing the cognitive make-up of the blind depend rather heavily on verbal performance. Even the present non visual Witkin type tests are really haptic modifications of a test (the embedded figure test) which correlates only moderately with the main test of Witkin et al. (q.v. Axelrod and Cohen, 1961; Witkin, Birnbaum, Lemonace, Lehr and Herman, 1968).

2

Space orientation tests

Witkin's orientation tests had their origin in the studies of Asch and Witkin (1948 a,b). Asch and Witkin using the experimental design of Wertheimer (1912), wanted to determine whether, in a cue conflict situation between visual and somaesthetic cues, vision or somaesthesia dominates. They in fact wanted to resolve the contradictory findings of Wertheimer (1912) (who found vision to dominate) and Gibson and Mowrer(1938) (who found that subjects gave preference to somaesthetic cues) in the cue conflict situation. Asch and Witkin instead found an individual difference in response to the test situation.

Witkin and his colleagues (e.g. Witkin and Asch, 1948 a,b; Witkin, 1948; Witkin, Lewis, Hertzman, Machover and Wapner, 1954) subsequently simplified Wertheimer's mirror arrangement for obtaining the cue conflict to a room and chair and a rod and frame and proceeded to study the relationship between their measures and various aspects of personality functioning. Witkin et al. (1962) call their measuring instruments "mode of perception tests". The following are brief descriptions of their tests.

2.1 THE TILTING-ROOM-TILTING-CHAIR TEST

The test apparatus consists of a chair which can be tilted to the left or to the right surrounded by a small room that can also be tilted independently of the chair. The subject is seated on the chair and is required to adjust the chair (his body) to the true vertical whilst the room (called the field) is tilted to the left or to the right. The subject who is able to adjust his body to the true vertical is said to be field independent; the subject who is influenced by the tilt of the room is said to be field dependent-meaning that he is unable to separate his body from the surrounding field. This test is also called the body adjustment test. A variation of the test is to require the subject to adjust the room to the true vertical whilst the chair on which he sits is tilted.

2.2 THE ROD-AND-FRAME TEST

In the rod-and-frame test the subject is required to adjust a luminous rod surrounded by a tilted luminous frame to the true vertical in the darkened room. The test can be done in three manners called the three series of the test. In series one of the test the subject (seated in a chair) is tilted in the same direction as the frame. In series two the subject's body and the frame are tilted in opposite directions. In series three the subject's body remains erect during the test performance. Because of the more complicated apparatus required for series one

and series two of the rod and frame test, and because Witkin et al. (1962) suggested that because their data indicates that series three may be substituted for the total rod-and-frame test scores with no loss in validity, series one and two are often dispensed with in rod-and-frame test studies. Portable versions of the rod-and-frame test have been developed (Morris, 1967; Oltman, 1968) which correlate well with the original version of the test.

The embedded-figure test is not a space orientation test but it is one of Witkin et al.'s perceptual tests and one of their indicators of personality functioning. The embedded-figure test is a paper-and-pencil test adapted from the one designed by Gottschald (1926).

In the test situation the subject is required to locate a given simpler geometric figure in a more complex figure in which the simpler figure is concealed or embedded. The time taken to find the simpler figure from each of twenty-four complex patterns is taken as a measure of the subject's performance on the test. A maximum time of five minutes or of three minutes in the shortened form of the test by Jackson (1956) (which uses twelve complex patterns) is stipulated. Witkin et al. (1962) argue that the embedded-figure test, tests the ability of the subject to separate an item from the field in which it is embedded and is thus similar to their other test.

2.3 THE INTERCORRELATIONS BETWEEN WITKIN'S TESTS

Witkin et al. (1962 / 1977) give the following intercorrelations between the tilting-room-tilting-chair test and the rod-and-frame test

TRTC TEST

	MEN	WOMEN
RFT	0,64	0,52

The following intercorrelations between the embedded-figure test and the rod-and-frame test are extracted from the study of Young (1959)

MALES, N=49

	RFT SERIES 1	RFT SERIES 2	RFT SERIES 3	EFT
RFT S.1	-	0,84	0,44	0,26
S.2	0,61	-	0,42	0,24
S.3	0,57	0,63	-	-
EFT	0,65	0,50	0,38	-

FEMALES, N=48

2.4 THE RELIABILITY OF THE RFT

Since the present study is concerned primarily with the rod-and-frame test, reliability measures of only the RFT are given here. Witkin et al. (1954 / 1977) give the following test-retest correlations for their rod-and-frame test

STABILITY OF THE RFT

	r 5 WK INTERVAL BETWEEN TESTS				r 1 YR. INTERVAL BETWEEN TESTS				r 3 YR. INTERVAL BETWEEN TESTS			
SERIES	MEN	N	WOMEN	N	MEN	N	WOMEN	N	MEN	N	WOMEN	N
1	-	-	.81	95	.81	51	.46	51	.56	32	.69	30
2	-	-	.69	95	.78	51	.67	51	.72	32	.69	30
3	-	-	.88	95	.90	51	.38	51	.94	32	.29	30

Only the test-regest correlation after three years for women in the third series is not significant.

Witkin et al. (1954 / 1977) give the following odd-even reliability for the RFT

SERIES	MEN	N	WOMEN	N
1	.79	136	.79	258
2	.80	136	.78	258
3	.90	136	.91	258

(All these correlations are below the 1 percent level of significance). The stability of the rod-and-frame test has been confirmed (e.g. Witkin, Goodenough and Karp, 1967; Adevai and McGough, 1968). There is thus adequate evidence that the rod-and-frame test is a stable and reliable measure.

2.5 SOME CORRELATES OF WITKIN'S RFT

Since Witkin et al.'s initial study an impressive number of relationships between Witkin's measures and other aspects of human functioning have been reported in the literature. According to Culver (1967,P.337) the rod-and-frame test has become "one of Psychology's most frequently used mesaures of individual difference". Thus Witkin's measure has been related to alcoholism (e.g. Bergman, Norlin, Bofg and Fyrö 1975; Goldstein, Neuringer and Klappersack, 1970; Goldstein and Shelly, 1971; Jacobson and Van Dyke, 1976); Asthma (Fishbein, 1958) senescence (Axelrod, 1961); Blood cholesterol level (Flemenbaum and Anderson, 1978); response to insulin (Silverman, McGough and Bogdonoff, 1965); masculinity using the MMPI (Stansell, Bautler, Neville and Johnson, 1975); attentiveness to faces (Konstadt and Forman, 1965; Messick and Damarin, 1964); sensitivity to social environment (Ruble and Nakamura, 1972). This rather short list may serve to illustrate the diversity of correlates of the rod-and-frame and related tests. The implication is thus that Witkin's measure must touch on the very roots of human functioning and that an understanding of the mechanisms underlying the measure are important and urgent.

3

The nature of Witkin's theoretical constructs

The measures developed by Witkin et al. have their origin in the Asch and Witkin (1948) observation that individuals differ in the extent to which they use bodily cues in cue conflict situations between vision and the bodily sense of the upright. The individual who is influenced by vision is said to be field dependent.

3.1 FIELD DEPENDENCE

In the rod-and-frame test (series 3) the subject is required to set a rod to the vertical in the presence of a tilted frame. The subject who tends to set the rod towards the inclination of the frame i.e. who is influenced by the tilt of the frame, is said to be "frame dependent". If the division of perceptual events into figure and field is used and the frame regarded as the field in the test situation, then the subject who is influenced by the frame is said to be "field dependent", and the subject not influenced by the frame is called "field independent".

Witkin et al. further hypothesize that the individual who is field dependent on their test experiences the world in a diffused or "global manner". Conversely, the subject who is able to separate the perception of the rod from the influence of the frame is said to perceive in an "articulate manner". Witkin et al. thus describe their test as measuring the mode of perception

of the subject along the continuum articulate to global.

Witkin et al. found (using projection tests) the personality characteristic that bast correlated with their mode of perception test to be the manner in which the individual deals with his environment. They found that the subject who is field dependent to be more passive with a greater readiness to submit to authority. Such field dependent subjects are also shown to have a poorer body image and to have an inability to function independently of their environment. The individual who is more field independent, on the otherhand, shows a greater active coping with, and an analysis of, his environment. Witkin et al. (1954) believe that they have evidence that the individual's mode of perception (or cognitive style) extends to other aspects of functioning as well. Thus in problem-solving, for example, the field dependent subject is found to have difficulties in solving problems requiring the isolation of essential elements from one context and using them in a different context.

Witkin et al. (1954) also linked their mode of perception measure to developmental processes. They found that their subjects' performance on their tests improved with age, attains stability with maturity and declines with the onset of senescence (cf. Axelrod and Cohen 1961). Changes towards field independence with age are, however, not so smooth. They report that 15-and 17-year olds to

be more field independent than their adult group. Thus Witkin et al. (1954) have related their measure to the individual's mode of adjustment (coping with the environment); they have some indication of how their measure develops with age but they have not shown whether mode of adjustment shows a similar pattern of change with age.

Witkin et al. (1954) hypothesize that because the field dependent subject is able to actively resist the effect of the frame in the RFT situation, he is also able to, in a similar manner, actively cope with situations in the environment. Field independence performance can, however, also be due to the subject's passive acceptance of proprioceptive cues. Active suppression is tenable only if it can be assumed that vision is the normally dominant sense. Further, a measure of the subject's ability to resist the visual cues must also take into consideration the relative strength of bodily-and visual-sensory input. The strength and efficiency of a sensory modality may be manipulated by training or deprivation of that sense. Finally, performance on the mode of perception tests might also be due to the ease with which sensory information of the frame is integrated with proprioceptive input of the body position. Witkin's theory, therefore, does not seem very convincing.

3.2 PSYCHOLOGICAL DIFFERENTIATION

When it was found that non-proprioceptive tests (such as the Koh's blocks, memory tests) can also be used as indicators of field dependence, Witkin et al. (1962) started to apply the concept of differentiation of Werner (1948) as the explanatory principle for their field dependence behaviour. A larger number of subsequent papers made use of the concept of differentiation to logically derive, or explain, relationships between Witkin et al.'s tests and other aspects of functioning. Witkin et al.'s tests were from then onwards sometimes described as measuring the degree of differentiation of the subject and research papers' topics containing the terms "psychological differentiation" almost invariably dealt with, or used one of Witkin et al.'s tests. It should be pointed out that Werner regarded his construct as essentially untestable, but with an aim of generating thought about developmental processes.

The differentiation of a system, according to Witkin et al. (1962) refers to the complexity of the system's structure. A more differentiated system is said to have a larger number of sub-parts with each sub-part capable of specializing in different response elements. Such a system will thus function more efficiently, and will also have a larger response repertoire. On the other hand, a less differentiated system, because it has a fewer number of sub-parts (i.e. is more homogeneous in contrast to the more heterogeneous structure of the more differentiated

system) will be able to respond in a limited manner to a variation of stimuli. The more differentiated a system is, however, the more complex must be the integration (interconnection) amongst the sub-parts in order for the system to function at full potential. Witkin et al. (1962) distinguish between "effective integration" and "complexity of integration". By effective integration they mean the "more or less harmonious working together of the system's components with each other, and the total system with the environment." (P.10) By complexity of integration Witkin et al. (1962) refer to the greater and more varied interconnection between the sub-parts of the system. A system with a greater complexity of integration must of necessity be more differentiated. Greater differentiation on the other hand, does not imply a greater complexity of integration.

Witkin et al. (1962) hypothesize that the individual who is better able to separate himself from the environment, or alternatively, who is better able to separate an object from surrounding field has developed to a greater degree of differentiation i.e. has developed further from the global manner of awareness of the neonate who, it is hypothesized, experiences the world and itself as a more or less amorphous and continuous mass. In this manner Witkin et al. (1962) link the subject who experiences in an articulate fashion with the differentiated person.

Witkin et al. now propose that the differentiated person has the ability to re-organise an organised field in a different manner. Witkin et al. (1962) further propose that the degree of differentiation is reflected in various areas of functioning and that this will in turn be reflected by the measures they have designed since (as they say) "it is highly unlikely that development will take place in separate channels". (P.11). Witkin et al. (1962) also explain the term "maturity" in terms of differentiation. Maturity implies developed differentiation together with effective integration. Highly differentiated persons are thus not necessarily mature; there must also be effective integration.

Witkin et al. (1962) claim that their measures are indicators of the extent of differentiation. If this is so then their measures should show a progressive improvement with age up to adulthood. According to Witkin et al. (1954) 15-and 17-year olds show a better performance on these measures than adults. It is highly unlikely that 15-and 17-year olds will be at al higher level of differentiation than adults.

Active coping of the individual with his environment can also be an indicator of the degree of success the individual has attained in his adjustment to his environment which would then be an indicator of effective integration. There is therefore no certainty whether Witkin's measures assess effective integration or the degree of

differentiation. The construct of differentiation also does not seem to have added anything new to the theory of Witkin's measure which the construct "mode of perception" could not add. Most writers now avoid the term "differentiation" when using Witkin et al.'s measures and even Witkin himself (e.g. Witkin and Goodenough, 1977; Witkin, Moore, Goodenough and Cox, 1977) does not mention the term in his later papers. Other writers (like Gardner, Jackson and Messick, 1960) regard field independence behaviour as a form of selective attention and use the term "field articulation" instead of field independence. In this sense then the field dependent person is viewed as being unable to "articulate" or pick out the figure from the surrounding field rather than as showing a dependence on the surrounding field.

4

The senses used in rft performance

An organism receives information from and about its environment through its sensory organs. These sensory organs are roughly divided according to the nature of the physical energy to which they are most sensitive. The set of sense organs that is sensitive to a particular type of physical energy may be called a sensory modality. Some modalities (vision, hearing) consist of a single system; others have more. The modalities with more than one sensory system (e.g. the somaesthetic modality) are treated as though it consists of a single sensory system. Investigators of sensory systems and sensory integration use the term in this manner as an expository device.

The physical energy that energizes a receptor is called a stimulus.

4.1 VISION

Vision is the most important sensory system in man. Dodwell (1966) estimates that about 90% of information input to the human organism is visual.

The visual modality responds to stimuli in the form of radiant energy of wavelength 4×10^{-7} to 7×10^{-7} metres. The field of

view is all points in space from which this radiant energy may enter the eye. These points form an image on the retina called the proximal stimulus which is then transmitted via the optic nerve to the central nervous system.

The function of vision is to i.a. enable the organism to locate and orientate its body with respect to more distant objects. The one-to-one projection of points from the retina through the optical chiasma and the geniculate body to the projection area in the brain may explain the way in which spatial information is transmitted to the central nervous system (Clark, 1932), though how this information is retained with movement of the eye is another matter.

The individual may also use his body, eye torsion (produced by eye tilt) as well as the visible frame to estimate the orientation of objects in this environment.

There is evidence (e.g. Rudel and Teuber, 1964; Sekuler and Rosenblith, 1964) that visual discrimination of spatial relations improve with age, and that such a discrimination is ahead of verbal discription of spatial relation (Asso and Wyke, 1970).

4.2 PROPRIOCEPTION AND KINAESTHESIA

The term proprioception was first introduced by Sherrington (1906) to describe the deep lying sensory systems which respond to the

body's own movements. The sensory systems include the viscera, muscular, joint-and labyrinthine-mechanism of the inner ear. Proprioception then, according to Sherrington, means the sense of motion and orientation of the body as a whole as well as the sense of motion and orientation of the body segments. Proprioception thus includes the sensing of forces (gravitational, pressure, shear and tensional) on the body or body parts. The term kinaesthesis, on the other hand, has a more limited meaning and according to Howard and Templeton (1966) is best understood as a behavioural term. The usage of Howard and Templeton is adopted in the present study. Howard and Templeton define kinaesthesis as the sensing of position, movement and amplitude of movement (both passively and actively produced) of the body parts. Proprioception thus refers to the whole body as well as its segments, whereas kinaesthesis has reference to body segments only. Both proprioception and kinaesthesis exclude the auditory and visual systems. It should be pointed out that the present meaning of kinaesthesis differs slightly from the meaning given to it by Adams (1968). According to Adams kinaesthesis refers only to the sensing of motion of the body parts and is not applicable to the sensing of position of the body segments.

The following receptors are considered important for kinaesthesis (Howard and Templeton, 1966); the golgi tendon organs, the muscle spindle receptors and the associated gamma efferents,

receptors of the joint capsule, skin receptors and also motor outflow. There is some evidence (e.g. Merton, 1964) that muscle spindle receptors and tendom receptors are not directly concerned in the sense of limb position. The outflow of neural activity to the muscle on the other hand provide kinaesthetic information. Lashley (1917), for example, noted that judgement of self-produced limb movement (though not the actual location of the limb) is possible in the absence of afferent nerve impulses from the limb.

The obvious sensory organ system for judging the upright of the body is the vestibular apparatus. The evidence that the vestibular apparatus is essential for the judgement of this passive upright position is not so clear. Clark and Graybiel (1963), for example, studying subjects with inner-ear defects, found that such subjects could perform as well as normal subject in orientation tests. On the other hand the muscle and joint receptors of the hip and spine seem important for detecting and maintaining the upright position because tabetic patients (i.e. patients who lost proprioception in the lower body) are very unstable when blindfolded (e.g. Walshe, 1963).

4.3 SOMAESTHESIS

Somaesthesis refers to the internal condition of the body such as pressure, but excluding sensation from muscles tendons and joints (Corso, 1967) temperature or pain. Somaesthesis is further

classified according to the layers of the body stimulated: cutaneous, muscular and visceral. The receptors for cutaneous somaesthetic sensations are located in the skin. According to Howard and Templeton, skin receptors do not contribute towards sensing the upright. Howard and Templeton quote the study of Arndt (1924) who found his subjects' ability to set their bodies to the vertical position by adjusting the chair on which they sit to be unaffected by local anaesthesia. Howard and Templeton ascribe Berthelot-Berry and Dauterive's (1949) greater average errors when padded chairs are used to the reduction in information available from body movement. The other somaesthetic senses (pain, temperature) and also the somaesthetic senses of the viscera are not the concern of the present study.

4.4 PERCEPTUAL INTEGRATION

The sensory systems provide the organism with information input called sensations. Perception is the process whereby these sensations acquire meaning (Jordaan, Jordaan and Niewoudt, 1975). This meaning is the result of the interaction between sensation, memory traces of past experiences and the degree of activation of the individual. The word "process" in the definition implies that perception is not static or a property of the organism, but an activity.

Perception is thus a process involving the past as well as the

present, internal as well as external stimuli. The process is thus highly complex and it is this complexity which can account for the many theories and philosophical speculation of perception which has arisen. Perception can be assessed by its behavioural consequences although Brunswik (1955) holds that this assessment can be made with only a certain probability of correctness.

The sensory information that gives rise to perception impinges on more than one set of receptors at a time. This sensory date may repeat or confirm information about the environment and the relation of the organism with the environment. The senses usually act as an integrated system. Good sensory integration means efficient information exchange (in the CNS) between sensory modalities. Information transfer (at CNS level) between different sensory modalities is called intermodal transfer and the tasks requiring the subject to make a matching response to a test stimulus in another modality are called intermodal matching tasks. Such tasks measure the efficiency of intermodal matching transfer of information. Connolly and Jones (1970) hypothesize that the input and test stimuli go via the relevant modality store to the central processor and that translation to another modality takes place before storage. Connolly and Jones further hypothesize that the modality into which the information is translated depends on the form in which it is required for the immediate task and that this is a function of the order of presentation. This in effect means that cross-modal matching involves the re-coding of information

received in one modality to the other in which it is required. The view of Connolly and Jones is similar to the one expounded by Pick (1970) with the exception that Pick believes that information is stored not in the form required by the immediate task but into the modality to which is best suited as determined by the nature of the information. Thus, for example, Pick believes that spatial information is stored in the visual modality.

If the testing and the matching stimuli are presented via the same modality then the test is called an intramodal matching task. According to Rudel and Teuber (1964) inter-modal matching is more difficult than intra-modal matching. Held and Bossom (1961) and also Held and Hein (1963) hold similar views. Cashdan (1968) and also Rose, Blank and Bridger (1972), however, presented evidence to the contrary. They found cross-modal matching to be similar to intra-modal matching efficiency within the tactual modality. The idea of modality memories (i.e. visual memory, tactile memory etc.) is, however, not generally supported. Goodnow (1971) for example holds the view that memory is unrelated to modality and related only to experience. The evidence that modality and memory are inter-related is fairly abundant. Jones and Connolly (1970) for example believe that vision and tactile memory have different decay times; Madsen, Rollins and Senf (1970) using simultaneous bisensory input found that their subjects retained the modality sequence in which the stimuli were presented, i.e. stimuli were

presented in rapid succession the subjects spontaneously recalled from one modality first before recalling from the other.

According to Birch and Lefford (1963) and also London (1954) sensory integration associated with control of behaviour is absent in animals at the lower phylogenetic level. At such lower levels the sensory systems are isolated and the organism depends on one modality only for information about its environment etc. but, as one ascends the phylogenetic scale sensory integration becomes progessively more intimate. Whether this multi-modal control of behaviour is due to the appearance of Guyton's (1974) gnostic area, or the tertiary area of Luria (1965), or the multisensitive neurons found in the various classical sensory areas (Albe-Fessard and Fessard, 1963; Dubner and Rutledge, 1964) at the highest phylogenetic level, it does diversify the scope of behaviour and learning of animals at the higher level.

According to Zinchenko (quoted by Vurpillot, 1976) cross-modal transfer between vision and the tactile sense is not possible in children younger than four years. Inter-modal transfer of sensory data becomes possible only after the age of four. Birch and Lefford (1963) in fact believe that the improvement of inter-modal transfer with age can be described by means of a logarithmic function. In a later paper (Birch and Lefford, 1967) they ascribed the improvement with age to an improved liaison between

the senses. Gottfrie and Yeterian (1977) have, however, recently found that cross-modal transfer is possible in infants.

According to Aronson and Rosenbloom (1971) infants show distress if confronted with conflicting spatial information. Aronson and Rosenbloom used the visual and auditory modalities. Bower, Broughton and Moore (1970) obtained similar results for conflict in the visual and tactile modalities. This tends to suggest that the technique for resolving sensory conflict is learnt.

5

The bases of individual difference in RFT performance

5.1 SEX DIFFERENCES

Witkin et al. (1954/1977) report a significant and consistent difference in the rod-and-frame test performance between males and females. This difference, they found, appears only after the age of 17 when there is a reversion to field dependence after a slightly more field independent performance at an earlier age. With females the reversion is steeper. The male-female difference in Witkin et al.'s measures have been confirmed by a number of investigators (e.g. Gruen, 1955; Bradburn and Galinsky, 1957; Gross, 1959; Witkin, Goodenough and Karp, 1967; Kananaugh and McConville, 1971; Saarni, 1973). The basis of this sex difference is, however, not clear and various hypotheses have been examined. Witkin et al. (1962) themselves suggested that the difference might be due to socializing factors. This has been investigated by Vernon (1970) and also by Sherman (1974) but the results have been inconclusive. Corah (1965) could also not determine from his results whether it is the difference in the perceived sex roles which is the cause of the sex difference in performance on Witkin et al.'s measures.

If sex differences in performance on Witkin et al's measures are biologically based then such differences should appear in all cultures. Small but consistent differences have been found with groups in the United States and Western Europe (q.v. Wit, 1955; Bennet, 1956). When, however, wider ranges of cultures are investigated, the expected uniformity of sex differences become less obvious (q.v. Witkin, Price-Williams, Bertini, Christiansen Ramiriz and van Meel, 1974).

Waber (1977) believes ~~that~~ the male-female difference on Witkin et al.'s measures to be due to lateralization of cerebral function. She found that subjects who show more complete lateralization in speech function to be more field independent on the rod-and-frame test. Such lateralization of speech perception, according to Kimura (1969) and Lake and Bryden (1976), is an indicator of cerebral lateralization.

The cause of the observed male-female difference in the rod-and-frame test performance is thus still not clear.

5.2 CEREBRAL HEMISPHERE FUNCTION

Sperry (1968, 1970) with his split-brain studies has shown that the right hemisphere may be associated with stereognosis. The left hemisphere on the other hand contained the centres for speech and other functions requiring sequential processing. Milner (1971)

also describes the same tendency towards such functional specialization between the hemispheres. Since the RFT is a spatial orientation type test it is expected to be performed by the right hemisphere. De Witt and Averill (1976) report a relation between rod-and-frame test performance and lateral eye movement. If Kinsbourne's (1972) findings that eye and head turning can be used as an indicator of cerebral lateralization, then De Witt and Averill have established a link between the rod-and-frame test and cerebral lateralization. Cohen, Berent and Silverman, (1973) seeking more direct evidence applied electroconvulsive therapy to either the right or the left hemisphere of their patients before testing them with the RFT. They found that patients given electroconvulsive therapy to the right hemisphere showed an improvement in rod-and-frame test performance, whereas electroconvulsive therapy applied to the left hemisphere resulted in a decline in RFT performance. The assumption is that ECT causes an improvement in performance of the treated hemisphere (q.v. Volavka, 1975). Performance on the Embedded Figure Test (Witkin et al.'s paper-and-pencil test for field dependence) could, however, not so easily be linked with right or left hemisphere function. Russo and Vignollo (1967) using the EFT for example, found that aphasic patients performed worse than non-aphasic patients with lesions in either left or right hemisphere. Patients with right hemisphere damage, however, did perform more poorly than left hemisphere damaged patients who are not aphasics, but better than aphasics with left hemisphere lesions. The embedded figure test, therefore,

seems to be a more complex task than the rod-and-frame test.

5.3 SOMAESTHETIC VS VISUAL SENSITIVITY

The relation between the rod-and-frame test measures and the subject's reliance on somaesthetic cues had at an early stage been demonstrated by Witkin himself (Witkin, 1950) with his rotating room test when he attempted to demonstrate the "accuracy" in perception of the upright is not an important factor of his mode of perception (or field dependence) measures. What he did instead show was that the body adjustment test (one of his measures of field dependence) does discriminate between subjects who show a vestibular-kinaesthetic rather than a visual sensory input preference during the body adjustment test performance. In the rotating-room test the forces acting on the vestibular apparatus are the resultant of the outward centrifugal force and the downward-acting gravitational force. The field independent subject of Witkin et al. continues to use the vestibular (and other somatic) senses in the rotating room test. Some writers (e.g. Young, 1959) have since come to regard field dependence tests as measures discriminating between visual and somaesthetic sensory preference and thus to speak of field dependence as visual dependence.

The somaesthetic sensory preference of the field independent subject may be due to a greater sensitivity of the somaesthetic senses as opposed to greater sensitivity in the visual senses;

in other words the field independent subject may be more somaesthetically alert than visually alert. Allison (1963) found that field dependent subjects have a lower threshold to low intensity stimuli than field independent subjects. Fine (1973) and also Blasi, Cross and Herbert (1972), on the other hand, found field dependent subject to have a higher threshold to weight discrimination in a weight-discrimination task. These findings seem to support the modality sensitivity hypothesis of rod-and-frame test performance if it is noted that Allison's task tested the sensitivity of the visual modality and the weight discrimination task of Fine and of Blasi, Cross and Herbert can be regarded as a test for the sensitivity of the somaesthetic senses.

The sensitivity of a sensory modality can be increased by asking the subject to concentrate on that modality (a form of modality specific alerting). Kurie and Mordkoff (1970) and also Klepper (1969) found, by asking their subjects to concentrate on their bodies during performance of the rod-and-frame test, a significant shift towards field independence. Kurie and Mordkoff (1970) as well as Culver, Cohen, Silverman and Shmavonian (1964) found that such a shift towards field independence does not occur on the embedded-figure test thus emphasizing the somaesthetic sensory component of rod-and-frame test performance. Further, Jacobson (1966) showed that after one hour of sensory deprivation his subjects become more field independent. Jacobson suggests that

this is due to the "increased salience of somatic activity" (P.118) of "Awareness of internal bodily sensation". There is thus some evidence for the modality sensitivity (or differential alerting) hypothesis of rod-and-frame test performance in the literature.

Whether long term stimulation of the kinaesthetic and vestibular sensory apparatus such as is the case with the training of dancers can cause them to become more field independent than the general population has been investigated by Gruen (1955). Gruen could, however, find no difference between his dancers and a control group on Witkin et al.'s measures of field dependence. Barrel and Trippe (1973), whilst corroborating Gruen (1955), found that highly skilled tennis players to be more field dependent than track and field athletes. These results seem to imply that, whilst training and stimulation of the kinaesthetic/vestibular senses does not cause the individual to become more field independent, stimulation and training of the visual sense (for sport requiring visual alertness) can cause the individual to become more field dependent. It is, ofcourse, not easy to say whether it was in fact the training that caused Barrel and Trippe's highly skilled tennis players to be more field dependent or whether field dependent players do in any event make excellent tennis players. The latter suggestion is, however, discredited a bit by the observation of Barrel and Trippe that the highly skilled tennis players are more field dependent than the skilled players. It

was assumed in this study that the highly skilled field and track athletes and the highly skilled tennis players developed similar levels of sensory motor co-ordination required for high level performance in their respective sport. Unfortunately, it is not possible to find individuals who had training in one modality only: Gruen's dancers could not have undergone their dancing training and experience with vision occluded. As it is, both modalities underwent the training experience.

White (1964 a, b) proposed that sensory systems mature in the following sequence: first the interoceptors then tactile kinaesthetic and finally the distance receptors (photic and sound). This means that at birth the neonate's attention is centred on visceral input; at a later stage touch and movement is central and finally on further development visual and auditory dominance emerges. White uses the observation of Schopler (1964) as support for his idea. Schopler (he says) observed that from the age of three to eight years children show a progressive increase in the time spent in visual play as opposed to tactile play. Schopler, however, noted that retarded children show a similar preference for visual play to normal children; so that this sequential development of the senses proposed by White seems related to chronological age rather than mental development. The theory of White also finds support in the study of Zinchenko and Lomov (1960). Zinchenko and Lomov observed that three year old children can visually dis-

criminate figures only after they have learnt to follow the contours with the fingers and, that in the absence of such fingering, eye-movement inspection of the figure is erratic and generally within the figure. Gregory and Wallace (1963) also produced evidence of the importance of early tactile experience for recovery from congenital and early blindness. There is thus some evidence that the senses do develop sequentially as suggested by White and that kinaesthesis and touch help in educating vision, or, to put it in another way: kinaesthesis and touch help in tuning vision. Since it may seem that the field dependent subject has developed past the kinaesthetic tuning stage (is now more independent of kinaesthesia) it is possible that field dependence represents a higher stage of development (or perhaps degeneration). In terms of the differentiation concept this might represent further (or developed) differentiation without a corresponding increase in the complexity of integration. Waber (1977) notes that the personal characteristics ascribed to rapid (i.e. early) maturers (e.g. Jones and Bagley, 1950; Ames, 1957) fit field dependent subjects as well. Late maturers on the other hand correspond to the characteristics ascribed to field independent subject. There may thus be some substance in the suggestion that field dependence ~~may~~ reflect a further (perhaps higher) level of development. This, in any event, fits in with Harvey, Hunt and Schroder's (1961) allocation of field independence to the relatively primitive stage 2 and field dependence to stage 3 of their 4 stage personality typology.

5.4 SALIENCE OF SOMAESTHETIC ACTIVITY

Another explanation that may be tendered for the rod-and-frame test performance of field dependent subjects is that the salience of proprioceptive input fades faster in the case of the field dependent subject. Gross, Webb and Melzack (1974) asked their subjects to plot the position of an arm that rests, without moving and out of view of the subject. They found that the subject could plot the arm quite accurately if the delay from last seeing the arm was relatively short. However, with the passage of time, the position tends to migrate. Morant and Beller (1965) also obtained a significant adaptation of his subjects to a tilted environment. They found the adaptation to be greater when the subject moved than when stationary. That a similar decrease in the salience of proprioceptive input occurs during the rod-and-frame test is suggested by the findings of Cohen and Tepas (1958). These authors found that their subjects become more field dependent with increasing exposure time to the test apparatus. Hays and Venables (1972) similarly found that increasing the intermovement intervals of the rod during the rod-and-frame test impairs performance on the test (i.e. the subjects produce more field dependent readings). Ehrlichman (1970) on the other hand found a significant positive correlation between an RFT projected for 0,15 seconds and the usual rod-and-frame test. This tends to suggest that the rod-and-frame test performance is a cognitive style rather than a form of intelligence and, secondly, that the increased exposure

time to the apparatus and the concommitant decrease in salience of somatic sensory awareness may not be critical in the usual rod-and-frame test.

5.5 THE RFT AND SENSORY INTEGRATION

According to Pick, Warren and Hay (1966) the senses do not seem to behave as an integrated system. They found that vision biases proprioception and audition and that proprioception in turn have some effect on visual judgement. Field dependence may thus be due to this lack of integration of the senses; unfortunately Pick, Warren and Hay could not find evidence that their subjects show a consistent bias to one sense.

In the rod-and-frame test two sets of sensory input seem relevant for good performance viz. visual input giving the tilt of the frame, and proprioceptive input giving the direction of gravity (to which direction the rod must be adjusted) as obtained from the body position. A measure of the extent of integration between vision and proprioception should thus be related to performance on the rod-and-frame test.

Adevai, Silverman and McGough (1968) found a correlation of 0,22 (significant at 0,01 level) between two point discrimination scores and the results of a subject operated rod-and-frame test. Two point discrimination is generally used in neurological examina-

tion as an indicator of tactile sensory integration. Adevai et al. could, however, not find any relation between their traced letter identification scores and rod-and-frame test performance. This is not what is expected since traced letter identification (letters traced on the skin) can be regarded as a form of crossmodal matching between the tactile sense and stored visual letter shapes (retrieved from visual memory storage). The question now is: is the rod-and-frame test performance related to cross-modal matching ability (matching from Kinaesthesia to vision) if visual afferants instead of visual memory is used for the matching tasks? The answer seems to be in the affirmative. Vaugh and Ellinger (1966) found a significant correlation between rod-and-frame test performance and form discrimination. An examination of the nature of form discrimination tasks will reveal that form discrimination is in fact a form of cross-modal matching task from the kinaesthetic to visual modality. According to Vaugh and Ellinger the more field independent the subject is, the more accurate is the information transfer from the kinaesthetic to the visual sense. Unfortunately Vaugh and Ellinger did not test to see if the rod-and-frame test performance is related to a cross-modal matching task from vision to kinaesthesia. It is of interest to note that Vaugh and Ellinger's correlations were considerably higher (at 0,001 level of confidence for active testing in the discrimination task) for females than for males. It is also of interest to note

that Axelrod and Cohen (1961) found a similar relation between the embedded-figure test performance and form discrimination.

In the present study Vaugh and Ellinger's (1966) experiment is repeated. The form is, however, changed to straight lines and widths of solid figures thus permitting more precise measurements. The study will then further attempt to investigate whether the rod-and-frame test performance is, in turn, also related to the efficiency of cross-modal matching tasks from vision to kinaesthesia. An attempt is also made to determine whether a modality specific rod-and-frame test in kinaesthesia (i.e. a rod-and-frame test that does not make use of vision) is in turn related to intra-modal matching ability in that modality.

6

Statement of the problem and experimental hypotheses

6.1 THE NON VISUAL RFT (SRFT) AND THE RFT (RFB)

Since development is not expected, in terms of Witkin's hypothesis, to take place separately in different channels, a correlation is expected between the RFT and the somatic rod-and-frame test (SRFT). The SRFT differs from the RFT only in that the visual component is replaced by tactual-kinaesthetic input for both rod-and-frame perception. The subject, who experiences in a global manner, or who is unable to separate visual input in the RFT, is also expected to be unable to separate tactual-kinaesthetic information from graviceptor input in the SRFT. Further, since tactual-kinaesthetic and graviceptors are all part of the somaesthetic senses, good performance in the SRFT may possibly also be regarded as indicating a higher degree of differentiation in the proprioceptive senses. The rod-and-frame box (RFB), a portable version of the RFT by Morris (1967) is used in this study.

1st HYPOTHESIS

There is a significant positive correlation between the RFT and the SRFT.

6.2 CROSS-MODAL MATCHING AND RFT PERFORMANCE

The field independent subject shows a preference for somaesthetic cues during RFT performance. This may be due to (1) the subject's ability to suppress the irrelevant visual information, (2) the subject's predisposition to attend to somaesthetic sensory input under the conditions of the RFT which may be due to an individual difference in the level of arousal in the visual, or the somaesthetic sensory modality (of Kurie and Mordkoff, 1970), (3) an effective block of inter-modality transfer of information or (4) an effective integration of the components of the sensory system and by effective integration is implied (in terms of Witkin's theory) the harmonious working together of the sub-parts of the sensory system. The findings of Vaugh and Ellinger (1966) tend to support the fourth of the above alternatives. Vaugh and Ellinger found a significant negative correlation between RFT performance and form discrimination. If form discrimination is regarded as a form of kinaesthetic-haptic to visual information transfer task (i.e. a cross-modal matching task) then this negative correlation would in fact be in support of Witkin's theory - cross-modal matching ability, as an indicator of effective integration, is expected to be correlated with RFT measures. The present study also favours the fourth of the above alternatives and uses lengths instead of shapes of Vaugh and Ellinger in the cross-modal matching tasks in order to achieve more precise measurements.

2nd HYPOTHESIS

(a) There is a significant positive correlation between good (i.e. low error) RFT performance and kinaesthetic to visual information transfer.

(b) There is a significant positive correlation between field independence as measured on the RFT and visual to kinaesthetic information transfer.

6.3 INTRAMODAL MATCHING AND SRFT PERFORMANCE

The SRFT is expected to be an indicator of the level of differentiation and of effective integration of the proprioceptive senses since good performance on the SRFT would indicate that there is a harmonious working together of the tactual kinaesthetic and graviceptors. Intra-modal matching ability is also expected to be an indicator of integration because good intra-modal matching ability would imply that there is a good interconnection between the subsystems of the proprioceptive senses.

3rd HYPOTHESIS

There is a significant correlation between SRFT performance and intra-modal matching within the kinaesthetic modality.

7

Experimental design

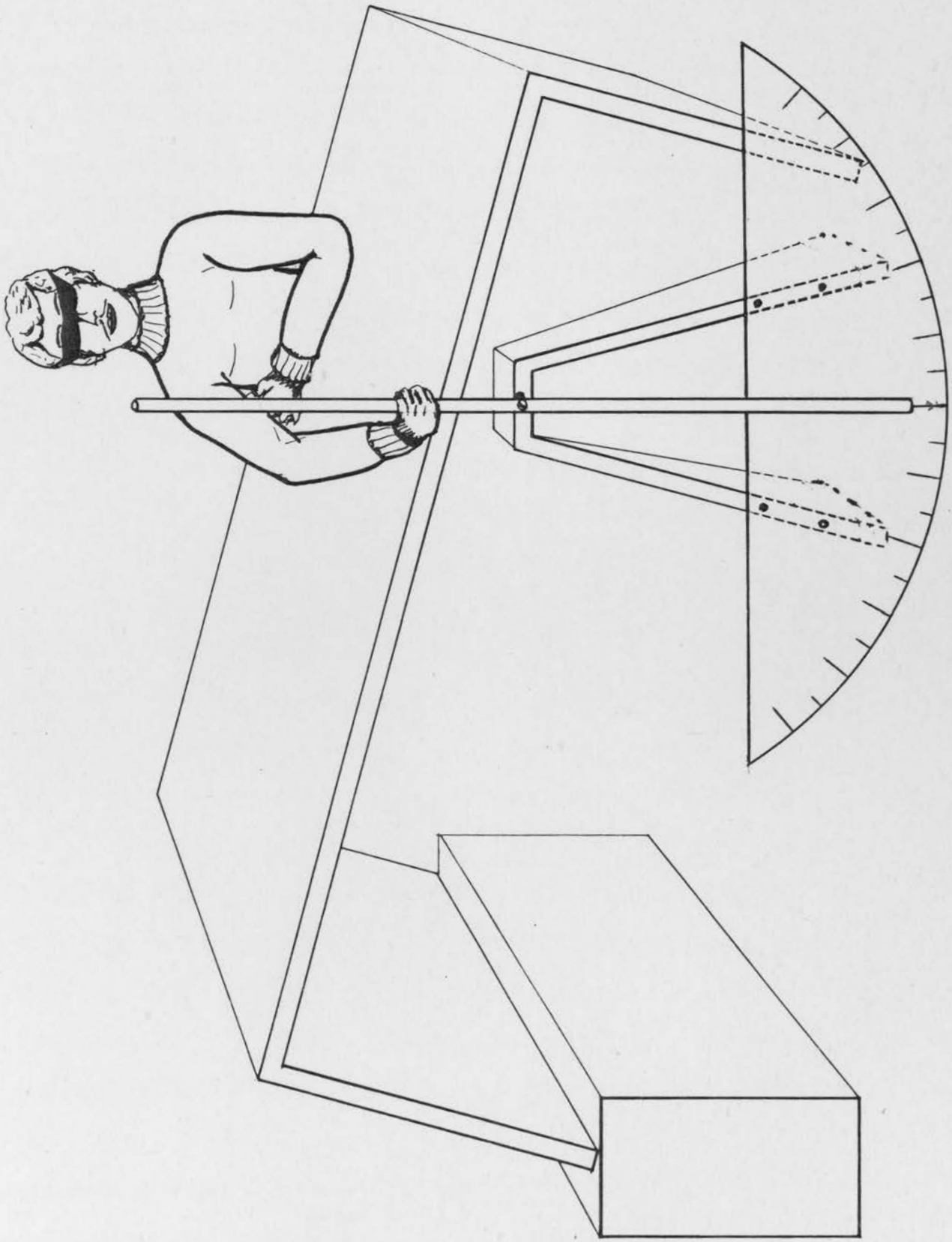
7.1. THE SAMPLE.

Because of the oft reported sex difference in field dependence measures (e.g. Wit, 1955; De Russy and Futch, 1971; Parles and Rajogopal, 1974; Macooby and Jacklin, 1974; Saarni, 1973; Witkin, Goodenough and Karp, 1967) an all male sample (n = 66) is used in this study. The age of the subject varied from 25 years to 54 years with an average of 39 years. All the subjects are literate with educational levels from standard 8 (10 years of schooling) to university graduate level.

7.2 THE TEST APPARATUS

7.2.1. THE VISUAL RFT

The visual rod-and-frame apparatus used in this study is the one described by Morris (1967). It consists of a box 22cm X 22cm X 28cm. One of the 22cm X 22cm X 22cm sides has a viewer so as to fit the face of the subject. The other 22cm X 22cm side has a circular section pivoted to its centre. On this circular section is a frame 11,3cm and 0,3cm thick drawn with luminous paint. The pivot allows the frame to be tilted 28^{o} left or right. This is kept in position at either 28^{o} left or 28^{o} right by means of magnets. On the same fulcrum as the circular section but capable of rotating through 360^{o} independently of the frame is mounted a



The SRFT Apparatus

luminous rod. The rod can be rotated by the subject by means of a knob mounted at the side of the box via a pully arrangement. A protractor at the back of the box enables the experimenter to read off the angle of tilt of the rod with the vertical. The whole interior of the box is painted a mat black and the luminous paint of the frame and rod can be activated by means of a strong source of light before each subject is called into the experimental room. Morris (1967) reports a correlation of 0,74 (Pearson's product moment co-efficient) between rod-and-frame test measures using the box as described above and the rod-and-frame test using method of Witkin(1954) (Series 3).

7.2.2 THE NON-VISUAL RFT (THE SRFT)

The rod of the somatic rod and frame test is a light wooden bar 1m long, 60mm wide and 5mm thick and is pivoted at its 50cm mark to the centre of the edge of a table (board) 60cm wide and 75cm high. The table is capable of being rotated 28^{o} to the left or 28^{o} to the right as a second class lever. The subject sits blindfold in front of tnis table (which is tilted 28^{o} either left or right) and is required to reach across the tilted surface for the rod which he is required to set to the vertical. The arm not used for reaching to the rod is kept resting on the tilted table with the forearm parallel witn the frontal plane of the body and thus, actually, of following the tilt of the board. The inclined table thus performs the function of the tilted frame in

the usual RFT. Head supports keep the head in a vertical position.

7.2.3. THE CROSS AND INTRA-MODAL MATCHING TASKS.

The cross and intra-modal matching tasks used in the present study consist of standard and test stimuli in each modality and resembles the tests used by Petrie (1967).

7.2.3.1. THE KINAESTHETIC TEST STIMULUS

The kinaesthetic test stimulus consists of a wooden bar 7cm wide and 12cm long which the subject is required to hold between thumb and fore-finger in order to estimate its width.

7.2.3.2. THE KINAESTHETIC STANDARD

The kinaesthetic standard is 72cm long wooden strip 4mm thick tapering uniformly from 7,7cm at one end to 4,0cm at the other end. The subject is required to slide thumb and fore-finger of one hand along the length of the standard in order to make a kinaesthetic match to a test stimulus in either modality.

7.2.3.3. THE VISUAL TEST STIMULUS

The visual test stimulus consists of a black line on a white surface presented 40cm to 50cm from the eyes of the subject and parallel to the frontal plane of his body.

7.2.3.4. THE VISUAL STANDARD

The visual standard consists of four different sets of thirty lines. The lines in each set vary uniformly in length from large to small and are drawn between two faint converging lines in order to help carry the eye and simulate the kinaesthetic standard. The sets are presented one after the other in random order and from each set the subject is required to choose a line that he judges best to correspond in length to the given stimulus in kinaesthetic modality.

7.3 PROCEDURE

7.3.1 THE RFB (ROD AND FRAME BOX)

Morris' (Morris, 1967) procedure is used in the present study with the exception that a set of "zero" readings with the frame tilted at 0^{o} is taken before a set of experimental readings. Three readings are taken with the frame tilted to the left and three readings with the frame tilted to the right. The algebraic difference between the averaged zero readings and the averaged experimental readings is taken as the RFT measure for each subject. This procedure, according to Lester (1969) produces results with the smallest mean error but do not differ significantly from data collected by the usual procedure. The reliability of the test was estimated by testing a sample (n = 15) and retesting the same sample after a lapse of the two weeks.

7.3.2. THE NON-VISUAL RFT (SRFT)

The subject is seated blind-folded in a chair in front of the apparatus. He is then asked to rest the arm of his non-dominant hand, flexed at the elbow, on the surface in front of him and to reach out with the other hand for the rod pivoted to the opposite edge of the surface. The rod is slanted at an initial angle of 60^{o} with the horizontal. He is then required to try and adjust the rod to the vertical position by repeatedly shifting the rod and testing whether it is vertical. The subject is told that he may slide his hand up and down the rod when testing for verticality and to pronounce the word "right" when he considers the rod to be truly vertical. The angular displacement from the true vertical is then noted. The process is then repeated with the starting position of the rod at 120^{o} (i.e. from the opposite direction). Three readings are taken from each of the two rod starting positions. A set of "zero" readings are taken with the surface (the "frame") tilted at 0^{o} followed by a set of experimental readings with the surface slanted at 28^{o} is taken for each subject. The algebraic difference between the zero readings and the experimental readings is taken as the subject's score on the SRFT. The reliability of the test was estimated by testing and retesting a random sample of sixteen subjects with an interval of two weeks between tests.

7.3.3. THE CROSS- AND INTRAMODAL MATCHING TASKS

The following conditions are used in the present study.

7.3.3.1 THE KINAESTHETIC TO KINAESTHETIC CONDITION

The subject is seated at a table and blindfolded. The Kinaesthetic test stimulus is presented to the subject to hold between his thumb and forefinger at a level below the table. The subject's other hand is placed on the wider end of the kinaesthetic standard which he must grip between thumb and forefinger in the same manner as he grips the test stimulus. He is then asked to slide thumb and forefinger slowly and carefully down the standard until he reaches a point where the width felt on the standard is judged to be the same as the width of the test stimulus in the other hand. After the position of the hand on the standard is noted, the subject is asked to release the standard. The standard is then shifted to a new position on the table before the procedure is repeated. This is done to prevent the subject from using kinaesthetic memory of arm position. Six kinaesthetic matches are made with the subject starting alternately from the wider and the narrow end of the kinaesthetic standard. The absolute difference between the average of the six readings and the actual width of the test stimulus is taken as the subject's kinaesthetic matching ability.

7.3.3.2 THE VISUAL TO KINAESTHETIC CONDITION

A black line drawn on a white sheet of paper, constituting the visual test stimulus, is presented to the subject and he is required to make a kinaesthetic match on the kinaesthetic standard as above (paragraph 7.3.3.1). The visual stimulus is presented on a

platform mounted above the kinaesthetic standard so that the subject can not see his hand when making the corresponding kinaesthetic match. The difference between the average of the subject's kinaesthetic matches and the actual length of the line is taken as his visual to kinaesthetic score.

7.3.3.3 THE KINAESTHETIC TO VISUAL CONDITION

A kinaesthetic test stimulus different from the one used in the kinaesthetic-to-kinaesthetic condition as described in paragraph 7.3.3.1. is presented to the subject to hold between thumb and forefinger and kept out of sight below the surface of the table. The subject is shown each of the visual charts (visual standards) in random order with the request to name (by number) the line from each chart which best correspond in length to the width of the test object held in the left hand. The average of the lengths of the four lines chosen constituted the subject's visual match of the kinaesthetic stimulus.

The absolute difference between the subject's visual match and the actual width of the test stimulus is taken as the measure of the subject's kinaesthetic to visual matching score.

7.3.4. ORDER OF PRESENTING THE TESTS

The five tests were given in random order to each of the 46 subjects. About four or five subjects were seen per day.

Unfortunately, because some subjects had other commitments during the day of their test not all five tests could be administered to them during the same session and because also of shortage of time the SRFT were not administered to the latter twenty subjects.

A random 15 subjects were requested to come back two weeks after their first session for retest on the RFB and the SRFT. These results were used for estimating the stability of the RFB and the SRFT.

8

Analysis of the data

The following table gives the means and the standard deviations obtained for each of the test employed.

THE MEAN AND STANDARD DEVIATION OF TEST SCORES

TEST (IN DEGREES)	MEAN	SD	N
THE RFT (RFB)	8,35	5,40	66
THE SRFT	6,62	4,17	46
THE MATCHING TESTS (IN CM)			
KIN. TO VIS.	0,95	0,71	66
KIN TO KIN.	0,53	0,38	66
VIS. TO KIN.	0,55	0,35	66

The frequency polygons for the rod-and-frame box scores and the SRFT scores are given in Figure 1 and the frequency polygons for the three matching tasks are given in Figure 2.

Pearson's correlation co-efficients were calculated for the obtained scores in:-

(i) the RFB and the SRFT

(ii) the SRFT and the kinaesthetic to kinaesthetic matching tasks

(iii) the RFB and the kinaesthetic to visual matching task and

(iv) the RFB and the visual-to-kinaesthetic matching condition.

All the correlations, except that between the rod-and-frame box scores and the kinaesthetic-to-visual matching scores, are not significant at the 0,05 level of confidence. The correlation between rod-and-frame box performance and the kinaesthetic matching tasks is -0,28. To test for curvilinearity a scatter diagram of the two sets of data is constructed. The scatter plot (Figure 3) shows no signs of curvilinearity.

Since the standard deviation can be regarded as a good measure of variability, the standard deviation of the kinaesthetic-to-visual matching score of each subject is calculated. The assumption thus is that greater standard deviations will indicate greater degrees of uncertainty and might, therefore, also be used as an indicator of the efficiency of information transfer between the modalities. The correlation between these standard deviations and the subject's score on the rod-and-frame test is, however, found not to be significant at the 0,05 level of confidence.

FREQUENCY DISTRIBUTION OF RFT AND SRFT SCORES

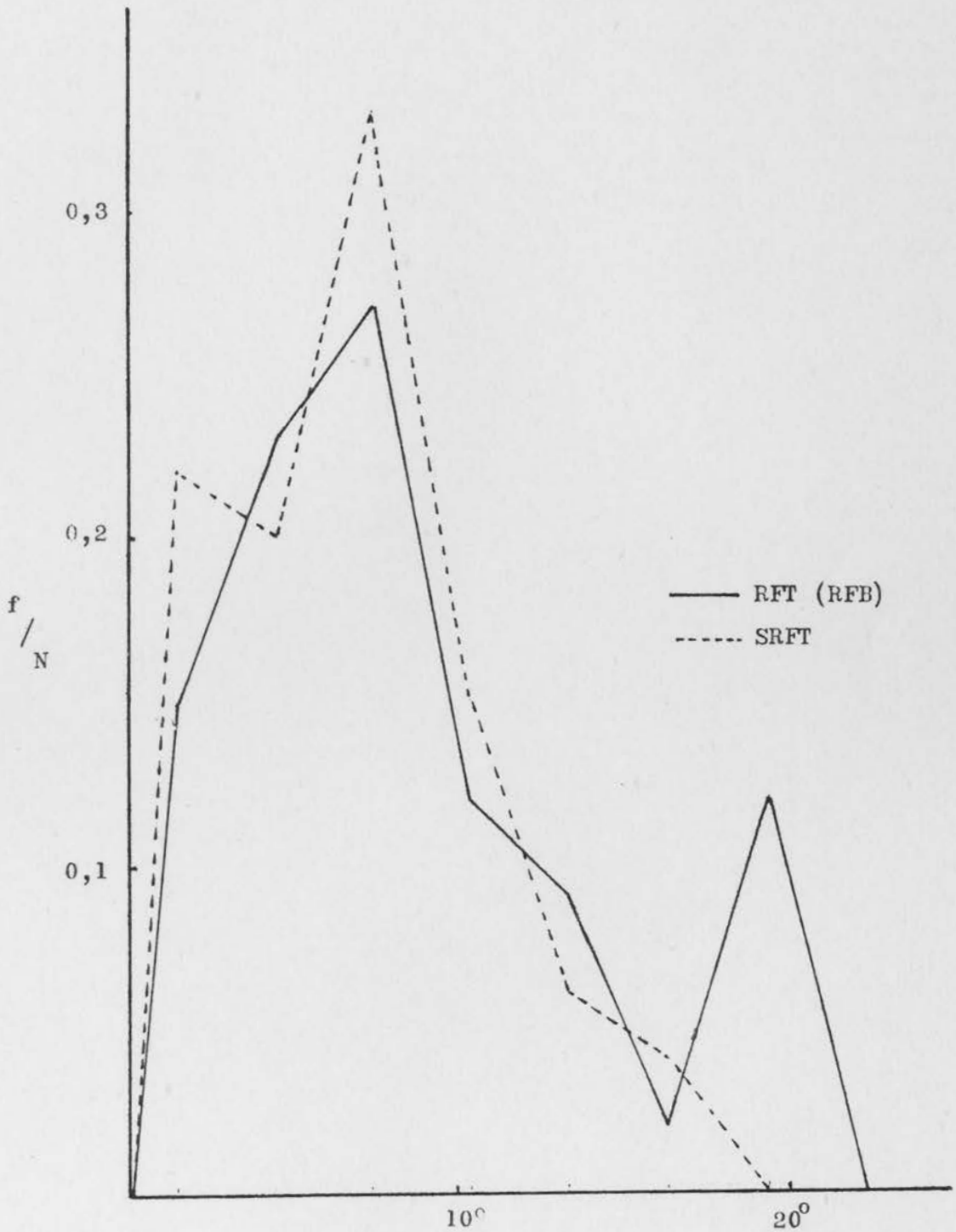


Fig. 1

FREQUENCY DISTRIBUTION OF INTER- AND INTRAMODAL MATCHING TASKS

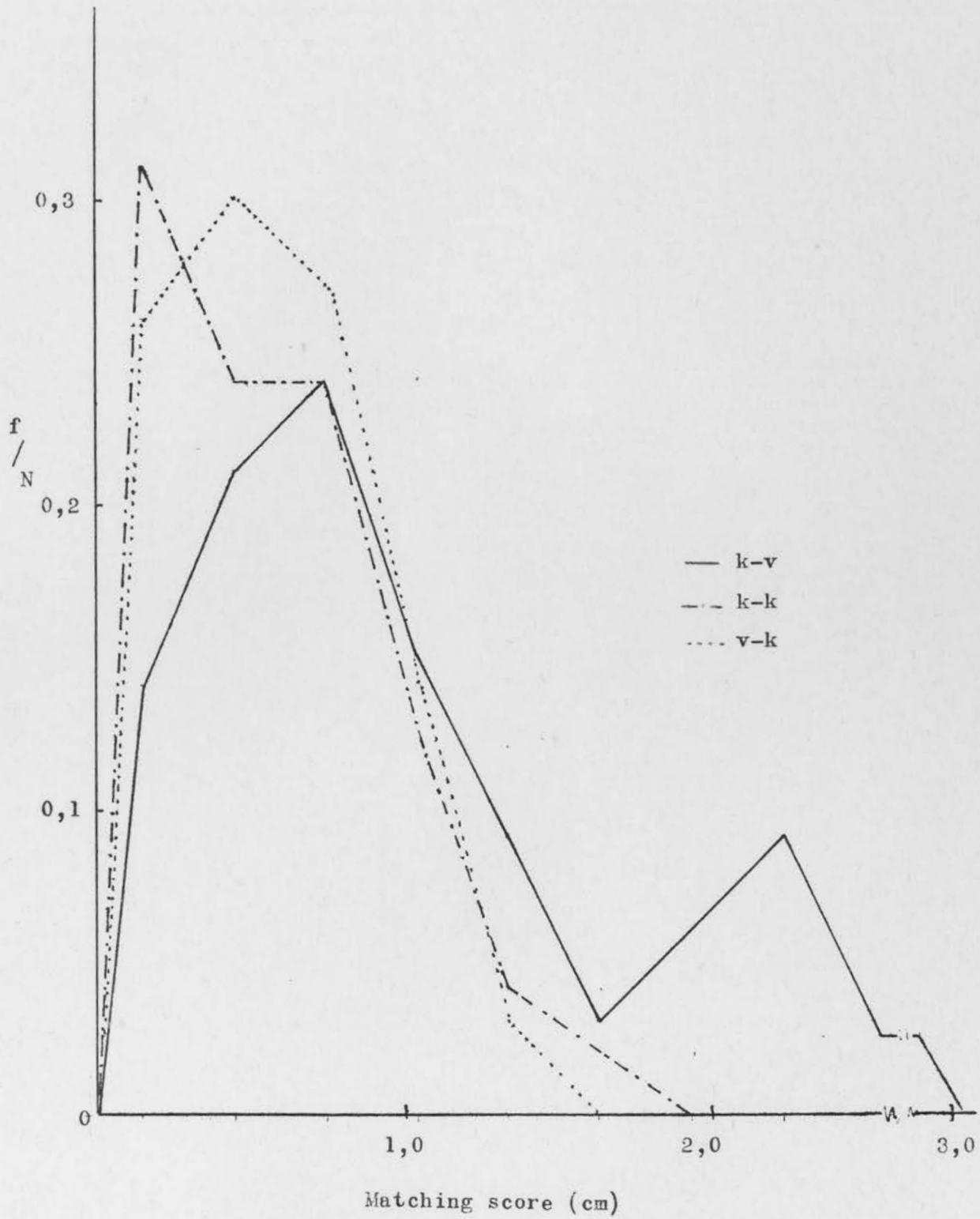


Fig. 2

SCATTER DIAGRAM OF THE RFT (RFB) AND THE K-V MATCHING SCORES

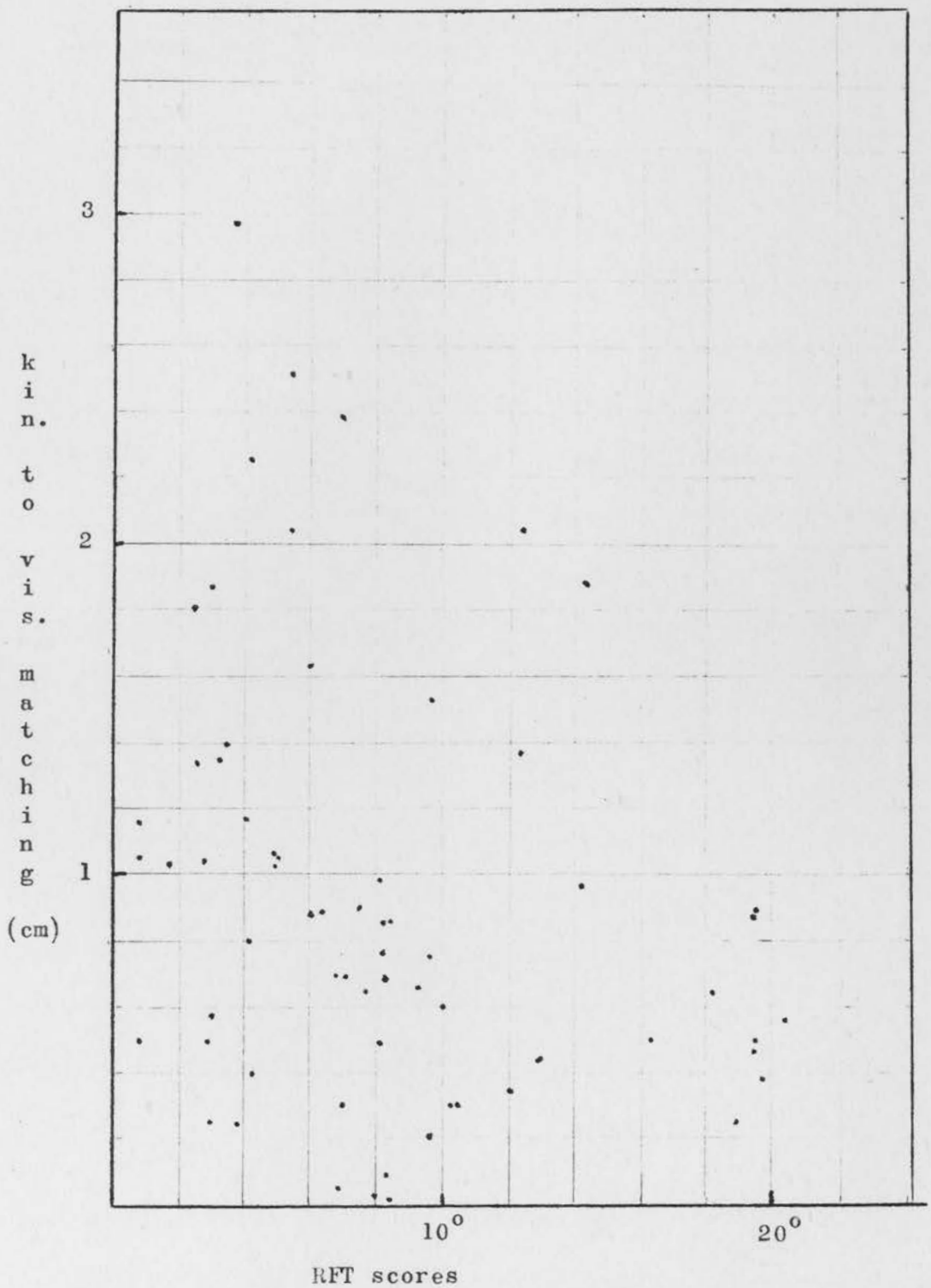


Fig. 3

9

Results and discussion

9.1 THE SRFT

The first hypothesis which proposed that there is a significant correlation between the SRFT and the usual RFT (in the form of the rod-and-frame box) is not supported by the date of the present study. This is not conducive to the theory of Witkin et al. (1962)(the differential hypothesis). However, Witkin et al. speak of their test as assessing the subject's ability to overcome an embedding context and Karp (1963) found this overcoming of an embedding context to be different from "resisting distraction". It is possible that the SRFT may measure resisting distraction. This would require further investigation.

The SRFT seems a fairly stable test, having a test-retest correlation after two weeks of 0,67. Two of the subjects the experimenter used to practice the test procedure on showed interesting variations on the test according to the time of day. It would thus be interesting to determine what personality or other correlates the SRFT has.

In the RFT and the SRFT it is either the vestibular apparatus or the joint receptors of the hip and spine (or both vestibular apparatus and joint receptors) which signal the direction of gravity

to the central nervous system. Since there is no correlation between RFB and SRFT performance (and also as indicated in the literature) it is unlikely that the vestibular apparatus is mainly responsible for signalling the upright in the stationery position. It can, therefore, be said that during RFT performance the subject is required to resolve the sensory conflict between vision and joint receptor input, whereas in SRFT performance the subject is required to resolve conflicting evidence from the joint receptors of the hip and spine on the one hand, and from joint receptors of the arm and shoulder on the other. Poor SRFT performance is thus due to poor resolution of joint receptor input and may thus be related to the extent of differentiation of the proprioceptive modality.

The third hypothesis which expected a correlation between SRFT and intra-modal matching accuracy within the kinaesthetic senses is also not supported by the data of the present study. This suggests that joint receptor sensitivity of the hand and the CNS projection areas (perceptual integration) is not related to joint receptor differentiation of the hip and spine. Joint receptors function independently and there is no functional category of joint receptors.

The explanatory concepts of differentiation and integration are, therefore, not of much use as theoretical constructs for rod-and-frame performance.

9.2 THE RFT AND CROSS MODAL MATCHING

Only the first part of the second hypothesis which proposed that there is a significant positive correlation between the rod-and-frame test performance and the kinaesthetic to visual cross-modal matching task has been partially born out by the data of the present study: the obtained correlation is negative instead of positive. This implies that the field independent subject does not accurately transmit information from the kinaesthetic sense to the visual modality. This is contrary to the findings of Vaugh and Ellinger (1966) who found field dependent rather than field independent subjects less capable of visually recognising the shapes of objects felt with the hand. The present study on the other hand found no correlation between rod-and-frame test performance and a visual to kinaesthetic cross-modal matching task.

The findings of this study, therefore, suggest that good rod-and-frame test performance is related to a blocking of information from the kinaesthetic to the visual modality rather than effective integration. Since the field independent subject responds to the proprioceptive input rather than the visual it means that the information must block occur at (a hypothesized) secondary visual pathway. The field independent subject is aware of the visual frame but the information is not readily available for comparison.

A more tenable suggestion to explain the findings is that the

field dependent subject, because he is more visually dependent, makes a visual analysis of the visual standard in the kinaesthetic to visual cross-modal matching task and then compares the result with the kinaesthetic test stimulus whereas the field independent subject, being more inclined to use bodily information input, makes a kinaesthetic analysis and then compares it with the visual standard and since, according to Jones and Connolly (1970), the visual storage system functions as a 'rehearsal' mechanism, less information loss will occur with the method used by the field dependent subject. This, unfortunately, does not explain why there is no corresponding correlation between rod-and-frame test performance and the visual to kinaesthetic matching condition unless the movement required by the kinaesthetic matching task on the kinaesthetic standard forces both field dependent and field independent subjects to make their analysis in the kinaesthetic modality.

The findings of Dodds (1978) might also explain the correlation between rod-and-frame test performance and the kinaesthetic to visual cross-modal matching ability of the subjects of the present study. Dodds, using a tactual-recognition task found that a stimulus given (randomly) to either left or right hemisphere (via left or right hand)produced constant right hemisphere advantages in performance suggesting, he says, that the right hemisphere is doing the processing whilst the left hemisphere has

access to the results. He further suggests that the information loss occurs during hemisphere transfer. In the present study the kinaesthetic stimulus was given to the left hand i.e. to the right hemisphere and field independent subjects were found to show a greater degree of information loss. Such loss is expected to be greater in the case of field independent than field dependent subjects if the field independent subject has a greater degree of cerebral lateralization and isolation of function. Oltman, Ehrlichman and Cox (1976) believe that they have shown that field dependent subjects show a greater degree of cerebral lateralization.

It is also of interest to note that field independent subjects were found to be more susceptable to "simulator sickness" (Barret and Thornton, 1968). By "simulator sickness" Barret and Thornton mean the discomfort similar to motion-sickness produced by subjecting the individual to a moving field of vision without movement of the body. Barret and Thornton propose that the etiology of this condition to be sought in the conflict between vision and proprioception produced by the moving visual field. The results of the present study where a relation between field independence and an inefficiency of information transfer from the kinaesthetic sense to vision is found tend to suggest that the lower susceptability to simulator sickness of the field independent subject to be related to the ineffective throughput of information from the kinaesthetic modality to vision thereby maximizing the

the resultant conflict. Long, Ambler and Guedry (1975) found that the field independent subject to ce less susceptable to motion sickness (as opposed to simulator sickness). This too might ce due to the inefficient throughput of sensory data from proprioception to vision which in this case would minimize the conflict situation, the assumption being that the visual following of the surrounding moving scene been normally too slow (unaccustomed eye movement) for the faster proprioceptiva input. Motion-sickness usually disappears as visual and proprioceptive input become more synchronized. Further investigation is, nowever, necessary, for according to Money (1970) no satisfactory explanation for motion-sickness has as yet been proposed.

The results of the present study might also indicate a relation field independence to Petrie's (1967) augmenters and field dependence to reducers. This, however, may not ce accurate firstly because of the rather low correlation obtained and secondly two of the field independent subjects were found to be extreme reducers.

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Conclusions

Witkin et al.'s (1962) hypothesis that the ability of the individual who can separate a figure from the ground i.e. who has the ability to experience in an articulate fashion can be used as an indicator of the level of differentiation of the subject is not supported by the present study when the figure and the ground are presented through the kinaesthetic sense. There is some evidence that the SRFT measures are approximately normally distributed (figure 1) (although the sample size is too small (N = 46) to come to any more definite conclusion) and that the individual tends to respond fairly consistantly on the SRFT.

What the SRFT measures is not certain. It is, however, logically expected to be an indicator of differentiation within the proprioceptive sense and, if it can further be shown to improve with age, then Witkin et al.'s differentiation hypothesis would need a revision. Witkin et al. (1954) themselves could not find a correlation between their measures and a RFT-like measure between vision and hearing. These non-correlation indicate the difficulties that would be encountered when attempting to fit concepts of development on one uni-dimensional measure.

Some hint of a relation between RFT performance and modality preference or of inter-hemisphere transfer is indicated by the figures of the present study. The inter-hemisphere transfer suggestion seems more useful since the field independent subject who is considered to show a greater degree of lateralization of the cerebral hemispheres is expected to show a greater loss of information during inter-hemisphere transfer. As it is there are already indications that lateralization is related to spatial ability and maturational speed and that the latter might be the cause of personality and other correlates of the rod-and-frame test performance (Waber, 1976). Differentiation might then become equated with lateralization and specialization of the cerebral hemispheres. It might thus be more fruitful to study the relations between personality (and other developmental) variables and lateralization (and causes of lateralization and cerebral development) in the search for biologically measurable indicators of behaviour.

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Appendix

APPENDIX 1

TEST SCORES

SUBJECT	RFT deg	SRFT deg	K-V cm	K-K cm	V-K cm
1	2,8	9,8	0,50	0,34	0,61
2	7,7	7,8	0,90	0,25	0,33
3	5,1	0,0	1,04	1,23	0,14
4	6,5	9,3	3,61	0,25	0,11
5	6,5	14,2	0,89	1,01	0,88
6	20,4	6,0	0,57	0,63	1,17
7	2,9	0,6	1,85	0,72	0,94
8	16,4	0,3	0,54	0,95	0,77
9	19,4	10,4	0,88	0,42	0,63
10	2,8	3,0	1,02	1,41	0,14
11	19,5	3,9	0,43	0,24	0,82
12	9,5	2,3	1,54	0,05	0,56
13	7,8	1,3	0,65	0,07	0,94
14	9,0	5,8	0,31	0,10	0,51
15	6,0	5,4	1,62	0,27	0,37
16	10,2	7,0	0,30	0,03	0,07
17	0,8	3,7	0,58	0,17	0,41
18	19,4	13,1	0,84	1,23	0,33
19	0,3	15,1	1,17	0,46	0,38
20	5,4	7,3	2,01	0,82	0,64
21	7,8	7,5	0,71	0,45	0,29
22	6,8	6,0	0,70	0,83	0,51

APPENDIX 1 (CONTINUED)

SUBJECT	RFT °	SRFT °	K-V cm	K-K cm	V-K cm
23	8,4	10,2	0,01	0,43	1,08
24	7,2	8,2	0,07	0,04	0,47
25	13,4	11,2	0,44	0,87	0,68
26	18,2	3,7	0,65	0,52	0,44
27	3,9	4,7	0,24	0,62	0,88
28	3,6	1,5	1,40	0,34	0,27
29	9,4	0,9	0,75	0,17	1,45
30	5,4	5,7	2,53	0,89	0,87
31	4,1	7,6	1,25	0,89	0,38
32	8,4	17,0	0,85	0,53	0,13
33	3,5	7,6	0,40	0,59	0,02
34	10,6	6,1	0,29	0,92	0,68
35	19,0	6,4	0,15	0,20	0,46
36	8,1	7,3	0,51	0,07	0,62
37	2,8	6,2	0,24	0,05	0,74
38	19,7	6,6	0,45	0,17	0,57
39	19,8	11,1	0,39	0,08	0,77
40	4,7	1,8	1,15	0,34	0,74
41	4,2	8,3	0,80	0,68	0,46
42	4,7	9,6	1,18	0,67	0,84
43	1,8	2,6	1,05	0,32	0,01
44	14,2	14,8	0,97	0,32	0,17
45	2,6	0,7	1,36	0,57	0,30
46	8,5	4,9	0,84	0,01	0,57

APPENDIX 1 (CONTINUED)

SUBJECT	RFT	SRFT	K-V	K-K	V-K
47	8,3		0,12	0,89	0,27
48	7,0		2,39	0,97	0,67
49	3,3		0,58	0,67	0,34
50	8,1		0,95	0,38	0,01
51	3,5		2,91	0,79	1,07
52	12,0		0,34	1,59	1,40
53	9,8		0,20	0,07	0,75
54	10,0		0,60	0,58	1,17
55	2,4		1,80	1,15	0,90
56	8,4		0,78	0,07	0,24
57	12,8		1,37	0,70	0,48
58	0,7		1,36	1,06	1,19
59	8,0		0,01	1,08	0,55
60	8,2		0,70	0,55	0,14
61	14,2		1,87	0,04	0,00
62	9,4		0,73	0,74	0,41
63	12,6		2,06	0,60	0,20
64	6,0		0,88	0,92	0,91
65	4,0		1,19	0,26	0,10
66	3,4		1,35	0,17	0,52

APPENDIX 2

SUBJECT	RFB	SD OF K-V MATCHING (cm)
1	2,8	0,96
2	7,7	0,01
3	5,1	1,15
4	6,5	0,20
5	6,5	1,07
6	20,4	0,54
7	2,9	0,97
8	16,4	0,83
9	19,4	0,68
10	2,8	0,06
11	19,5	1,35
12	9,5	0,34
13	7,8	0,62
14	9,0	0,31
15	6,0	0,04
16	10,2	0,85
17	0,8	0,87
18	19,4	0,81
19	0,3	0,87
20	5,4	0,44
21	7,8	0,30
22	6,8	0,80

APPENDIX 2(CONTINUED)

SUBJECT	RFB °	SD OF K-V MATCHING cm
23	8,4	0,34
24	7,2	0,67
25	13,4	0,69
26	18,2	0,19
27	3,9	0,23
28	3,6	3,25
29	9,4	0,18
30	5,4	0,00
31	4,1	0,13
32	8,4	0,52
33	3,5	0,31
34	10,6	0,81
35	19,0	1,47
36	8,1	0,29
37	2,5	0,67
38	19,7	1,11
39	19,8	0,21
40	4,7	0,90
41	4,2	1,45
42	4,7	0,24
43	1,8	0,88
44	14,2	0,02
45	2,6	0,72

APPENDIX 2 (CONTINUED)

SUBJECT	RFB °	SD OF K-V MATCHING cm
46	8,5	0,89
47	8,3	1,38
48	7,0	0,98
49	3,3	0,12
50	8,1	0,97
51	3,5	0,30
52	12,0	1,15
53	9,8	0,90
54	10,0	0,81
55	2,4	1,82
56	8,4	0,41
57	12,8	0,85
58	0,7	1,19
59	8,0	0,70
60	8,2	0,93
61	14,2	1,01
62	9,4	0,28
63	12,6	0,19
64	6,0	0,84
65	4,0	0,50
66	3,4	0,36

r - 0,12 (not significant at o,05 level of confidence.)

APPENDIX 3

Frequency tables; RFT (RFB) and SRFT

CLASS (deg)	RFT FREQUENCIES	SRFT FREQUENCIES
0,0-2,9	10	10
3,0-5,9	15	9
6,0-8,9	18	15
9,0-11,9	8	7
12,0-14,9	6	3
15,0-17,9	1	2
18,0-20,9	8	-
N	66	46

APPENDIX 4

Frequency tables: Inter and intra modal matching tests

CLASS cm	KIN.-VIS. FREQ.	KIN.-KIN FREQ.	VIS.-KIN. FREQ.
0,00-0,29	9	22	17
0,30-0,59	14	16	20
0,60-0,89	16	16	18
0,90-1,19	10	8	9
1,20-1,49	6	3	2
1,50-1,79	2	1	-
1,80-2,09	4	-	-
2,10-2,39	2	-	-
2,40-2,69	1	-	-
2,70-2,99	1	-	-
3,00+	1	-	-

APPENDIX 5

RELIABILITY OF THE SRFT: DATA

SUBJECT	TEST day	RE-TEST day
1	13,0	5,6
2	5,3	5,5
3	11,5	11,0
4	5,1	8,0
5	13,3	9,1
6	9,3	6,7
7	10,1	10,6
8	7,5	8,8
9	6,9	4,8
10	4,5	3,7
11	11,7	16,8
12	6,7	5,2
13	16,0	12,9
14	2,6	0,7
15	7,3	2,8
16	9,1	13,2

correlation co-efficient = 0,67

which is significant at 0,01 level

Re-test after a lapse of two weeks

APPENDIX 6

RELIABILITY OF THE RFB: DATA

The reliability of the RFB was estimated using the test re-test method with a time lapse of 14 days between tests

SUBJECT	TEST day	RE-TEST day
1	12,9	7,0
2	2,8	2,9
3	17,9	18,4
4	0,5	1,1
5	10,1	9,6
6	8,6	10,2
7	9,6	2,4
8	9,8	5,7
9	3,2	2,2
10	1,0	5,0
11	15,7	13,4
12	7,8	7,5
13	10,7	9,4
14	10,6	7,3
15	19,6	20,1

Correlation co-efficient = 0,87

Significant at less than o,01 level of confidence