PERSPECTIVE-TAKING AND COGNITIVE DIFFERENTIATION

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ABSTRACT

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Piaget has argued that the ability to understand a situation from multiple perspectives indicates a differentiated mode of organizing information about the world. Based on this argument, the present study investigated the relationship between perspective-taking ability and cognitive differentiation. Fifty subjects completed a multidimensional scaling task involving similarity judgments of self and significant others. Number of dimensions required to fit a person's similarity judgments provided an index of his level of differentiation. Perspective-taking was assessed using a spatial display of geometric objects. Subjects selected from 24 pictures of the display, that picture which most closely represented the point of view of the experimenter. The experimenter's view was changed on each trial. No relationship was found between either the frequency or magnitude of a subject's errors on this task and the number of dimensions (meanings) which he used in organizing information about his interpersonal world. Findings suggest that tasks which assess an adult's ability to imagine different visual perspectives may be confounding perspective-taking and perceptual-spatial skill. Possible advantages of a more socially-oriented approach to adult perspective-taking were discussed.

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Introduction

The central aim of this thesis is to explore the relationship between perspective-taking skill and cognitive differentiation. Perspective-taking refers to the ability to conceptualize a situation from multiple points of view. Cognitive differentiation is defined as the number of meanings used in organizing information about the world.

In the introduction that follows, the theoretical links between perspective-taking and cognitive differentiation will be elaborated. The potential relevance of these constructs for adult psychopathology will also be discussed. The methodological considerations involved in assessing these variables will then be presented, followed by a brief description of the methodology used in this study.

Both Piaget (1950) and Werner (1948) have formulated theories in which cognitive development is characterized by progressive increases in the child's ability to differentiate between various aspects of his experience. The child's mode of structuring his experience is said to evolve from one in which he views the world as an "undifferentiated absolute" (Piaget, 1930/1966, p. 128) to one in which he sees the world in increasingly differentiated terms. In Werner's (1957) words development "proceeds from a state of relative globality and lack of differentiation to a state of increasing differentiation, articulation, and hierarchic organization" (p. 126).

Piaget has proposed that differentiation begins with the child's ability to distinguish self from nonself. Step one involves the distinction between one's own body and the external world. By the age of 2 years the child is well aware of having a physical existence separate from that of the people and objects around him. He has, however, yet to develop a sense of himself as a distinct psychological entity. This, then, is the second step in the child's growing differentiation of self from nonself. This ability to differentiate his psychological self from the external world entails three basic components. The child must grow to realize that his cognitive and emotional experiences exist not as part but apart from the physical world; that other people do not have direct access to his own thoughts and feelings, nor do they necessarily share these same psychological experiences; and that even his perceptions of the physical world are highly subjective phenomena.

Piaget has used the term 'egocentrism' to refer to the lack of differentiation which is characteristic of the young child's mode of thought. According to Piaget (1930/1966), "the whole structure of the child's idea of reality rests on a primitive lack of differentiation between the self and the external world" (p. 284). For example, the child's failure to distinguish his internal psychological experiences from the external world renders him unable to appreciate the difference between psychological and physical causality (Piaget, 1930/1966). In other words, the child's egocentrism leads him to confuse those events which can be produced by human thought and action with those determined by natural law. It is this confusion which underlies the 'magical thinking' of the child — that is, his belief that merely thinking about or wishing for something will cause it to occur.

The child's confusion between self and the external world also underlies his tendency to endow inanimate objects with psychological properties and psychological phenomena with physical properties (Piaget, 1926/1959). This egocentrism results in the belief that inanimate objects possess thoughts, motives, and feelings at the same time that these psychological phenomena are believed to have material existence and be capable of physical force.

The child's egocentrism prevents him, as well, from understanding situations from varying points of view (Piaget, 1926/1959, 1929/1969). Only with the growing awareness of his own subjectivity does the child begin to realize that in any given situation a multitude of possible views (perspectives) exist. Until this awareness is developed, his ability to understand points of view other than his own (perspective-taking) is necessarily limited. This makes it difficult to form a comprehensive notion of reality, since an accurate understanding of the world requires that one be capable of differentiating and co-ordinating the numerous perspectives inherent in any situation (Piaget and Inhelder, 1956).

The restricted capacity to assume multiple points of view has been presented as one manifestation of a general inability to 'decenter' -- that is, to shift attention from one aspect of an object or situation to another while at the same time co-ordinating and integrating information from both sources (Piaget, 1950). This inability to decenter is reflected, as well, in failure to understand that a person can have more than one role, that a word can have more than one meaning, or that size involves more than a single physical dimension (Piaget, 1950). Difficulty in understanding situations from varying points of view can thus be regarded as one indication of a typically nondifferentiated mode of organizing information about the world (Piaget, 1950).

To summarize, it is central to Piaget's theory that cognitive development involves an increasing differentiation between self and non-self. As the person develops a distinct sense of self, his ability to organize his world in more differentiated terms also increases. This increasing cognitive differentiation is reflected, in part, by the growing ability to understand situations from multiple points of view.

This thesis was designed to test the proposal that perspective-taking skill represents a person's level of cognitive differentiation, defined in terms of the number of meanings which he uses to organize information about the world. If the ability to assume multiple perspectives is indicative of a differentiated mode of processing information, then a person who organizes information about his interpersonal world in terms of a relatively large number of meanings (high cognitive differentiation) would be expected to exhibit high accuracy of performance on a perspective-taking task. Conversely, a person who uses relatively few meanings (low cognitive differentiation) would be expected to have difficulty in accurately conceptualizing a situation from varying points of view.

This attempt to elucidate perspective-taking in terms of information-processing is in contrast to the multitude of studies concerned with delineating normative, developmental (age-related) trends (see Shantz, 1975 for a review of research in this area). These studies have focused primarily on revealing group differences among children of various ages with a relative lack of emphasis on individual differences. Those individual differences found to exist among children of the same age have frequently been interpreted as simply reflecting variation in the rate at which developmental changes take place (Dodwell, 1963; Flavell, Botkin, Fry, Wright, and Jarvis, 1968; Piaget and Inhelder, 1956). The assumption has apparently been that despite these differences in rate, all individuals will eventually reach the same asymptotic level. In other words, by adulthood all persons will necessarily have attained the same endpoint with regard to differentiation and, therefore, perspective-taking skill. In contrast to this assumption, the present study will examine the proposal that individual differences in perspective-taking skill persist even in adulthood — differences which reflect varying levels of cognitive differentiation and not just variation in developmental rate.

This thesis will address itself to the study of cognitive processes in normal adults. However, confirmation of a relationship between perspective-taking (egocentrism) and cognitive differentiation could have important implications for an understanding of psychopathology.

First, consider Piaget's (1930/1966) proposal that the child's lack of differentiation between self and nonself shapes his ideas about reality. Extrapolating from this model, an adult who has failed to develop clear boundaries between himself and the external world might be expected to maintain notions about the world typically characteristic of children at a similar level. In general terms, a level of differentiation which is developmentally out of keeping with a person's chronological age should be reflected in an anachronistic or 'abnormal' view of the world (Anthony, 1956; Elkind, 1976; Sullivan, Grant, and Grant, 1957).

Bearing this idea in mind, it is interesting to note the numerous similarities between clinically-evidenced aspects of psychosis in adults and normal, developmental aspects of the child's mode of thought. For example, the psychotic, like the child, often confuses internal psychological phenomena with the external physical world. This confusion could reflect a fundamental lack of differentiation between self and nonself (Elkind, 1970; Lidz, 1973; Sullivan et al, 1957; Werner, 1957).

Piaget has himself noted the basic similarity between the child's and the psychotic's frequent belief that other people have direct access to their internal psychological world. In Piaget's (1926/1959) terms, children "are perpetually under the impression that people can read their thoughts, and in extreme cases, can steal their thoughts away.

The same phenomenon is undoubtedly to be found in Dementia Praecox and other pathological cases" (p. 101).

Piaget has also drawn attention to the parallel between the child's and the psychotic's style of organizing and interpreting information about the world. He states that the child's mode of processing information has "the character of subjective and even pathological interpretations" (Piaget, 1926/1959, p. 150). For example, the child's egocentric tendency towards regarding his own point of view as absolute means that he "makes no attempt to find the intrinsic relations existing between things .... By the mere fact of not being considered in their internal relations ... things are conglomerated into a confused whole ... or else considered one by one in a fragmentary manner devoid of synthesis" (Piaget, 1928/1965, p. 220). This egocentric belief in the absolute validity of his own viewpoint also leads the child to be continually distorting new experiences in accordance with a single perspective. The similarities between the child's mode of organizing information about his world and typical, clinical descriptions of cognitive functioning in the adult psychotic are readily apparent. Whether these surface similarities reflect similar underlying processes remains to be demonstrated.

Piaget's notion of egocentrism may also have relevance for sociopathy, particularly the sociopath's frequently inferred lack of anxiety when lying. To return for a moment to the child, Piaget (1932/1968) has suggested that the child's propensity towards egocentric distortion is reflected in his tendency to verbally alter or misrepresent his experiences. Although the child's egocentrism makes him unaware that he is distorting, at the same time the inaccuracies inherent in his verbal accounts make him appear to be purposely lying or attempting to deceive his listeners (Piaget, 1932/1968). It may be that the sociopath, in a fashion similar to that of the child, is also led by the phenomenon of egocentrism to momentarily believe his own verbal distortions. If anxiety over lying can be assumed to arise because of a perceived discrepancy between the individual's words and his experience, then the sociopath would be expected to have no cause for anxiety.

According to Piaget (1951/1962) the child's egocentric confusion between self and nonself results in his being highly influenced by the ideas of other people, as well as in his being prone to imitate their actions. This tendency to confound self with nonself could, likewise, underlie the extreme suggestibility characteristic of certain adult personality disorders. For example, Anthony (1956) has proposed that the failure to differentiate self from nonself may lead to "pseudo-personalities, with chameleon-like responses to the environment" (p. 22). Deutsch (1942) has used the term 'as-if' personality to describe a type of disorder characterized by a high degree of suggestibility and a primarily imitative mode of relating to other people, coupled with an inability to appreciate interpersonal situations from another person's perspective.

Limited perspective-taking has, in itself, been linked to adult psychopathology. For example, both Cameron (1944/1964) and Sullivan (1944/1964) have attributed the frequently incomprehensible nature of the schizophrenic's speech to failure to acknowledge differences between his own perspective and that of his listener. Similarly, antisocial behaviour has, in the case of both the sociopath (Gough, 1948) and the delinquent (Chandler, 1972, 1973), been ascribed to failure to consider the implications of one's own actions from the perspective of another person.

In summary, the concept of egocentrism has frequently been invoked to explain adult psychopathology within a cognitive-developmental framework. While these theories have focused primarily on differentiation of self from nonself, the process of differentiation has, in more general terms, also been discussed with reference to psychopathology. Confirmation of a relationship between egocentrism (perspective-taking) and cognitive differentiation could provide a more comprehensive and integrative approach to this area.

The theoretical links between perspective-taking and cognitive differentiation have been explored. In addition, the potential relevance of these constructs for adult psychopathology has been noted. This thesis will now turn to an examination of the methodological considerations involved in assessing individual differences in perspective-taking ability and cognitive differentiation.

Methodological Considerations

There are a number of tests available to assess perspective-taking skill. These can be divided into three categories; those which measure the ability to understand (1) what another person is seeing (perceptual or spatial), (2) how another is feeling (affective), and (3) what another is thinking (cognitive). A perceptual task was used in the present study because it had the advantage of a nonverbal mode of response. That the subject need not verbalize his response reduces the possibility of confounding perspective-taking with verbal skill (Feffer, 1959; Feffer and Gourevitch, 1960; Wolfe, 1963). Of course, to perform successfully the person must have acquired the minimum level of verbal skill necessary to understand the task instructions.

The next methodological consideration was to choose a task which would generate sufficient individual variation in performance so as to enable individual differences to be revealed. Although a variety of perceptual measures exist, they all bear a basic resemblance to the 'three-mountains' procedure originally devised by Piaget and Inhelder (1956). The subject is seated in front of a miniature landscape containing three artificial mountains. He is then asked to select, from a set of pictures, the visual image that would be seen by another observer seated at a different position around the display. Alternately, he may be presented with a set of geographical formations, identical to those in the original landscape, and asked to reconstruct the view that would be seen from a given position. Or, he may be presented with a second landscape, identical to the standard, and asked to rotate it so as to arrive at a designated view.

The difficulty of this test has been shown to vary depending upon both the nature of the display (number, complexity, and spatial arrangement of stimulus-objects) and the required mode of response (see Shantz, 1975 for a review of factors which affect performance). For example, the use of a 'selection' as opposed to 'reconstruction' (Hoy, 1974; Piaget and Inhelder, 1956) or 'rotation' (Borke, 1975; Fishbein, Lewis, and Keiffer, 1972) format has been shown to increase task difficulty. A 'selection' task with abstract stimuli and symmetrical display was used in the present study so as to reduce the possibility of a ceiling effect, which could mask individual differences among persons with relatively high levels of perspective-taking skill.

Poor performance on perceptual tasks has typically been attributed to cognitive difficulty in shifting (decentering) from one's own to alternate viewpoints. This poor performance could, however, also be reflecting limited visual-spatial skill. An additional aim of this study was to examine the potential relationship between perspective-taking and visual-spatial skill.

Spatial ability has often been assessed through performance on the Block Design and Object Assembly subtests of the Wechsler Adult Intelligence Scale (Zimmerman, Woo-Sam, and Glasser, 1973). The subject's task on Block Design is to arrange a set of red-and-white plastic blocks so that the pattern formed by their surfaces matches that in a pictured design. This requires that the subject correctly orient and position each block relative to himself, as well as to one another. Each design must be completed within a specified period of time, with additional points being assigned for speedy performance. This test has generally been shown to be a reliable measure of an individual's ability to solve problems of a visual-spatial nature (see Zimmerman et al, 1973 for a review of research in this area).

The subject's task on Object Assembly is to assemble a set of cardboard pieces (similar to those in a 'jig-saw puzzle' but without the pattern) so that they form a familiar object, such as a hand. Performance is timed, as in the Block Design task. While the Object Assembly subtest is a less reliable measure than Block Design, it too provides a good indication of a person's ability to analyze, organize and integrate spatial relationships (Zimmerman et al, 1973).

The next methodological problem concerned an appropriate means of assessing an individual's level of cognitive differentiation, defined in terms of the number of meanings used to process information about his (interpersonal) world. Since the central focus of this thesis is on individual differences, a procedure was required that would allow each person to organize information according to whatever and with as many meanings he might choose. Questionnaire procedures have typically been used to examine an individual's perceptions of other people. This technique, although relatively easy to administer, has the disadvantage of asking subjects to respond with reference to a preselected set of meanings. These meanings may or may not correspond to those which the individual uses outside of the testing situation.

Kelly's (1955) Role Construct Repertory Test has also been used to look at the way in which an individual gives meaning to his interpersonal environment. However, there is some reservation regarding the use of this test to assess individual levels of differentiation. This procedure runs the risk of overestimating the number of meanings typically used. To begin with, each person is specifically instructed to think of a way in which two stimuli are similar to one another and different from a third. The person is thus forced to make a distinction which he might not otherwise make. There is also a potential difficulty in that the number of constructs derived from a relatively small number of comparisons is sufficiently high, relative to the number of measures taken, to introduce problems of reliability.

Christian (1976) has argued that the technique of multidimensional scaling (MDS) provides a suitable means of assessing an individual's level of cognitive differentiation. Unlike the questionnaire procedure, this technique has the advantage of allowing each person the freedom to make his judgments on the basis of whatever meanings he might choose. Furthermore, in comparison to Kelly's technique, MDS does not require that the person verbalize, or even be aware of, the meanings used.

The testing procedure used by Christian (1976) can be summarized briefly as follows: the subject is presented with a list of stimulus-persons and is asked to compare these stimuli, two at a time, on the basis of how similar or different he feels they are to one another. The degree of similarity-dissimilarity is indicated for each pair by having the subject assign a numerical rating along a 9-point scale extending from Very Similar (1) to Very Dissimilar (9). These similarity ratings are then analyzed using the statistical technique of multidimensional scaling.

The purpose of MDS is to represent the degree of psychological dissimilarity perceived among stimuli as the physical distances between points in a k dimensional (Euclidean) space. In other words, this model treats the person's dissimilarity judgments as distances between points in space and attempts to adjust these interpoint distances so as to approximate, as closely as possible, the subject's actual dissimilarity ratings. The exact location of each point (stimulus) in space is defined by its co-ordinate values on each of these k dimensions.

There are at present a large number of algorithms available for performing multidimensional scaling. While these models all assume some relationship between the psychological concept of dissimilarity and the mathematical concept of distance, the exact nature of this relationship varies across algorithms.

The early metric approaches to MDS (Torgerson, 1952, 1958) assumed a linear or one-to-one relationship between dissimilarity and distance. However, the strictness of this assumption limited the model's applicability and resulted in its being largely abandoned in favour of more widely applicable nonmetric algorithms (Shephard, 1962a, 1962b; Kruskal, 1964a, 1964b). These nonmetric models make considerably less stringent assumptions regarding the relationship between dissimilarity and distance. They assume this relationship to be 'monotonic'; in other words, that the rank-ordering of dissimilarity judgments corresponds to the rank-ordering of distances between points (stimuli) in space.

Although the nonmetric algorithms have the advantage of wider applicability, their more lenient underlying assumptions also entail certain disadvantages. First, these models cannot estimate the location of points (stimuli) in space as efficiently or as precisely as the metric approach. This criticism is particularly relevant when analyzing data from single subjects since the error of estimates is typically higher here than for group data. Second, these nonmetric algorithms do not allow the experimenter to perform statistical tests with regard to specific hypotheses. For example, it becomes impossible to carry out any statistical decisions regarding the number of dimensions most appropriate for representing a set of dissimilarity data.

A type of MDS which is intermediate to the metric and nonmetric models in the strictness of its assumptions is that of Ramsay (1977, 1978). This approach assumes a mildly nonlinear relationship between dissimilarity and distance and uses an iterative procedure, known as 'maximum likelihood estimation', to maximize the degree of fit between the dissimilarity data and the location of points (stimuli) in space. The specific quantity which this technique attempts to maximize is referred to as the 'log likelihood function' (log L).

MDS through maximum likelihood estimation affords a number of important advantages in comparison to nonmetric models. First, it estimates the location of points in space with greater efficiency (Ramsay, 1977, 1978). As noted previously, this factor becomes particularly important when analyzing data from single subjects. Second, this algorithm allows the experimenter to perform statistical tests with regard to a number of hypotheses. Foremost among these, for purposes of the present study, is that of testing whether a set of dissimilarity judgments can best be represented by a (Euclidean) space of k dimensions as opposed to one of k - 1 dimensionality. In other words, this approach provides a precise statistical rule for assessing the maximum number of MDS dimensions required to represent a set of dissimilarity data. In view of these two advantages, Ramsay's technique of MDS through maximum likelihood estimation was chosen to determine the number of dimensions most likely to best represent an individual's similarity judgments.

Using this technique, Christian (1976) has demonstrated substantial individual differences in the number of dimensions (meanings) which adults use in organizing their interpersonal world. He has, further, argued that this individual variation reflects varying degrees of cognitive differentiation. This variation could, however, also be reflecting varying levels of intelligence. A potential weakness, then, in Christian's argument that dimensionality reflects degree of differentiation is that level of intelligence was not assessed. A final goal of the present study is to explore the possible relationship between dimensionality (number of meanings) and IQ.

A short form of intelligence test often used consists of the Vocabulary and Block Design subtests of the Wechsler Adult Intelligence Scale (Zimmerman et al, 1973). The sum of an individual's scaled scores on these two subtests has been shown to be an excellent predictor of full-scale IQ,[1] with correlations between these measures varying between .91 (Silverstein, 1970b) and .92 (Maxwell, 1957). Estimated IQ scores, derived from this sum, can be obtained from the table provided by Silverstein (1970a). In addition, scaled scores on the Vocabulary subtest provide a means of examining the potential relationship between number of dimensions (meanings) and level of verbal skill.

Summary

The primary goal of this thesis was to test the proposal that perspective-taking ability reflects level of cognitive differentiation. This research derives from Piaget's theory of cognitive development, in which the ability to understand a situation from multiple viewpoints

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[1]Full-scale IQ is the intelligence quotient that would be derived from administration of all 10 subtests on the Wechsler Adult Intelligence Scale.

(perspective-taking ability) is presented as one facet of a more general capacity for organizing information about the world in a differentiated fashion.

Level of cognitive differentiation was defined in terms of the number of meanings used to organize information about self and others. The ability to imagine a situation from different points of view was assessed using a perceptual perspective-taking task (PPT).

It was hypothesized that number of dimensions (meanings) would be negatively correlated with error scores on the PPT. Subjects who used a large number of meanings in making their similarity judgments should have little difficulty imagining a spatial display from multiple points of view. Conversely, a small number of meanings should be reflected in poor performance on the PPT.

A second purpose of this study was to explore the relationship between perspective-taking and visual-spatial skill. Poor performance on perceptual tasks has typically been attributed to cognitive difficulty in decentering. This poor performance could, however, also be reflecting limited visual-spatial skill.

The present research was also designed to determine whether individual differences in dimensionality could be attributed to differences in IQ. Christian (1976) has argued that number of dimensions reflects degree of cognitive differentiation. Individual variation in dimensionality could, however, also be due to varying levels of intelligence.

Method

Subjects

Fifty persons (25 male, 25 female) participated in the present study on a voluntary basis with no monetary reward. Participants were English-speaking and had been educated in either Canada or the United States. At the time of the study, all were university students; forty-three at the undergraduate level and seven at the graduate level. The median level of university was 2.6 years. Subjects' ages ranged from 19 to 34, with a median of 21.9 years.

Procedure

Testing was done on an individual basis and required a total time of approximately three hours per subject. Each subject was administered, in order of presentation, (1) a test involving similarity judgments of self and significant others, (2) a perceptual perspective-taking task (PPT), and (3) the Vocabulary, Block Design, and Object Assembly subtests of the Wechsler Adult Intelligence Scale (WAIS). These measurement tools will be described in the order outlined above.

Self and Significant Others (Multidimensional Scaling). This test was adapted from that originally employed by Christian (1976). Each subject was presented with 14 descriptive statements and asked to select from among the people he knew those individuals whom he felt best fit these descriptions. In this way, participants were allowed the freedom to generate their own individual lists of significant others. This procedure also ensured that all subjects considered an equally broad range of stimulus-persons. Included in this list, as a fifteenth stimulus-person, was the word self.

The 14 descriptive statements were chosen from among those previously used by Christian (1976) and originally adapted from Kelly's (1955) Role Construct Repertory Test. The instructions to subjects, and list of self and significant others, were as follows:

> Please refer to the descriptions of different persons listed below, and select from among the people you know the person who best fits each description. Please do not repeat any names. If a person has already been listed, just make a second choice.
>
> 1. Your mother (or stepmother).
> 2. Your father (or stepfather).
> 3. Your brother (or a boy nearest your own age who was most like a brother to you).
> 4. Your sister (or a girl nearest your own age who was most like a sister to you).
> 5. Your wife (or husband) or your girlfriend (or boyfriend). If this does not apply, a person you might like to be your girlfriend or boyfriend.
> 6. The person you would most like to be like.
> 7. A person of the same sex as yourself who you once thought was a good friend but who strongly disappointed you later.
> 8. A person known to you personally with whom you would be most willing to talk over your personal feelings.
> 9. A person you know who for some reason appears to dislike you.

10. A person you would most like to help or for whom you feel sympathy.
11. A person with whom you feel very uncomfortable.
12. A person of the opposite sex to yourself who you once thought was a good friend but who strongly disappointed you later.
13. The warmest person you know.
14. A person you trust the most.
15. Yourself.

Once this list was completed, the subject was presented with the following set of written instructions:

> These descriptions have been provided for no other reason than to ensure that every participant in this study considered an equally broad range of persons in generating their own list of persons. I am now going to present you with a whole series of persons taken two at a time from your list. For each of these pairs your task is to decide how similar or different these two people are and then to indicate your decision using the nine-point scale in front of you. For instance, if you decided that these two people had nothing in common then you would indicate this by using a 9 on the scale (or Very Different). If, on the other hand, you felt these two people were very much alike then use a 1 from the scale (or Very Similar). The scale is provided to allow you to indicate the degree of similarity-dissimilarity you feel exists between two persons, so please try to use the full range of the scale in making your judgments. So, if you felt that two persons had as many similarities as differences

then use a 5; if they are different but not too different, use a 6 or 7; if they are similar but not very similar then use a 4 or 3. Remember, there are no right or wrong answers; what matters is that you indicate what you feel, for whatever reason, is the degree of similarity between each pair of persons. Do you have any questions? (Christian, 1976, p. 27)

At this point, any questions related to these instructions were answered. The names on the subject's list were then read aloud, two at a time, by the experimenter. For each pair of stimulus-persons the subject was asked to indicate, on a 9-point scale ranging from Very Similar (1) to Very Different (9), the degree to which he felt those two individuals to be similar or different from one another. Each of these n (n-1) combinations was presented once in the initial order (a,b) and once in reverse order (b,a), for a total of 210 judgments (see Appendix 1 for a copy of the matrix used to record a subject's similarity judgments).

The procedure used in this study differed from that of Christian (1976) in two ways: (1) the list of stimulus-persons was limited to self and only 14, in comparison to 17, other individuals, and (2) each person was compared to every other person two times, as opposed to only once. This resulted in an increase in the total number of comparisons from 153 to 210. The purpose of repeating each set of similarity judgments was to provide for greater reliability in the data obtained. A reduced number of stimulus-persons provided a reasonable limit on the number of similarity judgments required of each subject and limited the possibility that subject fatigue might override potential gains in reliability.

Perceptual Perspective-Taking. This measure was administered within one week of the subject having completed his similarity ratings of self and significant others. The subject was seated in front of a spatial display and asked to select, from a set of 24 photographs, the image that would be seen from each of 12 visual perspectives. A more detailed description of this task follows.

The spatial display, adapted from Eliot and Dayton (1976a, 1976b), consisted of five, geometrically-shaped, wooden blocks arranged upon a circular board, 33 inches (.84 m) in diameter (see Appendix 2 for photographs of the display as viewed from four visual perspectives). The board was cut from $^{1}/4$ inch (.64 cm) masonite and was painted flat black. Attached to its outer edge was a circular rim, 3 inches (7.62 cm) wide. This outer rim was also cut from $^{1}/4$ inch (.64 cm) masonite but was painted flat white, with 12 black $^{1}/4$ inch-wide lines marked at 30 degree (.52 rad) intervals. A wooden table, 27 inches (.69 m) in height supported the board.

A cardboard template was used to position the blocks in the display. The template was temporarily affixed to the board's surface prior to testing and was removed once the stimulus-objects had been properly positioned. The blocks were arranged so as to correspond to the five points of a pentagon, with each block being placed approximately 7 inches (17.78 cm) from the board's center.

The five geometric shapes used were a square, rectangle, cylinder, pyramid, and wedge, chosen so as to be clearly distinguishable from one another. Each wooden block was painted flat white so as to provide a maximum degree of contrast against the black surface of the board.

Twelve black-and-white photographs were taken at 30 degree (.52 rad) intervals around the display, keeping constant such factors as camera distance, center of focus, altitude, and lighting. These intervals corresponded to the 12 positions marked by black lines around the outer rim of the board.

Each photograph was printed twice; once with the negative 'face-side-up' and once with the negative 'flipped-over' (as with a slide inserted backwards into a projector). This procedure yielded an additional 12 photographs, identical to the actual views of the display except that the relative positioning of objects was reversed from right-to-left and vice-versa (see Appendix 3 for examples of these photographs). These 'flip-side' or 'mirror-image' photographs were included so as to increase the potential for error and, thus, for individual differences.

The subject was prevented from viewing the display from perspectives other than the one used to complete the task. This was done by having the subject look at the floor while being led into the testing room. The subject was then seated at a distance of 45 inches (1.14 m) from the front of the board and asked to maintain the same visual perspective throughout. Next, the experimenter presented the following set of verbal instructions:

> You have in front of you a circular board with five geometric shapes. I will be standing at various positions around the

board, the exact position being marked by these black lines around its outer edge. For each position that I stand at, I want you to look through a series of photographs and find the one that shows what I see from where I am. You may look through these photographs as many times, in any order, and for as long as you like. All I ask is that you do not get up from or move around in your chair and that you keep the photographs face up without changing their orientation. Are there any questions?

Any questions related to these instructions were then answered, following which the subject was presented with the set of 24 photographs. At this point, the experimenter moved to the first of 12 positions around the board and asked the subject to "find the photograph that shows what the board looks like to me from this position." At the same time, a red cardboard arrow was placed on the black line marking that position along the outside of the board. The subject was given unlimited time to respond. The same procedure was repeated for each of the remaining 11 positions, including the subject's own.[2] The order in which the positions were presented had been haphazardly determined prior to the start of testing and was constant for all 50 subjects.

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[2]This latter trial was included to ensure that each subject could accurately identify his or her own visual perspective. Since all subjects were able to do so, this trial was omitted from the data analysis. Results for this study, to be presented in the next section, are based upon only those 11 trials where the subject was asked to select the visual image corresponding to a perspective other than his own.

Once the subject's choice of view had been recorded, all 24 photographs were reshuffled for use on the next trial. Consequently, the order in which these photographs were examined varied in haphazard fashion from trial to trial both for different subjects and for any given individual.

Upon completion of the task, the subject was questioned as to his understanding of what he had been asked to do. In addition, he was asked to explain what strategy, if any, he had used in making his choice of view.

Wechsler Adult Intelligence Scale. WAIS subtests were presented in the same session as the perspective-taking task. Order of presentation was as follows: Vocabulary, Block Design, and Object Assembly. Each task was administered in accordance with the standard set of instructions given by Wechsler (1955).

Data Analysis

Similarity Judgments. Ramsay's (1978) 'MLMDS2' program for multidimensional scaling by maximum likelihood estimation was used to analyze a subject's similarity judgments of self and significant others. This program was executed on a CDC Cyber 172 computer system.

The iterative procedure was stopped and the log likelihood value retained when the largest relative change in any co-ordinate value was 10^{-3}. The maximum number of iterations required to reach this 'convergence criterion' varied considerably, depending upon both the subject and number of dimensions being used to fit his data. However, the majority of solutions required no more than a few hundred iterations.

Testing Dimensionality. The critical question with regard to an individual's similarity judgments was whether a k dimensional solution provided a significantly better fit to the data than did a solution of k - 1 dimensions. With respect to this decision, Ramsay (1977) has shown that "the criterion $X^2 = -2(\log L_{k-1} - \log L_k)$, where L_k is the log likelihood for a fit in k dimensions, has an asymptotic chi square distribution with n - k degrees of freedom" (p. 255), where n is the number of points (stimuli) being fit. An appropriate statistical test for whether a set of dissimilarity data is better approximated by a solution of k, as opposed to k - 1, dimensions can, therefore, be provided by examining whether the quantity $-2(\log L_{k-1} - \log L_k)$ has a significant chi square value for n - k degrees of freedom.

Based on the results of his Monte Carlo study, Ramsay (1978) has proposed that when the dissimilarity data for 15 stimuli are analyzed for a single subject, the use of twice the normal chi square testing-criterion is needed to provide a safe upper limit on the number of rejection errors. Therefore, the present study employed a stopping rule which required that the quantity $-2(\log L_{k-1} - \log L_k)$ be greater than twice the normal chi square criterion-value for n - k degrees of freedom, in order for a k dimensional solution to be retained. (See Appendix 4 for a summary of critical values used in this study).

Perspective-Taking. The scoring procedure for performance on the PPT was based upon a subject's choice of photograph for each of the 11 test trials. The photograph chosen could be identical to the view of (1) the experimenter (correct response), (2) the subject (egocentric response), or (3) neither (nonegocentric response). The total number of incorrect (egocentric and nonegocentric) responses was calculated across all 11 trials. A separate score for number of egocentric responses alone was also computed. The rationale for computing these two measures was (1) to assess the subject's overall accuracy of performance (total number of incorrect responses), and (2) to reflect the frequency with which he chose his own viewpoint in particular (number of egocentric responses). This approach is similar to that used in previous studies (Cox, 1975; Hoy, 1974; Huttenlocher and Presson, 1973).

For each of these incorrect responses, the extent of angular separation existing between the chosen view and the correct view was calculated (adapted from Eliot and Dayton, 1976b). This reflected the extent to which the view chosen differed from the actual view of the experimenter. The total degrees of angular separation across all errors made by a given subject was divided by his total number of errors. This provided a measure of mean magnitude of that subject's errors which was not biased by frequency of these errors.

Wechsler Adult Intelligence Scale. Performance on the WAIS was scored according to the standard set of instructions given by Wechsler (1955). This procedure yielded separate scores for Vocabulary, Block Design, and Object Assembly. The sum of an individual's scaled scores on Vocabulary and Block Design was used to estimate his full-scale IQ (see Silverstein, 1970a).

Results

Results for this study will be presented in the following order: multidimensional scaling of similarity judgments, perspective-taking performance, WAIS, and, finally, relationships between variables.

Multidimensional Scaling of Similarity Judgments

Analyses of similarity ratings for all 50 subjects indicated that two subjects were not using the full range of possible responses along the 9-point rating scale. The effect of limiting the range (categories) of responses can be to artificially increase the number of dimensions required to best fit a person's judgments (Christian, 1976). The data from these two subjects was, therefore, excluded from further analysis. All results subsequently reported are based upon the remaining 48 subjects (24 males and 24 females). Complete statistics relating to multidimensional scaling results for each subject can be found in Appendix 5.

Consistent with the finding of Christian (1976), these results show considerable "variation between subjects in terms of the number of dimensions required to fit their similarity judgments of self and significant others" (p. 44). The number of dimensions retained for different subjects ranged from two to six with a mean of 2.77 and a standard deviation of 1.06.

Table 1 shows the frequency of subjects within each category of dimensionality. The overall distribution of subjects was skewed towards solutions of lower dimensionality. Table 1 also shows that males and

Table 1

Number of Subjects Within Each Category of Dimensionality

Sample	Number of Dimensions Retained 1	2	3	4	5	6
Total		27	10	7	3	1
Male		14	4	4	2	0
Female		13	6	3	1	1
M unbiased standard error		.252	.235	.199	.195	.183

females were almost evenly distributed across these categories. A one-way analysis of variance for independent samples showed no significant differences between males ($M = 2.77 \pm 1.03$) and females ($M = 2.79 \pm 1.10$) in the mean number of dimensions retained [$F(1,46) = .02$, $p > .05$].

Table 1 shows, as well, a summary of the mean 'unbiased' standard error ('badness of fit') obtained for MDS solutions in the present study. This mean estimate of error was inversely related to dimensionality ($r = -.27$, $p < .05$). This finding is noteworthy because, unlike the 'final' standard error (or 'stress' in the case of MDSCAL; Kruskal, 1964a, 1964b), 'unbiased' standard error does not necessarily decline as a function of increasing dimensionality. Usually, this error estimate decreases only as one approaches the most likely solution and increases, thereafter, with any further increases in dimensionality. This curvilinear relationship would, on mathematical grounds alone, be expected to yield a zero correlation. That a significant inverse correlation was obtained could indicate a tendency for those subjects who use a relatively small number of meanings (dimensions) to also exhibit more variability, or perhaps less precision, in making their similarity judgments (Christian, 1976).

Perspective-Taking Performance

Results for performance on the perceptual perspective-taking task (PPT) will be presented in terms of both the frequency and magnitude of errors. Frequency data, to be presented first, were analyzed in two ways: (a) mean number of errors, and (b) proportion of subjects accounting for these errors. Results for frequency will also be presented for egocentric errors considered separately.

Mean Number of Errors. The mean number of errors made by subjects was low ($\underline{M}$ = 2.52); however, a considerable amount of individual variation did exist ($\underline{SD}$ = 2.49, with a range of 0 - 11). Although the mean number of incorrect responses made by females ($\underline{M} = 3.12 \pm 3.03$) was somewhat higher than that of males ($\underline{M} = 1.92 \pm 1.67$), this difference was not statistically significant [$F(1,46) = 2.94$, $p > .05$].

Proportion of Subjects Accounting for Errors. The proportion of subjects who made zero, one, two, or more than two errors can be found in Figure 1. Sixty-nine percent made no more than two (range = 0 - 2) incorrect responses; hence the low mean number of errors across subjects. The major portion of incorrect responses (range = 3 - 11) was accounted for by the remaining 31% of the sample.

Figure 1 also shows the proportion of males and females within each category of error. The distribution of males across these categories was relatively equal. In contrast, females appeared to be

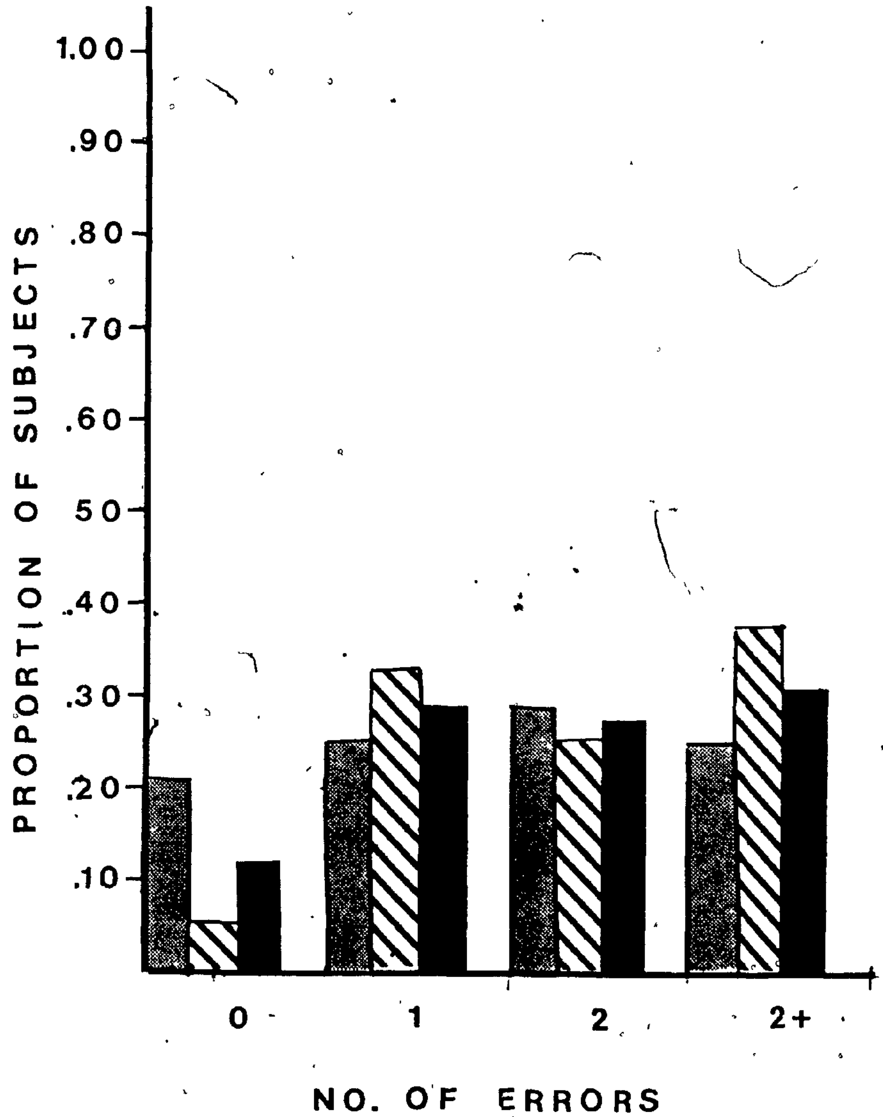

Figure 1 Proportion of Males ▒, Females ▧, and Total Sample ■ who made 0, 1, 2, or more than 2 errors on the PPT.

underrepresented among those subjects who performed without error and overrepresented among those subjects who made more than two. However, a chi square analysis for independent proportions (corrected for continuity) showed no significant difference in the distribution of males and females across these categories ($X^2 = 1.72$, $p > .05$).

Mean Number of Egocentric Errors. The mean number of egocentric responses across subjects was small ($M = .58 \pm 1.61$), with females ($M = 1.04 \pm 2.18$) making a significantly greater number of egocentric responses than did males [$M = .12 \pm .34$; $F(1,46) = 4.16$, $p < .05$].

Proportion of Subjects Accounting for Egocentric Errors. Figure 2 shows the proportion of subjects who made zero, one, two, or more than two egocentric responses. These results are presented for the total sample, as well as for males and females considered separately. The majority of subjects made no egocentric errors, with only a small proportion of the total sample making more than two. Once more, females appeared to be overrepresented in the category of highest error and underrepresented among subjects who performed without error. However, a chi square analysis for independent proportions (corrected for continuity) again revealed no significant difference in the distribution of males and females across these categories ($X^2 = 2.66$, $p > .05$).

Although the frequency with which subjects chose their own view (egocentric error) was low, examination of so-called 'nonegocentric' errors revealed a stronger preference in the direction of one's own view than would have been concluded from consideration of egocentric errors alone. For each of the 11 trial positions, subjects' errors could, hypothetically, be:

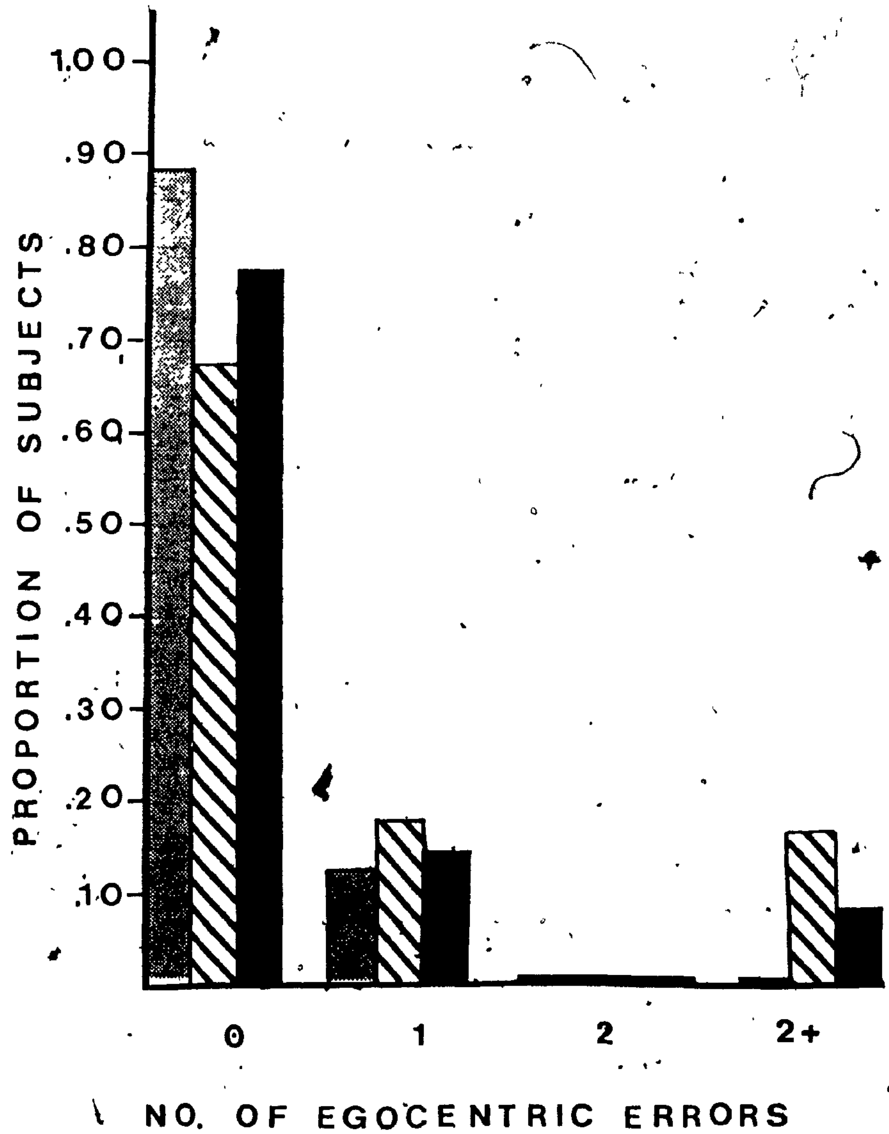

Figure 2 Proportion of Males, Females, and Total Sample who made 0, 1, 2, or more than 2 errors on the PPT.

1) randomly distributed around the correct (experimenter's) view;
2) skewed predominantly in the direction of the subject's own view; or
3) skewed predominantly away from the subject's own view.

In fact, 89% of nonegocentric errors were in the direction of the subject's own view. Furthermore, the frequency with which subjects responded in this direction was significantly greater than would be expected by chance ($X^2 = 28.65$, $p < .001$).

Magnitude of Error. Results for magnitude will be presented in two ways: (1) the total frequency with which errors of different magnitudes occurred across the sample as a whole, and (2) the mean magnitude of individual subjects' errors. Magnitude of error was defined by the degrees of angular separation existing between the experimenter's (correct) view and the view chosen by the subject (i.e. maximum possible angular separation = 180 degrees).

Figure 3 shows the total frequency with which errors of different magnitudes occurred (range = 30 to 180 degrees). The number of egocentric errors within each category is also shown. Three main findings are apparent. First, the majority of incorrect responses consisted of choosing a view only one removed (30 degrees away) from that of the experimenter (M magnitude of error = 31.90 ± 18.06). There were no significant differences between males ($M = 27.12 \pm 16.13$) and females ($M = 36.67 \pm 18.94$) in mean magnitude of error [$F(1,46) = 3.53$, $p > .05$]. Second, errors greater than 60 degrees were infrequent. And third, where large errors did occur, the view chosen was typically that of the subject (egocentric response). This latter finding is also reflected in a significant positive correlation between the mean magnitude of a subject's

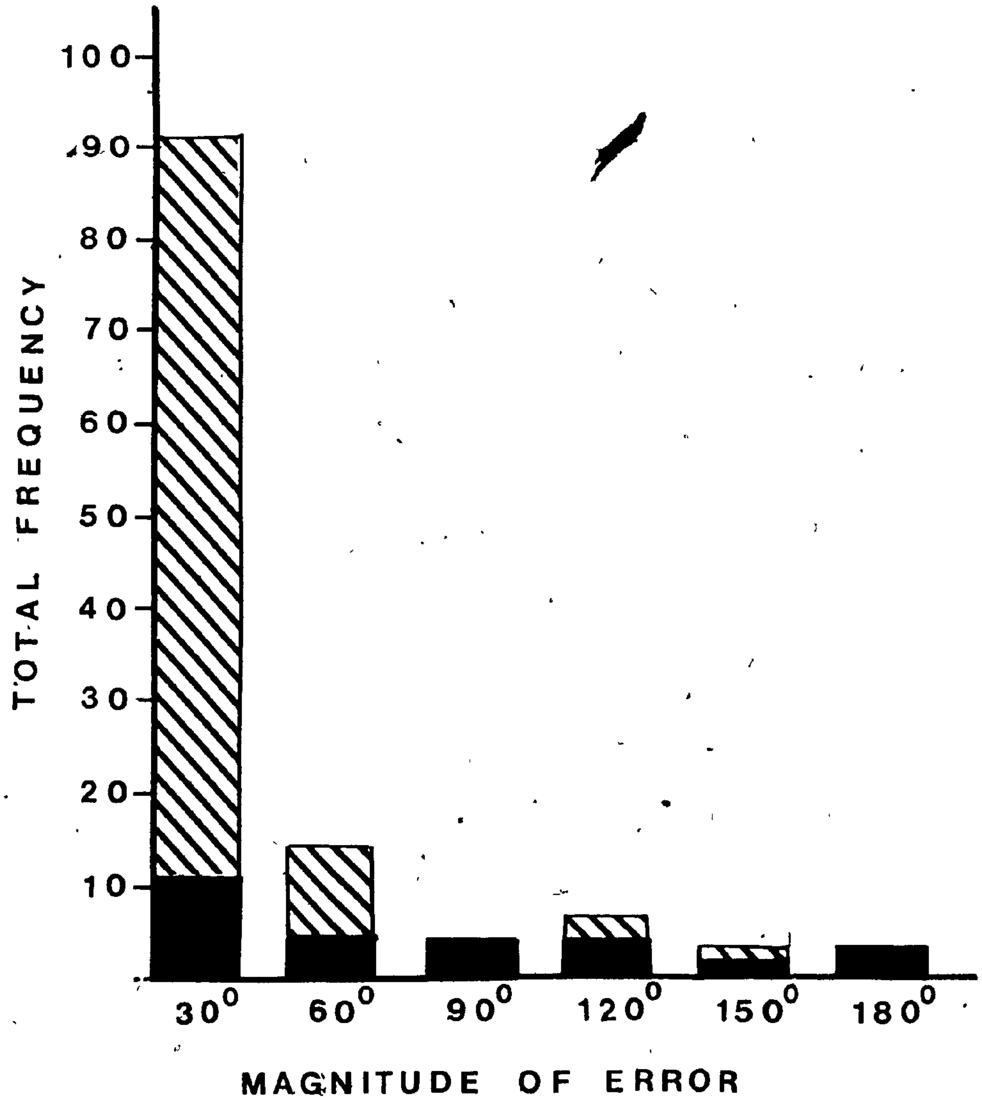

Figure 3 Total frequency of occurrence for perspective-taking errors [hatched] of different magnitudes. Number of egocentric errors [solid] within each category is also shown.

errors and number of egocentric responses ($\underline{r} = +.72$, $\underline{p} < .001$). In other words, those subjects who made the largest size errors also made the greatest number of egocentric responses. Furthermore, a significant positive correlation between frequency and mean magnitude of error revealed that those subjects who made the greatest number of errors also made the largest size errors ($\underline{r} = +.84$, $\underline{p} < .001$). Given these two relationships, a positive correlation between frequency of error and number of egocentric responses would be expected. This was, in fact, the case ($\underline{r} = +.80$, $\underline{p} < .001$). Subjects who made the most errors tended to make errors that were egocentric in nature. This latter finding is supported by a comparison of those subjects who never made an egocentric error with those subjects who made at least one. A median test for independent samples (corrected for continuity) revealed that subjects who made more than two incorrect responses were more likely to respond with their own viewpoint than were subjects who made two incorrect responses or less ($X^2 = 12.40$, $\underline{p} < .001$).

Wechsler Adult Intelligence Scale

Table 2 contains a summary of mean scores and standard deviations for the Vocabulary, Block Design, and Object Assembly subtests of the WAIS. Mean estimates of full-scale IQ, derived from the sum of scaled scores on Vocabulary and Block Design, are shown in Table 3. The only significant finding was that males ($\underline{M} = 114.67 \pm 9.85$) scored higher than females ($\underline{M} = 109.54 \pm 7.17$) in estimated IQ [$F(1,46) = 4.24$, $\underline{p} < .05$].

Relationships Between Variables

Relationships between variables in this study will be presented in the following order: dimensionality and perspective-taking,

Table 2

Mean Scaled Scores on WAIS Subtests

Sample	Mean	Standard Deviation	F
		Vocabulary	
Total	12.83	1.96	
Male	13.08	2.26	
Female	12.58	1.61	.78
		Block Design	
Total	11.54	2.67	
Male	12.25	2.82	
Female	10.83	2.37	3.55
		Object Assembly	
Total	11.21	2.87	
Male	11.62	3.41	
Female	10.79	2.19	1.02

Table 3

Mean Estimates of Full-Scale IQ

Sample	Mean	Standard Deviation	F
Total	112.10	8.91	
Male	114.67	9.85	
Female	109.54	7.17	4.24*

* $p < .05$.

perspective-taking and spatial skill, dimensionality and estimated IQ. A complete summary of interrelationships can be found in Appendix 6.

Dimensionality and Perspective-Taking Performance. The main hypothesis of the present study was that number of dimensions needed to fit a subject's similarity judgments would be related to accuracy of performance on a perceptual perspective-taking task. Table 4 contains a summary of this relationship. Contrary to prediction, there were no significant correlations between the number of dimensions required to fit an individual's similarity judgments and either the frequency or magnitude of his errors on the PPT. Nor were significant correlations found between unbiased standard error estimates, derived from the multidimensional scaling, and these perspective-taking scores. Furthermore, a comparison of those subjects who made no egocentric errors with those subjects who made at least one revealed that individuals who used only two dimensions were no more likely to respond with their own view than were individuals who used greater than this median number (two) of dimensions [X^2 (corrected for continuity) = 1.36, $p > .05$].

Perspective-Taking Performance and Visual-Spatial Skill. A second purpose of this study was to examine the relationship between perspective-taking and spatial skill. A summary of this relationship can be found in Table 5. Significant negative correlations were noted between error scores (frequency and magnitude) on the PPT and performance scores on both the Block Design and Object Assembly subtests of the WAIS. However, even this low level of correlation may have been spuriously high, due to a few outlying scores which biased an otherwise haphazard distribution (see Figure 4). Outlyers also seemingly

Table 4

Matrix of Pearson Correlation Co-efficients For MDS Results and Perspective-Taking Performance

	No. of Dimensions	Unbiased Standard Error Estimate
No. of Errors	+.02	+.10
No. of Egocentric Errors	+.04	+.01
M Magnitude of Error	-.01	+.10

Table 5

Matrix of Pearson Correlation Co-efficients For Perspective-Taking Performance and WAIS Results

	No. of Errors	No. of Egocentric Errors	M Magnitude of Error
Block Design	-.39**	-.35**	-.40**
Object Assembly	-.24*	-.29*	-.24*
Vocabulary	+.09	.00	+.13
Estimated IQ	-.25*	-.28*	-.24*
Age	+.32*	+.32*	+.29*
Years of University	-.05	-.12	-.03

* $p < .05$

** $p < .01$

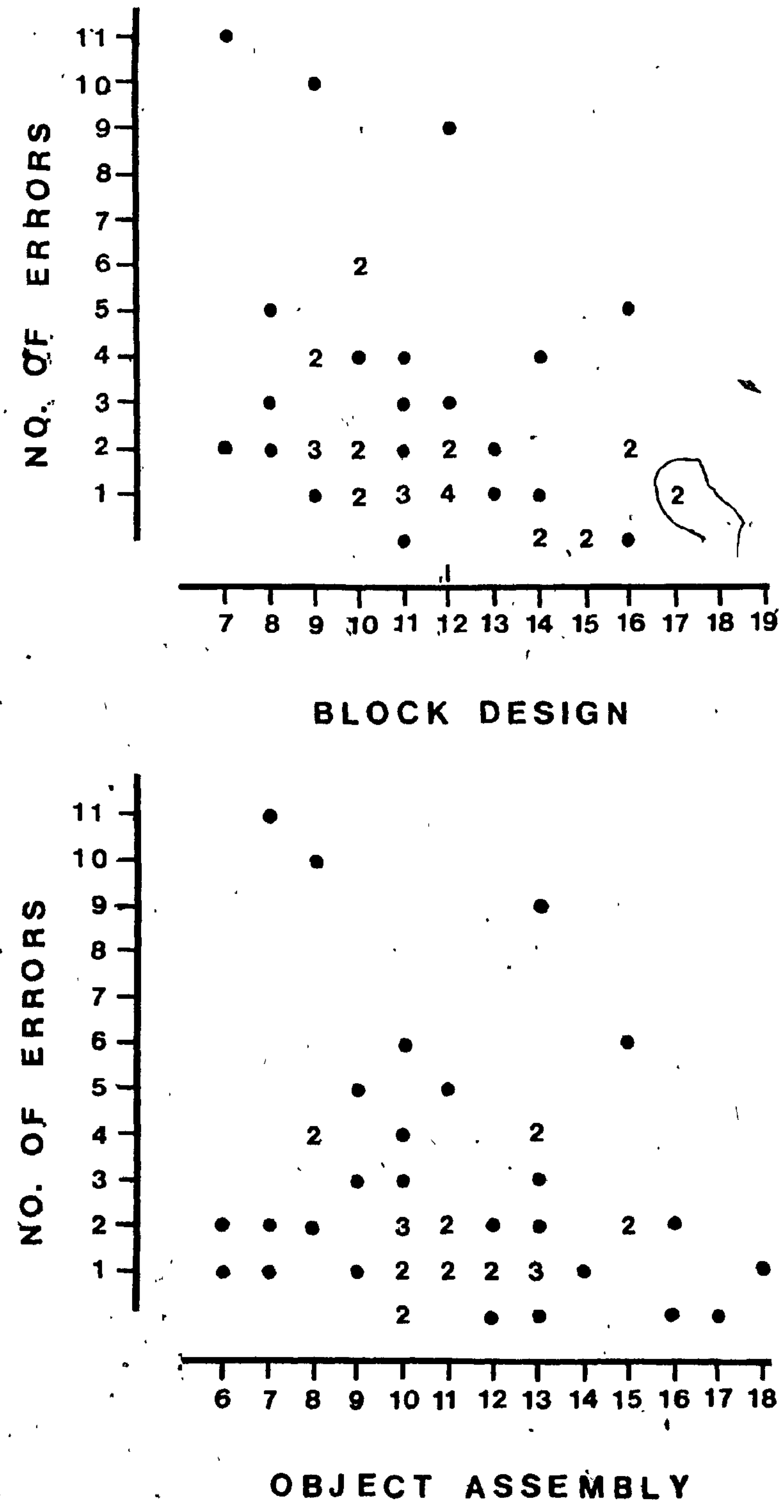

Figure 4 Plot of relationship between frequency of errors on the PPT and spatial performance on the Block Design and Object Assembly subtests of the WAIS.

contributed to low negative correlations between error scores and estimated IQ (Figure 5), as well as to low positive correlations between error scores and age (Figure 6).

Dimensionality and Estimated Level of Intelligence. A third goal of this study was to explore the relationship between number of dimensions and estimated IQ. Table 6 contains a summary of this relationship. No significant correlations were noted between the number of dimensions required to fit a person's similarity judgments and his estimated full-scale IQ. Nor were significant correlations revealed between dimensionality and individual scores on any of the three WAIS subtests (Vocabulary, Block Design, and Object Assembly) administered in this study.

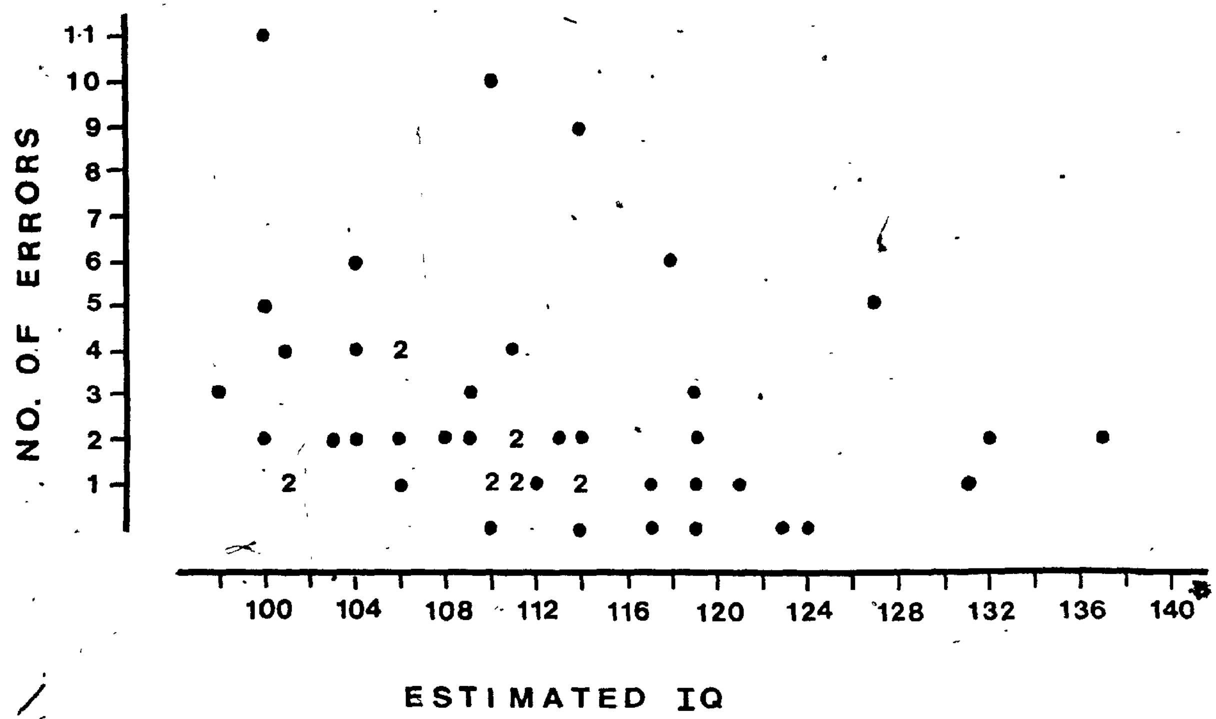

Figure 5 Plot of relationship between frequency of errors on the PPT and estimated full-scale IQ.

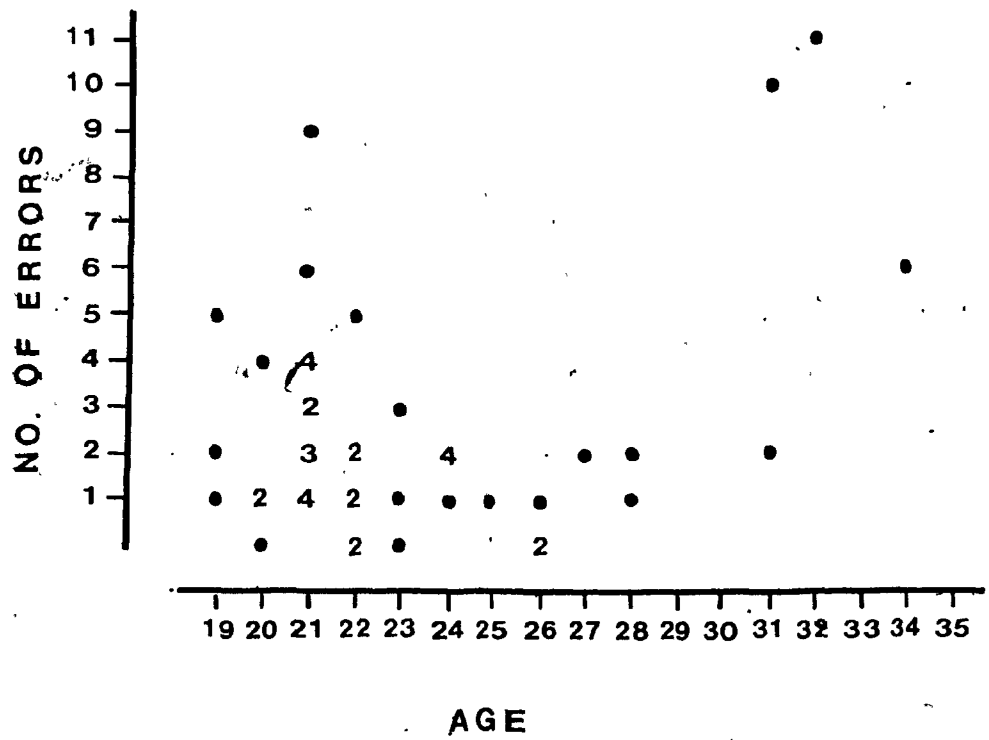

Figure 6 Plot of relationship between frequency of errors on the PPT and age.

Table 6

Matrix of Pearson Correlation Co-efficients For MDS and WAIS Results

	No. of Dimensions	Unbiased Standard Error Estimate
Estimated IQ	-.14	.01
Vocabulary	-.05	-.10
Block Design	-.15	.06
Object Assembly	-.13	-.13
Age	-.08	-.02
Years of University	-.07	.08

Discussion

The present study was designed to examine the relationship between dimensionality and perspective-taking performance. The findings pertaining to each variable will be discussed first, followed by a discussion of their interrelationships.

Multidimensional scaling analyses of subjects' similarity ratings through maximum likelihood estimation revealed substantial variation across individuals in the number of dimensions required to fit their data. This finding, consistent with that of Christian (1976), provides support for the argument that individual differences exist in the number of meanings which adults assign to their interpersonal environment. Furthermore, the fact that dimensionality was unrelated to estimated IQ suggests that these differences were not attributable to varying levels of intelligence. Nor could these differences be ascribed to individual variation in age, sex, level of university education, verbal ability, or visual-spatial skill.

Unbiased standard error estimates derived from MDS analyses were typically low and, therefore, well within acceptable limits (Ramsay, 1978). These low error estimates suggest that subjects were being consistent in making their similarity ratings. That these error estimates were typically lower than those obtained by Christian (1976) may reflect the fact that MDS solutions obtained in the present study were based upon repeated (two) similarity judgments with a reduced number of stimuli. Additional work is needed to clarify the possible effects of such procedural variations on both number of dimensions and size of unbiased error estimates.

Use of the maximum likelihood estimation model (Ramsay, 1978) had the advantage of allowing for a statistical stopping rule on which to decide the maximum number of dimensions needed to fit an individual subject's data. This may lead, however, to the potential problem of retaining too many dimensions. While the stopping rule sets an <u>upper</u> limit on the number of dimensions retained, it cannot ensure that a solution of <u>lesser</u> dimensionality would not be adequate to represent a subject's similarity ratings. In fact, the high precision of the maximum likelihood algorithm may make this model overly sensitive to small degrees of data variation that exist in mathematical terms but have little psychological meaning. Some caution is thus called for in interpreting the results of this study with regard to the determination of dimensionality. More definitive statements await further clarification of stopping rules for MDS solutions based on the data of single subjects.

Another basis for establishing a stopping rule for dimensionality might be to determine the relative contribution of each dimension (rotated to principle axes) in fitting the dissimilarity data. This would be analogous to assessing the variance accounted for by each factor of a factor analytic solution. While the co-ordinate values on any given dimension sum to zero, and thus yield little information as to the relative importance of that dimension, the sum of the squared co-ordinate values can, in comparison, be used as a more meaningful measure. A plot of these summed values against dimensionality allows for visual examination of 'scallops' as an index of rapid changes or decreases in the relative importance or contribution of each dimension. Similar approaches are used in factor analysis (plotting eigenvalues against factors) and MDSCAL (plotting 'stress' against dimensions). Use of this procedure could more accurately reflect individual differences in dimensionality.

An important outcome of this study was the demonstration of individual differences in perspective-taking ability among adults. This finding is in contrast to Piaget's assumption that all normal adults will have attained uniformly high levels of perspective-taking skill. Additional research is needed to determine whether the individual differences demonstrated in this study have relevance for other areas of adult behaviour.

Greater individual variation was observed in the number of incorrect responses made than in the actual size of these errors. From a methodological standpoint, this finding suggests that frequency of errors, as opposed to magnitude, provides a more useful measure of individual differences in adults.

The number of trials on which subjects actually chose their own view (egocentric error) was low, indicating that most could differentiate between their own and other perceptual viewpoints. Although subjects did not typically respond with their own point of view, they did tend to err in that direction. Considering the symmetrical nature of the board, this tendency to err in the direction of one's own view cannot be explained in terms of a right-left response bias -- that is, a preference for responding in a particular (rightward or leftward) direction. Rather, given some uncertainty regarding the correct view, subjects favoured views which more closely resembled their own. From a Piagetian standpoint, this preference could be reflecting degree of confusion between self and other. At another level, in situations of uncertainty, people may show a preference for familiarity and thus for points of view which bear some resemblance to their own.

Subjects could have responded incorrectly on all eleven trials without ever having chosen their own view. This would have led to a lack of relationship between frequency of error and number of egocentric responses. Such was not the case, however. In fact, subjects who made frequent errors tended to make errors that were egocentric in nature (r = +.80). While a high frequency of error could have resulted from a large number of egocentric responses alone, this relationship could also indicate that subjects who made egocentric errors tended to make a large number of nonegocentric errors as well. It is worthwhile noting that, on any given trial, an incorrect response could consist of the subject choosing either his own view (egocentric error) or another view different from that of the experimenter (nonegocentric error), but never both. Therefore, as the number of egocentric errors increased, the potential for making a large number of nonegocentric errors decreased. Even though the scoring procedure was biased against a high frequency of egocentric and nonegocentric errors together, a significant positive relationship between these measures was found (r = +.25). Subjects who responded with their own view (egocentric error) tended to make a larger number of nonegocentric errors as well. At least two interpretations are possible.

The first follows directly from Piaget's argument that egocentrism and perspective-taking are related phenomena. Difficulty in decentering from one's own point of view may have placed a limitation on some subjects' ability to imagine views other than their own. An alternate possibility is that both egocentric and nonegocentric errors were simply reflecting visual-spatial problems, rather than difficulty in decentering. The fact that both frequency and magnitude of error were inversely related to spatial measures (Block Design and Object Assembly subtests of the WAIS) provides some, although not strong ($-.40 \geq r \geq -.24$), support for this interpretation.

Error scores on the PPT were also inversely related to estimated IQ. The extent to which intellectual ability, and visual-spatial skill in particular,[3] influenced performance on the PPT is difficult to assess. Borke (1975) has argued, however, that "the more difficult it is for subjects to solve a task, the greater the likelihood that they will give their own perspective in an attempt to perform successfully in the situation" (p. 243). A similar argument has been put forth by Verkozen (1975). He states that when a task is beyond a person's capabilities, the person will resort to his own viewpoint as a way of denying his difficulty. As such, the tendency to respond with one's own view may represent a type of coping strategy.

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[3]Although the sum of an individual's scores on Block Design and Vocabulary was used to estimate IQ, this estimate was more strongly related to performance on the former subtest (r = +.84) than on the latter (r = +.63).

An interesting result of the present study was that females made significantly more egocentric responses than did males. Females also scored lower than males in estimated IQ.[4] If one assumes that lower intellectual (spatial-type) skills were contributing to difficulty on the PPT, then the fact that females choose their own view more frequently could represent a response to greater task difficulty. In other words, the greater the degree to which a situation stresses a person's intellectual or problem-solving capabilities, the more likely he is to become centered on his own point of view.

The main hypothesis of the present study was that accuracy of perspective-taking would be related to individual differences in dimensionality. Contrary to prediction, a significant relationship between these variables was not demonstrated. At least three possible explanations exist.

The first concerns the accurate determination of dimensionality. As discussed earlier, too many dimensions may have been retained in some cases. Potential inaccuracies in assessing number of dimensions could have contributed to inconsistent relationships with other variables.

A second explanation concerns the stability of dimensionality over time. The perspective-taking task was administered up to one week following the completion of similarity judgments. This time

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[4]Differences in Block Design and Object Assembly, although not significant, were in the same direction.

lapse, although relatively short, may have been sufficient to allow for changes in dimensionality. That performance on the PPT was examined in relation to dimensionality as assessed one week previous could account for the lack of relationship between these variables. Repeated comparisons of self and significant others are needed, however, to determine whether dimensionality, as defined by the number of meanings which an individual assigns to his interpersonal world, varies over time. For example, a person's ability to organize information according to multiple meanings may decrease temporarily during periods of emotional stress. Sustained increases in dimensionality over prolonged intervals may, on the other hand, indicate cognitive growth. In this sense, the MDS procedure could provide a viable means of assessing therapeutic change (Christian, 1976).

Third, inconsistent relationships with dimensionality could have been due to a restricted variation in perspective-taking scores. There were individual differences in simple frequency of error but the magnitude of these errors was seldom more than 30 degrees removed from the correct view. While restricted variation should not have affected correlations with dimensionality, it is possible that these results are reflecting certain inadequacies in the procedure used to assess perspective-taking skill.

Subjects were allowed unlimited time to respond. This may have produced a ceiling effect which would have masked individual differences. If so, this problem could be corrected by imposing an upper bound on response time. On the other hand, subjects might still be allowed unlimited time but then estimation of performance would be based on consideration of response speed as well as response accuracy.

Of course, it is also possible that results on the PPT reflect a simple lack of individual differences on tasks which require adults to visualize another person's spatial point of view (perceptual perspective-taking). Success on such tasks is based on the ability to imagine changes in the spatial orientation and relative positioning of concrete visual stimuli. Other measures (Chandler, 1972; Feffer, 1959; Rothenberg, 1970) have been designed to assess the ability to infer another person's thoughts, feelings, motives, and intentions (social perspective-taking). Although perceptual and social perspective-taking are theoretically related, empirical support for this relationship has been equivocal (Kurdeck and Rodgon, 1975; Rubin, 1973; Sullivan and Hunt, 1967). These findings suggest that perspective-taking may not be a unitary skill.

While limited individual variation may, in fact, be characteristic of adult performance on perceptual tasks, greater individual differences might be found in more social areas of perspective-taking skill. Larger individual variation on social tasks would be expected on the basis of their greater complexity. One need only consider another person's location in space to imagine his visual perspective. One must, however, take into account a large variety of information (age, social background, and so on) — all of which may, or may not, influence his point of view — when attempting to make social inferences about this other person. These increased task demands should increase sensitivity to individual differences.

Piaget has argued that perspective-taking develops from exposure to different points of view. The opportunity to view the world from many spatial perspectives should, given normal circumstances, be uniformly high across individuals. The chance to share thoughts and feelings different from one's own could, however, vary greatly from one individual to another. A greater diversity of social, as opposed to perceptual, perspective-taking ability would, therefore, be expected.

Perceptual and social perspective-taking could also represent different levels, as well as different types, of cognitive skill. Piaget has argued that cognitive development involves a gradual transition from perceptual (concrete) to conceptual (abstract) processes. If perceptual processes do precede those of the conceptual domain, it follows then that two individuals who have each mastered the ability to visualize alternate spatial views could, nevertheless, have progressed to different stages with respect to social perspective-taking. Greater individual variation on social tasks would again be predicted. This variation could more accurately reflect adult differences in egocentrism and perspective-taking skill.

In addition to the use of social tasks, future research ought also to consider a broader range of populations. One possibility for establishing a more heterogeneous sample would be to select subjects on the basis of probable developmental level. This could be done by selecting children of different ages, or who score at different developmental stages on standard Piagetian tasks (conservation, classification, seriation, and so on). Subjects could also be selected on the basis of clinical populations which, on theoretical grounds at least, suggest different developmental levels of functioning. Inclusion of developmentally varied populations might more clearly elucidate a relationship between perspective-taking and cognitive differentiation.

References

Anthony, E. J. The significance of Jean Piaget for child psychiatry. British Journal of Medical Psychology, 1956, 29, 20-34.

Borke, H. Piaget's mountains revisited: changes in the egocentric landscape. Developmental Psychology, 1975, 11, 240-243.

Cameron, N. Experimental analysis of schizophrenic thinking. In J. S. Kasanin (Ed.), Language and thought in schizophrenia. New York: W. W. Norton & Company, 1964. (Originally published, 1944.)

Chandler, M. J. Egocentrism in normal and pathological childhood development. In F. J. Marks, W. W. Hartup & J. de Wit (Eds.), Determinants of behavioural development. New York: Academic Press, 1972.

Chandler, M. J. Egocentrism and antisocial behaviour: the assessment and training of social perspective-taking skills. Developmental Psychology, 1973, 9, 326-332.

Christian, J. D. Psychological differentiation and definition of self: a multidimensional scaling approach. Unpublished doctoral dissertation, McGill University, 1976.

Cox, M. V. The other observer in a perspectives task. British Journal of Educational Psychology, 1975, 45, 83-85.

Deutsch, H. Some forms of emotional disturbance and their relationship to schizophrenia. Psychoanalytic Quarterly, 1942, 11, 301-321.

Dodwell, P. C. Children's understanding of spatial concepts. Canadian Journal of Psychology, 1963, 17, 141-161.

Elkind, D. Children and adolescents. New York: Oxford University Press, 1970.

Elkind, D. Cognitive development and psychopathology: observations on egocentrism and ego defense. In E. Schopler & R. J. Reichler (Eds.), Psychopathology and Child Development. New York: Plenum Press, 1976.

Eliot, J., & Dayton, C. M. Egocentric error and the construct of egocentrism. The Journal of Genetic Psychology, 1976, 128, 275-289. (a)

Eliot, J., & Dayton, C. M. Factors affecting accuracy of perception on a task requiring the ability to identify viewpoints. The Journal of Genetic Psychology, 1976, 128, 201-214. (b)

Feffer, M. H. The cognitive implications of role-taking behaviour. Journal of Personality, 1959, 27, 152-168.

Feffer, M. H., & Gourevitch, V. Cognitive aspects of role-taking in children. Journal of Personality, 1960, 28, 383-396.

Fishbein, H. D., Lewis, S., & Keiffer, K. Children's understanding of spatial relations. Developmental Psychology, 1972, 7, 21-33.

Flavell, J., Botkin, P. T., Fry, C. L., Jr., Wright, J. W., & Jarvis, P. E. The development of role-taking and communication skills in children. New York: John Wiley & Sons, Inc., 1968.

Gough, H. G. A sociological theory of psychopathology. The American Journal of Sociology, 1948, 53, 359-366.

Hoy, E. A. Predicting another person's visual perspective: a unitary skill? Developmental Psychology, 1974, 10, 462.

Huttenlocher, J., & Presson, C. C. Mental rotation and the perspective problem. Cognitive Psychology, 1973, 4, 277-299.

Kelly, G. A. The psychology of personal constructs (2 vols.). New York: W. W. Norton & Company, 1955.

Kruskal, J. B. Multidimensional scaling by optimizing goodness of fit to a nonmetric hypothesis. Psychometrika, 1964, 29, 1-27. (a)

Kruskal, J. B. Nonmetric multidimensional scaling: a numerical method. Psychometrika, 1964, 29, 115-129. (b)

Kurdeck, L., & Rodgon, M. Perceptual, cognitive, and affective perspective-taking in kindergarten through sixth-grade children. Developmental Psychology, 1975, 11, 643-650.

Lidz, T. The origin and treatment of schizophrenic disorders. New York: Basic Books, Inc., 1973.

Maxwell, E. Validities of abbreviated WAIS scales. Journal of Consulting and Clinical Psychology, 1957, 21, 121-126.

Piaget, J. The psychology of intelligence. New York: Harcourt & Brace, 1950.

Piaget, J. The language and thought of the child. London: Routledge & Kegan Paul Ltd., 1959. (Originally published, 1926.)

Piaget, J. Play, dreams, and imitation in childhood. New York: W. W. Norton & Company, 1962. (Originally published, 1951.)

Piaget, J. Judgment and reasoning in the child. London: Lowe & Brydone Ltd., 1965. (Originally published, 1928.)

Piaget, J. The child's conception of physical causality. London: Routledge & Kegan Paul Ltd., 1966. (Originally published, 1930.)

Piaget, J. The moral judgment of the child. London: Routledge & Kegan Paul Ltd., 1968. (Originally published, 1932.)

Piaget, J. The child's conception of the world. Totowa, New Jersey: Littlefield, Adams & Co., 1969. (Originally published, 1929.)

Piaget, J., & Inhelder, B. The child's conception of space: London: Routledge & Kegan Paul Ltd., 1956.

Ramsay, J. O. Maximum likelihood estimation in multidimensional scaling. Psychometrika, 1977, 42, 241-266.

Ramsay, J. O. Multiscale: four programs for multidimensional scaling by the method of maximum likelihood. Chicago: National Educational Resources, Inc., 1978.

Rothenberg, B. B. Children's social sensitivity and the relationship to interpersonal competence, intrapersonal comfort, and intellectual level. Developmental Psychology, 1970, 2, 335-350.

Rubin, K. H. Egocentrism in childhood: a unitary construct? Child Development, 1973, 44, 102-110.

Shantz, C. U. The development of social cognition. In E. M. Hetherington (Ed.), Review of child development research. Chicago: University of Chicago Press, 1975.

Shephard, R. N. The analysis of proximities: multidimensional scaling with an unknown distance function. Psychometrika (I & II), 1962, 27, 125-139, 219-246. (a & b)

Silverstein, A. B. Reappraisal of the validity of a short short form of Wechsler's Scales. Psychological Reports, 1970, 26, 559-561. (a)

Silverstein, A. B. Reappraisal of the validity of the WAIS, WISC, and WIPPSI short forms. Journal of Consulting and Clinical Psychology, 1970, 34, 12-14. (b)

Sullivan, H. S. The language of schizophrenia. In J. S. Kasanin (Ed.), Language and thought in schizophrenia. New York: W. W. Norton & Company, 1964. (Originally published, 1944.)

Sullivan, C., Grant, M. Q., & Grant, J. D. The development of interpersonal maturity: applications to delinquency. Psychiatry, 1957, 20, 373-385.

Sullivan, E. V., & Hunt, D. E. Interpersonal and objective decentering as a function of age and social class. The Journal of Genetic Psychology, 1967, 110, 199-210.

Torgerson, W. S. Multidimensional scaling: I. theory and method. Psychometrika, 1952, 17, 401-419.

Torgerson, W. S. Theory and methods of scaling. New York: John Wiley & Sons, Inc., 1958.

Verkozen, J. Egocentrism: stage or state? Psychoanalytic Review, 1975, 62, 305-308.

Wechsler, D. Manual for the Wechsler Adult Intelligence Scale. New York: Psychological Corporation, 1955.

Werner, H. Comparative Psychology of Mental Development. New York: Science Editions, Inc., 1948.

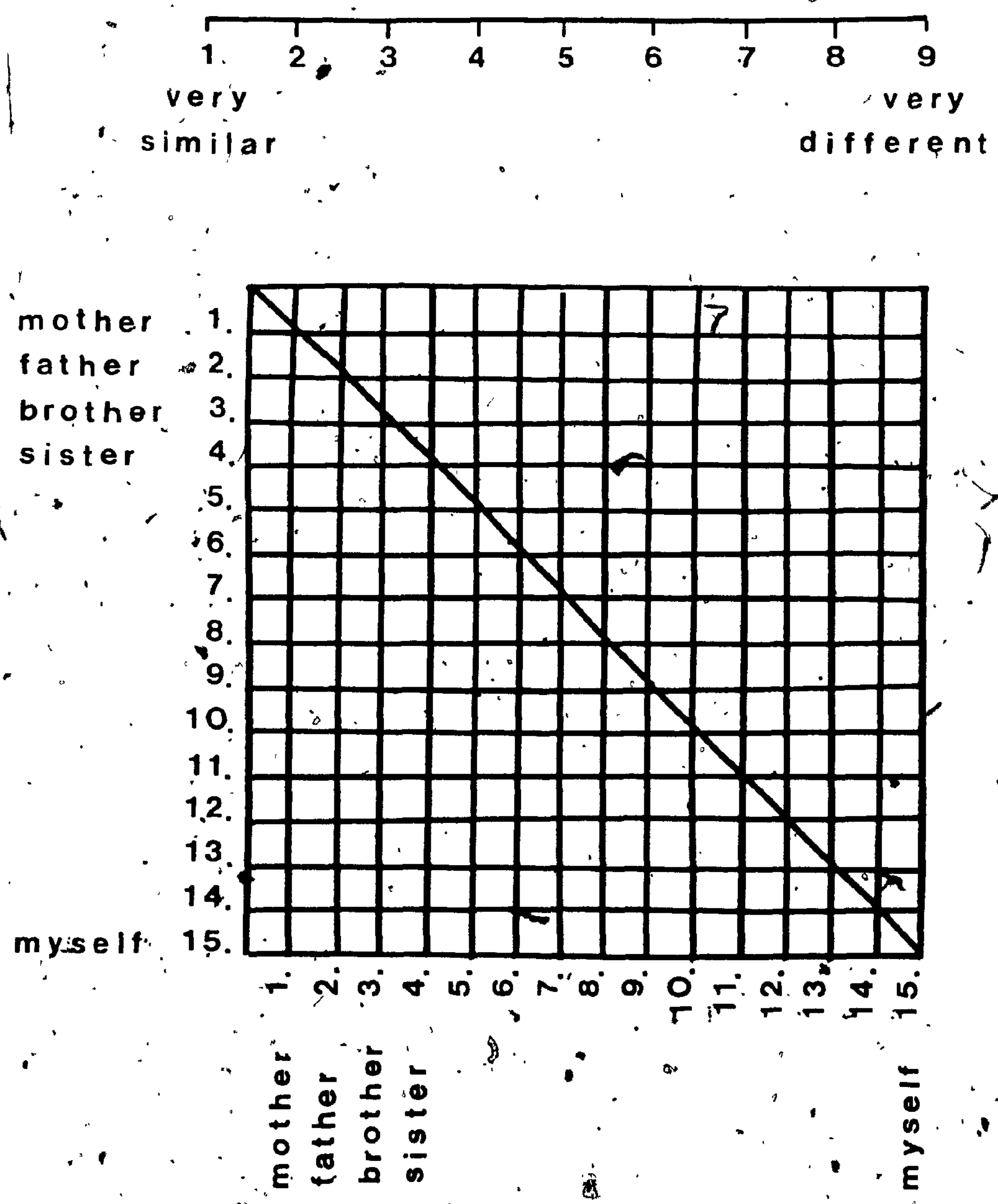
Werner, H. The concept of development from a comparative and organismic point of view. In D. B. Harris (Ed.), The concept of development. Minneapolis: University of Minnesota Press, 1957.

Wolfe, R. The role of conceptual systems in cognitive functioning at varying levels of age and intelligence. Journal of Personality, 1963, 31, 108-123.

Zimmerman, J. L., Woo-Sam, J. M., & Glasser, A. J. Clinical interpretation of the Wechsler Adult Intelligence Scale. New York: Grune & Stratton, 1973.

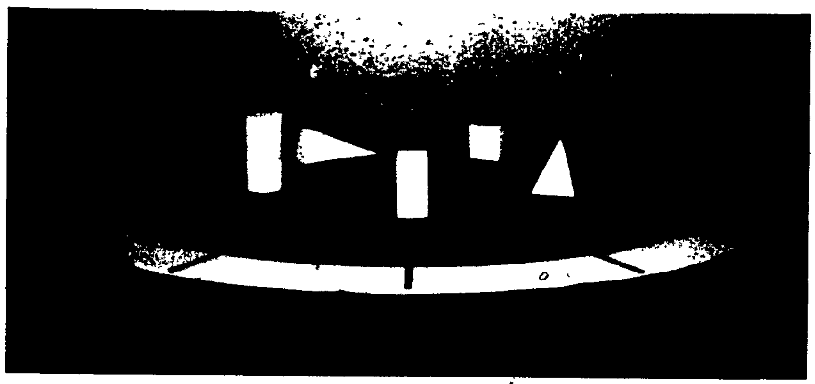
Appendix 1

Matrix Used to Record a Subject's Similarity Judgments of Self and Significant Others

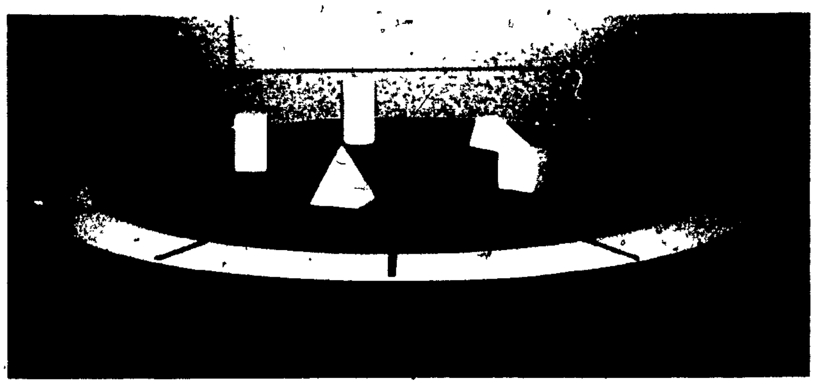


Appendix 2

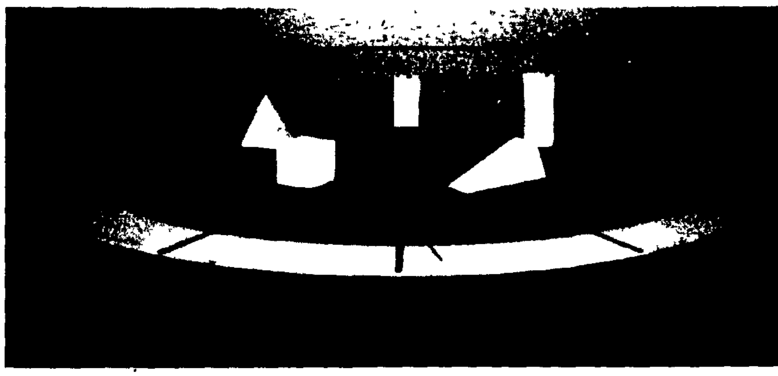
Spatial Display as Viewed From
Four Visual Perspectives



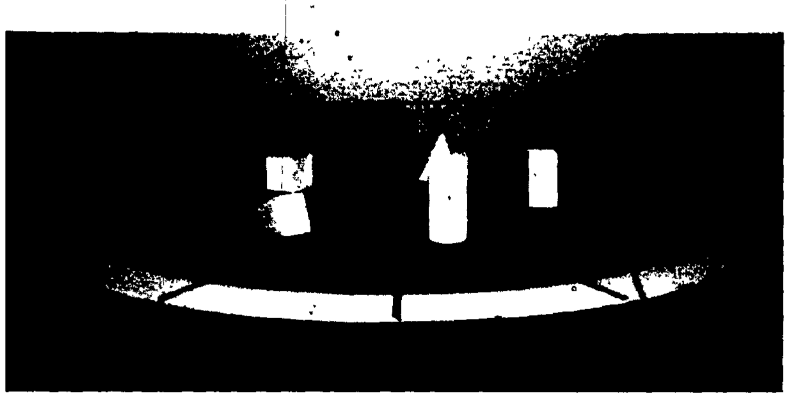
1. Subject's perspective



2. 90 degrees to the right of
subject's perspective



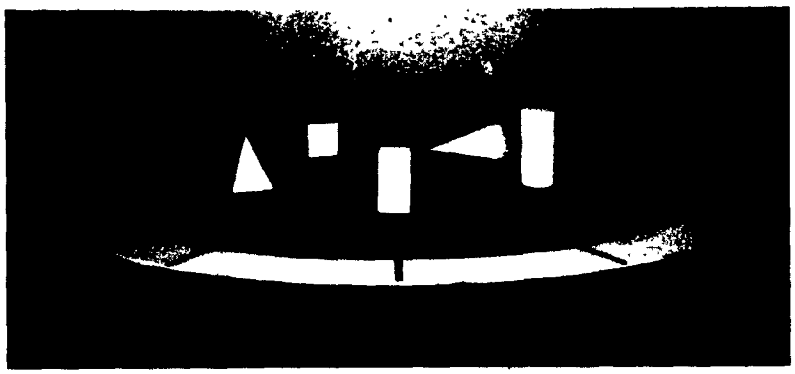
3. Directly opposite the subject's perspective



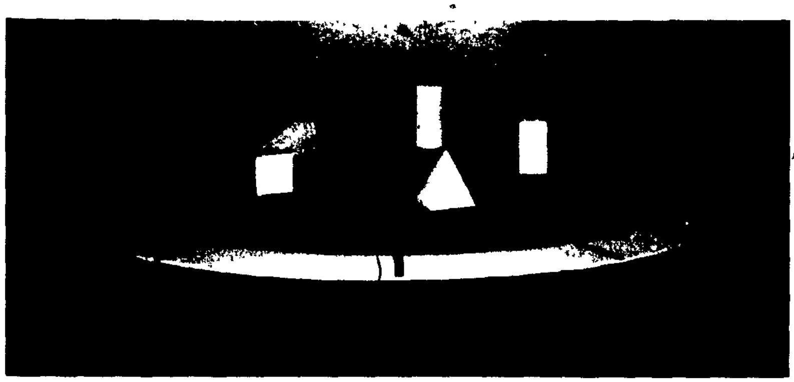
4. 90 degrees to the left of subject's perspective

Appendix 3

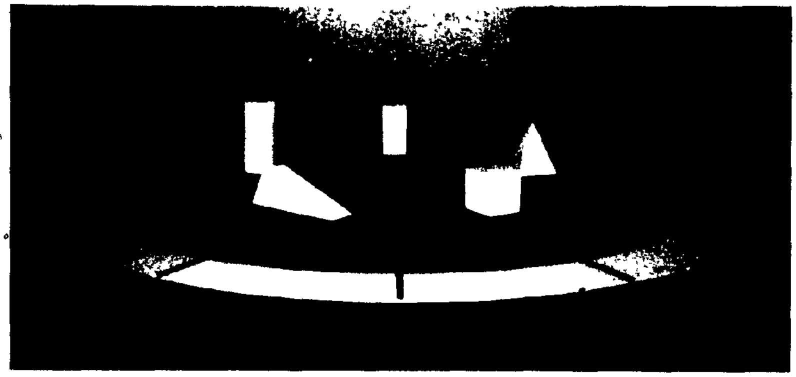
'Flip-side' Photographs of Four
Visual Perspectives



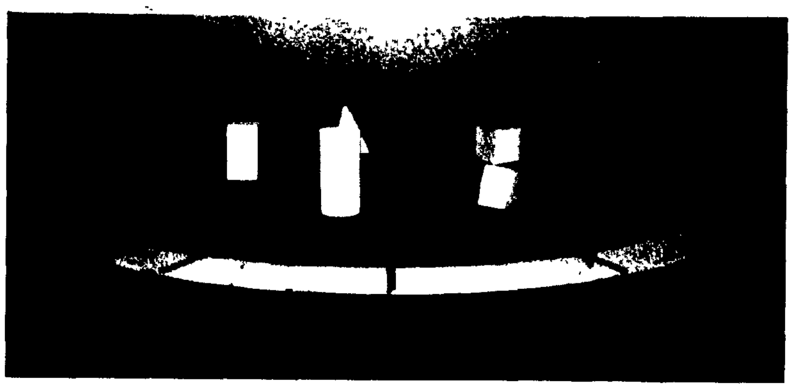
1. Subject's perspective



2. 90 degrees to the right of
subject's perspective



3. Directly opposite the subject's perspective



4. 90 degrees to the left of subject's perspective

Appendix 4

Critical Values of $-2(\log L_{k-1} - \log L_k)$

For n - k Degrees of Freedom, where n = 15

Level of Significance	Degrees of Freedom 13	12	11	10	9
.05	44.72	42.06	39.36	36.62	33.84
.01	55.38	52.44	49.44	46.42	43.34
.001	69.06	65.82	62.52	59.18	55.76

Appendix 5

Results of Multidimensional Scaling by Maximum Likelihood Estimation for Each Subject

Subject		Number of Dimensions 1	2	3	4	5	6
1	No. of iterations to convergence	11	544	22			
	Unbiased standard error	.264	.192	.184			
	Log likelihood function	182.8	256.2	272.3			
	$-2(\log L_{k-1} - \log L_k)$		146.7	32.3			
	No. of dimensions retained : 2						
2	No. of iterations to convergence					573	289
	Unbiased standard error					.194	.183
	Log likelihood function					275.8	294.6
	$-2(\log L_{k-1} - \log L_k)$					47.3	37.6
	No. of dimensions retained : 6						
3	No. of iterations to convergence	382	321	158			
	Unbiased standard error	.324	.286	.277			
	Log likelihood function	139.6	173.2	186.4			
	$-2(\log L_{k-1} - \log L_k)$		67.2	26.6			
	No. of dimensions retained : 2						

		1	2	3	4	5	6
4	No. of iterations to convergence				100	112	182
	Unbiased standard error				.275	.252	.246
	Log likelihood function				195.4	221.3	232.2
	$-2(\log L_{k-1} - \log L_k)$					51.8	21.9
	No. of dimensions retained : 5						
5	No. of iterations to convergence	54	884	1896			
	Unbiased standard error	.204	.145	.138			
	Log likelihood function	236.8	315.4	333.5			
	$-2(\log L_{k-1} - \log L_k)$		157.2	36.2			
	No. of dimensions retained : 2						
6	No. of iterations to convergence			200	172	254	
	Unbiased standard error			.273	.257	.249	
	Log likelihood function			189.7	209.9	222.9	
	$-2(\log L_{k-1} - \log L_k)$				40.4	26.0	
	No. of dimensions retained : 4						
7	No. of iterations to convergence	222	310	197			
	Unbiased standard error	.235	.190	.183			
	Log likelihood function	207.0	259.0	273.8			
	$-2(\log L_{k-1} - \log L_k)$		104.0	29.6			
	No. of dimensions retained : 2						

		1	2	3	4	5	6
8	No. of iterations to convergence		205	106	139		
	Unbiased standard error		.354	.328	.317		
	Log likelihood function		128.2	151.2	165.1		
	$-2(\log L_{k-1} - \log L_k)$			46.1	28.0		
	No. of dimensions retained : 3						
9	No. of iterations to convergence	5	229	297			
	Unbiased standard error	.348	.219	.205			
	Log likelihood function	124.7	229.1	250.1			
	$-2(\log L_{k-1} - \log L_k)$		208.9	42.0			
	No. of dimensions retained : 2						
10	No. of iterations to convergence		907	215	375		
	Unbiased standard error		.240	.221	.212		
	Log likelihood function		209.7	234.5	250.0		
	$-2(\log L_{k-1} - \log L_k)$			45.5	30.8		
	No. of dimensions retained : 3						
11	No. of iterations to convergence	31	202	79			
	Unbiased standard error	.309	.250	.235			
	Log likelihood function	149.4	200.8	221.0			
	$-2(\log L_{k-1} - \log L_k)$		102.8	40.4			
	No. of dimensions retained : 2						

		1	2	3	4	5	6
12	No. of iterations to convergence		192	1041	262		
	Unbiased standard error		.187	.156	.150		
	Log likelihood function		262.0	306.9	322.7		
	$-2(\log L_{k-1} - \log L_k)$			89.8	31.5		
	No. of dimensions retained : 3						
13	No. of iterations to convergence		126	52	103		
	Unbiased standard error		.231	.213	.213		
	Log likelihood function		217.4	241.5	249.0		
	$-2(\log L_{k-1} - \log L_k)$			48.3	15.0		
	No. of dimensions retained : 3						
14	No. of iterations to convergence			82	583	117	
	Unbiased standard error			.198	.182	.173	
	Log likelihood function			256.8	282.3	299.6	
	$-2(\log L_{k-1} - \log L_k)$				51.1	34.6	
	No. of dimensions retained : 4						
15	No. of iterations to convergence		181	78	328		
	Unbiased standard error		.270	.246	.240		
	Log likelihood function		185.2	211.7	224.2		
	$-2(\log L_{k-1} - \log L_k)$			53.0	25.1		
	No. of dimensions retained : 3						

		1	2	3	4	5	6
16	No. of iterations to convergence	29	68	114			
	Unbiased standard error	.694	.548	.531			
	Log likelihood function	-20.6	36.2	50.0			
	$-2(\log L_{k-1} - \log L_k)$		113.5	27.6			
	No. of dimensions retained : 2						
17	No. of iterations to convergence	286	411	170			
	Unbiased standard error	.312	.226	.222			
	Log likelihood function	147.7	222.0	233.4			
	$-2(\log L_{k-1} - \log L_k)$		148.5	22.9			
	No. of dimensions retained : 2						
18	No. of iterations to convergence		657	302	198		
	Unbiased standard error		.176	.161	.152		
	Log likelihood function		[illegible]	301.2	320.2		
	$-2(\log L_{k-1} - \log L_k)$			53.6	38.0		
	No. of dimensions retained : 3						
19	No. of iterations to convergence		154	172	162		
	Unbiased standard error		.307	.278	.266		
	Log likelihood function		157.8	186.2	202.0		
	$-2(\log L_{k-1} - \log L_k)$			56.8	31.5		
	No. of dimensions retained : 3						

		1	2	3	4	5	6
20	No. of iterations to convergence	172	273	142			
	Unbiased standard error	.325	.259	.243			
	Log likelihood function	138.8	193.4	214.4			
	$-2(\log L_{k-1} - \log L_k)$		109.1	42.0			
	No. of dimensions retained : 2						
21	No. of iterations to convergence			43	38	134	
	Unbiased standard error			.211	.198	.190	
	Log likelihood function			244.2	264.2	279.6	
	$-2(\log L_{k-1} - \log L_k)$				40.1	30.5	
	No. of dimensions retained : 4						
22	No. of iterations to convergence	122	919	440			
	Unbiased standard error	.214	.159	.151			
	Log likelihood function	226.6	296.8	314.6			
	$-2(\log L_{k-1} - \log L_k)$		140.4	35.6			
	No. of dimensions retained : 2						
23	No. of iterations to convergence	129	207	236			
	Unbiased standard error	.429	.307	.295			
	Log likelihood function	80.6	158.0	173.5			
	$-2(\log L_{k-1} - \log L_k)$		154.5	32.0			
	No. of dimensions retained : 2						

		1	2	3	4	5	6
24	No. of iterations to convergence		94	157	198		
	Unbiased standard error		.274	.254	.250		
	Log likelihood function		182.2	205.1	215.0		
	$-2(\log L_{k-1} - \log L_k)$			45.8	19.7		
	No. of dimensions retained : 3						
25	No. of iterations to convergence	17	307	162			
	Unbiased standard error	.420	.339	.325			
	Log likelihood function	84.9	137.2	153.1			
	$-2(\log L_{k-1} - \log L_k)$		104.7	31.7			
	No. of dimensions retained : 2						
26	No. of iterations to convergence	131	331	122			
	Unbiased standard error	.162	.135	.130			
	Log likelihood function	284.9	330.5	345.8			
	$-2(\log L_{k-1} - \log L_k)$		91.1	30.6			
	No. of dimensions retained : 2						
27	No. of iterations to convergence			106	176	200	
	Unbiased standard error			.225	.200	.197	
	Log likelihood function			230.8	262.1	272.7	
	$-2(\log L_{k-1} - \log L_k)$				62.5	21.3	
	No. of dimensions retained 4						

		1	2	3	4	5	6
28	No. of iterations to convergence			107	168	459	
	Unbiased standard error			.182	.171	.166	
	Log likelihood function			275.4	295.4	307.7	
	$- 2(\log L_{k-1} - \log L_k)$				40.0	24.6	
	No. of dimensions retained : 4						
29	No. of iterations to convergence	14	.133	.25			
	Unbiased standard error	.319	.267	.256			
	Log likelihood function	143.0	187.6	203.7			
	$- 2(\log L_{k-1} - \log L_k)$		89.3	32.1			
	No. of dimensions retained : 2						
30	No. of iterations to convergence	24	254	333			
	Unbiased standard error	.232	.166	.156			
	Log likelihood function	209.3	286.8	307.8			
	$- 2(\log L_{k-1} - \log L_k)$		155.0	42.0			
	No. of dimensions retained : 2						
31	No. of iterations to convergence	346	94	107			
	Unbiased standard error	.230	.175	.166			
	Log likelihood function	211.3	276.2	293.7			
	$- 2(\log L_{k-1} - \log L_k)$		129.8	35.0			
	No. of dimensions retained : 2						

		1	2	3	4	5	6
32	No. of iterations to convergence		85	62	130		
	Unbiased standard error		.182	.169	.161		
	Log likelihood function		267.8	290.2	308.0		
	$-2(\log L_{k-1} - \log L_k)$			44.8	35.6		
	No. of dimensions retained : 3						
33	No. of iterations to convergence	85	129	173			
	Unbiased standard error	.324	.272	.255			
	Log likelihood function	139.7	183.1	203.9			
	$-2(\log L_{k-1} - \log L_k)$		86.8	41.6			
	No. of dimensions retained : 2						
34	No. of iterations to convergence	212	218	211			
	Unbiased standard error	.244	.182	.180			
	Log likelihood function	199.2	267.4	277.6			
	$-2(\log L_{k-1} - \log L_k)$		136.5	20.4			
	No. of dimensions retained : 2						
35	No. of iterations to convergence	59	230	83			
	Unbiased standard error	.218	.193	.186			
	Log likelihood function	222.8	255.3	269.9			
	$-2(\log L_{k-1} - \log L_k)$		64.9	29.2			
	No. of dimensions retained : 2						

		1	2	3	4	5	6
36	No. of iterations to convergence	288	412	59			
	Unbiased standard error	.324	.278	.270			
	Log likelihood function	139.3	178.6	192.2			
	$-2(\log L_{k-1} - \log L_k)$		78.8	27.1			
	No. of dimensions retained : 2						
37	No. of iterations to convergence			317	118	98	
	Unbiased standard error			.214	.201	.193	
	Log likelihood function			241.0	261.3	276.3	
	$-2(\log L_{k-1} - \log L_k)$				40.6	30.0	
	No. of dimensions retained : 4						
38	No. of iterations to convergence				198	77	163
	Unbiased standard error				.218	.202	.193
	Log likelihood function				244.5	267.1	282.5
	$-2(\log L_{k-1} - \log L_k)$					45.2	30.9
	No. of dimensions retained : 5						
39	No. of iterations to convergence	122	105	114			
	Unbiased standard error	.334	.285	.271			
	Log likelihood function	133.1	173.4	191.4			
	$-2(\log L_{k-1} - \log L_k)$		80.7	36.0			
	No. of dimensions retained : 2						

		1	2	3	4	5	6
40	No. of iterations to convergence			247	115	317	
	Unbiased standard error			.209	.185	.178	
	Log likelihood function			246.4	278.4	293.0	
	$-2(\log L_{k-1} - \log L_k)$				64.1	29.2	
	No. of dimensions retained : 4						
41	No. of iterations to convergence	205	88	101			
	Unbiased standard error	.250	.181	.171			
	Log likelihood function	193.8	269.2	287.5			
	$-2(\log L_{k-1} - \log L_k)$		150.8	36.6			
	No. of dimensions retained : 2						
42	No. of iterations to convergence	369	90	164			
	Unbiased standard error	.638	.534	.513			
	Log likelihood function	-2.9	41.8	57.3			
	$-2(\log L_{k-1} - \log L_k)$		89.4	31.1			
	No. of dimensions retained : 2						
43	No. of iterations to convergence		203	991	130		
	Unbiased standard error		.366	.328	.315		
	Log likelihood function		121.2	151.1	166.6		
	$-2(\log L_{k-1} - \log L_k)$			59.8	31.1		
	No. of dimensions retained : 3						

		1	2	3	4	5	6
44	No. of iterations to convergence	52	330	268			
	Unbiased standard error	.272	.216	.212			
	Log likelihood function	176.3	231.4	242.6			
	$-2(\log L_{k-1} - \log L_k)$		110.1	22.4			
	No. of dimensions retained : 2						
45	No. of iterations to convergence	160	437	551			
	Unbiased standard error	.331	.262	.248			
	Log likelihood function	134.9	191.5	209.6			
	$-2(\log L_{k-1} - \log L_k)$		113.9	36.2			
	No. of dimensions retained : 2						
46	No. of iterations to convergence	73	589	277			
	Unbiased standard error	.218	.168	.161			
	Log likelihood function	222.8	284.2	300.7			
	$-2(\log L_{k-1} - \log L_k)$		122.7	33.1			
	No. of dimensions retained : 2						
47	No. of iterations to convergence				419	176	280
	Unbiased standard error				.143	.132	.130
	Log likelihood function				332.8	355.9	366.6
	$-2(\log L_{k-1} - \log L_k)$					46.2	21.4
	No. of dimensions retained : 5						

	1	2	3	4	5	6
48. No. of iterations to convergence	422	219	69			
Unbiased standard error	.407	.359	.339			
Log likelihood function	91.5	125.3	144.1			
$-2(\log L_{k-1} - \log L_k)$		122.7	33.1			

No. of dimensions retained : 2

Appendix 6

Complete Matrix of Pearson Correlation Co-efficients

		1	2	3	4	5	6	7	8	9	10	11
1	No. of Dimensions											
2	Unbiased Standard Error Estimate	-.27										
3	No. of Errors	.02	.10									
4	No. of Egocentric Errors	.04	.01	.80								
5	M Magnitude of Error	-.01	.10	.84	.72							
6	Vocabulary	-.05	-.10	.09	.00	.13						
7	Block Design	-.15	.06	-.39	-.35	-.40	.13					
8	Object Assembly	-.13	-.13	-.24	-.29	-.24	.19	.61				
9	Estimated IQ	-.14	.01	-.25	-.28	-.24	.63	.84	.59			
10	Age	-.08	-.02	.32	.32	.29	.45	-.18	-.07	.05		
11	Years of University	-.07	.08	-.05	-.12	-.03	.11	-.13	-.24	-.07	.27	