

PROBLEM SOLVING AS A FUNCTION
OF FIELD DEPENDENCE IN MEN AND WOMEN

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ABSTRACT

Individual differences in analytical ability have been found in perception, and have been referred to as field dependence-independence by Witkin and his associates. The dimension of field dependence-independence has been reported to bear some relationship to problem solving ability. Various studies have shown that males tend to be more field independent than females, and corresponding sex differences have been reported on some problem solving tasks.

In a study by Harris (1962) it was reported that the ability to solve "insight" problems was positively related to field dependence, as measured by the embedded figures test. As the sex of the subjects was not specified, this relationship might have been confounded with sex differences.

The purpose of the present study was to provide a test of Harris' findings, while controlling for sex differences in both problem solving and field dependence. Two measures of field dependence (embedded figures test and rod and frame test) were employed, as well as two Duncker problems and an anagram solving task. Sex differences on the two problem solving tasks were investigated, and an attempt was made to determine the relationship between problem solving and field dependence, while controlling for sex of the subjects.

It was concluded from the results that the type of problem solving involved in the anagram task bears some relationship to field dependence, while the relationship between anagrams and Duncker problems was slight. Solution of Duncker problems was found to be related to field dependence. Sex differences were found only for the Duncker problems, with men being superior in problem solution.

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CHAPTER I

INTRODUCTION

It is common knowledge that individuals differ in their physical and psychological characteristics; yet, despite the obviousness of this fact, it was not until the early part of the nineteenth century that scientists became aware of the widespread significance of individual differences.

In 1796, Maskelyne, who was the astronomer royal at the Greenwich Observatory, dismissed Kinnebrook, his assistant, because Kinnebrook consistently measured the times of stellar transits almost one second later than did Maskelyne. It was assumed by Maskelyne that his assistant's observations were "errors" due to the use of some irregular and confused method, and it was not until some forty years later that Bessel, another astronomer, challenged the view that Kinnebrook's observations were "in error". Bessel showed that there were highly consistent differences between individuals in reaction times and that, indeed, one could calculate "personal equations" for individual observers (Boring, 1957). Within this notion of a personal equation lay the germ of the present day concept of perceptual style.

The realization of the prevalence of individual differences in behaviour triggered off intensive work on the part of psychologists in the area of measurement of abilities. This widespread emphasis on abilities, however, resulted in the fact that individual differences in perception were overlooked. But there were some scattered attempts to define consistencies of perceptual functioning and to relate these to the personality of the individual. For example, in 1906, Wiersma investigated the critical flicker frequency (CFF) in normal, manic and melancholic patients by means of a rotating red and green colour disk. His results showed that manics exhibited a substantially higher CFF than normal individuals and that the melancholic patients exhibited slightly lower than normal CFF's.

Another early study which suggested distinct modes of perception was conducted by Benussi (1914). He presented the Muller-Lyer illusion tachistoscopically, and reported two types of responses. One group of Ss experienced the Muller-Lyer illusion with short exposure times, while the other group of Ss required longer exposure times. On the basis of these results, Benussi postulated an analytic perceptual mode, in which persons

reacted to parts first and required time to perceive the whole; and a synthetic mode in which the whole is perceived first, and time is required to perceive the parts. Benussi did not pursue this line of research, but other investigators, such as Kretchmer (1948) postulated a similar kind of dimension. Kretchmer proposed the concept of dissociation-integration. Dissociation refers to the ability to dissect complex material into its constituent parts, while the absence of this ability (integration) results in perceptions that tend to be more concrete.

An early investigation which provided an empirical basis for an analytic-synthetic dimension of perception was carried out by Thurstone (1944) in a factor analytic study. Thurstone included a number of perceptual measures which, on the basis of their structure, appeared to involve analytic-synthetic or dissociative-integrative abilities. These tests were the Gottschaldt Figures, Shape Constancy, Space Perception, Brightness Contrast and Hidden Digits. Analysis indicated that all these tests had high saturation on a factor representing the ability to form closure in a given presentation, especially against a background of distraction. Other tests, such as the Street Gestalt Completion, and Mutilated Words, which structurally appear to involve integrative ability, also had some saturation on this factor, but to a lesser degree. These results pointed to the presence of an underlying factor contrasting analytic and synthetic modes of perception.

The Concept of Perceptual Style

Personality develops as the child acquires percepts of the various aspects in his environment. Goals may be seen as positive or negative, and responses are developed in relation to these goals. Cattell (1950) proposed that once a percept was established, it tends to resist change. Therefore a person who has acquired a certain percept will behave consistently when this percept is evoked by a stimulus in the environment, or by similar stimuli (stimulus generalization).

Stagner (1961) criticizes this approach to personality in that it would seem that all personalities develop in the same manner. Thus the concept of personal style was proposed to account for the uniqueness of the individual.

Personal style involves a characteristic pattern of perceiving or of responding (Stagner, 1961). This paper is limited to a consideration of perceptual style, involving individual differences in modes of perceiving.

The psychologist who clearly saw the relevance of perception for personality was George S. Klein (1950). Klein recognized that personality involved both universal and unique aspects:

" The organism continually wrestles with and seeks equilibrium between two sources of tension, its inner strivings and the demands of reality... Perception lends itself to this (use) by virtue of its 'adaptive' properties. But these properties, common to all perceivers, are employed idiosyncratically, the personal styles in using them for reality appraisal, I have called perceptual attitudes. "

(p.138)

As the term "attitude" in regard to perception is rather confusing, the term "perceptual style" has been substituted, while Klein's meaning of the term is retained. From Klein's work, it can be concluded that individuals develop characteristic ways of handling sensory input, regardless of sensory modality or content. This "perceptual style" seems to be a significant source of unity and consistency within the personality. Thus a characteristic perceptual style may be considered to be a means of distinguishing between different personalities.

Klein described two major types of perceptual style, i.e. leveling-sharpening and intolerance of ambiguity. In regard to the dimension of leveling-sharpening; levelers tend to overlook changes in stimuli, while sharpeners are sensitive to changes. An early study of this dimension was that of Holzman and Klein (1956), in which Ss were required to judge the size of squares.

Initially, only squares ranging from 2 to 6 inches were presented. After several presentations of these squares, the smallest square (2 inch square) was omitted from the stimuli and a 7 inch square was added. After a few presentations of these stimuli, the 3 inch square was omitted and an 8 inch square was added. In this manner, the stimuli presented for judgement were gradually increased in size, while a constant range of stimuli was maintained. The S was unknowingly forced to deal with gradually changing sets of stimuli. Ss who developed a set for a given size and repeatedly made the same judgement even when it was no longer correct were classified as levelers. Thus when the 2 inch square was omitted, they would judge the 3 inch square as 2

inches, for it then became the smallest in the set of stimuli. Ss who were more accurate in their perception and changed their estimates as the stimuli changed were termed sharpeners.

Klein found that levelers performed poorly on the Gottschaldt figures, which involve finding a simple figure embedded in a complex design. Levelers also reported less contrast in judging figures varying in brightness, and they had difficulty finding hidden faces in puzzle pictures.

In regard to personality, traits, Stagner (1961) suggests that levelers tend to overgeneralize from past to present situations. Stagner noted that patients described by therapists as passive, dependent and self-abusive frequently behaved like levelers in perceptual tasks.

The leveling-sharpening dimension is similar to the concept of rigidity. Related to Klein's work are studies cited by Luchins (1951) using the Einstellung test. The S is given a number of problems which may be solved by a far simpler method. The S who persists in using the more complex method would appear to be related to Klein's levelers.

Another dimension of perceptual style which Klein postulated was referred to as "resistance to instability". This was studied using the apparent-movement phenomenon, in which two lights are flashed in succession, and the light appears to move through space. Some Ss resist the perception of movement in this situation, and also when different visual stimuli are used. It was also demonstrated that Ss resisting instability in this experiment also resisted perception of movement on the Rorschach test (Klein and Schlesinger, 1951).

Witkin's Dimension of Field Dependence - Independence

The relationship between personality and perception has been subjected to extensive study by Witkin and his associates (1948, 1949, 1950, 1952, 1954, 1959, 1962). Witkin initiated his research with the problem of determining factors responsible for the maintenance of proper orientation to the upright in space. Witkin and Asch (1948) found that when a strong visual field is present, the perceived upright is determined with relation both to the axes of that field and to impressions received from the body, with visual factors playing a dominant role. Most striking were the wide and highly consistent individual differences observed in the extent to which Ss depended on

visual rather than kinesthetic functions when the two sources of information were in conflict. At one extreme, the Ss relied almost exclusively on the visual field; while at the other extreme, Ss relied almost entirely on bodily experiences, disregarding the visual field. Witkin termed the former Ss "field dependent" and the latter "field independent", and thereafter directed his research to the problem of determining why such marked individual differences occurred in field dependence.

A series of experiments were carried out with three major problems in mind. The first was to determine the pervasiveness of field dependence and its stability through time. The second was to ascertain the sequence of factors entering into spatial orientation as the individual develops; and the third, to study the relationship between an individual's characteristic way to perceiving and his general personality organization.

Tests Of Field Dependence. A number of tests of field dependence were employed in Witkin's research. They included the embedded-figures test (EFT), the tilting-room-tilting-chair tests (TRTC), and the rod and frame test (RFT). The EFT, developed by Witkin (1950) was an elaboration of the figures originally developed by Gottschaldt (1924). It consisted of 24 complex figures and 8 simple figures. Each complex figure contained one of the simple figures, which was embedded so as to be perceptually obscured. All but one of the complex figures were coloured in a manner which reinforced a given pattern and further obscured the simple figure. The simple figures were all uncoloured. Witkin and his colleagues argued that successful performance depended on the ability to deal with a given configuration analytically, i.e. to separate the item from the field.

The TRTC tests evaluated the S's perception of the position of his body and of the surrounding field in relation to the upright. This test was composed of two parts; the room adjustment test (RAT) and the body adjustment test (BAT). The RAT consisted of 8 trials, 4 in which the room and chair were tilted to opposite sides and four where they were tilted to the same side. On each trial, E moved the room according to the S's instructions to a position which the S perceived as upright. The BAT involved 3 trials in which the room and the chair were tilted to the same side and 3 in which they were tilted to opposite sides. The S moved the chair to the apparent

upright position.

The RFT evaluated the S's perception of an item within a limited visual field in relation to the upright. In this test the S was placed in a darkened room facing a luminous frame which surrounded a moveable luminous rod. With the frame tilted, he was required to bring the rod to a position which he perceived as upright. For successful performance of this task, the S was required to extract the rod from the tilted frame with reference to body position. On some of the trials, the S was sitting erect, while on other trials he was tilted, making it more difficult to use the body. A field dependent S reported the rod to be straight when in reality it was considerably tilted.

Reliability Of Tests. Subsequent research showed that the tests cited above are highly reliable. Test-retest correlations were obtained by Bauman (1951) and Dana and Goocher (1959). With a three year interval between test-retest, Bauman's correlations were as follows: RFT, $r = .84$ for males and $.66$ for females; BAT, $r = .77$ for males and $.74$ for females. Dana and Goocher reported a correlation of $.92$ for the EFT, with an interval of one week. Split-half reliabilities were still higher. Linton (1952) and Loeff (1961) reported correlations between $.84$ and $.90$ for the BAT. Corrected odd-even correlations between $.88$ and $.92$ were obtained for the EFT by Linton (1952), Longnecker (1956), Gardner, Jackson and Messick (1960) and Loeff (1961), respectively. These correlations are sufficiently high to indicate that the tests used by Witkin and his associates to measure field dependence yield consistent results.

Intercorrelations Among Tests. Early work by Witkin and his associates, as well as other investigators, established the fact that the various measures of field dependence described above were correlated with each other. In 1962, Witkin et al., summarized the research on the intercorrelations among the tests of field dependence. The intercorrelations were reported by Witkin et al. (1954); Gruen (1951, 1955); Linton (1952) and Epstein (1957). The correlations among the scores for the RFT, EFT, and BAT were predominantly significant, suggesting the generality of the field dependence dimension among these measures. However, correlations of the RAT with other measures

were lower, and frequently insignificant. Witkin et al. (1954) explained this by stating that the perceptual processes involved in the RAT differ from those involved in the BAT, RFT, and EFT. The latter tests require separation of elements from the field in which they are embedded; whereas the RAT requires the S to evaluate the position of the field itself. Because of these considerations, Witkin and his colleagues did not use the RAT in deriving an index of field dependence.

In summary, it can be stated that the RFT, the EFT, and the BAT are all reliable tests which appear to measure a factor which involves the ability of a person to overcome an embedding context in a perceptual situation.

Field Dependence and Problem Solving

One question that immediately arises is whether the ability to overcome an embedding context is limited to perceptual tasks, or is a more general cognitive ability. The possibility that field dependence is a more general ability is raised by a consideration of Wertheimer's (1945) conception of the processes involved in problem solving. Wertheimer suggested that intellectual problems which call for a high degree of creative activity may often involve the ability to separate parts from the context in which they are embedded, and to bring these parts within new relationships. Witkin et al. (1954) went on to argue that if a person possesses the basic ability to "break up" a configuration, it will probably be manifested in problem solving situations, as well as straightforward perceptual situations.

Insight Problems. One of the earliest investigations which showed a relationship between field dependence and problem solving was carried out by Guilford et al. (1952, 1955a, 1955b, 1957) in a series of factor analytic studies. Guilford identified a factor which he called "adaptive flexibility". The types of tests that loaded highly on this factor were: insight problems similar to those used by Duncker (1945); match problems, involving the extraction of triangles or squares from a lattice design; an adaptation of Thurstone's Hidden Pictures Test; and an adaptation of Thurstone's Gottschaldt test.

What is of major interest here is the fact that the Thurstone Gottschaldt and the EFT (a measure of field dependence) both use a modification of

Gottschalldt's original figures, with S required to locate a simple figure embedded in a complex one. A high relationship between these tests would therefore be expected, and, indeed, such a relationship has been demonstrated. Witkin et al. (1954) Phillips et al. (1957) and Goodman (1960) all assessed that relationship between the EFT and the Thurstone Gottschalldt and reported correlations ranging from .46 to .77. Further evidence that the Thurstone Gottschalldt provides a measure of field dependence is provided by the finding that the RFT (another measure of field dependence) is also related to the Thurstone Gottschalldt. Correlations ranging from .27 to .55 between these two tests have been reported by Rudin and Stagner (1958), Crutchfield et al. (1958) and Goodman (1960). Finally, it was noted that Goodman also obtained a correlation of .42 between the Gottschalldt and BAT scores. Thus, it appears reasonable to argue that the ability to solve insight problems is related to the dimension of field dependence.

Additional evidence that problem solving is related to field dependence comes from a study reported by Witkin et al. (1962). These investigators administered nine tests, five of which are important for the relationship between field dependence and problem solving. The five tests included the EFT, the RFT, the BAT, 12 of Guilford's insight problems and 18 of Guilford's match problems. Thirty-one college men served as Ss. The intercorrelations obtained by Witkin are shown in Table 1.

Table 1
Intercorrelations Among Measures
of Field Dependence and Problem Solving

Test	EFT	BAT	Match Problems	Insight Problems
RFT	.86**	.75**	.55**	.40*
EFT		.74**	.60**	.58**
BAT			.27	.37*
Match Problems				.51**
Insight Problems				

* significant at .05 level
** significant at .01 level

It is clear from this table that there was a substantial relationship between the measures of field dependence and the two tests of problem solving ability. It is of interest to note that the EFT provided the highest correlation with the problem solving tasks, while the BAT produced the lowest correlations.

A study by Harris (1962) provided evidence that field dependence is related to one measure of problem solving. Harris employed two of the problems Duncker (1945) developed in his study of functional fixedness. Duncker selected his problems so that Ss used familiar objects in unfamiliar ways. Two examples of Duncker problems are the box problem and the pliers problem. In the box problem, S is given 3 candles and asked to affix them to a door at eye level. In the experimental room are located various objects, some of which are irrelevant to the solution of the task. The objects included three small cardboard boxes filled with matches, thumb tacks, and paper clips. Correct solution involves tacking the boxes to the door to serve as a platform for the candles.

In the pliers problem, a shelf must be constructed consisting of a board resting on two supports. Two boards, nailed together, and a pair of pliers are on a table in the room. To solve the problem, S must use the pliers to remove the nail, and employ the pliers and one board as supports for the remaining board.

It appears that the familiar function of an object provides a context which interferes with finding and utilizing an unfamiliar function for solution of the problem. Presumably, those Ss who can quickly overcome the embedding context of familiar solution would solve the problem more readily. Harris put this hypothesis to a test. She administered the EFT, the Kohs' Block Design Test, the pliers problem and the box problem to a sample of Ss. She then classified Ss in two ways. Ss were classified into the 13 most field dependent and the 13 most field independent. A similar classification was carried out into those Ss solving both Duncker problems and those solving neither Duncker problems. The results were quite striking, for of the 13 most field independent Ss, 12 solved both problems and one failed both problems. Of the 13 most field dependent Ss, 11 failed both problems and 2 solved both problems.