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TO ASSIMILATION TENDENCIES IN TIME-ERROR.

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THE RELATIONSHIP OF AGE, ANALYTICAL ABILITY, FIELD ARTICULATION, AND LEVELING-SHARPENING TO ASSIMILATION TENDENCIES IN TIME-ERROR

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THE RELATIONSHIP OF AGE, ANALYTICAL ABILITY,
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APPROVED BY

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CHAPTER I

INTRODUCTION

Background of the Study

A notable trend in educational circles today is an espousal of instructional design, which has as one of its assumptions that the teacher assesses the entering behaviors of the students and designs a unit of instruction based upon that assessment, in conjunction with other relevant instructional variables (Gerlach and Ely, 1971; Gagne, 1974). The implication here is that individual differences in abilities, prior learnings, and interests should serve as a major determinant of the nature of a particular unit of instruction. Until recently, scores on intelligence tests, achievement tests, prior course grades, and informal interactions with students have provided the teacher with most of the data for this kind of assessment. Now it is possible to explore another cognitive dimension in order to gain insight into how students vary in their approach to a learning task. This dimension is composed of several cognitive controls, which govern the way different learners approach and deal with different kinds of tasks.

Cognitive controls are enduring patterns of cognitive functioning that mediate the expression of particular intentions when the individual is confronted with particular stimulus conditions (Gardner, 1964). They are one's "preferred" forms of cognitive regulation: "preferred" in the sense that they are one's typical means of approaching certain types of cognitive problems (Holzman and Klein, 1954).

Many cognitive controls have been enumerated by theorists, and most theorists assume several such controls coexist within a given personality. The two controls to be investigated in this study are leveling-sharpening and field independence-field dependence. Briefly, leveling is the tendency to minimize differences between figure and ground; sharpening, the tendency to maximize such differences. Field independence applies to the selective deployment of attention to items within the field. It is the ability to extract an item from the field in which it appears; field dependence is the tendency to experience one's surroundings globally and passively conform to the influence of the prevailing context or field (Bieri, 1971). Field dependence-field independence is the perceptual component of a broader theoretical construct H. A. Witkin and his associates have named psychological differentiation, or articulation. The concept of articulation grew out of research Witkin pursued on field independence and dependence. The person whose experience is articulated, Witkin contends, experiences his world as structured, that is, complexly integrated. Perceptually, that person is field independent. The opposite end of the cognitive style continuum is called "global" and its perceptual counterpart is field dependence. (Witkin, Goodenough, and Karp, 1967).

This investigation posits a relationship between leveling-sharpening and field independence-dependence, and a perceptual phenomenon of long-standing interest in psychophysics, that of visual time-error. Time-error is a constant error in the judgment of successive stimuli, in which the intensity of one stimulus, the comparison stimulus, is judged relative to that of a standard stimulus. Time-error is expressed in directional terms, as either negative or positive. In negative time-error, the subject judges the second stimulus as greater; in positive time-error, the subject perceives the second stimulus as smaller, or less intense. Time-error was first noted in 1860 by the psychophysicist Fechner in a series of experiments on lifted weights, as a departure from experimental expectation. He attributed it to a fading image (Woodworth, 1954). Many early psychophysicists saw this phenomenon merely as an experimental error that needed statistical correction, but it has since been studied in its own right, primarily by Gestalt psychologists.

A watershed article in time-error theory was published in 1923 by Wolfgang Köhler, who studied the phenomenon in terms of psychophysiology. Köhler said the first excitation leaves a neural trace, which consists of an accumulation of positive H-ions set loose by the excitation. According to Köhler, the neural trace of the first stimulus begins to fade or sink after three seconds, but even in its altered state the first stimulus provides the psychological level against which the second stimulus may be compared. This theory was later modified by Otto Lauenstein, who added a theory of assimilation, by which adjacent traces interact in the subject's cortex.

Until 1952, time-error was considered simply in terms of gross effects on groups of subjects. In that year Philip Holzman noted striking individual consistencies in a previous time-error study of Koester (1945). This observation, supported by strong rationale in perceptual theory, led Holzman to suspect there might be a relationship between the dimension of leveling-sharpening and assimilation tendencies in time-error.

Holzman found a significant relationship between leveling-sharpening and assimilation tendencies, but he also noted in his conclusion that he had found glaring within-group variance. He concluded there might be other important but hitherto unaccounted for determinants of variation in time-error in his experiment. Surprisingly enough, this tantalizing possibility has not been pursued in psychological research to date. Based upon Holzman's findings and for theoretical reasons to be discussed below, this paper in part replicates Holzman's study and also explores the role of the added dimension of field articulation in assimilation tendencies in time-error. The rationale for employing the dimension of field articulation is well grounded in Witkin's theory and is further suggested by research that has evolved from his work.

It is hoped that the comparative judgment task in this study may help elucidate a developmental model proposed by Santostefano (1969), in which field articulation pre-dates developmentally and predetermines an individual's degree of leveling-sharpening. These two controls should account together for a significant amount of time-error displayed by subjects. In general, the rationale proposed here is that the standard stimulus and the interpolated stimulus, after the moment of perception, become embedded in a configuration of memory traces; thus, the subject's ability to accurately judge comparative stimulus intensities should be a function, in part, of his degree of field articulation, as well as his degree of leveling. It is further proposed that a dimension of intelligence, analytical ability, may indirectly be a determinant of time-error. Previous research has indicated that analytical ability correlates significantly with field articulation: that subjects high in analytical ability tend to be more field independent (Witkin, Dyk, Faterson, Goodenough, and Karp, 1962). Age and analytical ability are considered in the overall design as predictors of field independence. Age and field independence are considered as predictors of leveling-sharpening.

Problem Statement

The problem of this study is as follows: What is the relative contribution of these subject variables: age, analytical ability, field articulation, and leveling-sharpening to assimilation tendencies in time-error in a visual task of comparative judgement?

Statement of Hypotheses

H_{01}: There is no relationship between the dependent variable field articulation, and age and analytical ability.

H_1: There is a relationship between the dependent variable field articulation, and age and analytical ability.

H_{02}: There is no relationship between the dependent variable leveling-sharpening, and field articulation and age.

H_2: There is a relationship between the dependent variable leveling-sharpening, and field articulation and age.

H_{03}: There is no relationship between the dependent variable assimilation tendencies in time-error, and the cognitive controls leveling-sharpening and field articulation.

H_3: There is a relationship between the dependent variable assimilation tendencies in time-error, and the cognitive controls leveling-sharpening and field articulation.

H_{04}: There is no linear relationship between the dependent variable assimilation tendencies in time-error, and the following subject variables: age, analytical ability, field articulation, and leveling-sharpening.

H_4: There is a linear relationship between the dependent variable assimilation tendencies in time-error and the following subject variables: age, analytical ability, field articulation, and leveling-sharpening.

Limitations of the Study

An attempt was made in this study to obtain a random sampling of ten and thirteen year old girls in the Norman Public School System, and a random sample was requested of the School System. However, each school involved in the study had its own mechanism of providing subjects, and it is possible that the selection process in some schools was more truly random than in others. In addition, children diagnosed as having learning disabilities were excluded from the study, at the request of the School System. Furthermore, obtaining written parental permission was necessary in order to test each child. A few parents of children originally selected for the study did not permit their children to be tested; consequently, a small measure of self-selection may have been operating.

Another limitation of the study was that none of the children were given visual acuity tests. Subjects were questioned regarding visual acuity and, if it was determined that a subject had a visual handicap and was not wearing corrective optics, she was not included in the sample. This did occur in one instance.

A final limitation of the study was that the testing had to be done in each school participating in the study and consequently, adequacy of physical testing facilities varied tremendously. This was most obvious in the time-error test, which required the room to be darkened. Some schools had better facilities for darkening than others. In addition, some open schools did not have sufficiently large testing areas segregated from other functional areas and, consequently, noise levels were quite variable between schools.

Operational Definition of Terms

The following definitions are applied in this research:

Time-error: Time-error is measured as the difference between the objective mean of the series to be judged and the subject's mean judgment.

Positive time-error: A mean judgment of the comparison stimuli by the subject of less than 6.54 (6.54 = the value of the standard) is positive time-error.

Negative time-error: A mean judgment of the comparison stimuli by the subject of more than 6.54 (6.54 = the value of the standard) is negative time-error.

Leveling: Leveling is represented by leveling-sharpening ratio scores above the median for each age group in the sample on the Leveling-Sharpening House Test.

Sharpening: Sharpening is represented by leveling-sharpening ratio scores below the median for each age group in the sample on the Leveling-Sharpening House Test.

Field dependence: Field dependence is represented by scores below the median for each age group in the sample on the Group Embedded Figures Test.

Field independence: Field independence is represented by scores above the median for each age group in the sample on the Group Embedded Figures Test.

Analytical ability: Analytical ability is represented by each subject's scores on three Performance Subtests of the Wechsler Intelligence Scale for Children-Revised (WISC-R): Picture Completion, Block Design, and Object Assembly. Raw scores on each subtest are first transmuted into normalized standard scores within the subject's age group. The subtest scaled scores are expressed in terms of a distribution with a mean of ten and an SD of three points. (Anastasi, 1954). The mean scaled score on the three Subtests represents the child's analytical ability score.

Significance of the Study

Gardner has acknowledged that more than one control principle may operate as an individual approaches an adaptive task. He stated in 1964 that he was especially interested in the relationship between leveling-sharpening, on the one hand, and field articulation. The multiple occurrence of cognitive controls has been demonstrated by L. Ausburn (1976), who found in a study of visual vs. haptic perceptual types that visuals tend to display field independence and sharpening and, conversely, that haptic perceptual types display field dependence and leveling. The two cognitive controls field independence-field dependence and leveling-sharpening are independent principles (Gardner, et al., 1959) and yet they seem to operate in similar tasks. Leveling-sharpening appears to operate when the individual is confronted with sequential stimuli which require the operation of memory functions. Field articulation involves the deployment of selective attention when one is confronted with similar stimuli and governs one's ability to discriminate a particular stimulus from its embedding context. The visual time-error test in the present study requires all three operations: memory, attention, and discrimination. This study, therefore, should build upon Gardner's and Ausburn's studies by exploring the simultaneous operation of multiple control principles in a given perceptual task; specifically by evaluating the relative contribution of the dimensions leveling-sharpening and field articulation to assimilation tendencies in time-error.

Santostefano (1969) has placed these two cognitive controls into a hierarchical developmental model, in which field articulation chronologically precedes the development of leveling-sharpening controls (See Figure 4). He proposes that the degree to which one develops leveling or sharpening tendencies is determined by the extent to which the individual has developed field articulation. Thus, he posits an antecedent-succedent relationship between the two controls. In a developmental study of six, nine, and twelve year olds, Santostefano found leveling-sharpening tendencies not clearly differentiated at age six; but he found that sharpening tendencies increased as the subject approached age twelve. In another developmental study, Witkin (1954) found increases in field articulation development most pronounced between ages ten and thirteen. The present study tests Santostefano's model using subjects at ages ten and thirteen. If these differences are also found in the present study, the amount of assimilation in time-error should be much more prevalent in ten year olds than in thirteen year old subjects, since time-error should be predicted by leveling-sharpening and field articulation.

The phenomenon of time-error is of interest primarily as it yields perceptual data which will help isolate regulatory processes in the perceiver. An analysis of the time-error behavior and, specifically, assimilation tendencies in time-error, suggests that assimilation is a fusing of the stimulus with its background and, as such, should be related to global perception, as is experienced by the field dependent subject, and to leveling tendencies. This investigation extends two lines of research which first met in Holzman's work (time-error and the cognitive control leveling-sharpening) several steps further by employing the cognitive control field articulation and placing both dimensions within a developmental model.

If the predicted relationships between the independent subject variables age, analytical ability, field articulation, and leveling-sharpening; and the dependent variable time-error are borne out, it may be possible to isolate antecedent-succedent relationships among subject variables, and between these subject variables and perceptual behavior. This study also explores one aspect of the controversy over the relationship between I. Q. and cognitive controls by retesting a previously demonstrated relationship between analytical ability and field articulation. (Witkin, Dyk, Faterson, Goodenough, Karp, 1962). If this relationship is again borne out in the present study, a relationship between analytical ability and leveling-sharpening may also be suggested. Santostefano maintains that field articulation is a necessary pre-requisite for the development of leveling-sharpening, and it may be that analytical ability differentiation is a necessary pre-requisite for the development of both cognitive controls. Witkin has said that all three subtests of the WISC measuring analytical ability (Block Design, Picture Completion, and Object Assembly) evaluate the ability to overcome an embedding context, to "break up" an array into component parts and reassemble it according to the requirements of the task (Witkin, Dyk, Faterson, Goodenough, and Karp, 1962). It seems intuitively that two of the tests, Picture Completion and Object Assembly, may also be closely related to leveling-sharpening, in that a missing element must be detected, involving not only figure-ground disembedding, but also a reliance on one's memory of the appropriate details of a given object (for example, of a girl wearing socks on both feet instead of on just one in Picture Completion; and of the appropriate location of parts in a given object, like an automobile as required in Object Assembly). This memory function may be a leveling-sharpening operation. By placing all three variables within a developmental framework, it may be possible to ascertain first if there is a relationship between field articulation and leveling-sharpening; and if there is, then it will be possible to determine whether the relationship between analytical ability and leveling-sharpening is indirect only, through the intervening variable field articulation, or whether there is a direct relationship.

Thus, this investigation is aimed primarily at theory building. Many of the relationships have been demonstrated in previous research: this study attempts to synthesize previous findings and place them within a developmental framework, hypothesizing within that framework a not-before-demonstrated relationship between field articulation and time-error. This study builds upon Santostefano's and Witkin's research by testing Santostefano's hypothesis of a sequential ordering of the two cognitive controls and by hypothesizing that the two controls jointly predict time-error behavior. If the proposed path analysis is borne out, it should demonstrate some of the major factors involved in individual differences in the perception of visual stimuli.

CHAPTER II

A REVIEW OF SELECTED LITERATURE

Time-Error Theory and Research

Köhler said in his influential article on time-error theory, published in 1923, that a process of isomorphism takes place when the subject is confronted with a comparative judgment task. Although the two stimuli are presented separately, they are not perceived as discrete, but as a configuration composed of a step or gradation. Köhler derived this theory from a series of successive comparison experiments with auditory stimuli. He found the amount of negative time-error (second stimulus judged greater) increased with the lengthening of the interval between the standard and the comparison stimulus beyond two or three seconds; but that there was a preponderance of positive time-error (second stimulus judged weaker) within intervals of less than three seconds. He explained the latter phenomenon by proposing that the trace increases in intensity shortly after stimulation, and then begins to fade after three seconds. Köhler rejected the prevalent notion that a fading memory picture was involved in this phenomenon. Instead, he said time-error could be explained using "straightforward physiological concepts." (Köhler, 1923).

Nine years later, Otto Lauenstein modified Köhler's theory of sinking traces by adding an interpolated stimulus in a series of experiments on visual and auditory time-error. An interpolated stimulus is a stimulus in the same modality as the comparison and standard stimuli, but of a differing intensity. Typically, it fills the interval between the two stimuli. Lauenstein varied both the interstimulus interval, and the relative intensities of the interpolated field and of the standard and comparison stimuli. Lauenstein found a negative time-error with time intervals of more than five seconds when the interpolated stimulus was less intense than the standard, and a positive time-error when the interpolated stimulus was more intense than the standard. With shorter time intervals positive time-error occurred with both intensities of interpolated field. Thus, Lauenstein found a consistent interaction between the stimuli and the surrounding field. He then concluded that adjacent traces do not merely fade; rather a process of assimilation occurs between the trace and the neural effects of background stimuli. This assimilation process in turn results in greater time-error. (Lauenstein, 1932).

Interestingly enough, Lauenstein was not the first to use an interpolated stimulus to extend the Gestalt theory of time-error. In 1921, Guilford and Park tested Köhler's theory by inserting an interpolated weight in an experiment of comparative judgment. They postulated that the interpolated weight would disrupt the direct continuity between the standard and comparison. One interpolated weight was heavier than the comparison and standard weights; the other interpolated weight was lighter than all other weights in the experiment. They found the additional heavy weight tended to decrease the impressions of the comparison weights (positive time-error) and a light weight tended to increase them (negative time-error). These findings are similar to those of Lauenstein.

Carol Pratt took issue with Lauenstein because he thought Lauenstein had overgeneralized from his results. Pratt did not think assimilation occurs in situations in which the background is empty. Pratt contended that if one followed Lauenstein's logic, the time-error obtained in experiments with no intervening stimulus must be greater than the time-error produced by any intervening stimulus of any intensity; in Pratt's words, "assimilation to zero must produce a lower trace and hence a greater preponderance of greater judgments, than assimilation to any value above zero." (Pratt, 1933, p. 294). Pratt found in experiments with auditory stimuli and lifted weights a greater time-error with a soft interpolated noise and with a very light interpolated weight than with an empty interval. Pratt concluded that Lauenstein's theory of assimilation applies to those experiments in which there is an interpolated stimulus, but the trace merely fades when the interval is empty. Pratt saw the presence of interpolated stimuli as a special case and not the usual situation. He said that in cases in which there is nothing in the interval, the trace merely fades, as Köhler had suggested.

In the same year as Pratt's article appeared, Woodrow published the results of a series of weight discrimination experiments in which he compared the effects of a constant and a varying standard. He found that with a fixed standard, all subjects showed a negative time-error. With the varying standard, the time-errors, although generally negative, varied greatly with the weight of the standard. To explain this phenomenon, Woodrow submitted a concept of set as an alternative explanation to Kohler's positive H-ions. Woodrow suggested that when a subject is instructed to compare two successive stimuli, the first stimulus sets him up in readiness for a certain intensity of the following stimulus, which is a weighted average of previous stimuli. (Woodrow, 1933).

In 1936 Pratt again took issue with Lauenstein's theory of assimilation. This time Pratt reported that he had performed an experiment with an interpolated stimulus and obtained results similar to those of Lauenstein. However, Pratt insisted that the course of a trace is governed, not by assimilation alone, but also by a weakening of the traces. Pratt noted that weakening always occurs, but in experiments utilizing an interpolated stimulus the fate of this trace is altered. Thus he reiterated that Lauenstein's theory is an over-simplification: that assimilation occurs only when an interpolated stimulus is introduced.

A phenomenon which seems to this researcher to be identical to assimilation is what Sherif calls an "anchoring effect." (Sherif, et al., 1958). In a kinesthetic weight lifting experiment, Sherif found that if an anchor weight was added to a series of graded weights, it could exert two possible effects on the judgments of the graded weights. If it was just slightly heavier than the graded weights, subjects tended to judge the graded weights as heavier than they actually were (it served as an anchor); but if it was markedly heavier than the graded weights, it made the graded weights seem lighter than they actually were. (It exerted a contrast effect). It is interesting in this regard that Holzman found the greatest amount of assimilation in time-error with an interpolated field slightly dimmer than the graded visual stimuli in his time-error experiment (1952).

Kreezer accepted Köhler's theory of the physiologic trace and undertook to determine if cortical factors are involved in time-error. He so arranged conditions that the time-errors could not be due to stimulus after-effects in nerve pathways leading to the brain. Kreezer selected vision as the most convenient modality for investigation, since impulses from the left and right halves of the retinas reach the visual projection areas of the brain cortex via separate pathways. Consequently, he set up circular areas projected in succession on opposite sides of a fixation point, thus exciting opposite sides of the retina. "Under these conditions, after-effects which may occur in the pathways activated by the first stimulus will not be capable of influencing the neural volleys transmitted over pathways activated by the second stimulus. Consequently any time-errors which occur must depend on effects produced by the first impulse train on reflex centers in the mid-brain or on mechanisms in the cortex, conditions which are in turn effective in the second stimulation." (Kreezer, 1938, p. 21). Kreezer found that negative errors occur when successive stimuli impinge upon opposite sides of the retina, suggesting that brain mechanisms are primarily responsible for the time-errors.

Time-error is usually computed as "the difference between the objective midpoint of the series to be judged and the subject's judgment of where the midpoint lies, his point of subjective equality (PSE). The PSE has been represented as a level of indifference above which the subject experiences stimuli as stronger and below which stimuli appear to him as weaker... The PSE and hence the time-error is a function of the value of the stimuli within the series and the effects of any other stimuli in the field, such as interpolated intensities." (Holzman, 1952, pp. 11-12).

A theory closely related to the PSE is that of Helson's adaptation level, which Helson sees as a broad phenomenon which underlies all judgments. It originated as what he calls a "short-hand description and explanation of certain fundamental phenomena in vision... Fundamental to the theory is the assumption that effects of stimulation form a spatio-temporal configuration in which order prevails. For every excitation-response configuration there is assumed a stimulus which represents the pooled effect of all the stimuli and to which the organism may be said to be attuned or adapted. Stimuli near this value fail to elicit any response from the organism or bring forth such neutral responses as indifferent, neutral, doubtful, equal, or the like, depending upon the context of stimulation. Such stimuli are said to be at adaptation level." (Helson, 1937, p. 2). To the extent that a stimulus is greater than the current value of adaptation level, the stimulus is judged stronger (or larger) than the standard to which it is compared. Helson says that at every moment of stimulation there is an adaptation level, a function of all the stimuli acting upon an organism at a particular moment and of all past stimuli. It is expressed mathematically as a weighted geometric mean in which background is loaded three times as heavily as the log mean of all stimuli in the series.

Helson saw his theory as an all-inclusive one which explains the general factor operating in judgmental situations. Certainly, it is relevant to this study not only because it is a parallel development to time-error theory, but also because Helson emphasizes the importance of individual differences in perception. Adaptation level theory takes past experience and previous stimulation into account and specifies their effects quantitatively. (Helson, 1964).

Postman and Page in 1947 adapted a paradigm from conventional memory studies to studies of judgment to test the hypothesis that discrimination is subject to retroactive inhibition: an experimental group made a series of judgments accompanied by an interpolated judgment task; a control group had a rest session between two judgment tasks; and a control practice group had the same judgment tasks throughout the series. They found that the interpolated task set up an incompatible response tendency which interfered with the ability to respond to the original attribute tested for in the original task. Thus, Postman concluded, "the processes underlying judgment and recall are basically continuous. Both types of performance can be conceptualized as abilities to abstract from a complex field--a sensory complex in judgment, a trace complex in the case of memory." (Postman, 1947, p. 377).

Karlin (1953) extended traditional studies of time-error in judgments of stimulus intensity to judgments of magnitude. His stimuli were projected circles of varying sizes. He also varied the stimulus durations (one, three and five seconds) and the interpolated intervals (one, three, and eight seconds). He found a decreasingly negative time-error when the stimulus duration increased from one to three seconds. But when the stimulus duration was increased from three to five seconds, the time-error became more negative. He also found that the time-error became increasingly negative as the length of the interpolated interval increased.

Time-error studies have also been done in the auditory modality by varying the quality, that is, the pitch, of the tone. L. Postman (1946) found no time-errors in pitch, but did find significant time-errors in judgments of loudness. Koester (1945) also studied time-error in judgments of pitch and loudness and obtained similar results. Tresselt (1948) found ambiguity in Postman's results and undertook to determine if there is a negative time-error in pitch comparisons and if the introduction of background tones affects the direction of time-error. He found a significant negative time-error. He concluded that sinking of the trace occurs with heterogeneous material; and that assimilation occurs with homogeneous material.

In the last fifteen years, there have been few studies of time-error per se. Certain aspects of time-error, however, have received some attention: the effect of pre-instruction and the order of presentation of stimuli (Gleitman, 1964); relative effect of pre-instruction and post-instruction (Kind and Brown, 1966); and order of presentation and length of viewing time (Rogers and Sanders, 1974).

Thus, in previous experiments physical aspects of the experimental situation have been manipulated in various ways: the stimulus itself (auditory, visual, or kinesthetic); and in all three modalities stimuli of intensity, magnitude, and quality (e.g., pitch); the length of inter-stimulus interval; the length of the interpolated stimulus; the intensity of the interpolated stimulus; and retinal excitation. The consensus seems to be that time-error is operative in all three modalities: auditory, visual, and kinesthetic; that the interpolated stimulus exerts a consistent effect on successive comparisons, depending on its relative intensity and length; and that central neural processes are involved in the time-error phenomenon.

The time-error phenomenon alone, however, is not the subject of this investigation. Rather, the purpose of this study is to explore how several subject variables predict the perception of sequentially displayed visual stimuli. The time-error phenomenon and its experimental paradigm derived from psychophysics, provide a precisely measurable vehicle which represents the specific cognitive operations: attention, memory, and discrimination, which this researcher proposes are related to the cognitive controls pertinent to this investigation: field independence-dependence and leveling-sharpening.

Individual Differences in Perception

In the 1940's interest began to grow in individual differences in perception and has continued to flourish. Klein and Schlesinger observed in 1968 that much previous research in perception was incomplete because it ignored individual differences. In fact, "classical psychophysics as a prototype of sensory experimental methodology, considered as its methodological virtue its having ruled out the organism in its individual variability." (Werner and Wapner, 1968, p. 90). Gestalt psychology was primarily concerned with the influence of field factors on the individual's experiences, and not with individual differences, although Wertheimer did acknowledge the role of set and past experience in perception. Witkin says that one important contribution of Gestalt psychology was that it brought 'reality' into a central position in psychological theory. His research built upon Gestalt precepts. He says it is necessary to modify the Gestalt conception of perception to account for systematic and pervasive perceptual differences his studies revealed. (Witkin, 1954).

In 1949, Klein argued for extending perceptual research to the adaptive significance of perception. Failure to do so has "effectively divorced such studies from problems of personality, since by definition the latter must be concerned with the adjustive responses of the organism." In the same article, Klein suggests "it would be interesting to investigate the generality and constancy of different thresholds for several sense modalities in individuals of clearly defined, differing ego organizations." (Klein, 1949, p. 16).

A fellow researcher of Klein, Philip Holzman, pursued this line of research in 1952, studying specifically the relationship of leveling-sharpening to assimilation tendencies in time-error. In part, the present study replicates Holzman's study. In his review of previous research, Holzman analyzed the data of a previous time-error experiment by Koester, in which judgments of pitch and loudness were studied. Koester expressed time-error in "E percent," which is a measure of constant error. (See Table 1). Clearly, as Holzman noted, there are striking individual differences: subject NS consistently reported a positive time-error; subject TK, on the other hand, consistently reported a negative time-error.

Table 1

E-PER CENT VALUES FOR LOUDNESS JUDGMENTS MADE BY THREE PRACTICED OBSERVERS AT FOUR TIME INTERVALS IN KOESTER'S EXPERIMENT*

	Time Intervals in Seconds			
Subjects	1	3	6	9
NS	+18.00	+6.00	+10.00	+14.00
RK	+6.00	+8.00	+12.00	.00
TK	-.67	.00	-.67	+7.33

*This simplification of Koester's Table was done by Holzman. Reproduced from Holzman, 1952.

These patterns, Holzman postulated, might be partly explained by procedural differences in the experiment, since Koester arranged for many judgments to be made on each pair of stimuli, a factor which Köhler had cautioned might invalidate any time-error effect. However, these patterns might also reflect differing cognitive organizations of the subjects. Holzman then set out to explore these differences, postulating that the dimension of leveling-sharpening might account for a major portion of the differences (Holzman, 1952).

As early as 1946, Martin Scheerer had argued eloquently for this kind of approach to performance which explores individual differences:

> We have somewhat neglected to explore the problem of individual differences in perception, in favor of gross averages. We have grown too accustomed to accept perceptual laws on the basis of statistical majority, without showing scientific curiosity about the non-conforming minority. From the point of view of theory, however, we should feel obliged to account for both the majority and the minority by an explanatory principle from which we understand the phenomena on both ends of the scale. (Scheerer, 1946, p. 665).

Individual Differences Reflected in Cognitive Controls

Cognitive controls have strong theoretical underpinnings in many branches of psychology: personality theory, clinical diagnostic testing, psychophysics and Gestalt theory, drives and motivation theory, and psychoanalytic theory of defense (Gardner, 1959). The cognitive theorist assumes that man must preserve a sense of order in his chaotic world; and that he does this partly by learning relatively constant patterns of experiencing the world. These patterns have been variously called cognitive strategies, perceptual styles, and cognitive controls. The cognitive theorist posits an internal process of information transformation between stimulus and consequent behavior, and therefore, one of his central concerns is to determine how an objective stimulus is subjectively experienced or transformed by the person (Bieri, 1971).

Wachtel has called the theory of cognitive controls a "child of the 'New Look' perceptual research," which emphasized the influence of personal needs on perception (1972, p. 781). A basic assumption of the New Look researchers is that perception takes place in the context of motivated behavior (Postman, 1953). In general, those researchers who study the effects of cognitive controls hold as a central postulate that the perceiver is a self-regulating system, which, though dynamic, is "quasi-stable and continuous" (Klein and Schlesinger, 1968, p. 36), enabling the researcher to tease out consistent behavioral patterns in perception. The emphasis is on the perceiver's method of mastering reality (Klein, 1970). Thus they prefer to study how the individual copes with stimuli, going beyond the generalized effect of a given stimulus on a group of subjects. Essentially, this school is distinguished by its orientation: the subject is of interest, not merely as a responder to stimuli, but also as an active participant in the experiment who brings a unique configuration of needs and adaptive styles to the experiment.

According to Klein, adaptation is a key element of most personality theories. "All theories of adaptation assume in one way or another that functioning is directed toward resolving tension and toward reaching an equilibrium between inner and outer worlds; perception is regarded as helping to accomplish these states" (Klein, 1970, p. 131).

A cognitive control, then, is a reflection of the ego's adaptive requirements regulating the way one perceives reality around him. Gardner cautions that an adaptive fit implies a "workable fit," not necessarily an accurate fit. "Cognitive controls involve individually varying standards of adequacy within intentional encounter that include perceptual, cognitive, and motor activities." (Gardner, et al., 1959, p. 10).

In a similar vein, Kogan makes an important distinction between cognitive controls and abilities:

> Cognitive styles can be most directly defined as individual variations in modes of perceiving, remembering and thinking, or as distinctive ways of apprehending, storing, transforming, and utilizing information. It may be noted that abilities also involve the foregoing properties, but a difference in emphasis should be noted: Abilities concern levels of skill --the more and less of performance - whereas cognitive styles give greater weight to the manner and form of cognition. (Kogan, 1971, p. 244).

Thus, although cognitive styles may be related to certain dimensions of intelligence, they are not merely reflections of intelligence; rather they are an individual's preferred mode of perceiving which has developed over time in response to the adaptive demands the person has perceived. (Wachtel, 1972). This is similar to the distinction Witkin makes between the content and formal features of personality. He says that typically the content features do not discriminate perceptual styles; but formal features, that is, characteristic modes of functioning based on given structural arrangements in personality, are critical (Witkin, 1962). Nevertheless, a value judgment seems to be implied in many studies of cognitive styles, strongly biased in favor of the ends of the continuum represented by sharpening and field independence. This study attempts to deal with part of this problem by placing a measure of I.Q. (analytical ability) in the prediction equation. The selection of this particular dimension of intelligence is based upon previous correlational findings (Witkin, 1962).

In an epic review of cognitive controls, Gardner discusses six control principles: leveling-sharpening, tolerance for unrealistic experiences, equivalence range, focusing, constricted-flexible control, and field dependence-independence. A factor analysis revealed that these dimensions are independent, although, Gardner posited, the simplest experimental performance is probably determined by more than one control principle (Gardner, et al., 1959). A clustering of cognitive control tendencies was discovered in L. Ausburn's study relating cognitive styles to perceptual types (1976). She found that those who are visuals tend also to be field independent, sharpening and reflective; those who are haptic tend also to be field dependent, leveling and impulsive.

There seems to be some ambiguity in the literature regarding the pervasiveness and immutability of cognitive controls. Santostefano (1969) has shed some light on this issue by observing that there are two major camps: those who use the term cognitive style, represented primarily by Witkin and Kagan; and those who use the term cognitive controls, represented by Klein, Holzman, and their co-workers. Santostefano contends that Witkin and Kagan each derived his concept of cognitive style empirically and not from cognitive theory. Witkin's concept of field independence evolved from a study which originally was intended as a search for universal laws in the perception of the upright. Witkin discovered a significant dichotomy in perceptual behavior which he found predicted behavior in a multitude of situations: he called this behavior field independence.

In a similar way, Kagan derived his concept of impulsivity-reflectivity empirically from a picture-grouping task. He then embarked on a series of studies which revealed consistent correlations of reflectivity-impulsivity with other behaviors. Both Kagan and Witkin, according to Santostefano, assume the predominance of a singular style in an individual's behavior.

By contrast, Santostefano asserts, cognitive controls have not been derived empirically but are strongly rooted in cognitive theory. Klein based his own theorizing upon the psychoanalytic view that man is a self-regulating, dynamic system. Consequently, man continually adapts by coordinating his own impulses with external situational demands. Thus, according to Klein, the individual is not characterized by an immutable cognitive style; rather he has developed over time a propensity to approach various problem situations in certain ways. Although certain enduring controls may characterize an individual, Klein assumes a dynamic interaction between the situation and the adaptive intentions of the individual. Thus, the individual may deploy various controls depending on the demands of the situation, as he perceives them (Klein, 1970).

Santostefano's distinction between these two schools of thought is insightful. The issue of whether a particular cognitive "style" is stable over time within a given individual or whether the individual regulates the operation of various cognitive controls depending on situational requirements and, by implication, whether cognitive controls are amenable to change, for example, through education, bears further research but is beyond the scope of the present study.

Leveling-Sharpening

Holzman and Klein were the first to isolate the cognitive control leveling-sharpening. At that time, they classified leveling-sharpening under the more general term "schematizing process," which they defined as "identifying and integrating sense impressions." (Holzman and Klein, 1950, p. 312). They derived the notion of schematizing from the neurologist Henry Head, who said that past impressions modify the perception of incoming stimuli to such an extent that the sensation "rises into consciousness charged with a relation to something that has gone before." (Head, 1920, p. 605). Thus, no sensation is perceived in isolation, but is always related to previous sensations.

Holzman defines sharpening as a tendency to maximize perceived differences, which gears the person to small gradients of difference between figure and ground. Leveling he defines as a propensity to minimize perceived differences and to 'prefer' the experience of sameness to that of difference. (Holzman, 1952).

Holzman used an instrument he developed called the Schematizing Test to measure the leveling-sharpening dimension. This test is composed of ten series of squares, each composed of five squares of regularly increasing size, randomly projected within each series, but increasing systematically from one series to the next. (See Figure 1). He found consistent individual differences in the ability to "keep up" with the systematic increase in size, especially in the middle ranges (i.e., reflecting smaller gradations in size) of each series. To check the generalizability of leveling-sharpening, he also administered the first three parts of

Thurstone's adaptation of the Gottschaldt figures and another test of detecting faces camouflaged in a larger picture. Apparently he designed the latter test himself. He found that sharpeners performed better on these two tests also. From these findings Holzman concluded that leveling-sharpening is a stable and significant cognitive control.

SIZES OF SQUARES IN INCHES

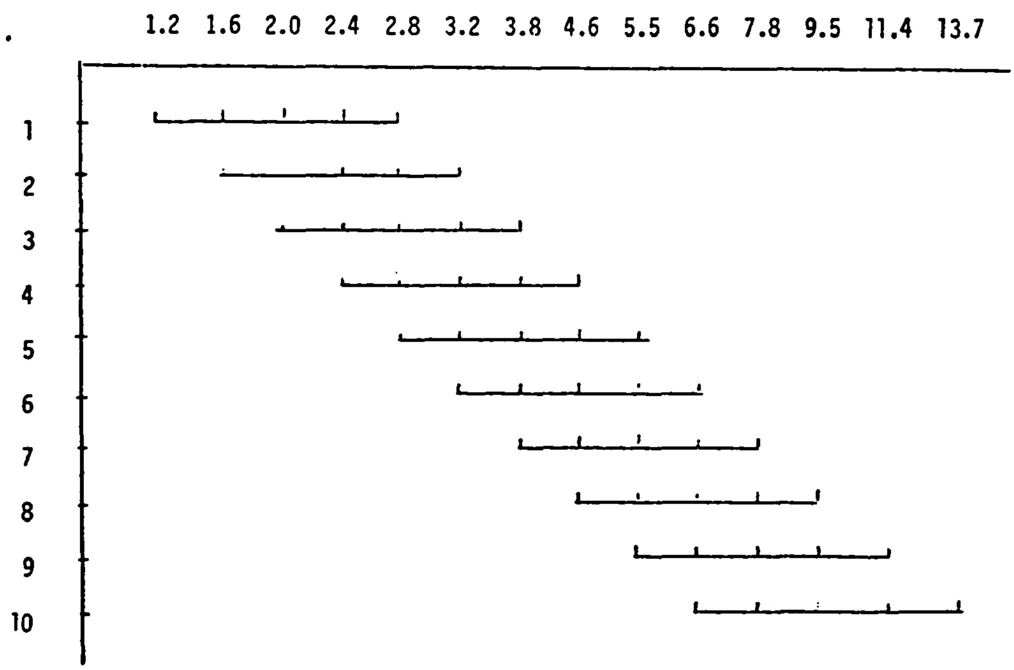


FIGURE 1. Fourteen squares arranged in progressive series of five for the Schematizing Test. (Holzman, 1952, p. 35).

Holzman then reasoned that since levelers have more difficulty extracting stimuli from their context, they might also experience more assimilation of brain traces, by fusing the relevant stimuli with the ground more than sharpeners do. He performed a time-error experiment in each modality: visual, auditory, and kinesthetic. In the visual experiment, he used three conditions of interpolated field: dim, bright, and no interpolated field; in the kinesthetic experiment, there were also three conditions of interpolated weight: light, heavy, and no interpolated weight; and in the auditory experiment, he used two interpolated stimuli: one soft and one loud. Through an analysis of variance, he found that levelers and sharpeners do differ in the predicted direction on assimilation effects in time-error; that levelers show a greater tendency to assimilate traces to the interpolated field. He found that the interaction of levelers and sharpeners with the conditions of the interpolated fields was greater in auditory and kinesthetic than in visual time-error, but in each case at the .05 level or less (Holzman, 1952).

Since Holzman's study was written, some researchers have attempted to generalize the cognitive style of leveling-sharpening beyond perceptual behavior, with varying degrees of success. In 1960, Gardner and Long studied the relationship of leveling-sharpening to a memory task involving the serial learning of lists of words similar in sound. They found that sharpeners gave more responses and made fewer errors. Specifically, sharpeners made significantly fewer backward errors than levelers; that is, they repeated fewer items out of place that had appeared earlier in the list (Gardner and Long, 1960).

In another study of memory, Gardner and Lohrenz (1960) studied the ability to retell a story in a "game of gossip" context. Levelers lost more of the original story and intermixed the different themes of the story. Gardner and Lohrenz attributed these differences to consistent differences in assimilation susceptibility.

Regarding the relationship between leveling and the use of repression as a dominant defense, there are conflicting results. Gardner (1959) and Holzman and Gardner (1959) found a significant relationship and concluded that repression seems similar to the process of assimilation. Lewinsohn (1970), on the other hand, did not find a significant relationship between leveling-sharpening and memory, nor between leveling-sharpening and repression.

Berkowitz (1957) administered two memory tasks (reproduction of particular designs and reproduction of a story). He found a significant relationship between leveling-sharpening and a preference for a simple phenomenal experience. He thinks that individuals who prefer simplicity achieve this simplicity by leveling, i.e., by forgetting some of the details of earlier experiences.

Field Independence-Field Dependence

The cognitive control field independence-field dependence was first isolated by H. A. Witkin as a result of an epic series of experiments carried out between 1947 and 1952. Field independence is the ability to extract an item from the field in which it appears. By contrast, field dependence is "dominance of perception of an item by the organization of the prevailing field, or the relative inability to separate item from field, or to overcome embedding contexts. (Witkin, 1964, p. 176).

Witkin's study began in 1947 as an investigation into the factors responsible for maintaining the upright in space; however, such striking individual differences were uncovered that the study shifted its emphasis to individual differences in maintaining proper orientation toward the upright (Witkin, 1954). Witkin used three principal space-orientation tests: the Tilting Room, Tilting Chair Test (TRTC); the Rod and Frame Test (RFT); and the Rotating Room Test. The TRTC Test evaluates the subject's perception of the position of his body and of the surrounding field in relation to the upright, requiring him to bring his body to a position he perceives as upright. Extreme bodily tilts in the direction of the tilted field indicate field dependence; movements toward the true upright indicate resistance to the influence of the field and, therefore, field independence.

The RFT has become the most widely used of Witkin's space-orientation tests. A luminous rod within a luminous frame is presented to the subject in a darkened room. The test evaluates the individual's perception of an item (the rod) within a limited visual field (the frame), in relation to the upright. The subject must 'extract' the rod from the tilted frame through reference to bodily position. A large tilt of the rod when it is reported to be straight indicates field dependence. A small tilt indicates independence of the field and a reliance on the body.

In the rotating room test, the subject is rotated about a circular track, feeling the pull of both gravity and centrifugal force. He is required to adjust his body or the room to a vertical position. The field-independent is more attentive to postural sensations, and tilts the room and body toward alignment with the force. Conversely, the field dependent perceives body and room as straight in their initial position.

Witkin found significant consistency in a person's orientation toward the upright: that is, a tendency to rely mainly on the visual framework (field dependent) or mainly on bodily experiences (field independent). He also found high test-retest correlations, with a three-year interval between test and retest: .84 on the RFT for men and .66 for women and .89 on the TRTC test for both sexes (Witkin, 1954).

Witkin also wished to determine whether the ability to separate item from field is a generalized characteristic of an individual's perception. In order to do that, he devised the Embedded Figures Test (EFT), which is a paper and pencil test that requires a subject to find a particular simple figure in a larger complex figure. The simple figure is hidden by being incorporated into the pattern of the larger figure. The test uses the figures developed by Gottschaldt in 1926. The EFT has been frequently used by researchers largely because of its high validity and reliability and because it is fairly easy to administer. It measures the same perceptual domain, as evidenced in the high correlations Witkin found between the orientation tests and EFT scores: .66 for men and .46 for women, both of which were significant at or below the .01 level (Witkin, 1954). After three years, test-retest reliability of the EFT was .89 for both men and women (Witkin, 1968).

Primarily through follow-up clinical interviews, Witkin found that field dependence was associated with general passivity in dealing with the environment, lack of self-awareness, relatively poor control of impulses, and low self-esteem. On the other hand, field independence was found to be associated with activity dealing with the environment; awareness of one's inner life and effective impulse control; and high self-esteem. Witkin places these characteristics in three main categories: the nature of the individual's relationship to his environment (either passive or active); impulse management; and self conception. The first two are coping scores, and the last is an introspective score. Witkin has said that the personality characteristic most closely related to field dependence-independence is the tendency toward active coping with or passive submission to the environment (Witkin, 1954).

Since Witkin's landmark study, researchers have looked for further correlations of field independence-dependence with other perceptual and personality variables. Linton (1955) postulated a relationship between field dependence and suggestibility. In a series of suggestibility experiments, he found an appreciable correlation between field dependence and conformity.

In 1957 Gardner found a correlation between field dependence and susceptibility to illusions. Marlowe (1958) found a significant relationship between field independence and intraception (the need to be analytical about one's own behavior and motives and those of others) and a negative relationship between field independence and succorance (passive-dependent needs).

Several researchers have explored the relationship between field dependence and various cognitive processes. In 1954 Gollin and Baron found that speed on the EFT, and the amount recalled and rate of relearning on a retroactive inhibition experiment using nonsense syllables were significantly related. Kazelskis (1970) further studied recall using two lists of nonsense words, one high meaningful, the other low meaningful; and using two modes of presentation: one oral and one combined oral-visual. The field independents recalled more syllables than field dependents.

In 1961 Gardner and Long studied recall and recognition of word lists under interference conditions, in that all the words were similar (started with the same letter and sounded very similar). They found that field independents were superior in both recall and recognition. They suggest in conclusion that this superior performance is related to the field independent's ability to attend selectively to relevant material.

By contrast, female field dependents were found to recall more socially loaded words they heard in the background but which were irrelevant to an experimental task than female field independents. This may reflect, according to the authors, a social orientation which tends to characterize field dependents, as opposed to a task orientation, which characterizes field independents (Fitzgibbons, Goldberger, and Eagle, 1965).

Verbal learning was investigated in 1962 in a recall task of two similar lists of similar words, in which the subject was instructed to recall the words in the proper sequence and in the proper list. Field dependents learned more slowly and were less accurate in recall; field independents were superior on all learning and recall tasks (Long, 1962).

To make certain that superior visual acuity, especially depth perception, is not responsible for field independence, Barrett (1967) tested a group of subjects for stereopsis (depth perception) and found no significant correlation. Therefore, he concluded that field independence is a cognitive phenomenon.

An interesting relationship between field independence-dependence and leveling-sharpening has been found. Gardner reports a moderate correlation is found between measures of leveling-sharpening (the Schematizing Test or its variant) and solution time in the EFT. Schematizing Test scores of pre-adolescents (ages nine to thirteen) were found to load modestly on a field articulation factor (.39) (Gardner and Moriarty, 1968). Gardner explains this in terms of memory image:

> To perform effectively, the subject must maintain an adequate memory image of the simple figure while searching for it in the complex figure. The more accurate the memory image, therefore, the faster the solution time, which may explain the moderate correlation between measures of leveling-sharpening and solution time in the EFT, around the .10 level of significance. (Gardner, et al., 1959, p. 73).

In the same vein, Wallach says that an object is perceived through a memory function derived from previous experience with an object. "Hidden figures fail to be recognized because they do not appear as separate units and are therefore unable to make trace contacts." (Wallach, 1968, p. 11).

B. White (1954) found a significant correlation between performance on a visual embedded figures task and an auditory disembedding task. For the visual embedded figures he used Thurstone's modification of the Gottschaldt figures (1944) and for the auditory disembedding task he designed a hidden tunes test. His major finding was that the ability to identify a figure embedded in a more complex figure (called Closure Factor 2 by Thurstone) is not specific to vision, but can be generalized to the auditory modality.

An interesting precedent for the present study was done in 1972. Blasi and his associates studied the relationship between the absolute judgment of a series of weights and field independence-dependence. They found that field independents performed significantly better and suggested further research using other sense modalities and different kinds of perceptual tests. The present study used relative visual tasks, but the fact that a significant relationship between field independence and absolute perceptual judgment in another modality has been found suggests that similar relationships may exist.

Of theoretical significance is that Witkin has related field independence to memory traces.

> Central to individual differences in performance in our perceptual tests is the extent to which the person is able to keep an item apart from a context. It is possible to translate such effects into the operation of neural traces. Taking the EFT as illustrative, we may presume that the simple design creates a trace which remains after the design is removed. Upon this memory trace is superimposed the trace of the complex design which contains the simple figure. We may speculate that the memory trace of the simple figure has a different fate, in the presence of the new trace, for the person who easily finds the simple figure than for the person who has great difficulty. In the first instance, it may be considered, the boundaries of the memory trace remain firm; in the second they do not, with the result that the trace readily fuses with the new trace or is in other ways affected by it. (Witkin, et al., 1962, p.388).

It seems to this investigator that Witkin is describing a phenomenon very similar to Lauenstein's assimilation and that one could test Witkin's speculation using psychophysical experiments in time-error.

As the number of correlates of field independence increased, Witkin reformulated the cognitive style construct, giving it a broader label: "Global vs. articulate" style, based primarily on the degree of differentiation with which the individual experiences a field. A global style is an outgrowth of the narrower term field dependence; an articulate style, an outgrowth of the concept of field independence. Witkin found that level of differentiation cuts across psychological areas. His research began in the cognitive perceptual sphere and then proceeded to uncover correlates in other areas. Witkin defines differentiation as the structural complexity of a pyschological system (Witkin, 1965).

A related concept similarly named but more narrowly defined is the cognitive control dubbed by Santostefano field articulation. According to Santostefano's definition, the field articulate individual can accomplish a given task when confronted with irrelevant and disruptive information. For example, on the Color Fruit Test C the subject must name the colors of fruit which have been colored incorrectly. Thus, the individual must direct attention selectively to relevant stimuli and ignore irrelevant stimuli, as directed by the experimenter. In Color Fruit Test D the fruit to be named is surrounded by distracting incidental pictures, which is a problem closely related to the embedding context in Witkin's Embedded Figures Test. In a factor analysis employing 29 cognitive measures, Santostefano found that the field articulation tests loaded on a factor which involved motor control, as well as focal attention and field articulation. His field articulation tests also loaded even more heavily on the field articulation control factor (See Tables 5 and 7). On the basis of these results Santostefano posited a hierarchical relationship between these cognitive controls which he placed within the framework of a developmental model (Figure 4), by which focal attention precedes and is a requisite for, field articulation (Santostefano, 1969). Santostefano suggests that one must develop attention-directing and scanning controls before field articulation tendencies emerge.

Cognitive Controls, and Intelligence and Age

Intelligence. It is difficult not to infer value judgments when reading studies which correlate cognitive controls with other behaviors. It is implied in many studies that sharpening and field independence are highly desirable, and leveling and field dependence equally undesirable. Holzman acknowledged this problem (1952) and said that one could devise a test in which leveling behavior, rather than sharpening, is the desired performance. This was done by DeVaris, who in an unpublished study reported field dependents more accurate in recognizing photographs of their own facial features (Witkin, 1962). This may reflect the tendency of field dependents to view themselves more externally than field independents do.

Intelligence is an area in which the practitioner may be tempted to make such value judgments by inferring that field independence and sharpening are related to superior intelligence. Actually, the relationship between intelligence and these two cognitive controls has been found complex in the case of field articulation and elusive in the case of leveling-sharpening. The relationship between leveling-sharpening and I.Q. has received little attention. Staines (1968) found only a slight (.07) relationship between leveling-sharpening on the Schematizing Test and Otis I.Q. in a sample of adolescent females.

Conflicting findings have been reported with regard to I.Q. and field articulation. In an attempt to unravel some of the elements of this relationship, it is useful to follow the chronology of Witkin's work. In 1950 Witkin's associates Woerner and Levine found significant correlations between scores on the Wechsler Intelligence Scale for Children (WISC) and their battery of tests measuring field independence-dependence. In a follow-up study, based on the hypothesis that disembedding ability would be manifested in intellectual activities as well as perceptual activities, Witkin and his associates administered Form L of the

1937 Stanford-Binet to ten year olds. They found a significant relationship between I.Q. and perceptual index scores for both boys ($r=.57$, $p<.01$) and girls ($r=.76$, $p<.01$). Certainly this confirmed Woerner and Levine's findings with the WISC. However, further study by Witkin and others suggested that field independence-field dependence is related to specific dimensions of intelligence rather than to the general I.Q. Witkin administered the WISC to ten and twelve year olds and found significant correlations between I.Q. and perceptual index scores for boys at less than the .01 level ($r=.55$ for ten year olds; $r=.73$ for twelve year olds) but only moderate and insignificant correlation for girls at age twelve ($r=.36$). An analysis of the WISC subtest scores revealed that the relationship between the Performance Scale of the WISC with the perceptual scores was higher than that of the Verbal Scale of the WISC. To determine if certain types of subtests of the WISC account for the relationship between I.Q. and field dependence-field independence, Witkin and his co-workers did a factor analysis of the matrix of intercorrelations among subtests of the WISC and five perceptual tests: the Children's Embedded Figures Test (CHEF), Thurstone's Hidden Figures Test, the Rod and Frame Test (RFT), Body Adjustment Test (BAT), and the Room Adjustment Test (RAT). They found that the perceptual tests loaded most heavily on the analytical field approach factor. Three subtests of the WISC also loaded on this factor: Block Design, Picture Completion, and Object Assembly (Table 2). The Block Design Subtest requires the child to reproduce a given reference design by the appropriate arrangement of blocks. The Picture Completion Subtest requires the subject to detect the missing element in a meaningful picture. In the Object Assembly Subtest the child must assemble parts of a picture into a meaningful whole, in a process similar to solving a jigsaw puzzle (Witkin, 1962).

Table 2

Factor III - Analytical Field Approach*
Obtained in Factor Analysis by Witkin

Variable	Ten year old group loading	Twelve year old group loading
RFT - Body tilted (Series 1)	.74	.68
(Series 2)		.50
RFT - Body erect (Series 3)	.69	.58
CHEF	.61	-
WISC - Picture Completion	.52	.38
WISC - Block Design	.50	.42
BAT (Series 2a)		.39
(Series 2b)	.43	.44
WISC - Object Assembly	.33	.57
RAT (Series 1a)		.06
(Series 1b)	.37	-.03
Hidden Pictures	.27	-

*Source: Witkin, 1962, p. 65.

Bigelow (1971) found no significant relationship between performance on the Children's Embedded Figures Test (CHEF) and verbal intelligence in children between the ages of five and ten, confirming Witkin's findings. Bieri (1958) found a significant relationship between EFT performance and mathematical ability. Rosenfield (1958) found a similar relationship using the Progressive Arithmetic Test with thirteen and fifteen year olds. However, in Witkin's factor analysis the WISC Digit Span and Arithmetic loaded most heavily on the factor called attention-concentration. Surprisingly enough, none of Witkin's perceptual tests loaded significantly on the attention factor (Witkin, 1962), a finding which conflicts with Santostefano's hypothesis.

A factor analytic study led Gardner and his associates (1960) to conclude that one cognitive control is probably related to several abilities. For example, they found that field articulation is relevant to at least four abilities: flexibility of closure, spatial relations and orientation, associative memory, and inductive reasoning. In an attempt to place these findings in a developmental framework, they suggest that direct and indirect kinds of causative interactions take place between abilities and cognitive controls. For example, the development of selective attention may be a necessary condition for the development of several related abilities, which in turn may contribute to the differentiation of a particular control principle. The present study hypothesizes that analytical ability is a necessary condition for the development of field articulation.

Age Differences. Both Witkin and Santostefano have found significant developmental aspects of cognitive controls. Witkin and his associates (1962) conducted a series of developmental studies in field independence. Longitudinal studies tapped behavior at infancy, ages six, eight and ten; another group of subjects were studies at ages ten, fourteen and seventeen; and a third group of subjects were studied at ages eight and ten. In addition, Witkin conducted cross-sectional studies. Both types of studies revealed the same developmental trend. As Witkin and his co-workers had hypothesized, they found interpersonal consistency across perceptual tests and increasing differentiation as children grew older.

Certainly this is not a revolutionary concept in psychology. For example, the developmental progression from global perception to increasing differentiation is also central to Piaget's developmental theory (Piaget, 1947). These similar findings, in this author's opinion, lend greater strength to both theories.

Witkin, Goodenough and Karp (1967) found increases in field independence in the five to eight year old period. Witkin also found increases between the ages of eight and fifteen. Specifically, he found little increase in field independence between the ages of eight and ten, but striking differences between the ages of ten and thirteen, and only small differences between the age of thirteen and adulthood (Witkin, 1954, 1968) (Figure 2). The Rod and Frame Test revealed a general increase in field independence until age seventeen, after which age women became slightly more field dependent. Witkin's coefficients of stability for the perceptual test scores of children appear in Table 3. (Witkin, 1962).

Table 3

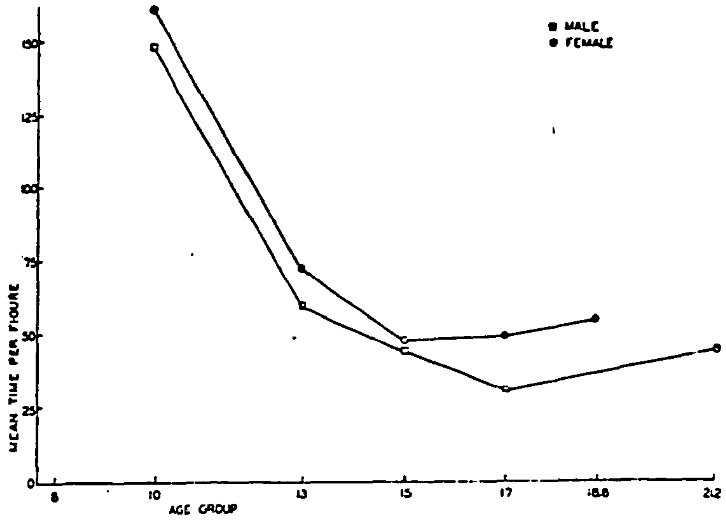
Coefficients of Stability for Perceptual Test Scores: Children Obtained by Witkin

Age of Subjects	Retest Interval	N		BAT		RFT		EFT		Index	
		M	F	M	F	M	F	M	F	M	F
10-14	4 years	27	24	.58	.66	.56	.57	.51	.69	.64	.88
14-17	3 years	27	24	.68	.88	.82	.75	.95	.95	.87	.94
10-17	7 years	27	24	.31	.63	.49	.53	.48	.68	.50	.79
8-13	5 years	26	22	.14	.36	.71	.61	n.a.	n.a.	n.a.	n.a.

Source: Witkin, 1962, p. 375.

Field independence apparently decreases with senescence. Axelrod and Cohen (1961) found in tactile and visual versions of the EFT that the elderly group had relative difficulty with the embedded materials.

Despite these age-related tendencies, Witkin and his associates emphasize that each individual maintains his relative position to his peers on the distribution of measures of field independence through the years (Witkin, Goodenough, and Karp, 1967).



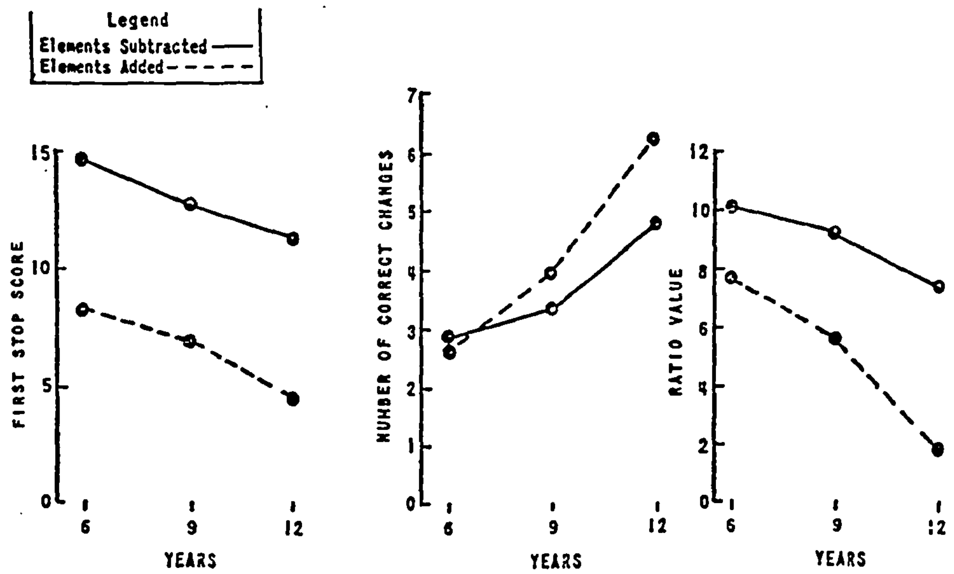
Mean Scores for Embedded-Figures Test for Various Age Groups.

Source: Witkin, 1954, p. 129.

Figure 2

The ages at which Witkin found the most striking increases in field independence (ten and thirteen) are close to those at which Santostefano found increases in leveling-sharpening. Santostefano randomly selected sixty children, ages six, nine, and twelve (twenty per group, ten boys and ten girls in each age group). Subjects were matched for intelligence. Santostefano administered several leveling-sharpening tests: the Wagon Test (Elements Subtracted), which consists of sequentially displayed pictures of a wagon, in which parts of the wagon are gradually omitted; the Wagon Test (Elements Added), in which the same elements are gradually added; and the Circles Test, in which circles of increasing diameter are sequentially displayed. The subject was instructed to press a response button when he detected a change in the pictures. Then he was asked to explain how the picture had changed.

Santostefano found that the most significant increases in number of correct changes reported and, therefore, the greatest increases in sharpening tendencies, occurred between ages nine and twelve (See Figure 3). The findings reported in Figure 3 are based on scores on Santostefano's Wagon Test, Elements Added and Elements Subtracted. Each test yields three scores: a first stop score, which is the position number of the picture frame at which the S first reports a change in the stimulus; number of correct changes reported; and a leveling-sharpening ratio, which is based on the number of displays between a reported change and the actual location of that change, the distance between any change not detected and the last frame of the tape, divided by the number of changes which take place (Santostefano, 1964). The Wagon Test is similar in format and scoring to the Leveling-Sharpening House Test, also devised by Santostefano, which was used in this study.



Mean First-Stop Score, Number of Correct Changes reported, and Leveling-Sharpening Ratio of each age group of the Leveling-Sharpening Wagon Test: Elements subtracted and elements added.

Source: Santostefano, 1964, p. 351.

Figure 3

Santostefano's Developmental Model

Santostefano has proposed a developmental model (1969) which helps to explain the approximately parallel findings of Santostefano and Witkin with regard to dramatic increases in both sharpening and field articulation. Both controls increase strikingly between ages nine and thirteen (Santostefano tapped behavior between ages six and twelve; Witkin, ages eight and thirteen). Santostefano administered a battery of twenty-nine cognitive tests to six, nine, and twelve year olds; a factor analysis revealed three factors similar to controls previously formulated by Klein: focal attention, field articulation, and leveling-sharpening and motor delay, and motor delay control. Factor loadings suggested to Santostefano that certain controls are subordinate to others developmentally. For example, leveling-sharpening tests loaded heavily (.60 and .49) on the motor delay factor (See Table 4); the field articulation Circles Test and the Block Design Test B loaded heavily on the motor delay control factor (See Table 5). This suggested to Santostefano that the capacity for impulse delay is necessary for the development of the controls of field articulation and leveling-sharpening.

FACTOR II. - LEVELING-SHARPENING CONTROL PLUS MOTOR DELAY*

Test	Factor Loading	Meaning of High Score
Impulse Control A	-93	Versus normal tempo, low motor control and impulsive; no external stress present
Impulse Control B	-83	Versus normal tempo, low motor control and impulsive; external stress present
Leveling-Sharpening A	60	Few changes detected or detected late; leveling of sequential information
Leveling-Sharpening C	49	Few changes detected or detected late; leveling of sequential information

*Source: Santostefano, 1969, p. 303.

Table 4

FACTOR III. - MOTOR DELAY CONTROL: ASSOCIATED WITH FOCAL ATTENTION AND FIELD ARTICULATION*

Test	Factor Loading	Meaning of High Score
Impulse Control Test C	79	Versus slow tempo with no external stress, high motor control and delay capacity with external stress
Block Design Test B	-49	Quick solution of block designs; information fractionated into relevant-irrelevant
Circles Test B	46	Strong positive illusion experienced; high extensiveness of scanning

*Source: Santostefano, 1969, p. 303.

Table 5

Factor 4, leveling-sharpening, is composed primarily of the leveling-sharpening tests, but Block Design Test B, which is a measure of field articulation, makes a minor contribution to the factor (.40). (See Table 6).

FACTOR IV. LEVELING-SHARPENING CONTROL*

Test	Factor Loading	Meaning of High Score
Color Fruit Test E	-75	Low number of peripheral cues recalled; memory undifferentiated; leveling
Leveling-Sharpening A	51	Few changes detected or detected late; leveling of sequential information
Block Design Test B	40	Long time for solution of block designs
Benton Visual Retention Test	-37	Inaccurate drawings of designs from memory

*Source: Santostefano, 1969, p. 305

Table 6

Factor loadings on Factor 5, field articulation, reveal a minor contribution of the Circles Test A (-53), a test of focal attention (See Table 7). Santostefano concluded from these findings that focal attention precedes the development of field articulation. In turn, the loading of the Block Test on the leveling-sharpening factor suggested to Santostefano that field articulation development precedes the development of leveling-sharpening tendencies.

FACTOR V. - FIELD ARTICULATION CONTROL*

Test	Factor Loading	Meaning of High Score
Color Fruit Test C	-78	Contradictory information (fruit colored incorrectly) read as fast as noncontradictory information (fruit colored correctly).
Color Fruit Test B	-75	Contradictory information (fruit colored incorrectly) read as fast as noncontradictory information (colored bars).
Color Fruit Test D	-62	Information surrounded by peripheral incidental distractions read as fast as information with no peripheral distractions.
Circles Test A	-53	Judging absolute sizes of pairs of single circles accurately; high degree of scanning.

*Source: Santostefano, 1969, p. 305.

Table 7

Santostefano synthesized all of these hypotheses into a developmental model of cognitive controls (See Figure 4). (Santostefano, 1969). The multilinear prediction equation used in the present study is based conceptually on this model.

	COGNITIVE CONTROLS	PRESUMED PROCESS
Developmentally Advanced Differentiated-Integrated	Leveling-Sharpening	Survey field; articulate relevant and irrelevant; maintain discrete impressions of past information and distinguish from differentiated present
↑ Organizational Levels between controls	Field Articulation	Survey field; direct attention to relevant information and withhold attention from irrelevant
Developmentally Early-Global Diffuse	Focal Attention	Direct attention actively; scan broadly vs. passive attention deployment and narrow or fragmented surveying.

GLOBAL-DIFFUSE ⟷ ARTICULATE DIFFERENTIATED
(Organizational levels within each control)

Figure 4. A Proposed Developmental Model of Cognitive Controls, Adapted from Santostefano (S. Santostefano, 1969, p. 307).

CHAPTER III

METHODOLOGY

The present study investigates the relative contribution of age, analytical ability, and two cognitive controls leveling-sharpening and field articulation, to time-error in a series of visual tasks of comparative judgment.

Design of the Study

The design of the present study is descriptive, in that the independent variables are nonmanipulable subject variables: age, analytical ability, field articulation, and leveling-sharpening. All subjects engaged in the same visual comparative judgment task, in which thirty-five pairs of visual stimuli were presented to the subject in random order. The first stimulus (the standard) remained constant in intensity (6.54 footcandles). The comparison stimuli ranged from 3.27 to 9.81 footcandles. An interpolated stimulus of 3.03 footcandles was displayed between the standard and comparison stimuli and between pairs of stimuli. The dependent variable was the amount of assimilation in time-error displayed by each subject. A complex set of interrelationships among the variables was proposed, which is depicted in a path analysis (Figure 5).

Path Analysis

Previous research (Witkin, 1962; Santostefano, 1969) suggests that age is predictive of field articulation and leveling-sharpening; and furthermore, that the analytical portion of intelligence is closely correlated with field articulation. (Witkin, 1962). To further test this proposition and to explore the relative contribution of these factors to the cognitive controls leveling-sharpening and field articulation, multilinear regression seemed the most promising research tool. Leveling-sharpening has already been demonstrated by Holzman (1952) to be a significant determinant of time-error. This study further proposed that field articulation accounts for much of the variance Holzman's study left unexplained. To depict the antecedent-succedent relationship of these factors to the dependent variable, time-error assimilation behavior, and the relative contribution of age and analytical ability to the development of the two cognitive controls, a model using path analysis technique was proposed (Figure 5).

This path analysis was based conceptually on Santostefano's developmental model of cognitive controls (1969) (See Figure 4). Previous research has demonstrated that age and analytical ability are correlated with field articulation; and that age is correlated with leveling-sharpening tendencies. Santostefano placed these two cognitive controls conceptually within a developmental model. The present study attempted to synthesize many strands of previous research by testing Santostefano's developmental model and additionally testing the relative contribution of age and analytical ability to the development of these cognitive controls. In turn, all of these factors were considered in a multiple regression equation as predictors of time-error behavior.

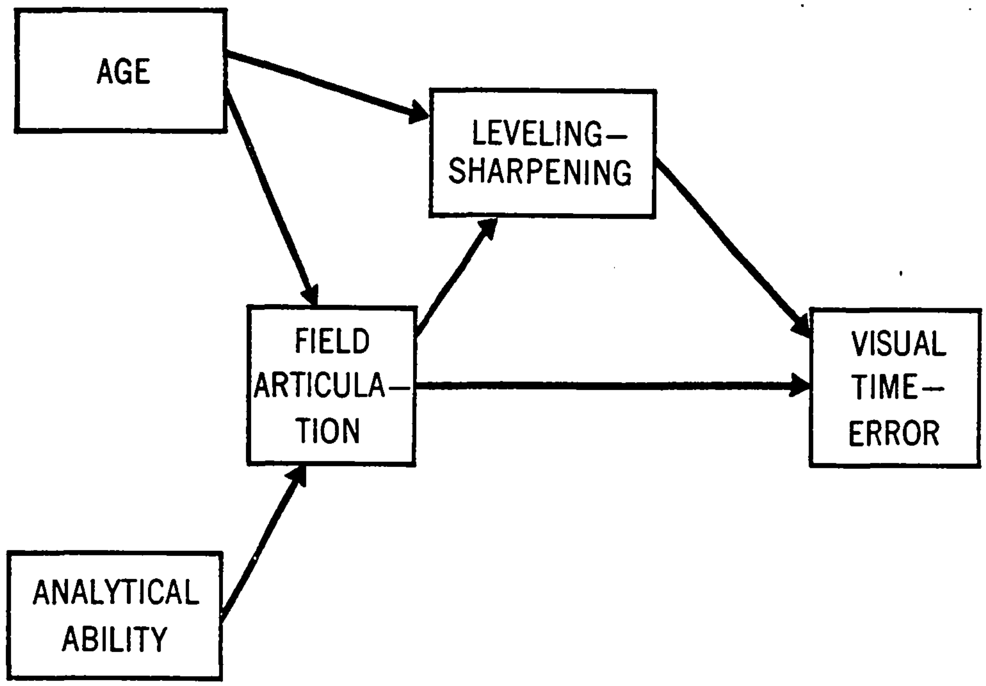


Figure 5. Path Diagram: Proposed Multiple Determinants of Time-Error

Stepwise multiple regression analyses were run to determine, respectively, the relative contribution of age and analytical ability to field articulation; the relative contribution of age and field articulation to leveling-sharpening; the relative contribution of field articulation and leveling-sharpening to time-error; and the relative contribution of the cognitive controls leveling-sharpening and field articulation, and age and analytical ability to time-error assimilation behavior. The latter analysis was run using a hierarchical strategy, which allows the researcher to specify the inclusion levels of variables.

Selection of Population

Based upon Santostefano's research findings and the developmental model that evolved from that research and upon the findings of Witkin, the greatest differences in field articulation and leveling-sharpening tendencies should be evident at ages ten and thirteen; and, since time-error behavior should be predicted by leveling-sharpening and field articulation, the amount of time-error should be much more pronounced in ten year olds than in thirteen year olds. This population is quite different from that of Holzman's study: he studied time-error behavior in college students. No research could be located on time-error behavior in children.

The present study sampled the behavior of eighty randomly selected subjects; forty ten-year old girls and forty thirteen year old girls, in the Norman, Oklahoma, Public Schools. Because gender has been found to be related to both leveling-sharpening and field independence-field dependence (boys tend to be more field independent and sharpening than girls) (Witkin, 1962, 1967, 1968; Santostefano, 1964), gender was held constant in this study.

Measurement of Analytical Ability: Wechsler Intelligence Scale for Children--Revised

The Test

The Wechsler Intelligence Scale for Children--Revised (WISC-R) is an individually administered intelligence test, designed for children between the ages of six and sixteen. In order to measure the same dimension Witkin and his associates called analytical ability (1962), the three subtests of the Performance Scale of the WISC that they found loaded most heavily on the analytical field approach factor: Block Design, Picture Completion, and Object Assembly, were used. WISC I.Q.'s are obtained by comparing each S's test performance solely with the scores of individuals in his or her own age group, thus yielding a deviation intelligence quotient (Wechsler, 1974).

Split-half reliability coefficients and Standard Errors of Measurement of the scores of ten and one half year olds and thirteen and one half year olds age groups and test-retest reliability coefficients for ten and one half year olds to eleven and one half year olds appear in Table 8.

Reliability Coefficients and Standard Errors of Measurement of Three WISC-R Subtests*

Test	Split-Half r		SE_M		Test-retest r
	10½ yrs.	13½ yrs.	10½ yrs.	13½ yrs.	10½ yrs.
Picture Completion	.68	.75	1.59	1.61	.82
Block Design	.86	.86	1.12	1.14	.86
Object Assembly	.64	.72	1.71	1.71	.72

*Source: Wechsler, 1974, pp. 28-32.

Table 8

Administration

A skilled psychometrist was engaged to give the three WISC-R subtests. Administration of the three subtests took a total of approximately thirty minutes per child. Sample items from each of the three subtests appear in Appendix C.

Because the items in many of the WISC-R subtests are graded in difficulty, beginning with easier items, the beginning item varies with the age of the child. The WISC-R manual directs the examiner to begin with the following items for children over eight: with item five on Picture Completion; with item three on Block Design; and with item one on Object Assembly. If the child does not obtain perfect scores on the initial items, the earlier items will be administered in reverse sequence as the manual directs. If the child does get a perfect score on his initial two items, he is given full credit for all earlier items. The WISC manual (1974) suggests that the tests be administered early because it is a good "icebreaker" and not as difficult as some of the other tests. Block Design was given second, and Object Assembly third.

The Picture Completion Subtest consists of twenty-six cards, three inches square, bound into a booklet. In each picture, an essential element is missing. As each card is presented, the child is asked to indicate the missing part on that card. If the child does not do so within twenty seconds, either by naming that part or by pointing to the correct spot, the item is scored as a failure, and the next picture is displayed. The maximum score is twenty-six points.

The Block Design Subtest consists of nine blocks colored red on two sides, white on two sides, and red/white on two sides; and of eleven cards with printed designs, bound into a booklet. The examiner lays out the blocks in random order and then arranges them into the design shown on the card, without showing the card to the child. Then, leaving the model intact, the examiner lays out another set of blocks scrambled randomly and instructs the child to make a design like the model. Within the time limit (forty-five seconds) the child is to try to duplicate the model. If the child fails, the blocks should be rescrambled and the model should be constructed again, and the instructions to duplicate the model are repeated. If the child passes the first trial on design three, he is given full credit for designs one and two also. If he or she passes only the second trial of design three or fails both trials, the examiner administers designs one and two. For designs four through eleven, the models for the child to duplicate are presented on cards. Each trial is timed, and no second trials are allowed. Four points are given for successful completion of a design within the time limit, plus a maximum of three bonus points per item for quick perfect performance. The maximum score is sixty-two points. (See Table 9).

Block Design: Scores for Designs 4-11 with Time Bonuses Included*

Design	Time Limit	Points with Time Bonus			
		7	6	5	4
4	45"	1-10"	11-15"	16-20"	21-45"
5	75"	1-10"	11-15"	16-20"	21-75"
6	75"	1-10"	11-15"	16-20"	21-75"
7	75"	1-10"	11-15"	16-20"	21-75"
8	75"	1-15"	16-20"	21-25"	26-75"
9(9 blocks)	120"	1-25"	26-35"	36-55"	56-120"
10(9 blocks)	120"	1-40"	41-55"	56-75"	76-120"
11(9 blocks)	120"	1-40"	41-55"	56-80"	81-120"

*Source: Wechsler, 1974, p. 88.

Table 9

The Object Assembly Subtest consists of five object assembly items which resemble large jigsaw puzzle pieces, each in a separate box, and a shield, behind which the pieces are laid out by the examiner. The entire test is given to all children. The sample item, an apple, is exposed to the child after it has been arranged behind the shield in a prescribed unassembled pattern. The child is informed what object the pieces will represent when assembled, and the examiner assembles the apple. Then, the same procedure is followed for the four test items, except that the child assembles the objects instead of the examiner. The child is instructed what object the assembled pieces will represent on the first two trials, but not on the last two trials. The child's score is a function of the number of cuts correctly joined. On the first two items, the number of joined cuts are multiplied by one; on the last two items, by one half. The maximum score is thirty-three points. (See Table 10 for maximum scores, with time bonuses).

Object Assembly
Scores for Perfect Assemblies with Time Bonuses Included*

Item	Time Limit	Points with Time Bonus 9	8	7	6	5
1. Girl	120"		1-20"	21-30"	31-120"	
2. Horse	150"		1-15"	16-20"	21-35"	36-150"
3. Car	150"		1-25"	26-35"	36-50"	51-150"
4. Face	180"	1-35"	36-50"	51-75"	76-180"	

*Source: Wechsler, 1974, p. 95.

Table 10

Obtaining Analytical Ability Scores

The raw scores obtained by each child on each of the subtests are converted to scaled scores appropriate to the age of the child by referring to the table entitled "Scaled Score Equivalents of Raw Scores" in the WISC-R manual (1974). The table is divided into four-month age spans. The subtest scaled scores are expressed in terms of a distribution with a mean of ten and an SD of three points. For purposes of this study the mean scaled score was obtained for each child, and this score represented his analytical ability score.

Measurement of field articulation: Group Embedded Figures Test

The Group Embedded Figures Test (GEFT) was administered to measure field independence-field dependence. It is a paper and pencil test designed to provide an adaptation of the original Embedded Figures Test (EFT), which was individually administered. Its validity and reliability coefficients for college undergraduates appear in Table 11 below. Witkin cautions that these statistics can serve only as a general guide for other populations. Unfortunately, data on other populations were not available when the most recent edition of the Manual for the Embedded Figures Tests was printed (1971). Norms and validity coefficients are available for the EFT for ten and thirteen year olds (See Table 12). Unfortunately, it is difficult to compare with performance on the GEFT, because the S's score on the GEFT is expressed in terms of number of figures correctly traced; the EFT, by contrast, is scored in terms of the mean number of seconds required per item. Witkin (1971) advises that the EFT and GEFT are appropriate for subjects (S's) aged ten through the geriatric age range, but he does suggest several modifications for ten year olds which will be described below.

Witkin's description of the procedure he followed when administering this test (Witkin, 1950) was followed as closely as possible, with modifications made as the Group Embedded Figures Test dictates and as Witkin suggests for administration to ten year olds. The task on the GEFT is to locate a simple figure within a larger complex figure. Each simple figure is embedded variously in several complex figures. The test consists of eighteen complex figures. As is the case with the EFT, both complex and simple figures must not be displayed simultaneously. On each trial, the complex figure is presented first, then the appropriate simple figure, and finally the complex one again. To accomplish this sequence on the GEFT, the simple form is printed on the back cover of the booklet and the complex figures on the booklet pages (Witkin, 1971).

GROUP EMBEDDED FIGURES TEST
VALIDITY COEFFICIENTS

Population	N	Criterion Variable	r with GEFT score*
Male undergraduates	73	Individual EFT, solution time	-.82
Female undergraduates	68	Individual EFT, solution time	-.63
Male undergraduates	55	PRFT, error **	-.39
Female undergraduates	68	PRFT, error	-.34
Male undergraduates	55	ABC, degree of body articulation ***	.71
Female undergraduates	68	ABC, degree of body articulation	.55

*r's with the EFT or PRFT should be negative because the tests are scored in reverse fasion.

**Portable Rod and Frame Test

***Articulation of Body Concept

Table 11

GROUP EMBEDDED FIGURES TEST
RELIABILITY COEFFICIENTS

Population	N	Formula	r
Male undergraduates	80	Spearman-Brown Prophecy Formula	.82
Female undergraduates	97	Spearman-Brown Prophecy Formula	.82

Source: Witkin, 1971, p. 29.

Table 11

Embedded Figures Test

Norms and Reliabilities for Ages Ten and Thirteen Obtained by Witkin

Age Level	Sex	N	Norms Mean (sec/item)	S.D.	Reliability*
10	M	51	117.9	32.9	.86
	F	52	126.9	30.1	.81
13	M	26	59.3	23.8	.61
	F	25	73.4	37.9	.85

*Reliabilities for the twelve-figure, three minute format are all based on data obtained by recomputing scores for tests given in the original full twenty-four figure, five minute form. All the reliabilities were computed by the Spearman-Brown method.

Source: Witkin, 1971, pp. 18, 19.

Table 12

A sample of the simple and complex figures appear in Appendix D, along with the details for administering and scoring the GEFT. When the S has located the simple figure within the larger figure, he is to trace the simple figure, just as the S is required to do on the EFT. The S's score is the total number of simple forms correctly traced in the second and third sections. (The first section is a practice section). For older subjects, the entire test takes approximately twenty minutes to administer;

the actual testing time is twelve minutes: two minutes for the first section and five minutes for the second and third sections. However, Witkin found that with ten year olds, the test differentiates more effectively when the time allowed for the second and third section is doubled (extended to ten minutes per section) (Witkin, 1971). The higher the S's score, the greater amount of field independence he has manifested.

Measurement of Leveling-Sharpening: Santostefano's House Test

A major departure from Holzman's study was made in the instrument selected to measure leveling-sharpening. Holzman used the Schematizing Test, which requires fairly elaborate administration and scoring techniques. It must be administered to small groups of three to five who must fill out an answer sheet using flashlights, since the room is darkened. Squares of systematically varying sizes are projected on a screen, and the S is instructed to judge the absolute size of the squares in inches. The subject's score is a combination of his accuracy score and his percent loss of accuracy.

The Schematizing Test was rejected for use in this study primarily because serious questions regarding the validity of the Schematizing Test as a measure of leveling-sharpening have been raised in the literature (Krathwohl and Cronbach, 1956). Krathwohl and Cronbach have criticized certain aspects of the test's administration procedure, but their primary criticism rests with the scoring method. Details of their criticism appear in Appendix A. Krathwohl and Cronbach used the Schematizing Test in a study using undergraduate architecture students. They found that a very large disparity (seven times) existed between the two standard deviations in the formula Klein and Holzman had used to compute leveling-sharpening, resulting in a very large positive weight for accuracy in judging the largest stimulus in each series and a small negative weight for accuracy on the other stimuli. Krathwohl and Cronbach say such weighting has no theoretical rationale.

Furthermore, Krathwohl and Cronbach compared the Schematizing Test with other tests that might be expected to correlate with the Schematizing Test. They found no significant correlation between the Schematizing Test and the Gough Rigidity Scale, a self-rating scale expected by Krathwohl and Cronbach to measure personality correlates of the Schematizing Test; nor with the Minnesota Clerical Test of attention to detail; nor the Object Aperture Test, which taps spatial judgment, attention to detail, and accurate size estimation. Thus, Krathwohl and Cronbach conclude, the results are inconclusive and not consistent with claims Klein and Holzman have made regarding the test. Consequently, since the test both requires elaborate administration techniques and possesses questionable validity, this researcher has decided that another measure of leveling-sharpening should be sought.

Santostefano's House Test seemed particularly appropriate for this study because it is one of the measures of leveling-sharpening which Santostefano used in the research from which his developmental model was derived. The Leveling-Sharpening House Test (LSHT) is an individually administered test consisting of a series of sixty line drawings of a house and related details. The picture changes in various ways as elements are omitted from the scene. The S is required to identify the changes. As is true of all of Santostefano's leveling-sharpening tests, this test yields three scores: a first-stop score (the position number of the picture at which S first stops the sequential display to report a change in the stimulus; number of correct changes reported; and leveling-sharpening ratio, which combines three factors: the number of displays that occur between the point at which a given change takes place and the point at which that change is first detected; the number of displays between any change not detected and the last display; and the total number of changes that take place (total = nineteen). The leveling-sharpening ratio was to measure leveling-sharpening in the present study. The higher the score, the greater amount of leveling manifested. The test takes approximately ten minutes to administer (Santostefano, 1976). Examiner's instructions and sample displays appear in Appendix E.

Test-retest reliability data is available for the LSHT from a longitudinal study done with fifty-one children, tested at intervals between kindergarten and fifth grade. Reliability coefficients for leveling-sharpening ratio scores are reported, since that is the score used in this study. (Table 13).

CORRELATION COEFFICIENTS FOR LSHT RATIO SCORES
Longitudinal Study, Kindergarten (K) Through Grade 5

	K	1	2	4	5
K	1.00	.58***	.65***	.23	.41**
1		1.00	.58***	.19	.48***
2			1.00	.36**	.52***
4				1.00	.72***
5					1.00

***$p < .01$
**$p < .05$

Source: S. Santostefano, 1977, Table 24.

Table 13

Norms have not been reported for the LSHT, but Santostefano has reported a mean leveling-sharpening ratio score, based upon an N of fifty-one, of 10.8 for ten year olds. His report did not include means for thirteen year olds (Santostefano, 1977).

Visual Time-Error Test

The Apparatus

The visual time-error test was conducted with a wooden box 21 x 17½ x 7½ inches. The front of the box was cut out and in the 21 x 17½ inch opening a sheet of milk glass 20 x 15½ inches was inserted. A piece of black cardborad was placed over the milk glass to mask the entire opening except for a circular opening five inches in diameter. This aperture served as a rear-screen on which the stimuli and the interpolated fields were projected. The rear of the box was open. Behind the milkglass and fastened to the sides of the box were two electric light bulbs connected in parallel. Their brightness was controlled by a Variac. The bulbs provided the illumination for the interpolated field. All of the above parameters accurately duplicate the apparatus in Holzman's visual experiment.

A minor deviation was that a 35 mm McClure filmstrip projector which uses a 150 watt bulb was used as a light source (Holzman used a 35 mm SVE projector with a 100 watt bulb). From the light source, the brightness stimuli were projected through the rear of the box onto the milk glass screen. The brightness of the stimulus pairs was controlled by a second Variac. The projector and the lights inside the box were connected to a mechanical timer which automatically switched the projector on and off, exposing a stimulus for one second. After the projector shut off, the timer switched on the lights in the box, providing the interpolated field illumination. The length of this interpolated field illumination varied systematically as described below.

The Test

The S's were tested in small groups, maximum of five per group. They were seated in front of the box, arranged symmetrically about the plane perpendicular to the center of the milk glass screen. Following Holzman's precedent, the distance from the center of the circle to the S's eyes in the first row was six feet and eight feet in the second row. At the beginning of the testing period, the S's were allowed five minutes for their eyes to adapt to the darkened room.

The S's judged five pairs of brightness stimuli. The stimulus pairs were identical to those Holzman used, but were converted from millilamberts to footcandles (Handbook of Chemistry and Physics, 1967, p. F-211).

6.54 - 3.27

6.54 - 4.90

6.54 - 6.54

6.54 - 8.17

6.54 - 9.81

The stimuli appeared as successive pairs of illuminated circles through the five inch milk glass disc. Each circle in a pair was projected for one second. Ten seconds separated standard and comparison, and twenty seconds separated pairs. During the ten second interval and the twenty second interval the screen was illuminated by a constant dim interpolated stimulus of 3.03 footcandles, providing a background for the standard and comparison stimuli. A comparative judgment was required of the S. on each stimulus pair, with only two categories of judgment allowed: the S. had to judge the second stimulus as brighter or dimmer than the first stimulus. The standard stimulus was always presented first. The 3.03 footcandle background was selected because it was the condition under which Holzman found the greatest amount of negative time-error (1952).

Following Holzman's precedent, the stimulus pairs were so arranged that each pair was preceded and followed by every other pair at least once, but not more than twice; and no pair was repeated until all five pairs had been projected. S's judged each stimulus seven times, making a total of thirty-five judgments. The test lasted approximately eighteen minutes.

Each S. was given an answer sheet on which she was to circle either "brighter" or "dimmer," depending on whether she thought the second light was brighter or dimmer than the first light. S's were given small pocket flashlights to help them record their judgments in the darkened room.

One practice trial was given at the beginning of the test, using 6.54 and 3.27 footcandles. S's were reminded to judge the <u>second light</u> as brighter or dimmer than the first one. They were also instructed to look at the screen constantly, taking their eyes off it only when recording their judgment. They were told that the screen would be lit most of the time by a dim light and that they were to judge only the two lights that interrupted this background. (Instructions and answer sheet for the time-error test appear in Appendix B).

Statistical Design

The implication of the path analysis upon which this study is based (Figure 5) is that time-error is likely to be affected by the S's degree of leveling-sharpening and field articulation. In turn, the S's degree of leveling-sharpening is proposed to be affected by his degree of field articulation and age; it is hypothesized that his degree of field articulation is, in turn, affected by his age and analytical ability. To obtain the path coefficients, then, a series of multiple regressions must be solved. A stepwise solution was used, in which the order of inclusion is based upon the respective contribution of each variable to explained variance. In the prediction of field articulation, research has not demonstrated which variable: age or analytical ability is the superior predictor; therefore, a stepwise regression strategy was used to determine the relative effects of age and field articulation on leveling-sharpening. The third analysis determined the relative contribution of the cognitive controls field articulation and leveling-sharpening to time-error. To study both indirect and direct relationships of all four independent variables and, thereby, to test the proposed path analysis, a hierarchical regression strategy was used to determine the direct relationship of leveling-sharpening and field articulation with time-error; and the indirect relationship of age and analytical ability to time-error, as mediated by field articulation and leveling-sharpening; and the indirect relationship of field articulation to time-error as mediated by leveling-sharpening. This hierarchical strategy specified two levels of inclusion: the two cognitive controls were entered first in stepwise fashion and then the remaining independent variables were entered in a stepwise manner, so that within each inclusion level, the variables were entered based upon their respective contribution to explained variance.

The independent variables are continuous, except for the dichotomous variable, age. However, SPSS allows one to treat a dichotomous variable as continuous, (Nye, 1975) which this investigator did.

Higher scores on the GEFT indicate a greater amount of field independence; higher scores on Santostefano's House Test indicate a greater amount of leveling, based on the leveling-sharpening ratio. Based on L. Ausburn's findings (1976), negative correlations between these two tests were expected.

Time-error was computed from the PSE (the S's Point of Subjective Equality), which is the S's judgment of where the midpoint of the series lies. The Constant Error was then computed, which is the difference between the objective midpoint of the series and S's judgment of where the midpoint lies. If S. judges the midpoint higher than it actually is, the time-error is negative; if he judges the midpoint lower, the time-error is positive. Time-error was computed according to the summation method devised by Woodworth (1958) and is expressed as Constant Error:

$$CE = PSE - St$$

(See Appendix B for procedure for computing time-error).

CHAPTER IV

STATISTICAL ANALYSIS OF THE DATA

Each of the four hypotheses upon which this study was based were tested by stepwise multiple regression analysis within the context of a path analysis. Consequently, in each instance the order of inclusion of independent variables was determined by the respective contribution of each variable to explained variance.

The hypotheses tested were as follows:

H_{01}: There is no relationship between the dependent variable field articulation, and age and analytical ability.

H_1: There is a relationship between the dependent variable field articulation, and age and analytical ability.

H_{02}: There is no relationship between the dependent variable leveling-sharpening, and field articulation and age.

H_2: There is a relationship between the dependent variable leveling-sharpening, and field articulation and age.

H_{03}: There is no relationship between the dependent variable assimilation tendencies in time-error, and the cognitive controls leveling-sharpening and field articulation.

H_3: There is a relationship between the dependent variable assimilation tendencies in time-error, and the cognitive controls leveling-sharpening and field articulation.

H_{04}: There is no linear relationship between the dependent variable assimilation tendencies in time-error, and the following subject variables: age, analytical ability, field articulation, and leveling-sharpening.

H_4: There is a linear relationship between the dependent variable assimilation tendencies in time-error and the following subject variables: age, analytical ability, field articulation, and leveling-sharpening.

In the first multiple regression analysis, analytical ability was entered first, resulting in an R of .608 (df = .78; F = 45.793; $p < .001$). Age was entered in the second step, with a Beta weight of .226. Together, the two variables resulted in an R of .649 (df = 2,77; F = 27.983; $p < .01$), accounting for 41% of the variance in field articulation. Thus, it was possible to reject the first Null hypothesis and to accept the alternative hypothesis.

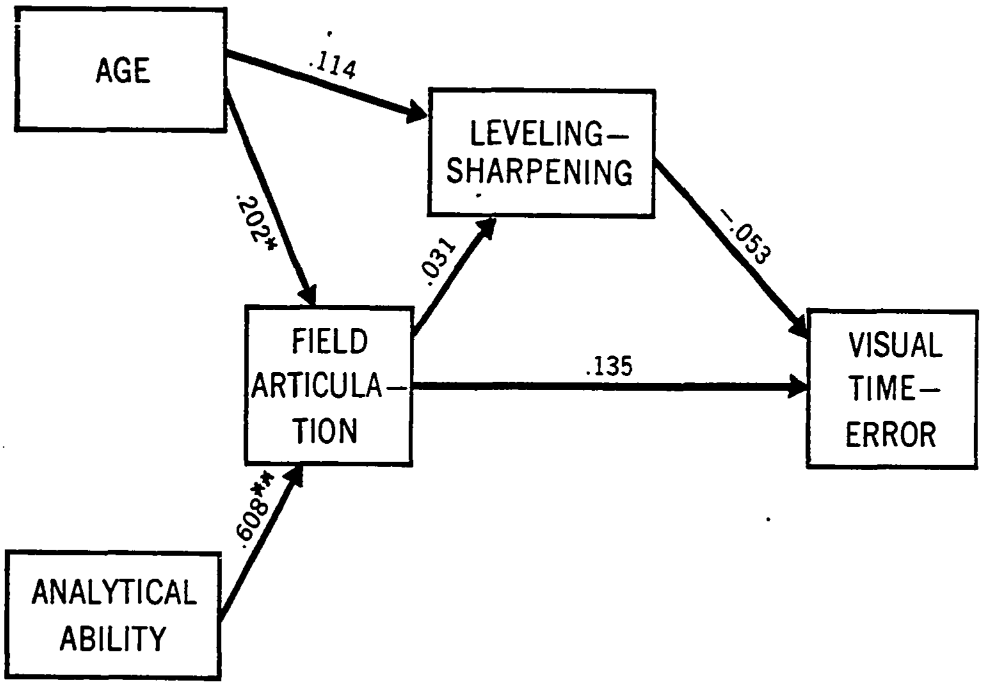
In the second stepwise regression analysis, the variable age was entered first as the better predictor of leveling-sharpening, resulting in an R of .121 (df - 1,78; F = 1.154; $p > .25$). Field articulation was entered next, producing an R of .124 (df = 2,77; F = .606; $p > .25$).

In the third stepwise regression analysis, the variable field articulation was entered first as the better predictor of time-error, producing an R of .132 (df = 1,78; F = 1.383; $p < .25$). Then leveling-sharpening was entered with a Beta weight of -.053. The two independent variables together produced an R of .142 (df = 2,77; F = .797; p > .25) and accounted for only 2% of the variance in time-error.

In the fourth stepwise regression analysis, which represented a cumulative analysis based upon a hierarchical strategy, the variables field articulation and leveling-sharpening were entered in the first two steps. Field articulation was entered first as the better predictor of time-error (R = .132, df = 1,78; F = 1.38, p < .25); leveling-sharpening was then entered, producing an R of .142 (df = 2,77; F = .797, p > .25). In the second inclusion level, the other variables were entered: analytical ability was entered first as the best remaining predictor of time-error (Beta of -.117) producing an R of .169 (df = 3.76; F = .745; p > .25). Finally, the variable age was entered, with a Beta weight of -.029, producing an R of .171 (df = 4,75; F = .567; p > .25). Certainly the addition of independent variables in this equation beyond the first, field articulation, did not add anything to the initial prediction, and even the strongest predictor, field articulation, failed to make a statistically significant contribution. It is also not likely that the strong correlations between age and field articulation, and between analytical ability and field articulation confounded the multiple regression on time-error because the simple correlation coefficients between age and time-error; and between analytical ability and time-error were very low (.011 and .017, respectively).

This, it was not possible to reject the second, third, and fourth Null hypotheses.

The path coefficients are represented in Figure 6.

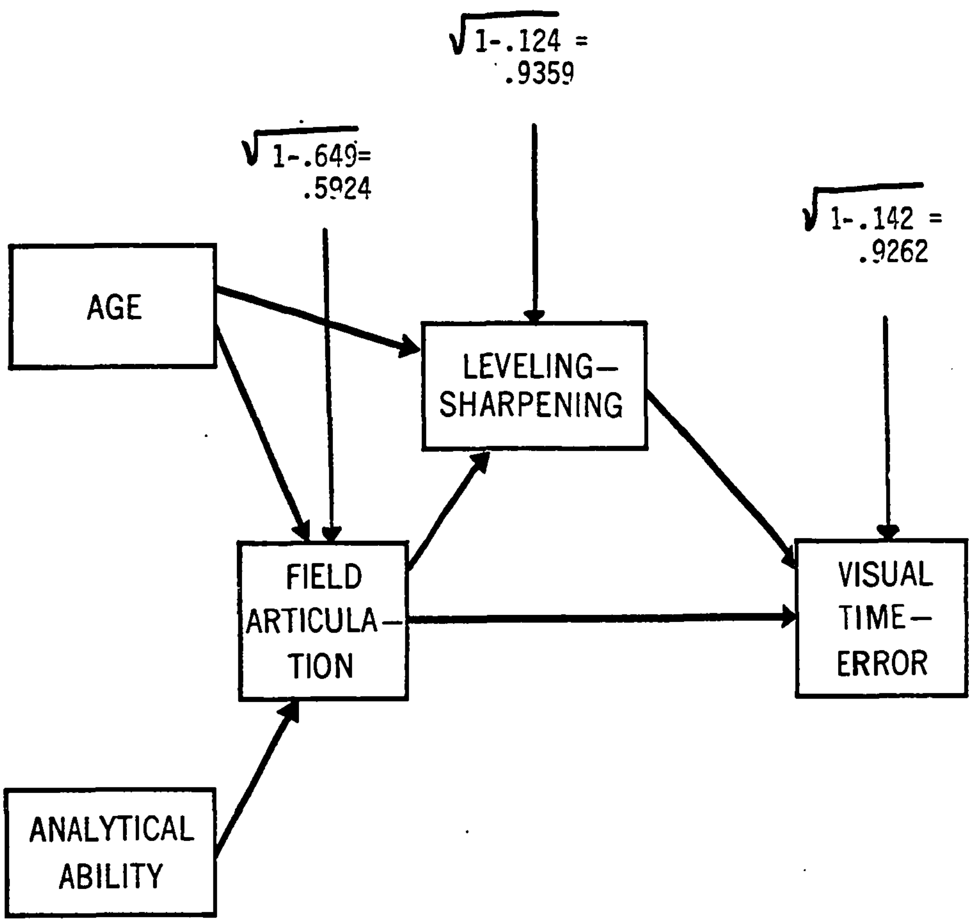


Proposed Multiple Determinants of Time—Error

Figure 6. Path Coefficients Obtained in Path Analysis

* $p < .1$
** $p < .001$

Path coefficients estimated from latent variables (i.e., residual factors associated with each dependent variable), computed as $\sqrt{1-R^2}$ appear in Figure 7.



Proposed Multiple Determinants of Time–Error

Figure 7. Path Coefficients from Latent Variables

Path analysis is an analytic tool for theory testing, in that with path analysis one can determine if a pattern of correlations is consistent with a formulation based upon theory. Having obtained a set of path coefficients, it is possible to delete those paths which do not appear meaningful, thus obtaining a more parsimonious model If after the paths deleted, it is possible to reproduce the original R matrix (which would be possible if spurious relationships were detected) or closely approximate the original R matrix (as the case is here) the data is consistent with the more parsimonious model. Kerlinger cites Land as suggesting that path coefficients of $<.05$ may be treated as not meaningful. Then, if the discrepancies between the original and reproduced correlations are small, (less than approximately .05), the researcher may conclude that the more parsimonious model is tenable (Kerlinger, 1973). By this principle, the path between field articulation and leveling-sharpening would be deleted. The path coefficient between age and leveling-sharpening then reverted to the simple correlation coefficient of .121, which is .07 higher than the Beta calculated when leveling-sharpening was regressed on both age and field articulation. This discrepancy is only slightly higher than the .05 criterion suggested by Kerlinger for assessing goodness of fit. In light of the low simple correlation between field articulation and leveling-sharpening (.053), it seemed appropriate to this researcher to delete the path between field articulation and leveling-sharpening.

The author also deleted the path between leveling-sharpening and time error. Before any paths were deleted, the coefficient (-.053) was slightly greater than the recommended .05 level. However, after the path between field articulation and leveling-sharpening was deleted, the path coefficient between leveling-sharpening and time-error would have reverted to the simple correlation coefficient of -.046, which is quite trivial and does not seem meaningful to this researcher. After the path between leveling-sharpening and time-error was deleted the path coefficient between field articulation and time-error reverted to the simple correlation coefficient, .132. Thus, the modified path diagram represents the deletion of two paths, producing a net change of .07 in the path between age and leveling-sharpening, and a change of .03 in the path between field articulation and time-error. Essentially, this reduced all remaining relationships to simple bivariate correlations.

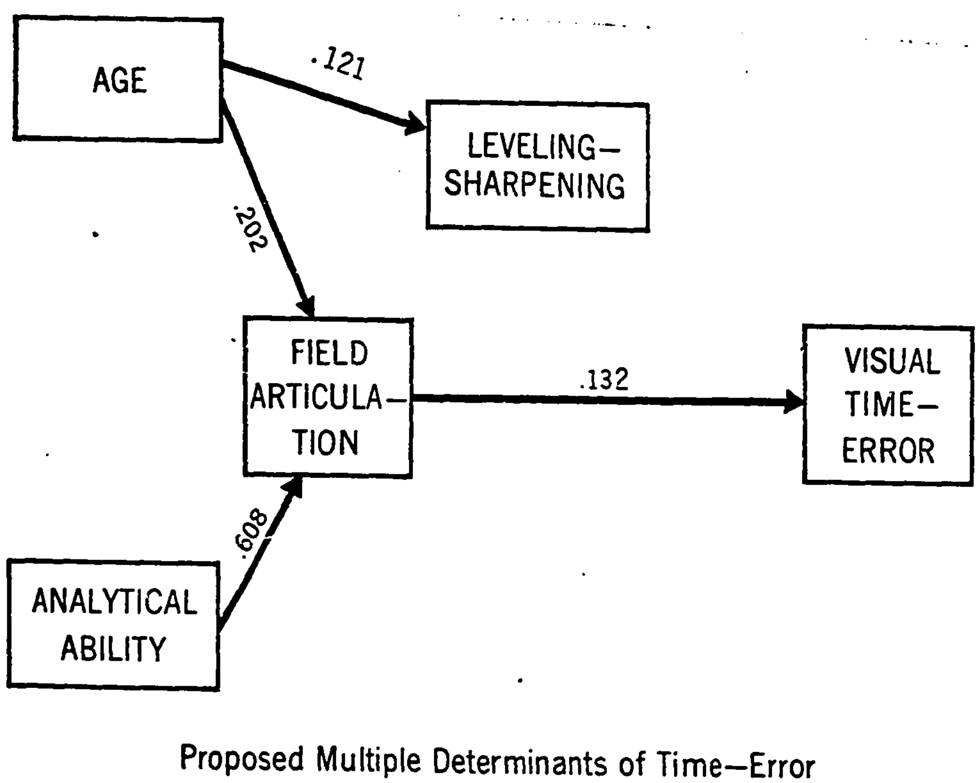


Figure 8. Path Diagram After Analysis with Two Paths Deleted.

Table 14 is a correlation matrix representing the bivariate relationships of all the variables in this study.

Table 14

Correlation Matrix for All Variables

	AGE	ANALYTICAL ABILITY	LSHT	GEFT	T.E.
AGE	1.000	-.038	.121	.202*	.011
ANALYTICAL ABILITY		1.000	-.115	.608**	.017
LSHT			1.000	.053	-.046
GEFT				1.000	.132
T.E.					1.000

* $p < .1$

** $p < .001$

In path analysis it is customary to decompose the bivariate relationships into direct and indirect relationships. Because only the correlations between field articulation and age, and field articulation and analytical ability were found to be statistically significant, it would be a meaningless exercise to divide near-zero correlations into direct and indirect "nonrelationships." Furthermore, the deletion of paths (Figure 8) demonstrates that the researcher did not find the patterns of indirect and direct relationships anticipated. Within the context of this path analysis, the bivariate relationship between age and field articulation (.202) and between analytical ability and field articulation (.608) represent direct relationships only. Age and analytical ability both predict field articulation in a single path;

that is, they do not also predict field articulation through their relationship with another variable in this study or with each other.

Although age was found to be a significant predictor only for the cognitive control field articulation, it is useful to see the mean scores of each age group on each test variable (Table 15). Contrary to Santostefano's findings, the thirteen year olds in this study showed more leveling behavior (as demonstrated by a higher score) than the ten year olds, although the difference is nonsignificant statistically. The means on the GEFT are in the expected direction since the thirteen year olds attained higher scores. (The highest possible score on the Group Embedded Figures Test is 18). The time-error scores are negative, as was expected, due to the use of a dim interpolated field. The thirteen year olds manifested less time-error, but the difference is statistically nonsignificant.

Table 15

Mean Scores, By Age Group

AGE	ANALYTICAL ABILITY	LEVELING-SHARPENING HOUSE TEST	GROUP EMBEDDED FIGURE TEST	TIME ERROR
10	11.171	11.64	6.73	-0.36
13	11.105	12.33	8.28	-0.32

Interestingly enough, the ten and thirteen year olds in this investigation displayed less time-error than the adults in Holzman's time-error experience with a dim interpolated field (1952). Holzman's subjects displayed a mean time-error of -1.85: the children in this study, a mean of -.34.

CHAPTER V

SUMMARY, DISCUSSION AND CONCLUSIONS, AND RECOMMENDATIONS FOR FURTHER RESEARCH

SUMMARY

A sample of 80 girls (40 ten year olds and 40 thirteen year olds) was tested with the Performance Scale of the WISC-R, the Group Embedded Figures Test, the Leveling-Sharpening House Test, and a visual time-error test in order to assess the relative contributions of age and analytical ability to the cognitive control field articulations; the relative contribution of age and field articulation to the cognitive control leveling-sharpening; the relative contribution of leveling-sharpening and field articulation to assimilation tendencies in visual time-error; and the relative contribution of the following subject variables: age, analytical ability, field articulation, and leveling-sharpening to time-error behavior.

Within the context of a path analysis, each of the four hypotheses was tested by stepwise regression analysis. The first regression analysis, which regressed field articulation on analytical ability and age, revealed that analytical ability and age together account for 41% of the variance in field articulation. None of the other multiple regression analyses yielded significant multiple correlation coefficients.

Discussion and Conclusions

The significant correlations between analytical ability and field articulation, and between age and field articulation obtained in this investigation support Witkin's prior findings and add the findings of relative contribution: that analytical ability is a stronger predictor ($r = .608$) than age (Beta = .226). Possibly the contribution of age would have been even higher if the thirteen year olds had been allotted more time in the administration of the Group Embedded Figures Test. Witkin suggested (1971) ten year olds be given twice as much time as older age levels because age ten is the youngest age level for which the test is designed. However, Witkin also specifies that all S's should be given enough time to attempt each complex drawing in the test booklet. In this study the examiners noted that many of the thirteen year olds did not appear to reach the last drawing in each section.

Certainly many of the results obtained in this study appear to contradict prior research. To summarize briefly, Holzman (1952) found a relationship between time-error and leveling-sharpening not borne out in this study; Gardner (1959), Gardner and Moriarty (1968) and Santostefano (1969) all report a moderate relationship between leveling-sharpening and field articulation, not found in this study; and Santostefano found an increase in sharpening with age (1964), which this investigation did not reveal.

Upon closer examination, one can discern certain clues which may account for some of these conflicting results. The lack of correlation between field articulation and leveling-sharpening, on the one hand,

and between leveling-sharpening and time-error assimilation may be partially due to the use of similar yet different instruments for their measurement. Holzman used the Schematizing Test, which he and his colleagues at the Menninger Clinic devised. The Schematizing Test consists of sequentially projected squares which systematically increase in size. The S is asked to perform an absolute judgment regarding the size of each square as it is projected. This investigator rejected the Schematizing Test for use in this study primarily because the scoring method Holzman used has been severely criticized in the literature (Appendix A) and perhaps even more important, because its construct validity has been questioned in a convincing manner (Krathwohl and Cronbach, 1956). Furthermore, making judgments regarding the size in inches of projected square seemed intuitively like an operation with which children this age might be unfamiliar and uncomfortable, despite the fact that it has been used in one study with preadolescents (Gardner and Moriarty, 1968). In addition, this researcher thought the task the Schematizing Test presents might be inherently monotonous to children, a conclusion also reached by Santostefano, who designed a similar leveling-sharpening test he called the Circles Test, which required a less difficult response from the S. In the Circles Test the child observes sequentially displayed circles and indicates when he or she notes a change in circle size. In a comparative study of three leveling-sharpening tests Santostefano devised: Wagon Test--Elements Subtracted; Wagon Test--Elements Added; and the Circles Test, he concluded that the Circles Test seemed the least successful because S's quickly lost interest in the monotonous task (Santostefano, 1964).

Santostefano suggests that the Wagon Test, Elements Subtracted, is the best of the three leveling-sharpening instruments for children. This test is most similar to another test also designed by Santostefano, the Leveling-Sharpening House Test, (used in this investigation) in that both tests are pictorial, sequentially displayed and require the S to identify the detail omitted in a given display either verbally or by pointing appropriately.

Santostefano computed intercorrelations among the scores on his three leveling-sharpening test (the two Wagon Tests and the Circles Test) (1964). The leveling-sharpening ratio of the Circles Test (the leveling-sharpening score also used in the present study) correlated moderately with the Wagon Test--Elements Subtracted scores of the nine year olds ($r = .22$, $p < .1$); and significantly with the same scores of the twelve year olds in his study ($r - .44$, $p < .05$). Correlation coefficients obtained for the two tests for nine and twelve year olds appear in Tables 16 and 17. (With 18 degrees of freedom, coefficients must be .44 and .57 to reach the .05 and .01 levels of significance, respectively.)

Table 16

Correlations among Scores of the

Wagon Subtraction Test and Circles Test for 9 Year Olds

	Wagon Subtraction		
Circles	First Stop	Correct Changes	Ratio
First Stop	.41	-.04	.12
Correct Changes	-.37	.20	-.30
Ratio	.43	-.12	.22

Source: S. Santostefano, 1964, p. 355.

Table 17

Correlations among Scores of the

Wagon Subtraction Test and Circles Test for 12 Year Olds

	Wagon Subtraction		
Circles	First Stop	Correct Changes	Ratio
First Stop	-.14	-.18	.07
Correct Changes	-.37	.57	-.56
Ratio	.15	-.51	.44

Source: S. Santostefano, 1964, p. 355.

The correlations Santostefano obtained between the Circles Test (variant of the Schematizing Test) and the Wagon Test(variant of the Leveling-Sharpening House Test) are somewhat confusing, certainly not conclusive, and one might suspect that the two tests are measuring related but different cognitive dimensions. This suspicion is strengthened by the finding in the present study of correlation not different from zero between Leveling-Sharpening House Test scores and time-error scores, whereas Holzman found significant correlation between the Schematizing Test and time-error in visual, auditory, and kinesthetic modalities; and a factor analysis by Gardner (1959) revealed a .65 factor loading of kinesthetic time-error on a leveling-sharpening factor, measured by the Schematizing Test. Thus, time-error behavior does seem to be related to the cognitive control leveling-sharpening if it is measured with the Schematizing Test or its variant, but not with leveling-sharpening if it is measured with the Leveling-Sharpening House Test.

An analysis of the Leveling-Sharpening House Test, the Schematizing Test, and the time-error test may be useful at this point. All three tests are timed and present stimuli to the S at a rapid pre-determined rate. The Schematizing Test and the time-error test present one simple item (a square or a circle) to the S and require an attributive judgment within a very brief period of time (a matter of seconds). On the other hand, the Leveling-Sharpening House Test presents a more complex display which is pictorial. The Leveling-Sharpening House Test requires the S to scan the entire display in search of a missing detail which makes the picture different from pictures previously viewed in the test. Because a comparison with earlier pictures must be made by the S, a logical visual sequencing is also required. Not only that, but, possibly, successful completion of the Leveling-Sharpening House Test (i.e., detection of missing elements when they occur in the sequence of pictures) may be related to an awareness of cultural appropriateness. Thus, an S sensitive to social conventions might be more aware of the presence or absence of a weather vane on the house in the picture, or the presence or absence of a shrub or the sidewalk. This possibility may be supported by a tangential finding in this study. In a follow-up analysis to determine possible relationships between leveling-sharpening and I.Q., a moderate but statistically significant correlation was found between the Leveling-Sharpening House Test and the WISC-R Subtest, Picture Arrangement ($r = .316$, $p < .01$). The Picture Arrangement Subtest involves the sequencing of nonverbal, pictorial material and requires an interpretation of social situations (Sattler, 1974). The above brief analysis suggests that the Leveling-Sharpening House Test is a more complex test, since it requires a synthesis of many skills and appears to present stimuli loaded with social connotations. However, the Leveling-Sharpening House Test does seem to share with the other leveling-sharpening test a visual perceptual element and a reliance on memory.

Previous investigators have generally held (Holzman, 1952; Gardner, 1959; Santostefano, 1969) that the one essential element in leveling-sharpening tests is the exercise of memory; and that sharpeners maximize differences in memory traces, whereas levelers minimize such differences, accounting for individual differences in time-error, among other behaviors. To analyze how each test exercises the memory process, it may prove useful to differentiate between short-term and long-term memory. Belmont and Butterfield, in an unpublished manuscript (Kagan and Kogan, 1970) reported that short-term memory (defined as a trace that lasts for a maximum of 30 seconds) is more influenced by encoding processes than by forgetting. By this definition, the memory store accessed by the time-error test is short term memory, since the one-second projections of light to be compared are separated by a 20 second interval, during which the S sees the dim interpolated field. Thus, each pair to be compared is projected over a span of 22 seconds. The Schematizing Test projects a square for 3 seconds, with 8 seconds between each stimuli. If Belmont and Butterfield are correct, the time-error test may be measuring primarily accuracy of encoding rather than accurate connecting of memory traces. Short-term memory may also be accessed when the S is engaged in the Circles Test and the Schematizing Test. On the other hand, long-term memory may be accessed during the Leveling-Sharpening House Test in two respects. At any time during the display of 60 cards the child may detect the omission of an element after it occurs, an interval which may span 20 seconds or several minutes. In addition, the S also may rely on his or her long-term memory of social conventions for the appropriateness or inappropriateness of each display.

Regarding the relationship between field articulation and leveling-sharpening, researchers typically find a moderate correlation between field articulation and leveling-sharpening around the .10 level of significance (Gardner, et al, 1959) and Santostefano found a moderate loading of field articulation on a leveling-sharpening factor (1969), but this investigator found a very low correlation, not significantly different from zero. Again, these differences may be due to the instruments used to measure these dimensions. Gardner attributes the moderate correlation typically found between the Embedded Figures Test and the Schematizing Test to a common reliance upon memory. Possibly the S accesses short-term memory in the Embedded Figures Test, because he is given the option of viewing the simple drawing as often as he needs to. Therefore, the common variance shared by the Embedded Figures Test and the Schematizing Test might also be found in the initial encoding of visual information: in the case of the Schematizing Test and the time-error test, in the accuracy of encoding each circle (or square) as it is visually displayed. Perhaps the Group Embedded Figures Test does not correlate with the Leveling-Sharpening House Test because the Group Embedded Figures Test may also primarily access short-term memory. The S is free to look at the simple figure as often as he wishes and, therefore, there may be no need to transfer the information into long-term memory. On the other hand the Leveling-Sharpening House Test is probably accessing specific visual traces of the picture as it gradually changes, which might be held either in short term or long term memory and it is probably also accessing many more complex associations in long-term memory.

A close analysis of Santostefano's factor field articulation also reveals a definitional problem (1969). Santostefano maintains that his concept of field articulation embraces Witkin's field independence-field dependence and Klein's constricted-flexible control. Santostefano used a series of Color Fruit Tests to measure field articulation. These tests are an exercise in attention to relevant detail and disregard for irrelevant detail surrounding the fruit (selective deployment of attention). Karp (1963) has suggested this may be only remotely related to Witkin's concept of embeddedness. Karp states that most prior research has found the two concepts of overcoming distraction and overcoming embeddness related, but some investigators have gone so far as to conclude that an embedding context is only a special case of a distracting context, which appears to be Santostefano's position. In order to clarify the distraction vs.

embedding issue, Karp performed a factor analysis and determined that his field independence-field dependence tests (Embedded Figures Test, Rod and Frame Test, Body Adjustment Test, WAIS Block Design, and WAIS Object Assembly) loaded highly on the embeddedness factor, but the distractions tests did not (Distracting Contexts Tests I, IIA, and IIB). The distractions tests contributed instead to Factor II, a distractions factor, although moderate correlations were found between factors representing these abilities. Even though the issue is not resolved, Karp casts consderable doubt on the previous notion that embedding and distraction are so closely related as to be subsumed by the same factor, a position that Santostefano appeared to still hold in 1969, at the time of his factor analytic study which led to his proposed developmental model (Figure 4).

The present study did not find the age differences in leveling-sharpening which Santostefano found (1964). This issue may be somewhat more difficult to resolve, but a study by Ward and Naus may shed some insight on the problem. Ward and Naus compared the pictorial encoding strategies of pre-school children and adults (1973). The S was shown a series of unrelated pictures which he was to commit to memory. Each picture was then paired with another picture of a similar nature which the S had not seen before. At that time the S was to remember the first picture seen and identify it. There were four instructional conditions: one group was instructed not to give a name to the picture as it was first presented; another, to give the picture a name; another, to name the dominant color in the picture; and the fourth group, to close their eyes and picture the object in their heads. The basic hypothesis was that children would experience ikonically and adults symbolically. It appeared that the S's disregarded their instructions and encoded in the way they could best remember. The researchers concluded that most adults prefer to encode pictorial information ikonically, as do children. They also found no significant age group differences in object recognition. This suggests several possibilities: one, that efficiency in pictorial encoding, as in the Leveling-Sharpening House Test, may not improve with age; and second, that cognitive structures may be hierarchically organized, in that adults may have available for their use ontologically earlier forms of information processing, which they may choose to use if it seems appropriate to the task at hand. This kind of self-directive behavior is supported by Klein's theory of adaptive interaction. He says cognitive structures intervene between drives and situational demands. Thus, cognitive structures enable the individual to regulate his mode of approaching a problem, based upon his perception of the demands of that situation (Klein, 1970). Ward and Naus' study suggests that most subjects (kindergarteners through adults) may choose to encode pictorial information in much the same way (ikonically) because ikonic encoding seems more appropriate to that particular task.

In the path diagram derived from the results of this study (Figure 8) the paths between leveling-sharpening and time-error; and between field articulation and leveling-sharpening have been removed because extremely low statistical correlations were obtained between these variables. This researcher suggests these near-zero correlations are probably due to the instruments selected to measure cognitive styles. Consequently, rather than reject the theory of hierarchical organization of cognitive controls, upon which this study was based, this researcher thinks it more prudent to conclude that the state of the art in cognitive controls is not precise enough yet to run an analysis of this sort. Before one can derive direct and indirect relationships between a set of variables, those variables must be precisely defined and valid instruments for their measurement developed, so that the researcher may proceed with a reasonable degree of confidence that the variables in his study represent the dimensions he intends. This need was also expressed by Herman Witkin:

> "First of all, there are the important tasks of sharpening the definition of some of the cognitive styles now in vogue, and of developing better marker tests for their identification. The obvious overlap among some of the styles described in the literature points to the need for 'codification' of cognitive styles." (H. Witkin, 1964, p. 172).

Suggestions for Further Research

The overwhelming implication of this study is that further research should be done in defining cognitive controls and developing precise instruments for their measurement. The fact that Witkin's prior findings regarding the relationships of analytical ability and age to field articulation were substantiated in this study, coupled with the impressive volume of reliability and validity data that has been amassed regarding Witkin's construct field independence-field dependence, suggests that Witkin has attained a high measure of reliability and construct validity which could well be emulated by other cognitive control researchers. Factor analyses would prove useful for the various tests now available which purport to measure the same cognitive control (for example, Santostefano's Leveling-Sharpening House Test and Circles Test and Holzman's Schematizing Test). This should be done in connection with a precise analysis of the tasks involved in each instrument. These tasks should then be related to the sequence of information processing. Kagan and Kogan have provided a model which might provide the framework for such an analysis. Their model consists of these steps: encoding, memory, hypothesis generation, evaluation, deduction, and public report (1970). This researcher contends that until cognitive control researchers can describe specifically what cognitive function or functions each cognitive control deploys, cognitive controls will remain vague constructs. Until a reasonable degree of standardization is reached, one will have to speak of leveling-sharpening "as Santostefano defines it," or leveling-sharpening "as Holzman defines it."

Related to the basic problem of definition, more research should be done into the developmental patterns of cognitive controls: when they emerge and how they relate at various stages of development to other cognitive controls, as well as to other variables such as I.Q., socioeconomic status, academic performance, cognitive styles of parents and teachers, etc. In this connection, Santostefano's developmental model should be tested further. The concepts of hierarchical integration and increasing differentiation upon which his model is based agree with many major developmental theories (Lewin, 1935; Piaget, 1947; Bruner, 1966; Wapner, 1964). Santostefano's model should be tested again, however, only after generally agreed upon, valid and reliable instruments have been developed for the measurement of cognitive styles at various age levels.

Another area recommended for research is the possible relationship of the variables in this study, especially leveling-sharpening, to visual literacy. Robin Garfinkel (1975) found, in connection with a renorming of the Stanford-Binet Intelligence Scale, that visual, nonverbal scores were much higher among pre-school children in the 1970's than they had been in the 1930's, but that this ability begins to drop after entry in public schools. Jack Debes (1977) suggests that this difference may be largely due to heavy television viewing among contemporary children. Debes contends that through television viewing, young children learn patterns of visual sequencing and a visual Gestalt. This investigator suggests these abilities may relate closely with the Leveling-Sharpening House Test. The moderate but statistically significant correlation found between the Picture Arrangement Subtest of the WISC-R and the Leveling Sharpening House Test in this study ($r = .316$, $p < .01$) would seem to support this possibility, since both the Picture Arrangement Subtest and the Leveling-Sharpening House Test involve the sequencing of visual material in a manner appropriate to social conventions. Mr. Debes has constructed a hierarchy of visual skills contributing to visual literacy. Near the bottom of the hierarchy is, "To be able to recognize differences in brightness (which seems superficially, at least, to describe time-error behavior). Near the top of the hierarchy are these behaviors: "To be able to read a spatial arrangement of objects commonly seen together; to read a sequence of objects or body language arranged in chronological order and related by process." (Debes, 1969, 26-27). It would be interesting to determine if these are the behaviors required of the subject in Santostefano's Leveling-Sharpening House Test.

BIBLIOGRAPHY

BIBLIOGRAPHY

Anastasi, Anne. Psychological testing. New York, Macmillian, 1954.

Ausburn, L. J. Relationships among cognitive style factors and perceptual types in college students. Unpublished doctoral dissertation, Norman, University of Oklahoma, 1976.

Axelrod, S. and Cohen, L.D. Senescence and embedded figures performance in vision and thought. Perceptual and motor skills, 1961, 12, 283 - 288.

Barratt, E.S. Space visualization factors related to temperament traits. Journal of psychology, 1955, 39, 279-287.

Barrett, G.V., et al. Relation of perceptual style to measures of visual functioning. Perceptual and motor skills, 1967, 25, 235-236.

Berkowitz, L. Leveling tendencies and the complexity-simplicity dimension. Journal of personality, 1957, 25, 743-752.

Bieri, J., et al. Sex differences in perceptual behavior. Journal of personality, 1958, 26, 1-12.

Bieri, J. Cognitive structures in personality. In H.M. Schroder, Personality theory and information processing. New York, Roland, 1971.

Bigelow, S. Field dependence-field independence in 5 to 10 year old children. Journal of educational research, 1971, 64, 397-400.

Blasi, E.R., et al. Effects of field dependence on weight comparisons. Perceptual and motor skills, 1972, 35, 111-114.

Bruner, J., Olver, R.R., and Greenfield, P.M. Studies in cognitive growth. N.Y., Wiley, 1966.

Cattell, R.B. Personality traits associated with abilities II. With verbal and math abilities. Journal of educational psychology, 1945, 35, 475-486.

Debes, J.L. The loom of visual literacy: an overview. Audiovisual instruction, October, 1969, 14, 25-27.

Debes, J.L. Visual literacy. Unpublished seminar paper presented at the University of Oklahoma, 1977.

Fitzgibbons, D., Goldberger, L., and Eagle, M. Field dependency and memory for incidental material. Perceptual and motor skills, 1965, 21, 743-749.

Fruchter, B. Measurement of spatial abilities: history and background. Educational and psychological measurement, 1954, 14, 387-395.

Gagne, R.M. Principles of instructional design. New York, Holt, 1974.

Gardner, R.W. Field dependence as a determinant of susceptibility to certain illusions. American psychologist, 1957, 12, 397.

Gardner, R.W., et al. Cognitive control. Psychological issues, 1959, 1, whole no. 4.

Gardner, R.W. The development of cognitive structures. In C. Scheerer, Cognition: Theory, research, promise. New York, Harper and Row, 1964.

Gardner, R.W., and Lohrenz, L.J. Leveling-sharpening and serial reproduction of a story. Bulletin of the Menninger Clinic, 1960, 24, 295-304.

Gardner, R.W. and Long, R.I. Leveling-sharpening and serial learning. Perceptual and motor skills, 1960, 10, 179-185.

Gardner, R.W. and Long, R.I. The stability of cognitive controls. Journal of abnormal and social psychology, 1960, 61, 485-487.

Gardner, R.W., Jackson, D.N., and Nessick, S.J. Personality organization in cognitive controls and intellectual abilities. Psychological issues, 1960, 2, #8.

Gardner, R.W. and Long, R.I. Field articualtion in recall. Psychological record, 1961, 11, 305-310.

Gerlach, V. and Ely, D. Teaching and media. Englewood Cliffs, N.J., Prentice-Hall, 1971.

Gleitman, H. and Hay, J.C. Effect of instruction on positive time-errors in successive comparison. American journal of psychology, 1964, 77, 286-290.

Gollin, E. and Baron, A. Response consistency in perception and retention. Journal of experimental psychology, 1954, 47, 259-262.

Guilford, J.P. and Park, D.G. Effect of interpolated weights upon comparative judgments. American journal of psychology, 1931, 43, 589-599.

Handbook of chemistry and physics. 48th ed. Cleveland, Chemical Rubber, 1967.

Head, H. Studies in neurology. London, Oxford, 1920.

Helson, H. Adaptation level as frame of reference for prediction of psychophysical data. American journal of psychology, 1947, 60, 1-29.

Helson, H. Adaptation level theory. New York, Harper and Row, 1964.

Holzman, P.S. Cognitive attitudes of leveling and sharpening in time-error assimilation tendencies. Unpublished doctoral dissertation. Lawrence, University of Kansas, 1952.

Holzman, P.S. Relation of assimilation tendencies in visual, auditory, and kinesthetic time-error to cognitive attitudes of leveling-sharpening. Journal of personality, 1953-54, 375-394.

Holzman, P.S. and Gardner, R.W. Leveling and repression. Journal of abnormal and social psychology, 1959, 59, 151-159.

Holzman, P.S. and Klein, G.S. The 'schematizing process': attitudes in sensitivity to change. American psychologist, 1950, 5, 312.

Holzman, P.S. and Lkein, G.S. Cognitive system principles of leveling-sharpening: individual differences in visual time-error assimilation effects. Journal of psychology, 1954, 37, 105-122.

Hurvich, L.M. and Jameson, D. The perception of brightness and darkness. Boston, Allyn and Bacon, 1966.

Kagan, J., et al. Psychological significance of styles of conceptualization. Monographs on Social Research and Child Development, 1963, 28 (2) (Serial no. 86).

Kagan, J., and Kogan, N. Individual variation in cognitive processes. In P. Mussen, Manual of Child Psychology. 3rd ed. N.Y., Wiley, 1970.

Karlin, L. The time-error in the comparison of visual size. American journal of psychology, 1953, 66, 564-573.

Karp, S. Field dependence and overcoming embeddedness. Journal of consulting psychology, 1963, 27, 294-302.

Kazelskis, R. Field independence and the free recall of nonsense syllables. Perceptual and motor skills, 1970, 31, 351-354.

Kind, B. and Brown, D. Time-error and the separation of cognitive systems. Journal of personality, 1966, 34, 569-576.

Klein, G.S. Adaptive properties of sensory functioning: some postulates and hypotheses. Bulletin of Menninger Clinic, 1949, 13, 16-23.

Klein, G.S. Perception, motives and personality. New York, Knopf, 1970.

Klein, G.S. and Schlesinger, H. Where is the perceiver in perceptual theory? In J.S. Bruner and D. Krech, ed. Perception and Personality. New York, Greenwood, 1968.

Köhler, W. Zur Theorie des Sukzessivvergleichs und der Zeitfehler. Psychologische Forschung, 1923, 4, 115-175.

Koester, T. Time-error and sensitivity in pitch and loudness discrimation. Archives of psychology, May, 1945, #297.

Kogan, N. Educational implications of cognitive styles. In S. Lesser, ed. Psychology and educational practice. Glenview, Ill., Scott, Foresman, 1971.

Krathwohl, D.R. and Cronbach, L.J. Suggestions regarding a possible measure of personality: the squares test. Educational and psychological measurement, 1956, 16, 305-316.

Kreezer, G. Neurological level of the factors underlying time-errors. American journal of psychology, 1938, 51, 18-44.

Landau, S.G., et al. Individual differences and reliability of information transmission in absolute judgements of loudness, brightness, and line length. Perceptual and motor skills, 1974, 39, 239-246.

Lauenstein, O. Ansatz zu einer physiologischen Theorie des Vergleichs und der Zeitfehler. Psychologische Forschung, 1932, 17, 130-177.

Lewin, Kurt. A dynamic theory of personality. N.Y., McGraw-Hill, 1935.

Linton, H.B. Dependence on external influence. Journal of abnormal and social psychology, 1955, 51, 502-507.

Long, R.I. Field articulation as a factor in verbal learning and recall. Perceptual and motor skills, 1962, 15, 151-157.

Michael, W.G., et al. Description of spatial-visualization abilities. Educational and psychological measurement, 1957, 17, 185-199.

Nie, N., et al. Statistical package for the social sciences. 2nd ed. New York, McGraw-Hill, 1975.

Piaget, J. The psychology of intelligence. Totowa, N.J., Littlefield, Adams, 1947.

Postman, L. Perception, motivation, and behavior. Journal of personality, 1953, 22, 17-31.

Postman, L. Time-error in auditory perception. American journal of psychology, 1946, 59, 193-219.

Postman, L. and Page, R. Retroactive inhibition and psychophysical judgement. American journal of psychology, 1947, 60, 367-377.

Pratt, C.C. Time-error in psychophysical judgements. American journal of psychology, 1933, 45, 292-297.

Pratt, C.C. Interaction across modalities: successive stimulation. Journal of psycholgoy, 1936, 2, 287-294.

Reichard, S. Mental organization and age level. Archives of psychology, 1944, no. 295.

Rogers, R.A. and Sanders, R.E. Effects of order of presentation and length of viewing time on size estimation. Perceptual and motor skills, 1974, 38, 511-517.

Rosenfeld, J.J. Mathematical ability as a function of perceptual field dependence and certain personality variables. Unpublished doctoral dissertation, Norman, University of Oklahoma, 1958.

Salomon, G. What does it do to Johnny? Viewpoints, 1970, 46, 33-62.

Santostefano, S.G. Developmental study of the cognitive control 'leveling sharpening'. Merrill-Palmer quarterly, 1964, 10, 343-360.

Santostefano, S.G. Cognitive controls versus cognitive styles: Diagnosing and treating cognitive disabilities in children. Seminars in psychiatry, 1969, 1, 291-317.

Santostefano, S.G. Clinical child psychology: a biodevelopmental approach. N.Y., Wiley, In press.

Santostefano, S.G. Personal communication to author. August 15, 1976.

Santostefano, S.G. and Paley, E. Development of cognitive controls in children. Child development, 1964, 35, 939-949.

Sattler, J.M. Assessment of children's intelligence. Philadelphia; Saunders, 1974.

Scheerer, M. Problems of performance analysis in the study of personality. Annals of the New York Academy of Sciences, 1946, 46, 653-678.

Sherif, M., Taub, D., and Hovland C.I. Assimilation and contrast effects of anchoring stimuli on judgements. Journal of experimental psychology, 1958, 55, 150-155.

Staines, J.W. Leveling-sharpening and academic learning in secondary school children. Australian journal of psychology, 1968, 20, 123-127.

Thurstone, L.L. A factorial study of perception. Chicago, University of Chicago, 1944.

Tompkins, S.S. Personality and intelligence: intergration of projective and psychometric techniques. In P.H. Hock and J. Zubin, ed. Relations of psychological tests to psychiatry. New York, Grune and Stratton, 1951.

Tresselt, M.E. Time-errors in successive comparison of tonal pitch. American journal of psychology, 1948, 61, 335-342.

Wachtel, P.I. Cognitive style and style of adaptation. Perceptual and motor skills. 1972, 35, 779-785.

Wallach, H. Some considerations concerning the relation between perception and cognition. In J.S. Bruner and D. Krech, ed. Perception and personality. New York, Greenwood, 1968.

Wapner, S. An organismic-developmental approach to the study of perceptual and other cognitive operations. In C. Scheerer, ed. Cognition: theory, research, promise. New York, Harper, 1968.

Wechsler, D. Manual for the Wechsler Intelligence Scale for Children-Revised. New York, Psychological Corporation, 1974.

Werner, H. and Wapner, S. Sensory-tonic field theory of perception. In J. Bruner and D. Krech, ed. Perception and personality. New York, Greenwood, 1968.

White, B.W. Visual and auditory closure. Journal of experimental psychology, 1954, 48, 234-240.

Witkin, H.A. Individual differences in ease of perception of embedded figures. Journal of abnormal psychology, 1965, 70, 317-336.

Witkin, H.A. Origins of cognitive style. In C. Scheerer, ed. Cognition: theory, research and promise. New York, Harper, 1964.

Witkin, H.A. Psychological differentiation and forms of pathology. Journal of abnormal psychology, 1965, 70, 317-336.

Witkin, H.A. Nature and importance of individual differences in perception. In J. Bruner and D. Krech, ed. Perception and personality. New York, Greenwood, 1968.

Witkin, H.A., et al. Personality through perception. New York, Harper, 1954.

Witkin, H.A., Dyk, R.B., Faterson, H.F., Goodenough, D.R., and Karp, S.A. Psychological differentiation. New York, Wiley, 1962.

Witkin, H.A., Goodenough, D.R. and Karp, S.A. Stability of cognitive style from childhood to young adulthood. Journal of personality and social psychology, 1967, 7 (3), 291-300.

Witkin, H.A., Oltman, P.K., Raskin, E., and Karp, S. Manual for embedded figures tests. Palo Alto, Ca., Consulting Psychologist, 1971.

Wohlwill, J. Developmental studies of perception. Psychological bulletin, 1960, 57, 249-288.

Woodrow, H. Weight discrimination with a varying standard. American journal of psychology, 1933, 45, 391-416.

Woodworth, R.Z. Experimental psychology. New York, Holt, 1954.

APPENDIX A

Krathwohl and Cronbach's Criticism of the Schematizing Test

As indicated in the text (p.62-63), Krathwohl and Cronbach (1956) criticized the scoring method Klein and Holzman used with the Schematizing Test. They particularly critize the method used for computing the accuracy loss score. It is obtained by examining separately the accuracy on the largest stimulus in each set of five (A_5) and the accuracy on the other four (A_1, A_2, A_3, A_4). The AL formula is a weighted combination in which A_5 counts positively and accuracy on the less easily judged stimuli counts negatively. The formula can be written:

$$A.L. = \frac{5A_5 - (A_5 + A_4 + A_3 + A_2 + A_1)}{4}$$

Cronbach says this sizeable disparity in weighting is difficult to defend conceptually as a measure of either acuity or flexibility.

Klein and Holzman's final leveling-sharpening formula is as follows:

$$L.S. = \frac{Acc}{\sigma_{Acc}} + \frac{AL}{\sigma_{AL}} = \frac{Acc}{\sigma_{Acc}} + \frac{5}{4}\frac{A_5 - Acc}{\sigma_{al}}$$

Krathwohl and Cronbach used the Squares Test in a study using undergraduate architecture students. They found that σ_{Acc} was 7 times larger than σ_{al}, yielding a positive weight in the Leveling-Sharpening formula for accuracy in judging the largest stimulus and a small negative weight for accuracy on the other stimuli. Krathwohl and Cronbach say such weighting has no theoretical rationale.

APPENDIX B

TIME-ERROR INSTRUCTIONS

Before we begin this test, print your name at the top of the answer sheet. In this test, I want you to compare 2 lights and tell me if the second one is brighter or dimmer than the first one. On your answer sheet, do you see the columns that say "Brighter" and "Dimmer?" If the second light looks dimmer, circle the word dimmer; if the second light looks brighter, circle the word brighter.

Now I will dim the lights and show you what the test will be like. (Dim lights) First there will be a background light like this (Demonstrate) followed by a short flash of light. (Demonstrate) Do you see the difference? You need to pay very close attention to this short flash of light. It will be followed by the background light again (Show). Then there will be another short light again (Show; raise meter). I want you to compare the 2 short lights.

In each case, decide if the second flash of light is brighter or dimmer than the first light. During the entire test, try to not take your eyes off the screen except to mark your answer sheet. To help you separate the pairs of lights, a long background light will be between them. This long (Demonstrate the 20 second and background light). I will also tell you each time when we are starting a new pair of lights. For example, I will say, "Ready for pair no. 1.)

Let's do one together before you do them by yourself. Use your flashlight so you can see your answer sheet. To turn the flashlight on, move the button on the side of the flashlight upward. For this first one we are doing together, you will be marking your answer in the box in the upper right hand corner labeled "Sample." Has everyone found the box?

Okay. Here is the background light.

Here is the first white light flash. (Move Variac to 6.54 foot-candles).

Here is a second background light which separates the 2 lights you are to compare.

Here is the second light flash. (Move variac to 3.25 footcandles.)

Was the second light brighter or dimmer than the first one?

(Dimmer). Right. And so you should circle the word "Dimmer" in the square. If the second lights had been brighter, you should circle the word "Brighter."

Remember, each time you judge whether the second light flash (second white light) is brighter or dimmer than the first one.

All right, let's begin.

LIGHT COMPARISON ANSWER SHEET

Name____

School____

Sample	
Brighter	Dimmer

1.	Brighter	Dimmer	19.	Brighter	Dimmer
2.	Brighter	Dimmer	20.	Brighter	Dimmer
3.	Brighter	Dimmer	21.	Brighter	Dimmer
4.	Brighter	Dimmer	22.	Brighter	Dimmer
5.	Brighter	Dimmer	23.	Brighter	Dimmer
6.	Brighter	Dimmer	24.	Brighter	Dimmer
7.	Brighter	Dimmer	25.	Brighter	Dimmer
8.	Brighter	Dimmer	26.	Brighter	Dimmer
9.	Brighter	Dimmer	27.	Brighter	Dimmer
10.	Brighter	Dimmer	28.	Brighter	Dimmer
11.	Brighter	Dimmer	29.	Brighter	Dimmer
12.	Brighter	Dimmer	30.	Brighter	Dimmer
13.	Brighter	Dimmer	31.	Brighter	Dimmer
14.	Brighter	Dimmer	32.	Brighter	Dimmer
15.	Brighter	Dimmer	33.	Brighter	Dimmer
16.	Brighter	Dimmer	34.	Brighter	Dimmer
17.	Brighter	Dimmer	35.	Brighter	Dimmer
18.	Brighter	Dimmer			

PROCEDURE FOR COMPUTING TIME-ERROR

I. Transfer each subject's (S's) responses from the answer sheet directly to the work sheet shown below. Record each response as a + or a -, depending on whether she judges the second stimulus (comparison stimulus) as brighter or dimmer. Comparison stimuli are presented in random order within rows, as numbers in parenthesis show. Then total the number of + responses for each stimulus value and compute the proportion of +'s (p+) for each stimulus value by dividing by the number of trials per stimulus value (=7).

Row	Comparison Stimulus in Foot candles				
	3.27	4.90	6.54	8.17	9.81
1	(1)	(4)	(2)	(5)	(3)
2	(8)	(10)	(6)	(9)	(7)
3	(15)	(14)	(13)	(12)	(11)
4	(17)	(16)	(18)	(20)	(19)
5	(22)	(24)	(21)	(25)	(23)
6	(27)	(26)	(30)	(29)	(28)
7	(33)	(31)	(34)	(32)	(35)

II. Construct an s-x-z-xz table, in which x = standard deviation units around the mean of 6.54 (-2, -1, 0, +1, +2). Convert the p+ values to standardized z scores for each stimulus value by referring to a p+ to z chart on page 206 of Woodworth (1954) and multiply x and z values. Then sum z and xz columns. See following page.

s	x	z	xz
3.27	-2		
4.90	-1		
6.54	0		
8.17	+1		
9.81	+2		

III. Ascertain mean interval between stimuli (i=1.635) and Av s (Av s = 6.54)

IV. When n=5 (n= number of stimulus values), Woodworth offers these formulas:

$$SD = \frac{10}{\Sigma xz} (i)$$

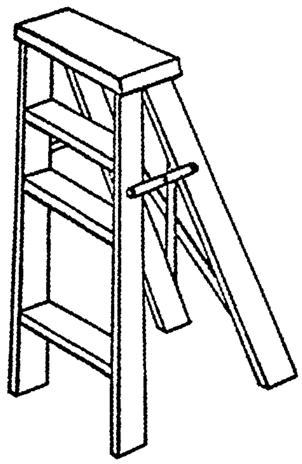
$$M = s_0 \frac{-2 (\Sigma z) (i)}{\Sigma xz}$$

V. M = PSE (Point of Subjective Equality, or the S's mean judgement)

VII. Te = PSE St (St = 6.54)

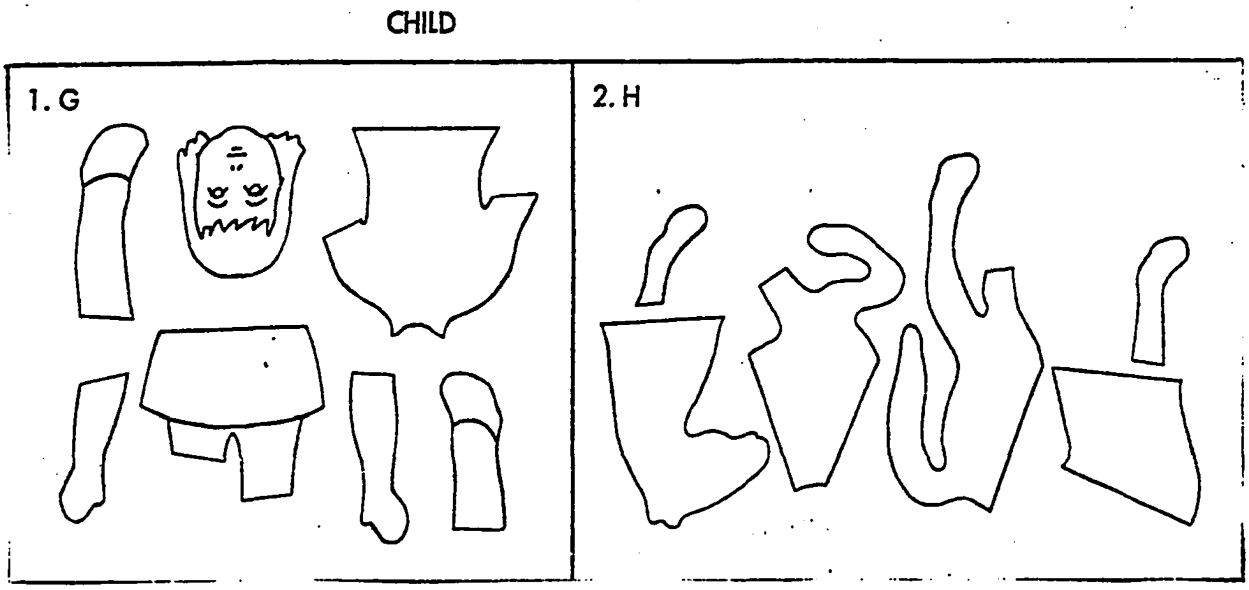
APPENDIX C

9

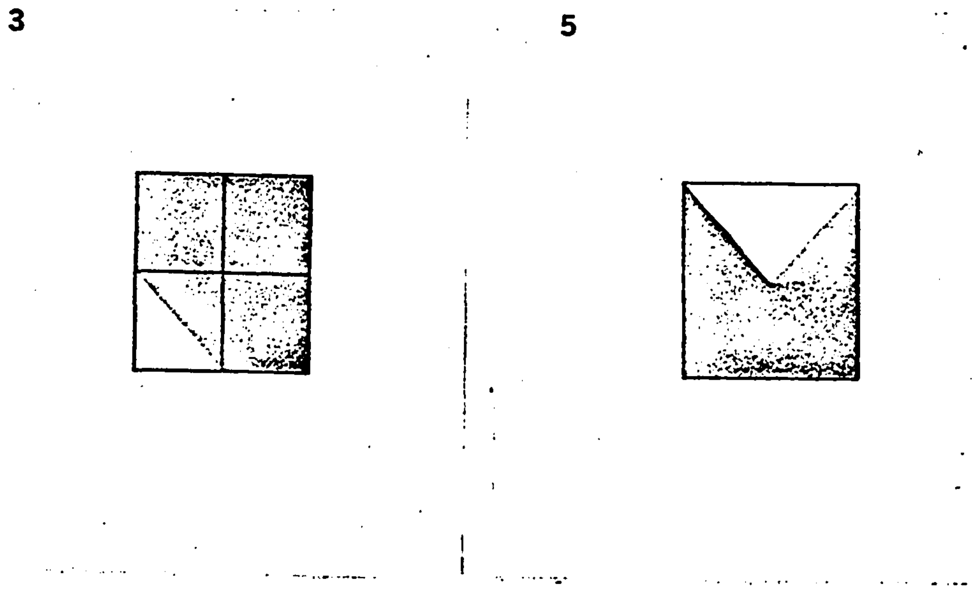


15

Samples from WISC-R, Picture Completion Subtest (Wechsler, 1974)



Samples from WISC-R, Object Assembly Layout Shield. (Wechsler, 1974).



Samples from WISC-R, Block Design Subtest. (Wechsler, 1974).

APPENDIX D

EXAMINER'S INSTRUCTIONS TO SUBJECTS FOR ADMINISTERING GROUP EMBEDDED FIGURES TEST

(The following instructions appear in the test booklet for the Group Embedded Figures Test, designed by P. Oltman, E. Raskins and H. Witkin, Consulting Psychologists Press, 1971.) The examiner read through the instructions aloud with the subjects. Phrases in parentheses indicate phrases used by the examiner but which did not appear in the test booklet.

This is a test of your ability to find a simple form when it is hidden within a complex pattern. (It is something like the games you may have played in Highlights, in which you try to find hidden objects, like animals hidden in a forest.)

Here is a simple form which we have labeled "X": This simple form, named "X", is hidden with the more complex figure below....Try to find the simple form in the complex figure and trace it in pencil directly over the lines of the complex figure. It is the SAME SIZE, in the SAME PROPORTIONS, and FACES IN THE SAME DIRECTION within the complex figure as when it appeared alone.

When you finish, turn the page to check your solution. This is the correct solution, with the simple form traced over the lines of the complex figure:

Note that the top right-hand triangle is the correct one; the top left-hand triangle is similar, but faces in the opposite direction and is therefore not correct.

Now try another practice problem. Find and trace the simple form named "Y" in the complex figure below it.

In the following pages, problems like the ones above will appear. On each page you will see a complex figure, and under it will be a letter corresponding to the simple form which is hidden in it. For each problem, look at the back cover of this booklet to see which simple form to find. (Let's all turn over our test booklet to the back cover. Does everyone see the simple forms, labeled A through H? Fine. Now, let's all return to page 3). Then try to trace it in pencil over the lines of the complex figure. Note these points:

1. Look back at the simple forms as often as necessary.
2. Erase all mistakes. (This is very important. Also be sure you have outlined all the lines of the simple figure.)
3. Do the problems in order. Don't skip a problem unless you are absolutely "stuck" on it.
4. Trace only one simple form in each problem. You may see more than one, but just trace one of them.
5. The simple form is always present in the complex figure in the same size, the same proportions, and facing in the same direction as it appears on the back cover of this booklet.

Are there any questions? ...... All right, you may begin.

SIMPLE FORMS AND EXAMPLES OF COMPLEX FORMS

GROUP EMBEDDED FIGURES TEST

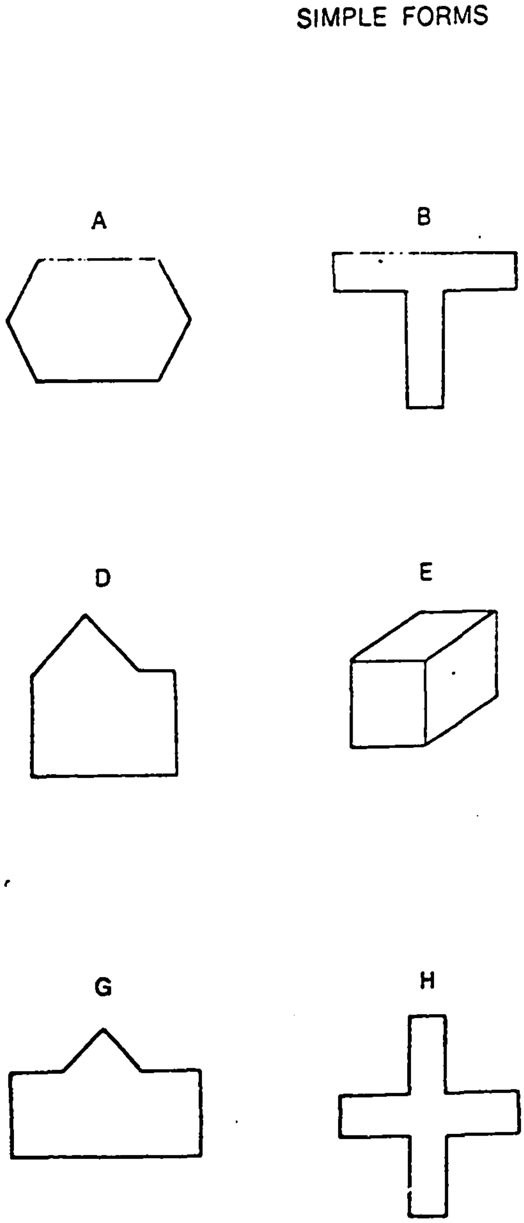
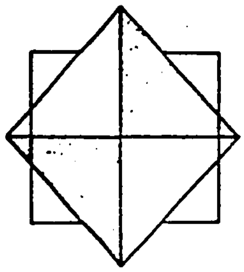


Figure 9. Simple Forms in the Group Embedded Figures Test. (Oltman, P.K., Raskin, E., and Witkin, H. Group Embedded Figures Test. Consulting Psychologists Press, 1971.)

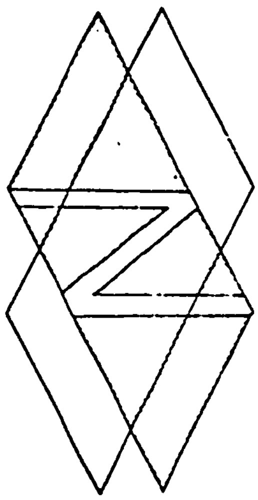
SECOND SECTION

1



Find Simple Form "G"

2



Find Simple Form "A"

Go on to the next page

13

Figure 10. Examples of Complex Forms in Group Embedded Figures Test. (Oltman, P.K., Rasin, E., and Witkin, H. Group Embedded Figures Test. Consulting Pyschologists Press, 1971.)

APPENDIX E

EXAMINER'S INSTRUCTIONS TO SUBJECT FOR ADMINISTERING LEVELING-SHARPENING HOUSE TEST

This is a test of your ability to remember a picture and to figure out how it changes. I will show you a picture. Look at it for a short time as carefully as you can so that you can remember as much as you can about it. Then I will take it away and show you another picture. When I show you a new picture, look carefully at it and tell me if the picture looks the same or whether anything has changes.

Now look carefully at this picture of a Christmas tree. Try to remember all of the picture (SHOW PRACTICE PICTURE 1 for 5 SECONDS). Now I will show you another picture of the Christmas tree. Look at it carefully. If this picture is different from the first one, say STOP and then tell me what is different from the first one. If there is nothing different, you don't have to say anything. (SHOW PRACTICE PICTURE 2 FOR 5 SECONDS.)

Let's continue with several practice pictures. Remember to say STOP any time you see that any picture is different from that first picture you saw. Then tell me what is different in the picture. If you can't think of the name of the object that has changed, you may point to it. You do not need to report a change more than once. Do you have any questions? (SHOW PRACTICE PICTURES 3 THROUGH 6 FOR 5 SECONDS EACH.)

Do you have any questions?

Now we'll begin the test pictures. I'll show you these pictures one at a time for a short time. Look at the picture as carefully as you can as long as it is in front of you. After you see the first picture, if any of the other pictures look different or something looks like it has changed, say STOP. Then either tell me what has changed or point to it in the picture. If the picture looks the same, you don't have to say anything. Remember, sometimes the pictures will look the same, and sometimes they will look different. Are you ready to begin?

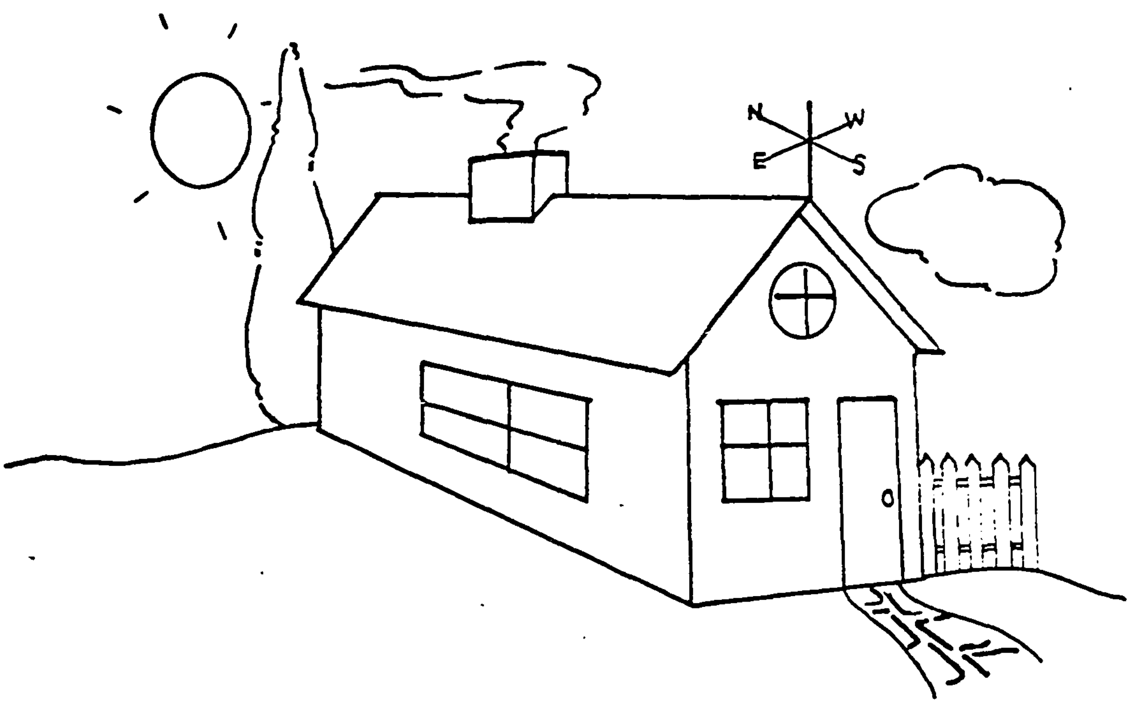


Figure 11. Sample drawing from Leveling-Sharpening House Test. Drawing 1, Against Which All Other Pictures Are To Be Compared. (S. Santostefano, Leveling-Sharpening House Test.)

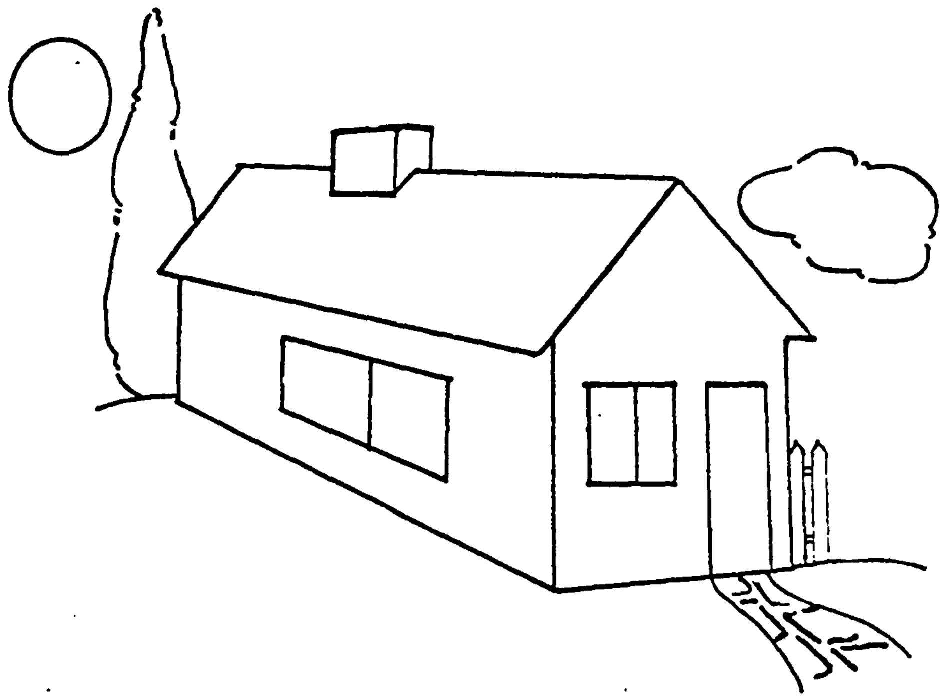


Figure 12. Sample drawing from Leveling-Sharpening House Test. Drawing 46, in which Many Details Have Been Omitted. (S. Santostefano, Leveling-Sharpening House Test,)

APPENDIX F

Table 18

RAW SCORES OBTAINED BY 10 YEAR OLD SUBJECTS

SUBJECT NUMBER	ANALYTICAL ABILITY	PICTURE COMPLETION	BLOCK DESIGN	OBJECT ASSEMBLY	PICTURE ARRANGEMENT	CODING	LSHT	GEFT	TIME-ERROR
1	13.66	14	11	16	11	15	12.36	05	- .97
2	12.33	12	13	12	17	14	3.63	09	- .51
3	11.33	09	12	13	15	14	11.31	14	+ .41
4	8.0	07	09	08	09	10	12.05	02	+1.18
5	11.66	10	12	13	12	13	13.68	07	+ .81
6	10.0	09	10	11	08	08	7.26	03	- .61
7	10.66	07	13	12	10	08	17.56	11	- .28
8	8.33	09	08	08	08	15	13.73	02	-2.66
9	9.66	10	09	10	06	08	12.15	06	+ .45
10	7.66	07	10	06	16	14	9.15	02	- .16
11	11.33	13	09	12	11	09	3.68	01	- .01
12	15.33	12	16	18	13	17	12.89	12	+ .37
13	13.33	12	14	14	12	17	9.21	09	- .27
14	12.66	15	11	12	15	12	4.1	05	- .49
15	9.0	11	07	09	06	12	12.63	02	- .73

RAW SCORES OBTAINED BY 10 YEAR OLD SUBJECTS

SUBJECT NUMBER	ANALYTICAL ABILITY	PICTURE COMPLETION	BLOCK DESIGN	OBJECT ASSEMBLY	PICTURE ARRANGEMENT	CODING	LSHT	GEFT	TIME-ERROR
16	10.0	08	09	13	13	12	11.68	05	- .42
17	9.66	10	09	10	13	11	13.84	05	- .26
18	8.00	09	06	09	12	09	7.63	02	+ .03
19	11.33	11	11	12	11	12	16.47	08	- .52
20	13.00	16	12	11	16	11	12.21	03	- .73
21	11.33	12	13	09	09	07	15.05	09	-1.44
22	15.0	13	17	15	15	12	8.15	11	- .30
23	14.33	12	15	16	13	14	7.63	11	- .66
24	10.33	11	11	09	14	09	8.78	02	- .29
25	11.33	11	14	09	11	07	17.15	09	+ .20
26	10.66	12	10	10	11	11	14.73	09	- .59
27	9.66	08	10	11	11	08	10.26	06	+ .44
28	9.0	07	12	08	07	12	14.10	03	-1.41
29	9.66	13	08	08	11	09	13.84	01	-1.05
30	8.33	11	03	11	11	08	11.31	00	- .55

SUBJECT NUMBER	ANALYTICAL ABILITY	PICTURE COMPLETION	BLOCK DESIGN	OBJECT ASSEMBLY	PICTURE ARRANGEMENT	CODING	LSHT	GEFT	TIME-ERROR
31	16.0	18	16	14	16	16	9.63	15	- .55
32	12.0	11	13	12	11	11	15.42	05	- .11
33	13.33	16	11	13	11	11	13.63	04	- .30
34	11.66	14	12	09	14	15	9.26	06	+ .17
35	8.0	07	11	06	07	05	16.36	01	-1.79
36	11.66	12	09	14	13	06	14.05	03	-1.72
37	11.0	10	13	10	09	13	8.78	15	- .04
38	13.33	10	15	15	14	15	14.05	18	- .01
39	14.33	16	14	13	14	13	10.31	12	- .76
40	13.0	13	14	12	12	06	15.73	16	-1.60

RAW SCORES OBTAINED BY 13 YEAR OLD SUBJECTS

SUBJECT NUMBER	ANALYTICAL ABILITY	PICTURE COMPLETION	BLOCK DESIGN	OBJECT ASSEMBLY	PICTURE ARRANGEMENT	CODING	LSHT	GEFT	TIME-ERROR
41	9.00	08	09	10	11	11	11.47	08	+ .70
42	13.33	13	13	14	13	11	10.05	18	-2.44
43	11.0	13	10	10	09	10	15.26	06	-1.23
44	10.66	09	11	12	12	10	12.47	07	- .61
45	13.66	11	13	17	13	08	16.05	14	-1.23
46	12.0	11	12	13	11	08	15.0	09	- .91

SUBJECT NUMBER	ANALYTICAL ABILITY	PICTURE COMPLETION	BLOCK DESIGN	OBJECT ASSEMBLY	PICTURE ARRANGEMENT	CODING	LSHT	GEFT	TIME-ERROR
47	10.0	09	11	10	09	10	11.68	09	- .49
48	11.33	11	11	12	11	13	8.52	10	+ .31
49	8.7	08	08	10	10	10	6.57	05	-1.07
50	11.66	15	11	09	11	07	12.31	06	- .47
51	11.33	11	10	12	11	11	12.15	07	-1.26
52	9.0	09	10	08	12	10	8.00	10	- .05
53	10.33	08	10	13	08	16	19.0	09	- .39
54	11.66	10	11	14	10	11	13.94	10	- .54
55	10.0	09	11	10	08	12	13.78	11	+ .35
56	13.66	15	12	14	09	09	11.89	13	- .22
57	17.0	17	19	15	14	15	14.42	11	- .39
58	7.33	07	07	08	10	10	16.84	03	- .95
59	7.0	08	06	07	08	14	18.0	01	- .03
60	14.66	17	10	17	17	14	8.63	08	- .40
61	8.66	07	10	09	07	08	8.15	03	+ .29
62	9.66	10	09	10	07	09	6.52	08	- .97
63	11.0	10	11	12	12	16	15.89	07	+ .35

SUBJECT NUMBER	ANALYTICAL ABILITY	PICTURE COMPLETION	BLOCK DESIGN	OBJECT ASSEMBLY	PICTURE ARRANGEMENT	CODING	LSHT	GEFT	TIME-ERROR
64	12.33	10	14	13	14	19	11.52	13	+ .49
65	10.66	10	10	12	15	11	9.21	07	- .13
66	9.33	06	12	10	08	11	18.26	14	- .59
67	10.66	09	10	13	12	13	11.68	04	+ .23
68	12.0	11	14	11	11	12	16.42	13	+ .18
69	12.33	11	12	14	13	10	14.68	11	- .24
70	11.33	15	11	08	16	11	11.52	08	-1.76
71	9.66	09	10	10	08	10	11.47	06	- .03
72	10.33	07	12	12	10	12	8.52	06	- .11
73	10.33	07	13	11	12	13	18.21	03	+ .31
74	12.33	13	12	12	14	13	14.78	11	+ .09
75	11.66	13	10	12	09	10	15.68	09	- .36
76	7.66	08	08	07	09	09	15.78	02	- .13
77	9.66	09	09	11	10	11	6.21	06	- .03
78	15.66	15	17	15	15	15	7.89	12	- .11
79	11.33	09	14	11	16	11	9.21	13	- .07
80	14.33	15	12	16	12	15	12.15	08	- .01