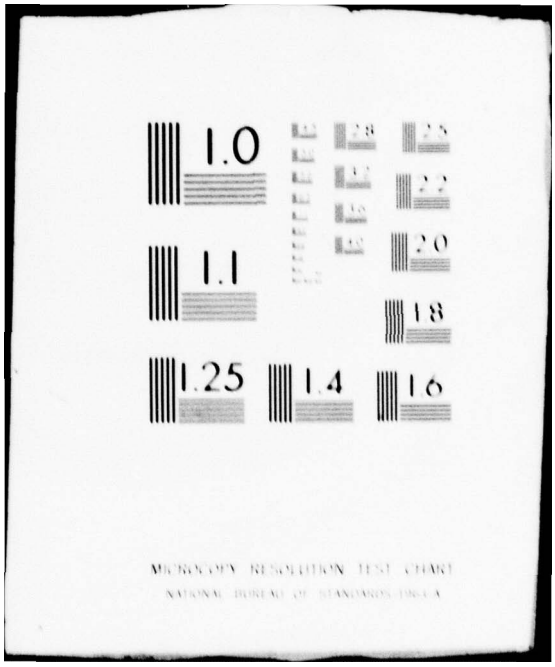
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COGNITIVE STYLES:
A REVIEW OF THE LITERATURE

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May 1979
Interim Report for Period January 1977 – January 1978

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This report has been reviewed by the Information Office (OI) and is releasable to the National Technical Information Service (NTIS). At NTIS, it will be available to the general public, including foreign nations.

This technical report has been reviewed and is approved for publication.

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The study reported herein is basic research which may be of interest only to a limited audience. Volume II of this report contains an extensive bibliography of literature concerned with cognitive styles.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

breadth of categorization	field dependence-independence	scanning-focusing
cognitive complexity-simplicity	impulsivity-reflectivity	technical training
cognitive styles	learning styles	tolerance for unrealistic experiences
conceptualizing style	leveling-sharpening	visual-haptic style
distractibility	perceptual styles	

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A review of the literature to identify the various cognitive style constructs and the instruments used to measure them was completed. Each was evaluated with specific attention to possible relationships to Air Force technical training. Ten cognitive styles were selected for an in-depth summary of the state of the art, with special attention given to those that gave most promise for use.

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INTRODUCTION

Individual differences that occur among learners are of much concern to organizations that deliver training. In designing and conducting training, many of these organizations, including Air Force, have attempted to provide for these individual differences by developing individualized instruction through such means as programmed instruction, automated media packages, and computer-assisted instruction. While often providing for differences in interest, ability, and personality dimensions, these techniques do not typically address differences on the dimension of learning styles or cognitive styles. These cognitive (learning) styles represent a group of individual difference variables that, although extensively investigated, have been incorporated into instructional practices only to a minor degree. Cognitive styles, which are the subject of this review of the literature, generally represent the manner in which an individual receives, processes and uses information. This literature review will attempt to cover the ten most prominent of these cognitive styles by reviewing the research literature of each style, reviewing and evaluating the instruments used to assess each style, and identifying the styles that hold the most promise for research and application to Air Force technical training. Following is an overview of each of the styles in the order of their presentation in the text:

1. Field dependence-field independence. an analytic as opposed to global manner of perceiving. Field independence reflects the ability to perceive visual stimuli as separate from an embedded context.

2. Impulsivity-reflectivity: individual differences in speed and errors when faced with response uncertainty. Reflective subjects consider the hypotheses longer and are usually correct upon choosing a response; impulsive individuals tend to select the first response that occurs to them and are usually incorrect.

3. Visual-haptic: the visual perceptual type is said to use his or her eyes as the primary sensory intermediaries, while the haptic is said to use his or her eyes only when necessary and relies mainly upon kinesthetic and body orientation.

4. Leveling-sharpening: individual differences in assimilation in memory. Levelers tend to incorporate new ideas with old memories, and blur the original image; sharpeners can add new ideas as well as holding on to the old image.

5. Constricted-flexible control: individual differences in reference to susceptibility to distraction.

6. Breadth of categorization: an individual's preference for broad versus narrow categorization.

7. Scanning: an individual difference reflected in extensiveness and intensity of attention deployment.

8. Tolerance for unrealistic experiences: individual differences in willingness to accept perceptions which are at variance with normal experiences.

9. Cognitive complexity-simplicity: differences in individuals' tendency to construe the world in a multi-dimensional and discriminating manner.

10. Conceptualizing styles: individual differences in categorization of stimuli with perceived similarities or differences; utilization of consistent conceptualization approaches in concept formation.

Investigations by various researchers have resulted in the identification and elucidation of these individual difference variables referred to collectively as cognitive styles. As mentioned, these cognitive styles are psychological dimensions which represent consistencies in an individual's manner of acquiring and processing information. For this reason, individuals may encounter tasks that require processing of information in a way that they are unable to accomplish, simply because their cognitive style restricts the availablity of the necessary processing techniques. The following review will explore the research literature of each cognitive style with this prospect in mind, particularly with respect to problems that might affect Air Force technical training.

COGNITIVE STYLES

Field dependence-independence

Of all the cognitive styles considered in this literature review, none has been more thoroughly investigated, nor provided more heuristic value, than the cognitive style of field dependence-independence. The extensive work by Witkin and his colleagues over the past 30 years (e.g., Witkin, 1949, 1950a, 1950b, 1952, 1959; Witkin, Lewis, Hertzman, Machover, Meissner, & Wapner, 1954; Witkin, Dyk, Faterson, Goodenough, & Karp, 1962; Witkin & Goodenough, 1976a,b; Witkin, Moore, Goodenough, & Cox, 1977) has provided an almost overwhelming amount of information concerning this cognitive style construct.

The original studies were developed to determine how individuals orient themselves in space or how they perceive the upright (Witkin & Asch, 1948a, 1948b; Witkin, 1949, 1950b, 1952). In these experiments, two sets of experiences were investigated in relation to these perceptions. One set of experiences involved the visual field surrounding the individual, with particular attention to the horizontal and vertical cues that aid in determination of upright. The other experience is that of kinesthetic cues from the pull of gravity on the body which give constant feedback as to the posture and balance of the body. It is the combination of these two factors that normally gives an individual a perception of the true upright in space. In the investigation of Witkin and his associates, however, these two standards were separated experimentally to provide a better understanding of the perception of uprightness. This separation of sensations was accomplished primarily by the use of two experimental techniques. The first technique is referred to as the Body-Adjustment Test (BAT). The BAT requires an individual who is seated in a small room to adjust his body to true upright when both his chair and the room are tilted in various directions. In the second experimental situation, an individual is seated in a completely darkened room and asked to adjust to true upright a luminous rod that is surrounded by a luminous frame. This task, the Rod and Frame Test (RFT), requires the individual to adjust the rod to true upright while ignoring a tilted visual frame that surrounds it. A less often used technique, the Rotating Room Test (RRT), separates the visual and kinesthetic standards for uprightness by modifying the pull of gravity through centrifugal force. A person seated in a

chair which can be adjusted with regard to angle of uprightness is rotated around a tract from which an upright room is viewed. The subject must adjust his body to what he considers the true upright.

All of these techniques accomplish essentially the same thing: that is, they change the usual relationship between an individual's visual and kinesthetic cues. It was this study of the conflict between the cues that uncovered wide individual differences in the way individuals perceive. Some individuals relied primarily on the visual field to judge uprightness while others used primarily impressions from their body to make their judgements. Of further importance was the fact that an individual is self-consistent with regard to these tests; that is, one's degree of reliance on either body or visual field remained constant across all of the tests (Witkin, 1959). It was this dependence or lack of dependence on the visual field that resulted in formulation of the perceptual constructs field dependence (FD) and field independence (FI).

Later studies were performed to investigate whether these self-consistencies would carry over into other perceptual situations where perception of the upright was not involved. A new task was developed that did not involve a conflict between bodily and visual cues, but, instead, the disembedding of an item from an organized visual field. It is called the Embedded-Figures Test (EFT) (Witkin, 1950a; Witkin, Oltman, Raskin, & Karp, 1971) and requires the subject to find a relatively simple geometric figure. It was found that individuals who were most affected by the visual field in the RFT and BAT (that is, who are field dependent) had difficulty in finding the simple embedded figure. Likewise, people who were most affected by their body position on the RFT and BAT (that is, who were field independent) found the simple figures rather easily. Witkin et. al. (1954; 1962; 1971) suggests that this difference is due to the ability (or lack of ability) to overcome the influence of the organized complex design in locating the simple one (or overcoming an embedding context). This field-dependence-independence dimension was further described as involving a perceptual analytical ability which was apparent throughout an individual's perceptual functioning and constitutes his "perceptual style." It should be noted that these perceptual styles are considered relative, since the field dependent-independent dimension is a continuum with individuals placed somewhere between extremes; that is, being relatively field dependent or

relatively field independent.

Witkin et al. (1954, 1962) in their studies have consistently found sex-related differences, with males being more field-independent than females. Also, a clear age-related change has been shown with a continuous increase in field-independence as a person's age increases from about 8 to 15, with a distinct leveling off to a plateau in early adulthood. Additionally, there seems to be a marked decline in field independence as a person reaches "old age" (Witkin et al., 1971). One aspect of these changes, however, is that an individual's position relative to his same-age group remains stable throughout his developmental years.

Most of the studies in this area have operationally defined field dependence-independence according to the two main perceptual tasks, the Rod and Frame Test or the Embedded Figures Test, or the two tests used together (Witkin et al., 1954, 1962).

The results of correlational studies between the two tests have been varied, with some investigators reporting low correlations and others reporting high correlations. However, Long (1972) suggests the most commonly reported correlations are somewhere between the two extremes (about .50). Several investigators have questioned the methodologies used to study field dependence. They have pointed out such problems as reliance upon extreme scores rather than on standardized criteria of field dependence-independence (Stansell, Beutler, Neville, & Johnson, 1975), questions of equivalence of results due to using different forms of the RFT and EFT (Long, 1972), variations in administering the RFT (such as differences in allowable light level in the RFT room, differences of head positions, differences in instructions given, and differences between experimenter- and subject-operated apparatus), as well as many other procedural and validity problems (Adevai, Silverman, & McGough, 1968; Elliot, 1961; Grosse & Moore, 1970; Gruen, 1957; Handel, 1972; Lester, 1968, 1969; Silverman, & King, 1970; Vaught, 1968; Vernon, 1972).

The Embedded Figures Test has been expanded with many different available forms. In addition to the original form developed by Witkin in 1950, the following tests are currently available: Jackson's shortened form (1956): a set of five different forms including a Group Embedded Figures Test (GEFT) and colored forms developed by Jackson,

Messick, and Myers (1964); the Group Hidden Figures Test (HFT) developed by French, Ekstrom, and Price (1963); and the Children's Embedded Figures Test (CEFT) by Witkin et al. (1971). The use of many different measuring instruments and thus different operational definitions for the constructs of field dependence-independence is a problem that must be resolved if future research results are to be comparable across studies.

Several different forms of the EFT have been devised to test competence at disembedding in other than visual sense modalities. A Tactile Embedded Figures Test (Axelrod & Cohen, 1961) as well as a Tactile Rod and Frame Test (Walker, 1972) has been developed. White (1954) has developed an auditory version of the EFT, but other researchers report that their efforts have been somewhat less successful than his (Lackey, 1971; Stansell, 1974). These studies seem to indicate that the styles observed in the visual task may indeed carry over intact to other sense modalities. Witkin (Witkin et al., 1962), in evaluating evidence accumulated over the years, indicates that not only perceptual phenomena but also intellectual activities may be involved in the field dependence-independence dimension. He assumed that the same tendencies that occur in a person's perception of stimulus configurations might also appear in the person's dealings with symbolic representations such as in problem solving. Witkin et al. (1971) report several studies in which relationships were found between performance on the EFT, BAT, and RFT and in problem-solving tasks where the solution depends on isolating an essential element from the context in which it is presented and using it in a different context. Also, factorial studies (Goodenough & Karp, 1961; Karp, 1963) have shown that tests of field-dependence seem to load on the "analytical factors" of the Wechsler Test (Wechsler Analytical Triad--WAT) which is made up of Block Design, Object Assembly, and Picture Completion subtests. These subtests seem to require a task of separating an item from its organized context. Additionally, there was only a low relationship between the EFT scores and the other two Wechsler subtests of verbal-comprehension and attention-concentration. This indicated that low-order relationships between field dependence and IQ scores found in previous studies were probably due to the relationship of field dependence to only the analytical triad and not to an overall Wechsler intelligence score (Goodenough & Karp, 1961).

As the stylistic tendencies first observed in perceptual tasks were being extended into the intellectual domain, Witkin (Witkin et al., 1962) renamed his perceptual styles cognitive styles. He designated the extremes of the field dependence-independence perceptual dimension as articulate versus global dimensions of cognitive functioning. Individuals who were found to be relatively field independent perceptually were found also to experience their world in an articulate fashion when dealing with problem-solving tasks. They can separate items from their background in organized fields and tend to actively impose structure on an inherently unorganized field in order to solve problems. Articulate cognitive functioning, therefore, includes both analysis and structuring in both perceptual and intellectual activities. Global cognitive functioning, on the other hand, represents a more passive manner of dealing with the field, accepting it "as is" with limited analytical and structuring abilities in both perceptual and intellectual activities (Witkin et. al., 1977).

The next theoretical step taken by Witkin et al. (1962) was the development of the Psychological Differentiation Theory. This theory resulted from increased research in many different areas. The dimension of relatively greater or lesser differentiation in a person's psychological functions paralleled and replaced the articulate-global cognitive style dimension. Definition of this broader psychological dimension was the result of studies dealing with the relationship between cognitive styles and various other psychological dimensions. One such dimension was that of body concept. Field-independent individuals were found to have a more articulate body concept, with definite limits and boundaries, while field-dependent persons had a more global body concept with less awareness of body as distinct and structured. Investigators found that, when measured on a scale of body articulation, the figure drawings of subjects (such as the Draw-a-Person Test) could be related to field dependence (Witkin et al., 1962; Witkin et al., 1971), with individuals who scored higher on body articulation being relatively more field independent.

Another psychologically related area is that of sense of separate identity, with an articulate cognitive style being associated with a more pronounced sense of separate identity. More global individuals have a less pronounced sense of separate identity and rely more heavily on the views of others for their sense of self, their attitudes, and their sentiments (Witkin et al., 1962, 1971).

The relationship between cognitive style and type of defense mechanisms employed has also been extensively investigated (Witkin et al., 1962, 1971; Witkin, 1965). Results have shown that individuals who are more toward the global end of the dimension tend to use less specialized defenses such as repression and denial (Witkin et al., 1962, 1971; Witkin, 1965).

Witkin's Theory of Psychological Differentiation (Witkin et al., 1962) thus includes four main areas of differentiation. The first is the articulate-global dimension, both in perceptual and intellectual functioning. The second consists of the degree of articulation of body concept. Next is the sense of separate identity, and fourth, the degree of specialization of the defense structures.

More recent research has caused Witkin and his coworkers (1976) to again modify their theory. In this newer version, differentiation is divided into three main subsections: segregation of psychological functions, segregation of neurophysical functions, and self-nonself segregation. The self-nonself segregation is further divided into restructuring abilities and autonomy in interpersonal relations. Research has found wide differences in people from different ends of the differentiation continuum in their ability to function in each area.

The "segregation of psychological functions" component of the older version of the differentiation theory was carried over very much intact to the new theory. The indicators of this function, as mentioned previously, include body concept, with field independents exhibiting a more articulate body concept; nature of defense mechanisms employed, with field independents using specialized defenses (such as isolation and projection) and field dependents using less specialized defenses (such as repression and denial); and control over impulse expression, with field independents exhibiting more control of impulses (Witkin & Goodenough, 1976a&b).

With regard to the segregation of neurophysiological functions, the theory indicates that the differentiation exhibited in psychological functioning should also be evidenced in neurophysiological functioning. The cerebral cortex would be the center for this segregation, with each hemisphere in a more differentiated individual showing more specialization of functions than in a less differentiated individual. The result of this specialization would be

greater lateralization of verbal functions in the left hemisphere and greater lateralization of configured processing in the right hemisphere. Empirical results seem to confirm this hypothesis in several instances. Research has indicated that when compared to field-dependent persons, field-independent individuals have a right ear advantage in dichotic listening tasks (Pizzamiglio, 1974). This reflects a greater specialization of verbal functioning in the left hemisphere where this function is normally found. Also, studies that have compared functions in the left and right visual hemispheres by means of tachistoscopic presentations of letters and faces found field-independent individuals to have better performance in one hemisphere over the other in certain tasks, (e.g. right-hemisphere advantage for face discrimination and left-hemisphere advantage in reaction time to letters) which indicates greater brain lateralization. No differences between hemispheres were found for field-dependent individuals (Witkin & Goodenough, 1976b). Further evidence for greater lateralization is the finding that right-handed individuals are more field-independent than left-handed or ambidextrous persons. It has been generally found that right-handed individuals are more strongly lateralized than are the other two groups (Adevai, Silverman, & McGough, 1968; Pizzamiglio, 1974).

The third area of segregation of functions is that of self-nonself. The self is segregated from the nonself when the individual begins to become aware of the distinctiveness "between characteristics, desires, and emotions that are one's own and those belonging to another," (p. 21). The self-nonself dichotomy involves psychological functioning in which one relies on the self as a primary referent as opposed to on the external field as that referent. This difference in referents affects an individual's ability to function autonomously in interpersonal relations and also the manner in which information about surroundings is processed. Individuals from the field-independent extremes of the continuum may restructure the information from the surroundings, while the field-dependent individual who is reliant on external referents would accept the information according to the dominant properties of the field. Thus the two subsections of self-nonself segregation are autonomy in interpersonal relations and restructuring ability (Witkin & Goodenough, 1976b).

Autonomy in interpersonal relations involves more than just independence of external social referents and affects other aspects of social functioning. Witkin & Goodenough

(1976a) review many studies in this regard and summarize them by describing the relatively field-dependent person as having the following attributes: "like being with others, sociable, gregarious, affiliation oriented, socially outgoing, prefer interpersonal and group to intrapersonal circumstances, seek relations with others, show participativeness, show need for friendship, interested in people, want to help others, have a concern for people, have wide acquantanceship, know many people and are known to many people" (p. 24). Thus, field-dependent individuals tend to be more attentive to social sources of information and to take others' points of view into account before forming opinions more than do field-independent individuals. They are better at remembering faces of people they have previously encountered and have better recall for incidental social words. Field-dependents actually prefer to be physically closer to those with whom they interact, and more readily make their feelings known to others. In addition to being better liked by others, field-dependent individuals seem to work more effectively in conflict resolution situations. Field-independent individuals, on the other hand, are less effective at social skills and are described as having the following attributes: "prefer solitary activities, individualistic, cold and distant in relations with others, aloof, never feel like embracing the whole world, not interested in humanitarian activities, value cognitive pursuits, concerned with philosophical problems, concerned with ideas and principles rather than people, task oriented, have work-oriented values such as efficiency, control, competence, excelling" (p. 25). Field-independent individuals thus seem to pay less attention to social cues and to social sources of information.

As might be expected these differences in abilities with regard to social skills carry over into educational/vocational interest, choices, and achievement (Arbuthnot & Gruenfeld, 1969; Zytowski, Mills & Paepe, 1969). Witkin et. al. (1977) indicate that:

> As a general principle, relatively field-independent persons, taken as a group, are likely to show interest in domains where their cognitive skill--competence in articulation or in analysis and structuring--are called for and where relations with people are not particularly involved. In contrast, relatively field-dependent persons, as a group, are likely to favor domains with a "people" emphasis--that is, which feature social

> content and which involve interpersonal relations in daily ongoing activities--and for which analytical/structuring competence does not particularly matter (p.40).

Field-dependent individuals usually favor areas of work requiring social skills such as social worker, minister, counselor, probation officer, and personnel director, while the field-independent individuals favor jobs in the sciences such as biology, physics, or practical-analytical oriented occupations such as production manager and mechanics.

The second subsection of the self-nonself segregation is that of cognitive restructuring ability. As indicated previously, field-independent individuals are better able to analyze and structure unorganized fields in problem-solving situations. This ability to restructure cognitively has been shown in several different types of cognitive tasks. Goodenough and Witkin (1977) have cited many research studies in this area in which field-independent individuals are better at tasks which require decentering (such as the Piagetian three-mountain problem), paper-and-pencil tasks that measure spatial visualization, Piaget conservation tasks, speed of closure tests, and tasks requiring a person to slow down and speed up spontaneous reversal rates. These findings indicate that differences in ability can be seen in many different cognitive task situations in addition to the traditional disembedding task first used to measure the construct.

These three dimensions (segregation of neurophysiological, and self-nonself functions) make up the latest revisions of Witkin's Theory of Psychological Differentiation. Witkin (Witkin & Goodenough, 1976b) indicates that the cognitive styles (field dependence-independence) are process variables that are pervasive, relatively stable over time, are bipolar in nature, and because of the relative value of each style under different conditions (social situations vs. structuring situations) are therefore neutral with regard to value.

Witkin and Goodenough (1976b) also discuss the dimension of fixity versus mobility. They state that certain psychological, individuals have a high degree of regularity in their cognitive style; that is, they are "fixed" in only being able to operate in a particular cognitive style mode. Other individuals are described as "mobile;" that is, they

are able to adopt either a field-dependent or a field-independent mode of operation based on the task at hand, or based on inner states and needs. The advantages of being mobile are obvious. An individual who operates in a field-independent manner and is mobile, for example, would have a tremendous advantage over the person who is field independent but can only operate out of a fixed mode. The more mobile person in this case could operate in a field-independent manner when performing tasks that require high structuring abilities, but he is able to switch to a field-dependent mode when it is necessary to be attentive to social cues, to accommodate his views to those of others, or to be emotionally close to others.

Witkin's cognitive style (as mentioned previously) is probably the most researched of all the cognitive styles. His theory is one that holds much for the researcher in the psychological and educational-training fields. The application of field dependence-independence research to the area of Air Force technical training seems not only obvious, but necessary. For example, a field-independent cognitive style may be helpful in learning and performance of fundamentally analytic tasks, such as troubleshooting an electronic malfunction. On the other hand, learning and performance of other jobs where interpersonal skills assume increased importance may be difficult for the field-independent person. Such jobs as teaching, law enforcement, and personnel management may rely upon the abilities of the field-dependent cognitive style. Certainly the field dependence-independence cognitive style is one that holds great promise for Air Force technical training.

Impulsivity-reflectivity

Another cognitive style dimension which may be of importance in Air Force technical training is impulsivity-reflectivity, or cognitive tempo. This psychological construct identified by Kagan and investigated in a series of studies (Kagan, 1965a&b; Kagan, Rosman, Day, Albert, & Phillips, 1964) attends to decision times in problems with response uncertainty. In general, the impulsive-reflective cognitive style is concerned with the manner in which hypotheses are selected and information processed. The two major dimensions of this cognitive style are latency and errors.

Kagan has defined the impulsive-reflective cognitive style in this manner:

> The reflection-impulsivity dimension describes the degree to which a subject reflects upon the differential validity of alternative solution hypotheses in situations where many response possibilities are available simultaneously. In these problem situations the subjects with fast tempo impulsively report the first hypothesis that occurs to them, and this response is typically incorrect. The reflective subject on the other hand, delays a long time before reporting a solution hypothesis and is usually correct (Kagan, 1966a, p.119).

In a problem-solving situation, the impulsive-reflective style seems to be involved in the selection of an hypothesis to act upon in order to solve the problem and in the evaluation of this solution hypothesis (Kagan, Pearson, & Welch, 1966a). When faced with response uncertainty, the impulsive individual seems to be at a disadvantage due to the fact that the solution hypothesis selected is usually done rapidly and without much evaluation; the impulsive individual tends to be incorrect in such a problem-solving situation.

The testing instrument most commonly used to assess the impulsive-reflective cognitive style is the Matching Familiar Figures Test (MFF; Kagan, 1969). This instrument has become the basic index in the measuring of this style (Kogan, 1971). There are several forms of the MFF available, for preschoolers, school-age children, and adults. When administered this instrument, the subject is required to look at a familiar picture (a standard) and select the standard's exact duplicate from a number of variants. For the adult version of this test, the subject is asked to respond to 12 test items. The dimensions of latency and errors are measured each time the subject completes the task; latency is recorded after the first response is made, and the total number of errors for that item is also recorded. The subject is classified as impulsive if he is above the median on errors and below the median on latency for a group similar to himself. Conversely, a subject is classified as reflective if he is below the median on errors and above the median on latency (Kagan, 1966b). Kagan has concluded that the MFF is the most appropriate test for this variable due to the high negative correlation on the latency

and errors dimensions, -.57 for males and -.51 for females (Kagan, 1966a). This method of classification, the median split, invariably produces a group of subjects who cannot be classified as being either reflective or impulsive. Block, Block and Harrington (1974) have brought this point to light. It is their belief that those subjects who fall in the other two quadrants, i.e., fast-accurate and slow-inaccurate, should also be given consideration. Kagan (1975) has responded to their criticism by noting that the two quadrants in question are not part of the basic construct. Messer (1976) comments that the dropping of the data on the fast-accurates and slow-inaccurates is wasteful as the data on these groups may shed some light on the impulsive-reflective style. The median split technique for classification purposes appears to be useful at this time due to the lack of national norms.

The reliabilities reported on the MFF have been low to moderate (Kagan, 1965b; Ayabe, Note 1). A more reliable instrument producing higher negative correlations between latency and errors would benefit researchers in their efforts to better understand this cognitive style dimension. Ayabe (Note 2) reports research conducted by Dunn-Rankin in 1970, in which higher negative correlations were recorded than those typically reported. In these unpublished experiments, testing equipment developed at Bell Laboratory was used to record latency and errors; the correlation obtained between latency and errors was -.67. Although this form of measuring impulsivity-reflectivity appears to yield better latency-error correlations than does the MFF, additional data will be needed before this technique could be used as a reliable method of testing (Ayabe, Note 2).

The impulsive-reflective cognitive style seems to have implications for many tasks. Kagan reports that a tendency to respond in an impulsive or reflective manner is found across almost all tasks which involve response uncertainty (Kagan, Rosman, Day, Albert, & Phillips, 1964). Intertask correlations are reported at .40 and upward for tasks involving response uncertainty (Kogan, 1971). Kogan also found that children who must generate their own alternative hypotheses demonstrate characteristics of this style (Kagan, 1965b).

While research demonstrated the generality of cognitive tempo across tasks, it also demonstrated stability over time. It appears that when impulsivity is evident during preschool years it may continue to be characteristic of an

individual for subsequent years (Kagan et al., 1964). From the age of 5 through 11, there is an increase in latency and decrease in errors for tasks involving response uncertainty (Kogan, 1971). Since an individual is assessed in a group of his peers, his tendency toward impulsivity or reflectivity relative to his age group can be measured and from this standpoint, cognitive tempo appears to be stable over time (Kagan et al., 1964; Messer, 1968; Yando, Note 3).

The impulsive-reflective cognitive style carries with it implications for education. Kogan states that of the cognitive styles identified "the reflection-impulsivity dimension has the most direct implication for the educational process" (Kogan, 1971, p. 266). In regard to educational ability, correlations between impulsivity-reflectivity and ability measures are, more often than not, positive for latency and negative for errors (Kogan, 1971).

Research indicates that those individuals possessing the impulsive cognitive style are at a disadvantage academically. In studies involving the relationship between cognitive tempo and inductive reasoning, impulsive students tended to respond more quickly and make more errors than reflective students (Kagan, Pearson, & Welch, 1966a). As many intelligence tests for children include inductive reasoning subtests, students who tend to be impulsive may perform poorly on tests involving such inductive reasoning and response uncertainty (Kogan, 1971).

Achievement in reading may also be influenced by the impulsive-reflective cognitive style. In a study conducted by Ausburn, Back, and Hoover (Note 4) secondary level remedial readers tended to be impulsive while readers of the same age performing at grade-level and above tended to be reflective. Kagan (1965b) reported that reflective first-graders committed fewer word recognition errors than did the impulsive students. In another study by Kagan (1966b), impulsive third-graders made more errors of commission than did the reflective students on a task involving the serial recall of 12 words. Anxiety was introduced into an experimental group through threats of failure. Impulsive children demonstrated little increase in errors. It was concluded that, although reflective students perform better than impulsive students on this task, performance of the reflective students could be altered when anxiety was introduced into the task. In other problem-solving tasks involving response uncertainty, the impulsive students consistently performed poorer than the reflective students.

Achenbach (1969) reported that in tasks of analogical reasoning, impulsives would usually answer with high-probability but incorrect answers, while reflective students employed analogical reasoning and were correct in their response.

Impulsivity may have an impact on the academic achievement of a student and may also affect the perception of the teacher about that student. Impulsive students are often misunderstood as not caring about their schoolwork because they make so many incorrect responses. A teacher who perceives a student in this manner may contribute to the student's academic failure (Kagan, Pearson, & Welch, 1966b). Messer (1970b) also observed the relationship between cognitive tempo and school failure. He found that impulsive children are more apt to experience failure than are reflective children.

Anxiety, or concern over performance, may affect an individual's tendency toward reflectiveness. When threats of failure were introduced in a serial learning task, reflectives increased in errors (Kagan, 1966a). In a study by Messer (1970a) increased latency was experienced by both groups but with reflectives increasing in errors. This result could have been due to the experimenter's interjection of feedback on correctness or incorrectness of the subjects' responses. Messer comments that an improvement in cognitive tempo on tasks involving response uncertainty may occur "only when anxiety over response accuracy can be readily coped with by increased reflectiveness" (Messer, 1976, p. 1039).

There appears to be little or no difference with regard to gender on the MFF, although studies reporting these data are not consistent or conclusive (Harrison & Nadelman, 1972; Kagan, 1966a; Lewis, Rousch, Goldberg, & Dodd, 1971). When sex-linked differences were reported, it seems that girls may be somewhat more reflective than boys (Messer, 1976). In regard to body build and cognitive tempo, no consistent relationship appeared (Kagan, 1966b). There were no differences in birth order between reflectives and impulsives as reported in the literature (Campbell, 1973; Hemry, 1973). It has appeared to some researchers that a solution to an impulsive student's difficulties in school could be found in the alteration of cognitive tempo. Several studies have been conducted in which attempts have been made to modify an individual's impulsivity in the direction of reflectivity. An early attempt was made by Kagan, Pearson

& Welch (1966b). In this study, impulsive first-grade students were divided into two experimental training groups and one control group. Training in one group consisted of making the student feel similar to the trainer; in another group no bonds of similiarity between the trainer and student were encouraged. The results showed that there was no difference between the groups and that, despite the fact that latency was longer, there was no difference in errors. In another study, results were similar; children exposed to a reflective model showed increased latency on the MFF but did not decrease errors (Debus, 1970). Another attempt by Yando and Kagan (1968) yielded much the same results, increased latency but no decrease in errors. Studies in modification of cognitive tempo fall into three main categories: forced delay, reinforcement for increased latency and decreased errors, and modeling (Messer, 1976), and to date, little evidence of success for any approach investigated can be found.

Another approach to reducing an impulsive individual's tendency to school failure may be in the matching of student and teacher. Few studies have been conducted in this area; however, matching may only be beneficial when a tendency toward impulsivity or reflectivity may be very detrimental to school success. Kogan (1971) comments on this problem of pairing,

> Where...impulsiveness and reflectiveness are associated with superior cognitive performance ..., teacher-pupil similarity may be more appropriate than teacher-pupil differences from the point of view of facilitating cognitive development. Consider, for example, the difference between impulsive children of high and low ability. An impulsive teacher is likely to associate quickness with intelligence, and will tend to reward bright, impulsive children who rapidly respond to questions with correct answers. The less-able impulsive child may well be handicapped in such a classroom setting, however, since speed of response will be associated with inaccurate answers in his case. Such a child is being taught to value quickness, but this can only have the effect of enhancing the likelihood of failure (Kogan, 1971, p. 270).

More research needs to be conducted in the area of teacher-pupil matching in order to determine whether this is a feasible approach to the problem of impulsivity and school failure.

Further research in impulsivity-reflectivity has attempted to investigate the scanning strategies of impulsive and reflective children. Drake (1970) found that impulsive individuals do not scan all of the variants in the MFF before responding while reflective individuals carefully study the standard and all of the variants before responding. Heider (1971) found that the teaching of scanning strategies increased latency and decreased errors in lower-class children. Instruction in proper scanning strategies needs to be investigated further in order to determine its usefulness in the modification of cognitive tempo.

The impulsive-reflective cognitive style may have implications for training tasks involving response uncertainty. Those trainees who possess the impulsive cognitive style may be at a disadvantage in a block of individualized instruction; if a trainee makes too many errors in the course of instruction, his progress in moving from one lesson to another will be impeded, a problem which may result in failure. Therefore, the impulsive-reflective cognitive style is one that may prove to be important to Air Force training.

Visual-haptic Perceptual Types

Research in the area of visual perception deals, in general, with the ways in which visual information is obtained and processed. Theory in visual perception might be divided into two primary schools of thought. One school treats visual perception as a capacity which is essentially the same for all humans. Theorists of this school conceptualize differences in visual perceptual-cognitive functioning as differences of degree rather than of type. Representative of this viewpoint is Arnheim (1969), who stresses the close ties of visual perception to thought processes and the developmental and trainable nature of visual perceptual skills. A similar theoretical viewpoint is taken by Piaget, who also views visual perceptual functioning as developmental and essentially the same for all individuals, with differences occurring only in degree or developmental level. Piaget views haptic, or non-visual, perception as the ability to translate kinesthetic and

tactile impressions into visual imagery, and he empirically demonstrated this ability to be developmental in children (Piaget & Inhelder, 1956). Piaget postulates two distinct components of haptic perception: (1) the translation of tactile perceptions into visual ones and (2) the construction of a visual image incorporating the tactile data. It is his contention that, in order to learn haptically, a perceiver must form visual images of haptically perceived stimuli (Piaget & Inhelder, 1956).

The views of visual perception represented by Arnheim and Piaget contrast with another school of thought, well represented by Lowenfeld, who stresses that individual differences exist in the very nature of perceptual-cognitive processes. Like Arnheim and Piaget, Lowenfeld believes that there is a close link between perception and thought processes and that perceptual skills are developmental. Lowenfeld does not believe, however, that perception is essentially the same process for all individuals or that the formation of visual imagery is necessary for learning to occur. Instead, he conceptualized individual differences in perceptual style in terms of a perceptual typology characterized by two distinctly different perceptual types: the visual type and the haptic type. These two types are, according to Lowenfeld, entirely different in their reactions to and processing of visual stimuli.

The visual-haptic perceptual typology was developed by Lowenfeld in extensive research in art education in the United States and Austria. The major criticism of his work has been his lack of empirical validation of his theory, but work by later researchers has helped to accomplish this validation.

In his early work, Lowenfeld (1939) found what he believed to be two distinct creative types, based on two unlike types of perception of, and reaction to, the world of experiences. Somewhat later, he conducted studies which led him to believe that "the distinction which is true for creative types can also be made among individuals" (Lowenfeld, 1945, p. 100). He claimed that there existed two distinct perceptual types, which he called the visual type and the haptic type, and he developed a battery of tests through which perceptual type may be identified for individuals. Lowenfeld's five tests (1945) consist of exercises requiring the subject to combine partial visual impressions into whole visual images (Integration of Successive Impressions), to make drawings of items or to estimate the number of floors in an imagined building (Test

of Subject Impressions), to make associations with words (Visual-Haptic Word Association Test), to form visual images of items experienced kinesthetically (Visualization of Kinesthetic Experiences), and to recognize figures perceived through tactile experience (Test of Tactile Impressions). Some of these tests are concerned with the manner in which a task is done. A variation of Lowenfeld's Integration of Successive Impressions is a test developed for military use entitled Successive Perception Test I (SPT-1). SPT-1 (United States Army Air Corps, 1944), which has been used in much of the research on the visual-haptic typology, is in motion picture form. It consists of 38 test items in which the subject is shown a pattern of which only a small section at a time is visible behind a moving slot. He is then shown five similar variants from which he must select the one which matches the pattern he saw behind the slot. Visuals, who have the tendency and ability to integrate partial visual perceptions into wholes, typically perform well on this test; haptics, who are satisfied to internalize the separate segments of partial impressions and who show neither tendency nor ability to integrate them into whole units, typically perform poorly.

Lowenfeld conceptualized his two perceptual types as the opposite ends of a continuum. The types refer to modes of perception and organization of the external environment. He identifies an individual of the visual perceptual type as one who uses the eyes as the primary sensory intermediaries for sense impressions. The visual type learns through visual imagery. An extremely visually minded person is "entirely lost in the dark and depends completely on... visual experiences of the...world" (Lowenfeld, 1957, p. 263) and would be "disturbed and inhibited if...limited to haptic impressions, that is, if...asked not to use sight but to orient himself only by means of touch, bodily feelings, muscular sensations, and kinesthetic functions" (Lowenfeld & Brittain, 1970, p. 234). The visual type is perceptually an observer, usually approaching things from their appearance, acquainting self with environment via the eyes, relating to experiences as a spectator, and transforming kinesthetic and tactile experiences into visual ones (Lowenfeld, 1957).

According to Lowenfeld, the haptic type is normally-sighted, but, in contrast to the visual, relies not on the eyes as primary sensory intermediaries, but rather on the "body-self": muscular sensations, kinesthetic experiences, tactile impressions, and other physical sensations to acquaint self with environment. The haptic type is primar-

ily a subjective type who tends to "feel" experiences rather than see them. The haptic does not transform kinesthetic and tactile experiences into visual ones, but is content with the tactile or kinesthetic modality itself. This implies that learning does not occur for the haptic through visual imagery (Lowenfeld, 1957).

The tests developed by Lowenfeld (1945) for identifying individuals of the two perceptual types are based on several theoretical distinctions between them:

(1) Whereas the visual has the ability to see a whole, break it up and see its component details, and then resynthesize the details back into a whole; the haptic is unable to do this.

(2) Whereas the visual tends to react to stimuli as a spectator and to "see" experiences, the haptic tends to react emotionally, to "feel" stimuli, and to place self into the situation.

(3) Whereas the visual has the tendency and ability to visualize and integrate tactile and partial experiences, the haptic has neither this tendency nor ability.

(4) Whereas the visual has the ability to maintain visual imagery mentally, the haptic is unable to do this.

Some research done by Lowenfeld himself can be offered in support of his visual-haptic theory. In his initial study (Lowenfeld, 1939) he simply observed, while working with the partially blind, that some individuals would use the limited sight they had to examine objects or to express themselves in clay modeling, while others would not use their eyes at all, but were content to use the sense of touch. This observation led him to theorize that some individuals who had a limited amount of vision available to them preferred to utilize it, while others actually preferred the haptic modality. He also noticed differences in the art produced by these two types of individuals. In comparing visually- and haptically-oriented art (Lowenfeld, 1957; Lowenfeld & Brittain, 1970), he observed that work by visual individuals tended to stress the visually-dominated, externally-directed aspects of light and shadow, proportion, and perspective. Work by haptic individuals, on the other hand, tended to utilize an internally-directed approach, to focus environment subjectively around self,

and to make subjective use of proportion and shading to express emotions rather than visual reality.

Other researchers have observed differences in creative expression which parallel Lowenfeld's observations for his typology. Drewes (1958) found that the Rorschach responses of a group he designated as "visualizers" tended to be whole and three-dimensional, while "nonvisualizers" produced more kinesthetic responses. Flick (1960) found that both haptic expression, defined as kinesthetic, subjective, and internally-directed, and visual expression, defined as sight-oriented, objective, and externally-directed, could be found in literature as well as in art. Zawacki (1956) found that haptics tend to relate material in terms of details of emotional significance while visuals do not.

One of the basic tenets of Lowenfeld's theory is that the mental formation of visual imagery is not necessary to the learning process. He uses the term haptic to mean a mode of perception and cognition which is not dependent on visual imagery and in which kinesthetic and tactile impressions are not translated into visual ones. This is in contradiction to the viewpoint of Piaget, who believes that learning must involve visual formation and defines haptic perception as the translation of kinesthetic and tactile impressions into visual ones. Lowenfeld's position is supported by a study conducted by Gottesman (1971) in which congenitally blind children, totally unfamiliar with visual imagery, were compared with sighted children. Two groups of sighted children and one group of congenitally blind children were given three-dimensional shapes to experience tactually only. One sighted group was then asked to match the shapes they had felt from four figures in a visual display. The second sighted group and the blind group were asked to respond tactually by identifying the shapes by touch. Gottesman found no differences between any of the groups. This appears to confirm the existence of direct tactile-to-tactile learning by the congenitally blind children and possibly by some of the sighted ones. Although it cannot be known whether sighted children using tactile impressions only were mentally forming visual images of the shapes, it is doubtful that congenitally blind children were doing so.

Lowenfeld has contended that perceptual type is linked to innate physiological characteristics. Some support for this contention comes from studies using an electroencephalograph (EEG). In a study by Drewes (1958), brain alpha

rhythms of subjects were recorded as they attempted to mentally visualize and manipulate geometric figures to form various combinations on a table top. Since alpha rhythm typically ceases when a visual image is seen or when one is induced mentally by suggestion, Drewes concluded that those individuals who recorded persistent alpha rhythms were not forming visual images, while those who recorded no alpha rhythms were constantly producing mental imagery. Based on alpha rhythm recordings, he divided his subjects into three types: visualizers, nonvisualizers, and responsives. He also recorded Rorschach responses for these groups and found that the responses of those he had identified as visualizers tended to be to whole and three-dimensional forms, while responses of nonvisualizers tended to be more kinesthetic and non-visual in nature.

A second EEG study of alpha rhythms was conducted by Walter (1963). Walter explains that alpha rhythms are typically prominent when the eyes are shut and the mind at rest, and they disappear when the eyes are opened, when visual imagery is either seen or induced mentally, and when the subject makes a mental effort. He observed, however, that some individuals produced either virtually no alpha rhythm or, at the other extreme, almost constant alpha. He reports research which sheds new light on these individual differences:

> ...in the course of war service at the Burden Neurological Institute...we were able to designate some of these exceptions as a stable group with definite characteristics. It was shown in 1943 that individuals with persistent alpha rhythms which are hard to block with mental effort, tend to auditory, kinesthetic or tactile perceptions rather than visual imagery (Walter, 1963, p. 214).

Having discovered a relationship between alpha rhythm and perceptual modality preference and functioning, Walter identified three types of individuals (Walter, 1963, p. 2.):

(1) P type: exhibits persistent alpha activity.

(2) R type: exhibits alpha activity responsive to open and closed eyes conditions.

(3) M type: exhibits no significant alpha activity under either condition and whose "thinking processes are conducted almost entirely in terms of visual imagery."

Walter's description of his three types is quite similar to Lowenfeld's conceptions of visuals, haptics, and indefinites:

> When a solution or decision of any kind can be reached by visualizing it, the performance of the M type is rapid and precise; but when they are faced with a problem of an abstract kind, or one in which the mental pictures required are too elaborate for them, they become sluggish and confused. On other hand, at the other extreme, ...[members of the] P group...do not use visual images in their thinking unless they are obliged to do so. Even then, their mind's eye is almost blind; they think in abstract terms, or in sounds or movements; they may even have to 'feel' their way out of an imaginary maze. The R group, the responsives,...are intermediate between the other two groups; while they do not habitually use private pictures for their everyday thinking, they can evoke satisfactory visual patterns when necessary. Moreover, they can combine data from various sense organs more readily than can either the M or P types (Walter, 1963, p. 217).

Walter's statement that "evidence already available... strongly suggests that the alpha rhythm characteristics are inborn and probably hereditary" (Walter, 1963, p. 218) indicates his support for Lowenfeld's premise that perceptual type is linked to innate physiological traits.

In considering the EEG data concerning visual functioning, however, it must be mentioned that other research (e.g. Barrett, 1956; Paivio, Simpson, & Rogers, 1967) suggests that imagery is not the only suppressor of alpha production and that alpha waves may therefore not be a reliable index of imagery ability.

In tests involving over 1100 subjects from numerous sex and age groups, Lowenfeld (1945) found that, although most individuals fall between the extremes of his typology, about 75% show an appreciable tendency toward either the visual or the haptic perceptual type. He reported the following distribution: visuals, 45%; haptic, 23%; indefinite, 30%. Rounding to allow for measurement error, he postulated the following theoretical distribution of perceptual types: visual, 50%; haptic, 25%; indefinite, 25%.

The distribution reported by Drewes and Walter in their EEG studies of alpha waves, while not identical to Lowenfeld's, is somewhat similar. Drewes (1958) found the following distribution: visualizers, 25%; nonvisualizers, 25%; responsives, 50%. Walter (1963) found about two-thirds of his 600 subjects to be R type, while the remaining one-third were about evenly split between the M and P types. In recent studies (Ausburn, F.B., 1975; Ausburn, L.J., 1976), Lowenfeld's distribution of perceptual types has been obtained in research involving college students, thus lending support to the postulated distribution.

Only a few studies have been conducted to determine the relationship of perceptual type to scholastic achievement. Erickson (1964, 1966) found that students of the visual type show superior performance in mechanical drawing. In a later study, Erickson (1969) found the mean level of reading achievement for haptic students to be one-half to one full grade level below that of visual students. Similarly, Templeman (Note 5) found that visual children learned to read faster than haptic children. Bruning (1974) found significant positive correlations between visual aptitude as defined by Lowenfeld and achievement in both reading and mathematics for high school students.

Virtually no studies have been conducted on instructional methods which interact with visual and haptic perceptual types. In the only applicable study that was located (Ausburn, F.B., 1975), it was found that multiple imagery resulted in superior performance over linear imagery in the presentation of a task in which subjects had to compare visual elements in a sequence of three pictures and then locate a specific item in a fourth picture. With multiple imagery, performance was better in terms of both accuracy and speed. While both visual and haptics were benefited by the use of multiple imagery, it was found that the greater benefit occurred for haptics. It was the conclusion of the study that the simultaneity of visual images inherent in multiple imagery supplanted (or performed for the learners) the psychological task of retaining visual images for comparison. Since this process is especially difficult for haptics, they were benefited most by the use of multiple imagery.

This area of cognitive style research is one that could hold much for trainee selection and for design of techincal training both in terms of learner variables and in terms of instruction. Although other dimensions of cognitive

style involve visual perception in both construct and measurement (e.g., field dependence-independence and leveling-sharpening), Lowenfeld's is a typology of perceptual style, per se. The visual perceptual demands of technical jobs are frequently complex and demanding. For example, jobs involving maintenance of complex electronic or mechanical systems would appear to frequently and directly require the visual memory and integration abilities of a person of the visual type and be extremely difficult for a person of the haptic perceptual type. For instruction and learning, when the match between a trainee's perceptual style and career field is less than optimal, there may be promise in employing supplantation techniques described above. Although selection may be the most cost-effective approach, an organization's options are frequently not completely open in having a sufficient number of potential trainees with optimal abilities to select among. To some extent then, the more difficult and expansive supplantation training design options may become necessary considerations. At any rate, compared with learning a skill on one's own in an informal setting, all instruction can be viewed as a supplantation process, needed in varying degrees and kinds by individuals with differing abilities and motivations. The visual-haptic typology may lend assistance in training design in helping to sharpen the specification of what kinds of help different individuals need in learning skills that require complex visual perceptual performance.

Leveling-Sharpening

Holzman (1952, 1953-54) and Klein and Schlesinger (1951) were the first to isolate the cognitive style of leveling-sharpening in the early 1950's. Their leveling-sharpening studies were followed by another major series of studies in the 1960's by Santostefano, whose primary interest has been in the developmental aspects of leveling-sharpening (1964, 1969).

Holzman and Klein classified leveling-sharpening under the more general term "schematizing process," which they defined as "identifying and integrating sense impressions" (Holzman & Klein, 1959, 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, a tendency which predisposes the person to observe small gradients of difference between figure and ground. Leveling he defines as a propensity to minimize perceived differences and to 'prefer' the experiences of sameness to that of difference (Holzman, 1952).

Holzman developed an instrument called the Schematizing Test to measure the leveling-sharpening dimension. This test is composed of 10 series of squares projected onto a screen, each composed of five squares of regularly increasing size. Each series is projected randomly, but the increase in size from one series to the next is systematic. He found consistent individual differences in the ability to "keep up" with the systematic increase in size, especially in the middle ranges (i.e., reflective 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 as well as on the Schematizing Test. From these findings Holzman concluded that leveling-sharpening is a stable and significant cognitive style.

Holzman then reasoned that since levelers have more difficulty extracting stimuli from their context, they might also manifest more time-error than sharpeners. Time-error is a constant error in the judgement of successive stimuli, in which the intensity of a comparison stimulus is judged relative to that of a standard stimulus. He hypothesized that levelers would experience more assimilation of brain traces, by fusing the relevant stimuli with the ground more than sharpeners do. Using adult subjects, 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. Holzman 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). However, a study involving 10- and 13-year-old girls by Butler (1977) revealed no difference between levelers and sharpeners on a visual time-error test which replicated Holzman's visual time-error experiment. These conflicting findings may be due to age differences in the populations sampled, but do call into question any clear-cut relationship between leveling-sharpening and visual time-error.

Since Holzman's study appeared, 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 & 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 intermitted 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, Holzman, Klein, Linton, and Spence (1959) and Holzman and Gardner (1959) found a significant relationship and concluded that repression seems similar to the process of assimilation. Lewinsohn, Flippo, and Bergquist (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.

Leveling-sharpening does not appear to be directly related to general intelligence. Staines (1968) found a

nonsignificant relationship between performance on the Schematizing Test and Otis IQ in a sample of adolescent females. Also studying adolescent females, Butler (1977) found a nonsignificant relationship between performance on the Leveling-Sharpening House Test (LSHT) designed by Santostefano and three subtests of the Performance Scale of the WISC-R (Picture Completion, Block Design, and Object Assembly), which together have been judged to measure analytical ability (Witkin et al., 1962). She did find a moderate relationship between the Picture Arrangement Subtest of the WISC-R and the LSHT (Butler, 1977).

Notable studies have been done on the relationship of leveling-sharpening to age and gender. Santostefano found striking increases in sharpening behavior on his Leveling-Sharpening Wagon Test (LSWT) between the ages of 9 and 12 (Santostefano, 1964). Santostefano's LSWT consists of sequentially displayed pictures of a wagon, in which parts of the wagon are gradually omitted in one version, and gradually added in the other version. Santostefano then found in a factor analytic study (1969) that certain cognitive style tests load on common factors in a predictable manner. For example, he found that leveling-sharpening tests contributed to a factor represented primarily by impulse control and that field articulation contributed to a factor represented primarily by leveling-sharpening (Santostefano, 1969). Given these factor analytic findings alongside the developmental pattern of increased sharpening with age, Santostefano formulated a developmental model of cognitive controls, under which the individual progresses from global and diffuse perception to increasingly differentiated and integrated perception. More specifically, the capacity for impulse control and focal attention is seen to be necessary for the development of the controls of field articulation and leveling-sharpening, and in turn, the development of field articulation precedes the development of leveling-sharpening tendencies.

A contradictory finding is reported by Butler (1977), who did not find a relationship between age and leveling-sharpening in a study in which the LSHT was administered to 10- and 13-year-old girls.

With regard to gender, Santostefano (1964) found that males tend to be sharpeners more frequently than females. Santostefano has suggested that this may be due to sex-related differences in identification early in development.

In general, the body of research on leveling-sharpening is suggestive but not conclusive. Studies defining the leveling-sharpening behavior and refining the instruments for its measurement are expected to determine whether the Klein and Holzman studies, which used the Schematizing Test, measured the same cognitive style as Santostefano's studies, using the pictorial LSWT and LSHT. Such basic analyses should help explain many of the conflicting results that have been obtained from research stemming from these two major pioneer groups in leveling-sharpening research.

One principal direction for such analyses would be refinement of the LSHT. Butler's study of this cognitive dimension (1977) concludes that greater precision must be achieved with the leveling-sharpening instruments before research can be done which is comparable to that in some of the other cognitive styles. In field dependence-independence, for example, Witkin has achieved a high measure of reliability and construct validity with the measures used. Such success has not occurred with the leveling-sharpening tests in their present form.

An appropriate alternative form of the LSHT would provide more reliable information on leveling-sharpening. An alternate form of the instrument delivered by, for example, videotape or computer, would avoid the testing variations associated with changes in test administrators. Each hand-administration is different from all others because of variations in the timing of the pictures (60 pictures, 5 seconds each), variations in the angles at which the pictures are displayed, and variations in the methods by which instructions are given. A videotaped or computer-delivered test, on the other hand, could offer exactly the same testing conditions to each subject and allow greater precision of measurement.

In eliminating the test administrator, such an alternative form of the LSHT could also be more practical for use in training settings. In its current form, the test requires individual administration by a person thoroughly familiar with the test. The preparation for and administration of the test are so time-consuming and difficult that little use in training settings would be feasible. In contrast, an alternative form of the LSHT can be self-administered, requiring only (1) a video playback unit and an answer sheet or (2) a computer with appropriate display and input provisions. Therefore, the test could more easily be administered to large numbers of trainees.

An alternate form LSHT should also make feasible a battery of easily administered cognitive style tests including, for instance, the LSHT, the SPT-1 (visual-haptic), the Embedded Figures Test and the Schematizing Test. Such a battery might help reveal what the LSHT actually measures, for instance, whether it is like or unlike the dimension measured by Holzman's Schematizing Test.

The refinement of the LSHT through development of an alternative form may reveal more implications for training than are now seen in leveling-sharpening. This cognitive style may hold promise from the standpoint of learning and subsequent retention of meaningful new material, if test refinement can lead to clarification of the present conflicts in leveling-sharpening research.

Distractibility

Distractibility is considered to be a cognitive style that can be measured by the individual's reaction to contradictory or intrusive cues, that is, the degree to which the individual directs attention selectively to relevant stimuli and withholds attention from irrelevant stimuli. This same construct was called "constricted-flexible" by Gardner et.al. (1959). Gardner pointed out that the constricted-flexible control is similar to Witkin's construct of field dependence-independence. A decade later, Santostefano dubbed the same construct "field articulation," which he defined as "the manner in which a person deals with a stimulus field containing information defined as relevant and irrelevant in terms of the adaptive requirements of the situation" (Santostefano, 1969). In that paper he acknowledged a similarity to field dependence-independence by asserting that field articulation combined the constricted-flexible principle and Witkin's field dependence-independence construct (Witkin, 1965).

Distractibility has been measured by various instruments: the Color-Word Test, Incidental Recall Test, Size Estimation Test, and the Free Association Test. All of these tests present distracting stimuli, except the Free Association Test. The basic assumption of the Free Association Test is that flexible subjects can produce more remote associations, while constricted subjects will produce associations that are closer to the word given by the experimenter. The most frequently used distractibility test is the Color-Word Test. According to Gardner et al. (1959), the test was first used by Jaensch in 1929 and was

introduced in the United States by Stroop in 1935. It consists of three parts: a warm-up page of color names printed in black; a page of colored asterisks that match the arrangement of words in part one; and a section in which the four colors and color names appear in contradictory combinations (Gardner et al., 1959). A group version of the Stroop Color-Word Test was developed by Golden (1975) which requires written responses from the subjects. Golden reports reliabilities of .89, .84, and .73 for the three parts of the group test.

A similar test designed for children is Santostefano's Color Fruit Test, in which the child is presented a card containing 50 drawings of fruits colored appropriately. The child is asked to name the colors as quickly as possible. On the second trial, the child is presented the fruit as it appeared on the first trial, except that each fruit is surrounded by black and white line drawings of common objects; the child is again asked to name the colors of the fruit. On the third trial, the child is presented with fruit colored incorrectly, and is asked to name the color each object should be (Santostefano, 1969).

After isolating the constricted-flexible variable in children 6, 9, and 12 years old by means of the Fruit Distraction Test (Santostefano & Paley, 1964), Santostefano further explored the developmental aspect of this cognitive style and its developmental relationship to other cognitive styles. By 1969, Santostefano had applied a different name to this control, calling it "field articulation," but continued to use the Fruit Distraction Test for its measurement. In a factor analysis employing 20 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. On the basis of these findings, Santostefano posited a hierarchical relationship between these cognitive controls which he placed within the framework of a developmental model, by which focal attention precedes and is a requisite for, field articulation development. Santostefano suggests that one must develop attention-directing and scanning controls before field articulation tendencies emerge (Santostefano, 1969).

The attentional process itself was analyzed by Sack and Rice (1974) in an effort to ascertain those aspects of attention that field dependence-independence and distractibility encompass. Testing eighth-grade students with a

battery of tests including the Color-Word Test and the Embedded Figures Test (a field dependence-independence test), they found that three attentional factors emerged, which they labeled selectivity, ability to resist distraction, and shifting. The Color-Word Test loaded moderately on the selectivity factor, which was primarily defined by heavy weightings of the embedded figures tasks. The Stroop Test loaded most heavily on the shifting factor, but had negligible loading on the ability to resist distraction factor. Thus, field dependence-independence was found to be a related but separate control. The shifting factor, which received the heaviest loading by the Color-Word Test, is defined by Sack and Rice as "a voluntary change in an established attentional focus," (p. 1005). The resistance to distraction factor was defined primarily by Karp's Distracting Contexts Tests, a timed arithmetic operations test, and a letter cancellation test, which measured the speed with which the subject could cross out designated letters on a page of randomly arranged letters. Karp's Distracting Contexts Tests present irrelevant stimuli surrounding or intersecting the critical items to be located. In contrast to Wiktin's Embedded Figures Tests, which disguise the critical shape to be identified, the critical items in Karp's test remain intact (Karp, 1963). The use by Sack and Rice of the term "ability to resist distraction" for the factor not defined by the Color-Word Test (the instrument commonly used to measure distractibility) is somewhat confusing and may suggest the need for further research into the nature of attention and into distractibility as a component of attention.

The relationship of distractibility to field dependence-independence has received considerable attention. Karp (1963) inquired into the nature of the relationship of embedding contexts to distracting contexts and found in a factor analysis that there was an absence of overlap of significant loadings of tests representing the two types of contexts, although moderate correlations were found between factors representing these cognitive controls. This finding was also obtained by Sack and Rice a decade later, as described above (1974).

The issue of field dependence-independence vs. distractibility, as measured by the Stroop Color-Word Test, was also studied by Houston (1969). He experimentally imposed stress on subjects by submitting a group of field-independent persons and a group of field-dependent persons to auditory distraction while they performed the Stroop Test, Digit Span, and Anagrams. Later both groups performed the tests without

auditory distraction. No significant differences between the groups were found, suggesting to Houston that Karp's conclusion that field independence is not related in a linear fashion to the capacity to ignore distracting stimuli could be extended to the auditory modality as a source of distracting stimuli.

Distractibility has also been studied in relation to the personality trait, extroversion, as well as field dependence-independence (Bone & Eysenck, 1972). A factor analysis revealed that the distractiblity tests and the field dependence-independence tests loaded on different factors, which corroborates previous findings discussed above. The third factor emerged with loadings on extroversion, field dependence, Stroop Interference Score, and negative loadings on the Stroop Time Scores. Bone and Eysenck concluded that extroverts tend to be field dependent, more prone to interference, but faster in reading the simple Stroop cards.

The relationship between distractibility and intelligence has been studied in second- and fifth-grade children (Friedman, 1971).. Using the Stroop Color-Word Test, Friedman found a significant relationship between IQ and performance on the Word Section for the second-graders. For the fifth-graders, a significant relationship was found between IQ and time scores on the Word and Color-Word cards. Friedman therefore concluded that IQ must be taken into account when using the test with young children.

The cumulative implication of the distractibility research is that distractibility is a cognitive style distinct from field dependence-independence, and not one which embraces Witkin's construct, as Santostefano has suggested (1969). Distractibility has not been researched as thoroughly as many of the other cognitive styles, and much remains to be learned about its role in the attentional process, as well as its relationship to other cognitive and personality variables. Whereas attending behavior remains a critical factor in learning from instruction, the cognitive control of distractibility could have an important effect on training performance, and might therefore be profitably studied in Air Force training settings.

Breadth of Categorization

The cognitive style breadth of categorization was discovered through research work in which individuals are required to perform a sorting task. In such a task, they

must make decisions about whether an event or item belongs to class A or to some other class (i.e., not class A). The relative willingness of an individual to include many different items within one category might indicate a relatively broad categorization style. On the other hand, an unwillingness to include very many items in one category would indicate a rather narrow categorization style. These two extremes represent the bipolar ends of the breadth of categorization cognitive style.

There are several different measures of this cognitive style, with Petigrew's paper-and-pencil questionnaire (1958) being one of the most prominent. In this procedure, a subject is given a category and asked to specify (given a list of alternatives) the parameters of that category. For example, a subject might be asked to specify the extremes (largest and smallest values) that are appropriate for the length of a whale. Other forms of judgements include a verbal test in which subjects must indicate all the words that could be used as synonyms for other words given in a sentence, and a geometric test in which figures are judged as belonging to a certain class according to acuteness of their angles (Kogan, 1971).

According to Kogan (1971) the cognitive strategy preference of individuals from each extreme of this cognitive style dimension reflects their desire to minimize certain errors. The broad categorizer would be interested in minimizing the risk of exclusion or the possibility that events omitted may have actually belonged to that class. On the other hand, the person who operated with narrow categories is minimizing the inclusion error, that is, the possibility that events included in the category may not belong to it at all. Kogan (1971) further states that individuals are consistent with their strategies (narrow or broad) across all the tests of this style (quantitative, verbal, and geometric). He also reports studies in which relationships between breadth of categorization and other variables have been found. One such relationship is that between category breadth and creativity. Children of the broad category style were shown to be the "most capable of conceiving of manifold and unusual possibilities on creative tasks" (p. 257). Bruner and Tajfel (1961) have found that a positive correlation exists between narrow categorizing and tests of intelligence. Messick and Kogan (1965) have also found evidence to indicate that when multiple-choice quantitative aptitude tests are used where the alternatives are widely spaced (large numerical spread in possibilities as is typically done), a significant

positive relationship is obtained between category breadth and quantitative aptitude. They assume that it is due to an "adaptive approximation strategy" employed by the broad categorizers on the multiple-choice quantitative problems and that this relationship disappears if actual computations are done or if answers are narrowly spaced.

Additional research into this cognitive style will give a clearer understanding of its significance to instructional design. At this point, the breadth of categorization cognitive style seems of lesser importance to Air Force training than do some of the others discussed in this review.

Scanning

According to Messick (1970), scanning is the style which involves individual differences in attention deployment. This individual difference "lead(s) to individual variations in the vividness of experience and the span of awareness" (Kogan, 1971). Initially explored by Schlesinger (1954), this style dealt with bipolar focusing-scanning. In 1959 Gardner et al. altered the original concept of the dimension, discovering that individuals categorized as "focusers" also deployed attention too broadly to be accurately so described. In later research, the term "focusing" was deleted and scanning became the construct to replace the original focusing-scanning dimension (Gardner, 1961; Gardner & Long, 1962a, 1962b).

Research subsequent to Schlesinger's original work deals with scanning as the relatively broad or narrow deployment of attention (Silverman, 1964; Wachtel, 1967). Early work by Gardner investigated scanning in terms of constant error in judgement of size-estimation (Gardner, 1961). In this method subjects are to adjust a circular patch of light until it appears equal in size to a disc projected on the wall or held in the hand. Here, errors in size estimation are inferred to be the result of low attention deployment. Research in eye movements made it possible to investigate this cognitive style dimension with more precision than before (Gardner & Long, 1962a). In this study, data concerning the number and duration of concentrations, or focusing on the attentional field were obtained.

The implications of this style for education are as yet somewhat vague. This may be due to the fact that Gardner and his associates, who have conducted most of the research in this area, are more concerned with the relation-

ship of scanning to personality structures than to education (Kogan, 1971). It appears, however, that extensive scanners have longer latencies before responding to the Rorschach inkblots, interpreted by Gardner and Long as concern for exactness (Kogan, 1971). This concern for exactness and latency may have some relationship to Kagan's impulsivity-reflectivity cognitive style, as latency and errors are the main dimension of this style. Kogan comments that Gardner's work on scanning may be of more benefit to the study of perception than to the study of cognition (Kogan, 1971). That there is a question as to whether this dimension is a "perceptual style" or a "cognitive style" is meaningful in itself, particularly in light of the fact that this and certain other style dimensions are typically and currently considered as cognitive styles. In any event, styles of scanning seem to hold less promise for Air Force training and instructional design than do some of the other cognitive styles.

Tolerance for Unrealistic Experiences

The cognitive style of tolerance for unrealistic experiences was discovered as a product of studies performed in the area of apparent movement. The illusion of apparent movement is produced by showing a subject a pair of stimuli (such as a horse or a man) alternately in a visual field. As the rate of presentation of the alternate figures increases, at some point they appear to move as a single figure. As the rate of presentation is increased further, the apparent movement stops and the figures appear to be two simultaneously flickering figures. This same illusion is also produced by using two alternately flashing lights. Measurement (in cycles per second) is taken when the subject first reports the illusory movement as well as the point at which this illusion ceases. The name "Tolerance for unrealistic experiences" comes from the fact that in the early experiments in this area the subjects were informed that the movement was in fact an illusion and as a result, the measurement taken was of a subject's willingness to report an experience that is contrary to conventional reality (Klein & Schlesinger, 1951; Gardner et al., 1959; Klein, Gardner, & Schlesinger, 1962; Segal & Barr, 1969). The dichotomy of this cognitive style involves "tolerant" subjects who are willing to accept their impressions of movement even when they are at odds with what they know is reality. These individuals report the illusion of movement earlier and will continue to report the motion longer than will less tolerant individuals. The tolerant individuals operationally have a lower initial threshold for the apparent movement illusion

and have a higher upper threshold, which results in a broader range. The less tolerant individual is more bound to reality and will have a much more restricted range of illusory movement.

Other measures have been used to indicate tolerance for unrealistic experiences (Kogan, 1971). One such measure is the use of reversible figures. Each visual figure can be perceived in two different ways by reorganizing the perceptual field. The ability to reverse the figures in neutral conditions and to resist reversing the figure when instructed to do so has been linked with tolerance for unrealistic experiences.

Aniseikonic lenses, which cause a perceived tilt in the surrounding visual field have also been used to measure this cognitive style through producing a perceived distortion of the visual field surrounding an object. The willingness of an individual to perceive the distortion serves as the tolerance score. This is done by measuring the length of time it takes the subject to report the distorted perception.

The last alternate measure of tolerance for unrealistic experiences involves responses on the Rorschach Test. Individuals who are relatively tolerant for unrealistic experiences will exhibit more responses that go beyond the reality of the stimulus cards.

Tolerance for unrealistic experiences has been included as a variable in several factor analysis studies. The results of the studies, however, have been inconclusive (Gardner et al., 1959; Wardell, 1974). It is clear at this point that knowledge on this cognitive style is quite limited, and therefore of lesser current utility to Air Force training than some of the more researched cognitive styles.

Cognitive Complexity-Simplicity

The cognitive complexity-simplicity dimension of cognitive style is concerned with individual differences in the tendency to construe the world in a multidimensional and complex way. In general, the study of cognitive complexity-simplicity attempts to examine the dimensionality with which individuals discriminate similarities and differences among items. However, the study of this cognitive style has been hampered by disagreement among researchers concerning its meaning and measurement. The dimension appears, in fact, to

include several distinctly different cognitive processes, the principal ones being the following:

(1) The number of different dimensions individuals use in analyzing their environment.

(2) The "articulation," or number of intervals or gradations, they employ within dimensions.

(3) The "hierarchic-integration" structure they employ, i.e., the extent to which they organize dimensions into super- and subordinate groups along an abstractness-concreteness continuum.

The original work with cognitive complexity-simplicity was done by Kelly (1955) as part of his study of the kinds of personal constructs employed by individuals for understanding their social environment. He conceptualized complexity-simplicity of personal constructs as dynamic, i.e., changing over time and with experience. The instrument developed by Kelly (1955) for assessing complexity-simplicity of personal constructs is the Role Construct Repertory (REP) Test. In this test, subjects are asked to make discriminations in the form of similarity-difference judgements about roles and individual persons, forming constructs with similarity and difference poles. Later researchers (Bieri, Atkins, Brian, Leaman, Miller, & Tripodi, 1966) simplified the REP Test and switched its format from the generation by individuals of their own constructs to the responding to constructs provided by the examiner. Substantial correlations have been reported (Jaspars, 1964; Tripodi & Bieri, 1963) for the cognitive complexity-simplicity scores obtained with the two procedures.

The generality of cognitive complexity-simplicity (as a trait) across diverse types of stimulus material and tasks is controversial, as there is evidence on both sides of the issue. Most researchers appear to have shifted away from a strict trait approach to cognitive complexity-simplicity and towards the study of interactions between this cognitive style dimension and the complexity of specific stimuli, tasks, or environments.

Much of the research of cognitive complexity-simplicity has been concerned with aspects of "differentiation" in forming complex or simple constructs; i.e., the number of different dimensions formed by individuals in their judgements, or the number of discrimination levels or intervals within constructs. Another approach has been taken by Harvey and his associates (Harvey, Hunt, & Schroder,

1961) who have studied variation in cognitive complexity, not as a matter of "differentiation," but along a continuum of abstractness-concreteness, or "integrative complexity." Involved in Harvey's continuum of complexity-simplicity are levels of abstraction based on ability to form "hierarchic integration" of subordinate and superordinate constructs. The Harvey's "integrative" conceptualization of complexity-simplicity is concerned with cognition in general, while the Bieri "differentiation" conceptualization is primarily concerned with cognition of persons and social environments. A major axiom of the "conceptual-systems" theory of the Harvey group is that the level of integrative complexity of adults is a function of their developmental history, particularly of prior interactions with major training figures, such as parents and teachers. The conceptual-system theorists have developed sentence-completion tests (Harvey, 1966; Schroder, Driver, & Streufert, 1967) of integrative complexity, which are scored according to criteria such as absolutism of expressed beliefs, consideration of modifying circumstance, dependence on external authority, acceptance of established social mores, and concern for interpersonal relationships, etc. These tests of integrative complexity used by the conceptual-systems theorists do not appear to relate significantly to the REP Test measure of differentiation in cognitive complexity (Vannoy, 1965); nor do they seem to be confounded by verbal fluency or the tendency to respond in a socially desirable way (Schroder et al., 1967).

Although this cognitive style seems to hold heuristic value for researchers, it does not seem, at its present level of development, to be as applicable to Air Force training as some other cognitive styles.

Conceptualizing Styles

The conceptualizing styles dimension of cognitive style is concerned with individuals' preferred approaches to categorizing perceived similarities and differences among stimuli and with conceptualizing approaches as bases for forming concepts. No standard instrument for assessing performance in this dimension has yet been developed. However, a uniform type of task has been established. Although many kinds of stimuli have been enployed, the basic task in assessing conceptualizing styles is always to sort or group items into categories.

There are several aspects involved in the concept of conceptualizing styles, making it a somewhat complex cognitive style dimension. The two principal aspects of the dimension appear to be (a) preference for forming either a few or many conceptual groupings, and (b) the conceptual strategy used in constructing the groupings.

The aspect of conceptualizing style concerned with the number of conceptual groups formed has been alternatively labeled equivalence range (Gardner, 1953) and conceptual differentiation (Garnder & Schoen, 1962). Equivalence range, i.e., preference for forming few or many conceptual groups, has much in common with the breadth of categorizing dimension of cognitive style. In fact some investigators (Gardner & Schoen, 1962; Murdoch & Van Bruggen, 1970; Tajfel, Richardson, & Everstine, 1964) have reported consistency of responding on a broad or narrow dimension to both breadth of categorizing and conceptualizing style tasks. Lack of consistency, on the other hand, has been found by others (Sloane, Carlow, & Jackson, 1963; Wallach & Kogan, 1965). The reason for the lack of complete generality in category-breadth responses in the breadth of categorizing and equivalence range dimensions is possibly related to the differences in the nature of the task used to assess them. Breadth of categorizing, as a cognitive style in itself, is assessed with a task in which a category is specified in advance and subjects must set limiting boundaries for the category by deciding whether individual stimuli do or do not belong to that category. In contrast, equivalence range, as an aspect of the conceptualizing style dimension of cognitive style, is assessed with a purely sorting or grouping task. No category is specified for subjects, and they must determine for themselves a categorizing strategy. Thus, with the sorting task, only after selecting or defining of categories by individuals does the boundary-setting aspect of category breadth come into play. It has been suggested (Messick & Kogan, 1963) that two processes operate in the sorting tasks: conceptual "differentiation," which represents the number of groups to which more than a single item are assigned; and "compartmentalization," which reflects the number of single items which are not placed in any categorical group. Conceptual differentiation has been shown to correlate positively with vocabulary level or verbal knowledge (Messick & Kogan, 1963) and to decrease with age, suggesting a developmental shift from emphasis on perception-dictated differences among stimuli to a synthesis-based, higher-order analysis of similarities (Bruner, Oliver, & Greenfield, 1966; Gardner & Moriarty, 1968). Compartmentalization has been shown to correlate

negatively with measures related to creativity (Frick, Guilford, Christensen, & Merrifield, 1959), perhaps implying an inability to generate alternative conceptual schemes which would allow objects to be viewed as members of a larger group (Kogan, 1971).

The second major aspect involved in the concept of conceptualizing style concerns the actual conceptual strategy used by an individual in forming categories of stimuli. In early work on this variable, Kagan and his associates (Kagan, Moss, & Siegel, 1960) classified conceptual or grouping performance into three types:

(1) Descriptive concepts: grouping by similarity on the basis of some objective abstract physical characteristic of the stimuli, such as color or shape.

(2) Categorical-inferential concepts: groupings which reflect treatment of the stimulus objects, as wholes, as independent representatives of a conceptual group, such as items of clothing or furniture.

(3) Relational concepts: groupings in which each object derives its meaning from its relationship to the other group members, such as in a story sequence.

In later research, the Kagan group (Kagan, Moss & Sigel, 1963) ignored "categorical-inferential" conceptualization and "descriptive" conceptualization and generated the "analytic-descriptive" construct. This was finally simplified to just "analytic." Therefore, the ultimate distinction in conceptualizing strategy became "descriptive-relational," "analytic-relational," or "analytic-nonanalytic." The analytic style is presumed to reflect active analysis of stimuli in concept formation, while relational style is presumed to reflect concept formation based on passive acceptance of entire stimuli. It has been suggested (Wachtel, 1968) that Kagan's analytic-relational dimension and Witkin's field dependent-independent dimension may be very much the same for children, but can be differentiated for adults on the basis that the former represents preference for analytic style while the latter is based on capacity for analytic functioning. Other evidence (Kagan et al., 1963) of a positive relationship between response time to produce a concept and number of analytic concepts produced led Kagan into the study of his well-known reflectivity-impulsivity dimension of cognitive style. The work of the Kagan group indicates a belief that the analytic conceptualizing style is superior and developmentally more

advanced than the relational one. They report evidence (Kagan et al., 1964) that analytic concept grouping increases with age. Later evidence, however (Bruner et al., 1966; Wallach & Kogan, 1965), suggests that this is too simple an interpretation and that use of analytic and relational conceptualization is affected by the nature of the stimulus material used in the sorting task. This is in contrast to the equivalence range aspect of conceptualizing style, which shows a tendency to be stable across types of stimuli.

Because work in the reflective-impulsive cognitive style is both more advanced and subsumes much of the conceptualizing style concern, this style may be of less current interest for research in training impact than some others.

CONCLUSION

Ten cognitive styles have been reviewed, with specific attention given to evaluation of measuring instruments of each style and to promise for research and application to Air Force technical training. The material presented in this review indicates that psychologists and educators (trainers) should be concerned with the impact of these cognitive styles upon instruction and training. Of the ten cognitive styles covered, three styles were singled out as being the most promising ones for research concerning Air Force technical training: field dependence-independence, impulsive-reflective. and visual-haptic. These styles were found to have been the most researched, have the best defined constructs, and have the most accurate measures. Also of importance was the fact that these styles involve aspects of cognitive and perceptual functioning for which reasonable hypotheses present themselves regarding impact on performance in Air Force technical training. In addition to these three styles, leveling-sharpening may--with additional refinement of the measures--have more implications for training than has been apparent thus far in the research. The remaining six cognitive styles, although holding promise for psychologists and educators, seemed less directly applicable to concerns of Air Force training.

The field dependence-independence cognitive style is well suited for research into the interaction between cognitive style variables and training. The literature indicates that individuals from each end of this cognitive style dimension should have distinct advantages under different circumstances. For example, field-dependent individuals are much better in interpersonal situations, while field-independent individuals are better at tasks requiring analytical structuring abilities. Both ends of this cognitive style continuum have adaptive properties which hold implications for training and instruction.

The impulsive-reflective cognitive style also seems to be well suited for consideration in Air Force instructional design. As mentioned previously, individuals who are reflective (slow, accurate) in contrast to those who are impulsive (fast, inaccurate) will probably have differing levels of success in tasks that involve response uncertainty. Differences in impulsive-reflective students' performance and time would be expected in individually paced courses of Air Force technical training.

The visual-haptic cognitive style is another cognitive style which may prove important. The research indicates that this style (like field dependent-independent and impulsive-reflective) also represents a continuum, in this case with haptics and visuals on each extreme. The visual-haptic style may have implications for Air Force training. One area of direct relationship may involve highly technical training courses, such as those involving electronics or troubleshooting, in which the ability to visualize complex stimuli is a necessity. Research into the visual-haptic style may suggest ways in which instruction can be adapted to better performance.

Research with the leveling-sharpening dimension has not been conclusive. This cognitive style could have importance in the study of learning and retention of new material, but conflicts in present research have made assessment of this dimension more difficult. Refinements of the leveling-sharpening measures may clarify the implications of this style for training design.

Although the remaining cognitive styles reviewed seem to hold less promise for research as it relates to Air Force training, they remain generally important psychological dimensions that may become more important after they have been more thoroughly researched.

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