THE EFFECTS OF INSTRUCTION AND STIMULUS CONTEXT ON ANGLE ESTIMATION IN FIELD DEPENDENT AND FIELD INDEPENDENT OBSERVERS

by

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Introduction

For most perceptual experience, the retinal image is rarely an accurate reflection of the distal form. The visual angle that an object subtends changes as a function of the orientation of that object relative to the perceiver. As an object moves away from an observer, the visual angle becomes smaller; thus the projected retinal image of the object becomes smaller. Likewise, as an object is rotated in three dimensional space, the shape of the retinal image of the object alters. In spite of this change in the retinal image, the observer usually maintains a constant, objective, interpretation of the qualities of an object. This phenomenon is known as perceptual constancy. The existence of the constancies is well documented and has been extensively studied (Epstein, 1977).

The phenomenon of constancy is evident in the perception of corners of closed figures. For example, as a rectangle is rotated in three dimensional space the right angle corner becomes more acute or obtuse, and the shape of the figure becomes trapezoidal in appearance. A 90 degree angle, while prominent in many environments, is rarely experienced retinally. Such an angle will most often subtend an acute or obtuse retinal image, depending on the relative orientation between the observer and the angle. Angle constancy exists to the extent that one maintains the cognitive interpretation of a right angle for an obtuse or acute image. This is to say that one may perceive an angle to be 90 degrees even though

the retinal image is not 90 degrees. The effect is that of underestimating obtuse angles and overestimating actue angles. In this way, one may move through the environment, and maintain a sta-le perception of surrounding objects. Thus, given knowledge of the orientation of the rectangle the observer may easily interpret the shape of a rectangle, in spite of the trapezoidal appearance.

There are individual differences in the degree of the interpretation of contextual cues such as orientation. An observer may have a tendency to interpret stimuli in a distal mode (field dependence), in which case context would be important, or in a proximal mode (field independence), where context may be ignored. In the former case, one would expect a high degree of constancy in the angle judgment, but not in the later case. Field dependence (FD) and field independence (FI) are considered to be variables of cognitive style (Witkin, 1954), which refer to the structural components of the stimulus the observer uses to perceptually organize the environment (Goldstein and Blackman, 1978). Theoretically, the field independent is one who perceptually organizes the environment according to proximal cues and the field dependent is one who organizes the environment according to distal cues.

Individual differences have been studied in regard to most of the constancies such as size and brightness, but not angle estimation. Explanations which have been suggested in the past involve personality or cultural factors as variables

influencing perception. The "carpentered world" research of Segall, Campbell, and Herkovitz (1966) attempted to demonstrate that environmental differences may lead to differences in an individuals ability to perceive size constancy.

Thouless (1932) studied perceptual/personality differences between individuals in the tendency to exhibit size constancy. He termed this tendency the "phenomenal regression" to the 'real' object. Subjects were instructed to report on the apparent size of an object. Two discs were used as stimuli, one larger than the other. The smaller disc was moved toward the subject until it was reported to be equal in size to the larger disc. It was found that subjects reported the two discs equal in size when the actual retinal image of the small disc was larger than the retinal image of the large disc. The "phenomenal" size reported was a compromise between retinal size and the object's real size. Thouless investigated these results further, and found individual differences which broke into main response sets. He termed these synthetic and analytic responses. The synthetic responders exhibited size constancy. These people used the objective stimulus of distance cues as the basis for the judgment of size. Analytic responders tended to judge size on the basis of retinal image.

Both types of responders which Thouless discussed may be aware of the other alternative response, but they are dispositionally inclined to respond in a particular mode. It is likely that each is capable of the alternative percep-

tion, and that instructions would direct the observer to the response type that the experimenter chooses. This issue will be explored later.

Field Dependence

Similar to the response set of Thouless, Witkin (1954) presented evidence indicating two different perceptual modes for processing stimuli. These modes were labeled field dependence and field independence. The former refers to a process by which an individual's perception is the result of a processing of distal cues in favor of proximal cues. Field independence refers to a reliance on proximal cues in the interpretation of the environment. Witkin first measured this variable using the Rod and Frame Test. The apparatus consists of a luminous square frame and rod. The rod within the frame could be pivoted independently of rotation of the frame. The subject's task is to judge the position of the rod. In order for this judgment to be correct, the subject must differentiate the position of the rod from the frame. If rod position is judged relative to frame position, there is a reliance on the visual field, hence field dependency. If the subject can report the true position of the rod, despite cues from the frame, the response is considered to be field independent.

Other tests developed by Witkin to measure FD and FI are the Tilting Room Tilting Chair Test, and the Rotating Room Test. Both of these evaluate the perception of body position, in relation to the environment. In the Tilting Room Tilting Chair Test, both the room and the chair within could be inde-

pendently adjusted away from vertical. The observer, seated in the chair, must indicate true vertical position by readjusting the chair or the room. The Rotating Room Test is similar to this except that the room and the chair move on a circular track. This motion produces centrifugal force, which may give cues to body position. A FI mode of perception would allow the subject to focus on proximal cues (body position), given distorting distal cues (tilted room).

The stability of test scores was measured with test-retest correlations given a time interval of over a year, Witkin (1949) reported correlations of .85 and .88 for men, and .86 and .87 for women.

Each of Witkin's tests measures ones ability to analytically break down a configuration into its discrete elements. The stimuli used in each test involve a surrounding field which must be disregarded if a correct perceptual judgment is to be made. The Embedded Figures Test (EFT) developed by Witkin is a paper and pencil test used to measure field dependency. Again this requires a subject to focus on a target independently from its surround. The EFT was found to be highly related to the other tests of field dependence. Witkin (1954) reports correlations between these tests to be in predicted directions and significant. Bouman (1951) found the EFT to be stable over time, given test-retest measures over a three year span.

A version of the EFT which permits testing is the Group Embedded Figures Test developed by Oltman, Raskin, and Witkin

(1971). Reliability between parallel test forms was .82 for both men and women. Validity of the Group Embedded Figures Test was measured using the Embedded Figures Test as a criterion. Correlations between the two tests were -.82 for men and -.63 for women (Witkin, Oltman, Raskin, and Karp 1971). Correlations were negative due to arbitrary differences in the scoring methods used for the two tests. These reliability and validity figures indicate that the Group Embedded Figures Test may be used as an alternative where individual testing is not feasible.

Sex Differences

Evidence indicates that women may be more field dependent than men (Witkin, 1971). Using the Group Embedded Figures Test, Witkin reported mean values of 12.0 for men and 10.8 for women. These values indicate number of items correct. Similar sex differences have been found using other measurement techniques of field dependence such as the Rod and Frame Test (Witkin, 1954, 1962). Validity data for the Group Embedded Figures Test have been reported to be lower for women than for men. The literature on sex differences, however, does not report consistent findings. Sherman (1971) and Goldstein and Blackman (1978) cite literature showing no significant differences between men and women on field dependence. Goldstein and Chance (1965) demonstrate a decrease of initial sex differences in EFT performance when both groups are given the same amount of practice.

In light of the evidence showing significant sex differences, particularly the lower validity of the test with women, research using data from Witkin's test should either conduct preliminary controls for sex differences or perform analyses which would show the influence of any existing differences.

Early in the discussion of individual differences it was considered that one may have a predisposition for a particular perceptual mode, yet one should be capable of using a different mode if directed to do so. Through instructions one may determine the extent to which this is true and possibly assess the strength of a perceptual style.

Instructions and Perceptual Constancy

Carlson (1960, 1962) studied the effects of instruction on size estimation. In the first paper he used three instruction forms: apparent size, objective size, and projective size. Two triangles were presented. The observer adjusted the near 'variable' triangle to match a far 'standard' triangle. For an apparent size match, the subject adjusted the variable such that it looked equal to the standard, not in a physical realm, but as it appeared to the subject. In the objective condition the subjects were to try to ignore apparent size and match the triangle such that both would be equal in actual physical dimensions, this being constancy. In the projective size instructions (retinal image) the subjects adjusted the variable triangle so its subtended visual angle would be equal to the angle subtended by the standard. Carlson (1962)

added a perspective size instruction in which observers lined up the variable triangle with the standard in a linear perspective method. The purpose of this was to enhance the objective mode bias. These instructions resulted in an overestimation of size. Observers were influenced more by contextual distance and perspective cues and less by visual angle.

The conclusions of Carlson (1960, 1962) were that overestimation in size judgments is due to response bias induced in the observer by the experimenter's instructions. In the case of objective size judgment the subject assumed a perspective attitude and made larger settings for a far variable triangle. This may demonstrate an over compensation of perspective to achieve a physical size match. The ability that these instructions have to manipulate response bias makes them an important research tool. The influence of instructions indicate that cognitive processes play an important role in perception beyond the physiological response to a stimulus percept. The attitude of the observer is an important component in how the environment is interpreted. The ability the researcher has to manipulate to observer's attitude allows us to examine the relationship between perception and attitude, and the use of environmental cues in perception. In the next section a discussion is made of research which has used instructions similar to those developed by Carlson for the study of individual differences in constancy.

Instructions, Constancy, and Individual Differences

Linden (1976) investigated the relation between size constancy and RFT performance under various instruction conditions. Instructions were designed to manipulate perceptual attitude. Apparent-object instructions directed the observer to respond to the object as it appears without any reliance on known laws of perspective or retinal size. Subjects were to judge the object according to their own reactions or perceptual style. The second instruction set was that of retinal-equality. Subjects were to take an 'analytic' attitude, and base their judgments according to the retinal image.

Linden theorized that FD subjects would be less able to attend to the retinal image size. The conflicting environmental cups to perspective would create a powerful set away from the retinal image. Results support this notion. Significant correlations were found between field independence and retinal matches in the analytic condition. These subjects were not influenced by the frame in the RFT, nor were they influenced by the cues to perspective in the size judgment test.

Signam and Oltman (1977) measured the relation between FD, FI and size judgment. Each stimulus consisted of a diamond shaped structure surrounded by a frame. The frame was used to increase the degree of constancy in judging the size of the enclosed figure by adding context. Sigman et al. predictated that there was a stable cognitive style which accounts for the magnitude of the framing effect. A measure of field

dependence in Witkin's RFT and EFT was correlated with size judgments under different framing and distance conditions. In the first condition two equal sized frames were shown at different distances from observers and in the second condition two different sized frames were shown at the same distance. A greater use of the frames was expected to bring about greater visual illusion in the second condition and greater constancy in the first. The frame use expected to be higher for the FD subjects. Correlations between unequal frame effects and FD were found to be significant, indicating a relation between perceptual style and size judgment. There was a reduction in this relation where cues to distance were lessened with equal frames.

If individual differences in the constancies are a compelling variable, they should be manifested in a wide range of perceptual phenomena. The present paper was an attempt to extend this range of phenomena with a discussion of how individual differences may affect angle constancy and present research which could define this effect.

Shape Constancy

The shape of an object, despite different orientations of that object, tends to remain perceptually stable. This is referred to as shape constancy. In an early study, Thouless (1932a) found that a perceived shape of an object was between the true objective shape, and the projective (retinal) shape. In later research, variables such as instruction, surrounding cue conditions, and object orientation were found to influence

perceived shape. Besides the effects of these variables there were systematic differences in the degree of shape constancy exhibited by individuals. These individual differences provide theoretical implications on the nature of shape constancy.

The finding of individual differences in shape constancy demonstrate that the phenomenon of constancy is not wholly determined by the stimulus. An object may subtend the same retinal image to different individuals, yet be judged differently by each observer. This indicates that each individual processed the perceptual information differently. The influence of instructions on size constancy reported earlier supports the theory that perceptual processing is part of an active and cognitive interpretation of the environment by the observer. The presence of individual differences provides further support to this theory.

Individual differences in shape constancy have been reported by Thouless (1932), Sheehan (1938), Moore (1938), Weber (1939), and Lichte (1952). In an investigation of shape judgment Lichte (1952) found that, while observers tended to be consistent in their judgments, some showed consistently high degrees of constancy. Lichte suggests that these differences may be due to uncontrolled attitudes of the observer. Following is a discussion of experiments which have attempted control of these attitudes through the use of instruction.

Instructions and Shape Constancy

Instructions have been found to be effective in directing the observer to an objective, analytic, or apparent attitude

(Gottheil and Bitterman, 1952; Epstein, Bontrager, and Park, 1962; Winnick and Rogoff, 1965; Lichte and Borressen, 1967; Kraft and Winnick, 1967; Landauer 1969; and Gregg and Pasnak, 1971). Epstein, Bontrager, and Park (1962) used phenomenal, objective, and analytic instructions and had observers adjust the height and base of a variable triangle. A background wall was varied by the experimenter to three degrees of slant: vertical, 20 degrees towards the observer, and 20 degrees away. Seperate monocular and binocular viewing conditions were conducted. Matches under objective instructions and binocular viewing conditions were closer to objective shape than were matches made under analytic and phenomenal instructions. Under monocular viewing instructions were ineffective. Observers also reported the perceived slant of the standard. Under monocular viewing instructions were ineffective. Observers also reported the perceived slant of the standard. Under monocular viewing the effect of the background slant on the perceived slant was greater than under binocular viewing. This is because under *monocular* viewing the background slant provided the major source of cues to slant.

Similar results using objective, image (retinal), and apparent instructions were found by Lichte and Borressen (1967). Under objective instructions a high degree of shape constancy was found. Image and apparent instructions did not differ significantly from each other. Results found under apparent instructions overlapped results found under both objective and image instructions. Landauer (1969) repli-

cated the findings of Lichte and Borressen with one exception. Apparent instructions were found to be significantly different from projective, or image instructions. Analyses demonstrated that apparent instructions produced responses which were unique from those of objective and projective instructions.

Indirect evidence of the effects of attitude on shape constancy was found by Thouless (1932), Sheehan (1938), and Leibowitz, Waskow, Loeffler, and Glaser (1959). These studies did not formally investigate the effects of instructions on shape constancy, but present evidence consistent with findings discussed above.

Stimulus Familiarity

Stimuli used in shape constancy research have most often consisted of simple geometrical forms. Such forms may have properties of familiarity or meaningfulness. Lappin and Preble (1975) displayed polygons in two different conditions consisting of complex and meaningful backgrounds. Observers judged the size of specific angles in these polygons using an objective or projective attitude. Projective instructions proved to be much less effective than objective instructions. Observers found it difficult to report a projective angle which was embedded on a three dimensional, meaningful form. Lappin stated that this supports the notion that the perceptual process operates primarily on a three dimensional basis rather than from a two dimensional retinal image. Lappin and Preble however, did not include slides of the same

polygons against a plain background, and the absence of projective responses could have been due to an artifact of the projective instructions.

Stimulus familiarity refers to the amount of exposure the observer has with the stimulus. Frequency of trials is often used to manipulate exposure time and therefore stimulus familiarity. Borressen and Lichte (1962) demonstrated an increase in shape constancy as the number of trials increased. From these results it was concluded that shape constancy was a function of stimulus familiarity.

These studies by Lappin and Preble (1975) and Borressen and Lichte (1962) indicate that distal properties of the stimulus such as dimension, context, and meaningfulness have a part in the perceptual processing which leads to constancy. The influence of such variables supports the idea discussed earlier that the observer has an active role in perceptual processing. It is possible that individual differences may show if the observer was measured on how these variables were interpreted. Context and meaningfulness may be used more by a field dependent rather than a field independent because, according to Witkin, the FD observer is more influenced by distal cues.

Many other variables have been found to influence the degree of shape constancy. These variables often involve cue reduction such as monocular viewing (Stavrianos, 1945; Beck and Gibson, 1955; and Epstein, Bontrager, and Park, 1962) or lumiance and exposure time (Leibowitz, Mitchell,

and Angrist, 1954; and Leibowitz and Bourne, 1956). Epstein and Park (1963) provide a review of the literature which explores the many variables used in shape constancy research.

Despite the information which has been amassed concerning shape constancy, there is little in the way of a sound theory describing the relationship between physical shape and perceived shape. One attempt at building such a theoretical framework was the shape-slant invariance hypothesis. This hypothesis proposes a relation of apparent slant to apparent shape according to the retinal projection, (Koffka, 1935; Beck and Gibson, 1955). The retinal projection determines a set of possible apparent shapes. When cues to the slant of an object are absent, the observer presumes a slant, according to the frontal plane, or background. The shape of the object is then determined by this presumed slant. When constancy occurs, the cues to slant are present (Beck and Gibson, 1955). Beck and Gibson tested this hypothesis by instructing observers to report the shape and slant of an object under monocular viewing conditions. Observers matched the standard with a comparison according to its frontal-parallel projection. Under binocular conditions, observers matched the standard to a comparison which was objectively equal. In the monocular condition, the frontal-parallel projection of the comparison changed with each judgment, thus perceived shapes were variable. This supported the invariance hypothesis.

Not all findings have provided the support for the invariance hypothesis that Beck and Gibson have. In the

Epstein, Bontrager, and Park (1962) study discussed earlier observers did not conform totality to the invariance hypothesis when judging slant. Neither perfect projective nor perfect objective matches were made according to apparent slant. The background slant, however, was found to affect the apparent slant of the standard as was discovered by Beck and Gibson. The different findings were likely due to different measurement techniques. Epstein et al. had observers choose from a continuously variable comparison. Beck and Gibson required that observers choose between the extremes of projective or objective judgments.

Other findings which have produced a weak link between apparent shape and apparent slant are Stavrianos (1945), Winnick and Rogoff (1965), and Kaiser (1967).

In order that functional relationships between stimulus variables and shape judgment be better understood, it is important that research in the area become more consistent in experimental procedure (Epstein and Park, 1963). Procedural differences in the literature have added to contradictory findings. In spite of these problems, however, the phenomenon of shape constancy and the effect of instructions have been consistently reported.

Angle Constancy

Angle estimation may work much like shape constancy, when contextual cues are present. The cues to angle estimation involve the form surrounding the angle. In the carpentered environment most observers have experience with 90 degree

angles as a prominent feature in the environment even though the right angle is rarely seen as a 90 degree retinal image (Cowan and Misceo, Note 1). For example, a 90 degree angle, rotated 45 degrees into the depth plane, subtends a retinal image of 109 degrees[1]. In spite of this, most observers could correctly report the distal image as 90 degrees. Thus, a 109 degree angle, embedded in a two dimensional or three dimensional "box" context, looks like a right angle. This is angle constancy.

Witkin's theory of field dependence indicates that FD observers find the presence of an embedding context to be more influential on the perception of a target than do FI observers. If this is the case, it may be that the FD observer has a greater tendency toward constancy judgments. As discussed earlier the work of Sigman (1977), Linden (1976), Witkin (1954), and Thouless (1932) indicate this tendency with size and brightness constancy, and theoretically such differences should also be found in angle constancy.

The present research represents an attempt to determine the differences between FD and FI individuals on an angle judgment task. The variable of stimulus dimension was designed to determine the effect of a more compelling three dimensional form, over a two dimensional form. The three dimensional forms were geometrical objects made from stiff poster board, the two dimensional objects were geometrical drawings on a flat paper. The surrounding context of the angle varied in terms of cubic interpretation. Angles were

presented in contexts which were not cubic at all, were somewhat cubic, and were highly cubic. The more cubic the surrounding context of an angle, the greater the expectation that 90 degree constancy would result. The variables of stimulus dimension and stimulus context may be factors which effect the meaningfulness of the object. The work of Lappin and Preble (1975) discussed earlier showed that the more meaningful the stimulus, the greater the degree of constancy. In the present experiment, the high degree of cubic context may be more meaningful to an observer than a lack of cubic context. Especially given the carpentered environment present in most societies at this time. In the absence of context, the only indication of angle size is the retinal image, which is determined by the object's position in space relative to the observer. One would not expect constancy in this condition.

Context, however, may direct the observer to more accurately interpret the object's orientation and geometrical properties. Thus a cubic surround would indicate a 90 degree angle. The extent to which the surrounds of the angle is used in the interpretation of that angle may be dependent, in part, on cognitive style. One would expect a FD observer to be most likely to show 90 degrees constancy with the presence of cubic context. According to Witkin's theory, these individuals tend to be influenced by context when making perceptual judgments. In contrast, the FI observer would be expected to show constancy only where instructions direct. When instruc-

tions do not direct the observer toward constancy, the FI observer would show an analytic attitude. According to theory, the FI subject would ignore context where it is not pertinent to the judgment. The present experiment explores these questions of how individual differences may be present in angle judgment. Furthermore, the nature of angle constancy itself, and the influence of variables such as context, dimension, and instruction are examined.

Method

Subjects. Thirty-six (18 males and 18 females undergraduate psychology students at Kansas State University participated as subjects in the experiment. It was required that subjects have at least 20-30 normal or corrected visual acuity. This requirement was stated on the subject sign-up sheet. Each subject received class credit for participation. The 36 participants were the 18 most extreme field dependent and the 18 most extreme field independent from a general psychology class of 176 students which were pretested on the Group Embedded Figures Test.

Test Materials. The Group Embedded Figures Test was used to separate the subjects into FD and FI groups. This test is an adaptation of the Embedded Figures Test which permits group testing. Appendix A contains an example of the test which is from the instructions of the actual Group Embedded Figures Test.

Stimuli: Three Dimensional Forms. Observers judged five different angles embedded in actual three dimensional figures. The angles were 150, 135, 120, 105, and 90 degrees. The figures consisted of three different contextual levels (high, medium, and low). The high context consisted of half of a box, seen as a full box by the subject. The medium contest was a construction of a box corner. High and medium context figures contain two sets of five angles besides the judgment set, which complete the three dimensional corner (see Table 1). The low context consisted of a flat triangle. High and medium context stimuli appear in Appendix B.

Place Table 1 about here

Stimuli: Two Dimensional Forms. Observers judged the same five angles listed above embedded in two dimensional figures. These angles represented the projected image of a 90 degree angle on the retina as it is rotated about a horizontal line through three dimensional space. These angles were presented in three context conditions: high, medium, and low. In the high context condition, stimuli consisted of line drawings of a box corner. The low context condition consisted of drawings of a single angle. Medium and high context two dimensional stimuli are presented in Appendix C.

All stimuli were mounted such that they were at identical orientations to the observer, with the apex of the judgment angle facing forward, toward the observer. The angles to be judged were marked by arrows in both three dimensional and two dimensional stimuli. Three dimensional stimuli were constructed from white poster board. The dimensional stimuli were drawn on white 8 1/2 x 11 paper, which was mounted on cardboard.

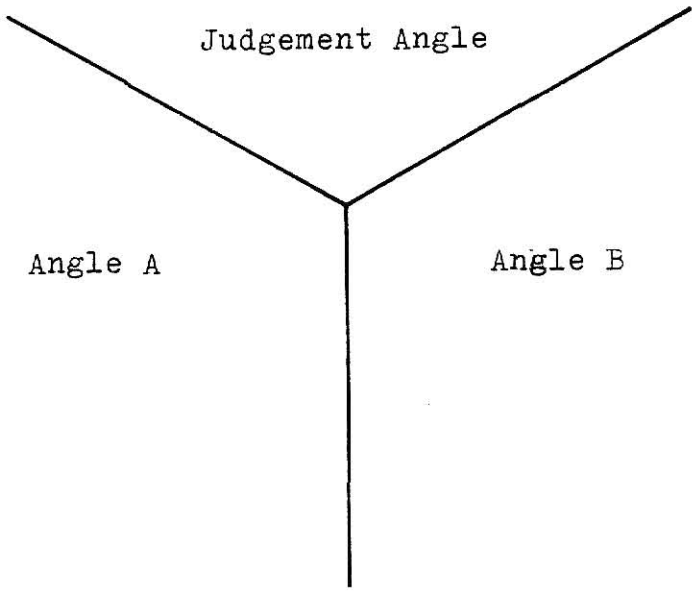
Apparatus. Stimuli were mounted on a vertical board, which stood 55.88 cm. from the observer. A goniometer was mounted on this board, 40.64 cm. to the right of the stimulus vertex. The goniometer consisted of a Pickett Protractor, model 6360, with two adjustable arms attached. The arms

Table 1

Angles comprising medium and high context three dimensional figures*

Judgment angle degrees	Angle a degrees	Angle b degrees
90	90	90
105	105	105
120	110	110
135	105	105
150	100	100

*Position of above angles on medium and high context three dimensional figures:



joined at the center of the protractor and could be independently adjusted to point in any direction around the circumference of the protractor. The observer's task was to adjust the arms of the goniometer such that it replicated the inspection angle. Degree values on the protractor were not visible to the observer. After each response, the degree values were recorded, and the arms of the goniometer returned to a horizontal or vertical position.

Design. In a 2 x 3 x 2 x 3 x 5 factorial design the independent variables were field dependence (FD, FI), instruction (objective, analytic, and apparent), dimension (three dimensional, two dimensional), context (high, medium, and low), and angle (90, 105, 120, 135, and 150). The dependent variable consisted of perceived angle measured by the goniometer. Instruction was a between subjects variable. Dimension, context, and angle were within subjects variables. The order of the context and angle stimulus variables was randomized. There were three replications per subject. The first replication was considered practice, the second and third replications were counter balanced for ascending and decending adjustment of the arms of the goniometer. Order of presentation of the three dimensional and two dimensional conditions was also counter balanced.

Procedure. Each subject was individually tested on angle judgment. All observers received one of the following instructional sets.

Three Dimensional Figures

General Instructions

You will be presented with three different figures (experimenter shows figures). These figures could be seen in the three dimensional space in which they exist, or they might be seen as flat projections on an imaginary flat surface.

Observers then receive the following instructions depending on which instruction condition they were placed.

Objective

Move the protractor upward (downward) so that it matches the angle given by the arrow, not as it may appear on a flat surface, but as it does appear in depth in the real world.

Analytic

Move the protractor upward (downward) so that it matches the angle given by the arrow, not as it does appear in depth in the real world, but as it might appear on a flat surface.

Apparent

Move the protractor upward (downward) so that it matches the angle given by the arrow, as it appears to you.

Two Dimensional Figures

General Instructions

You will be presented with 2, 3, and 9 line patterns (experimenter demonstrates). These patterns can be seen in the same plane as the paper on which they were drawn, or they could be seen as drawings of the corner of a sheet, the corner of a box, and a box. These interpretations may be seen as

figures rotated around a horizontal line into the depth plane (experimenter demonstrates).

Observers then received the following instructions depending on which instruction condition they were placed.

Objectives

Move the protractor upward (downward) so that it matches the angle given by the arrow, not as it appears flat on the page, but as it might appear in depth in the real world.

Analytic

Move the protractor upward (downward) so that it matches the angle given by the arrow not as it might appear in depth in the real world, but as it appears flat on the page.

Apparent

Move the protractor upward (downward) so that it matches the angle given by the arrow as it appears to you.

In cases where the observer did not understand the instructions in either the two dimensional or three dimensional condition, the instructions were repeated and clarified where necessary.

Results

Pretest

176 general psychology students pretested on the Group Embedded Figures Test. The mean score was 11.22 for females and 13.01 for males. From these distributions, extreme field dependents and field independents were selected. The distributions of subjects who participated in the experiment appear in Table 2.

Table 2

Distribution of subjects on

the Group Embedded Figures Test

Field Dependents	Mean	Standard Deviation
female	7	2.9
male	6.44	4.28
Field Independents		
female	17.44	.53
male	17.55	.53

Place Table 2 about here

Overall Analysis

An overall analysis of variance found that angle judgments of field dependent subjects were significantly different than judgments of field independent subjects $F(1,24)=14.22$ $p<.001$. Field dependents demonstrated a tendency toward constancy, the field independents showed greater analytic judgments. This supports the hypothesis that the two groups would judge angles differently, but it does not provide information on the effect of dimension, instruction, or context.

A main effect of dimension was found $F(1,24)=8.13$ $p<.01$, indicating differential judgments for two dimensional and three dimensional stimuli. In order to ascertain the effect of instruction and of context, it was necessary to conduct separate analyses for two dimensional and three dimensional stimuli. This was due to the presence of a significant higher order interaction; field dependence x instruction x dimension x context x angle, $F(16,192)=2.78$ $p<.001$. The following analyses consists of individual tests for simple main effects and simple interaction effects for the three dimensional and two dimensional conditions.

Three Dimensional Analyses

Overall Analysis

The analysis of three dimensional data showed a significant difference between field dependents and field indepen-

Table 3

Analysis of Variance Source Table
Three Dimensional Analysis

Source	Degrees of Freedom	Mean Square	F
FD/FI	1,24	12038.38	18.37***
Context	2,48	828.82	16.05***
Instruction	2,24	4525.63	6.91**
Angle	4,96	33730.03	546.30***
FD/FI x Angle	4,96	920.48	14.91***
Instruction x Angle	8,96	392.51	6.36***
Context x Angle	8,192	205.41	10.17***
FD/FI x Instruction x Angle	8,96	347.27	5.62***
FD/FI x Context x Angle	8,192	170.86	8.46***
FD/FI x Instruction x Context x Angle	16,192	41.34	2.05**

**$p < .01$

***$p < .001$

dents in angle judgment. Other significant main effects were context, instruction, and angle. No significant main effect was found for sex of subject, nor did this variable enter into any interaction. Table 3 presents F values for significant main effects and significant interaction effects (see Table 3).

Place Table 3 about here

The presence of higher order interactions suggests a complex relationship between field dependence, context, and instruction. Therefore, separate analyses have been conducted on individual cells in order to identify the source of each effect.

High Context

An overall analysis of high context judgments made with a cube found significant main effects of field dependence, instruction, and angle. Significant interactions were field dependence x angle, instruction x angle, and field dependence x instruction x angle. The presence of these interactions indicates that the pattern of responses through levels of instruction differed between field dependent and field independent subjects. Table 4 presents F values for the overall high context analysis, and for each separate analysis of instruction (see Table 4).

Place Table 4 about here

Table 4

Analysis of Variance Source Table
Three Dimensional-high Context Analysis

OVERALL ANALYSIS

Source	Degrees of Freedom	Mean Square	F
FD/FI	1,24	8163.48	37.49***
Instruction	1,24	2418.40	11.11**
Angle	4,96	8909.44	301.76***
FD/FI x Angle	4,96	946.70	32.06***
Instruction x Angle	8,96	216.99	7.35***
FD/FI x Instruction x Angle	8,96	170.85	5.79***

OBJECTIVE INSTRUCTIONS

Source	Degrees of Freedom	Mean Square	F
FD/FI	1,8	7741.11	80.20***
Angle	4,32	1708.95	56.10***
FD/FI x Angle	4,32	950.63	31.21***

APPARENT INSTRUCTIONS

Source	Degrees of Freedom	Mean Square	F
FD/FI	1,8	3282.93	22.71**
Angle	4,32	2804.82	92.19***
FD/FI x Angle	4,32	288.85	9.50***

ANALYTIC INSTRUCTIONS

Source	Degrees of Freedom	Mean Square	F
Angle	4,32	4829.56	176.35***

**$p < .01$
***$p < .001$

Given objective instructions, under high context stimuli, field dependents and field independents produced highly different angle judgments. Significant effects were field dependence, angle, and a field dependence x angle interaction (see Table 4). As illustrated in Figure 1, angle judgments by field dependent observers indicate a high degree of right angle constancy in that angles 90 to 150 were estimated to be from 90 to 98 degrees. These values consist of mean responses. In contrast, field dependent subjects tended to judge angles veridically.

Place Figure 1 about here

A similar pattern of responses by FD and FI subjects occurred under apparent instructions. Significant main effects were field dependence and angle. A significant interaction of field dependence x angle was also present (see Table 4). As occurred under objective instructions, the judgments of FI subjects were veridical. Field dependents demonstrated slight constancy, but unlike those under objective instructions, the judgments were intermediate that of a veridical slope and that of a 90 degree constancy slope (see Figure 2).

Place Figure 2 about here

In contrast with objective and apparent instructions, analytic instructions produced no differences in the angle

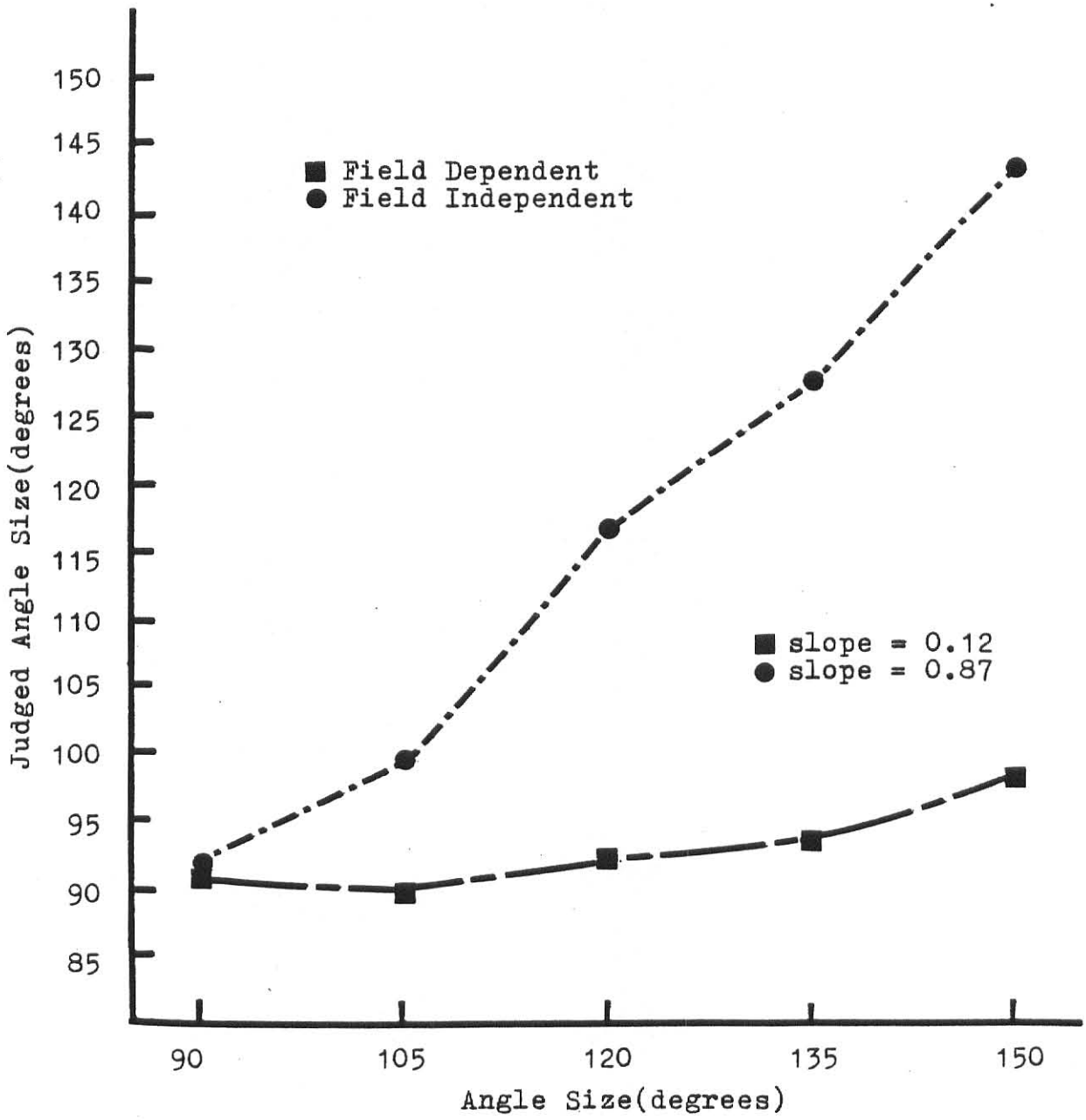


Figure 1. Angle estimation by FD and FI subjects given three dimensional high context stimuli and objective instructions.

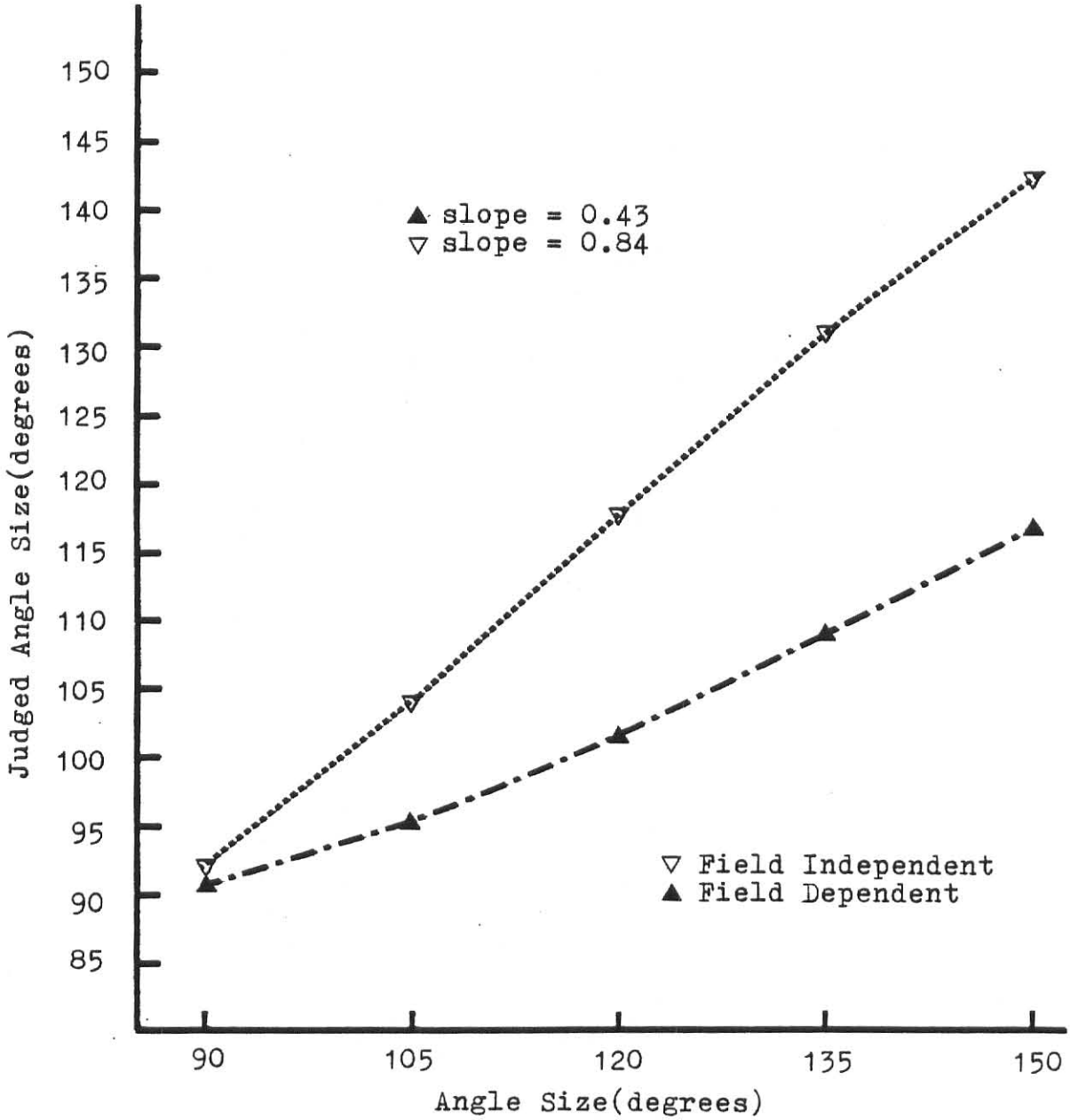


Figure 2. Angle estimation by FD and FI subjects given three dimensional high context stimuli and apparent instructions.

judgments of FD and FI subjects. A significant main effect of angle was present (see Table 4). Figure 3 illustrates veridical judgments by both field dependents and field independents (see Figure 3).

Place Figure 3 about here

Medium Context

An analysis of variance for three dimensional, medium context figures, i.e., cubic corners, revealed significant main effects for field dependence, instruction, and angle. Significant interactions were field dependence x angle, instruction x angle, and field dependence x instruction x angle. In order to determine the sources of these interactions, analyses for each instruction were conducted separately. Table 5 provides a source table for the overall medium context analysis and each separate analysis of instruction (see Table 5).

Place Table 5 about here

The analysis of objective instructions revealed main effects of field dependence and angle. A significant interaction of field dependence x angle was also present (see Table 5). The response of FD and FI subjects under medium context stimuli were similar to judgments under high context stimuli with objective instructions. Field dependents showed a high degree of right angle constancy, while field independents judged angles veridically (see Figure 4).

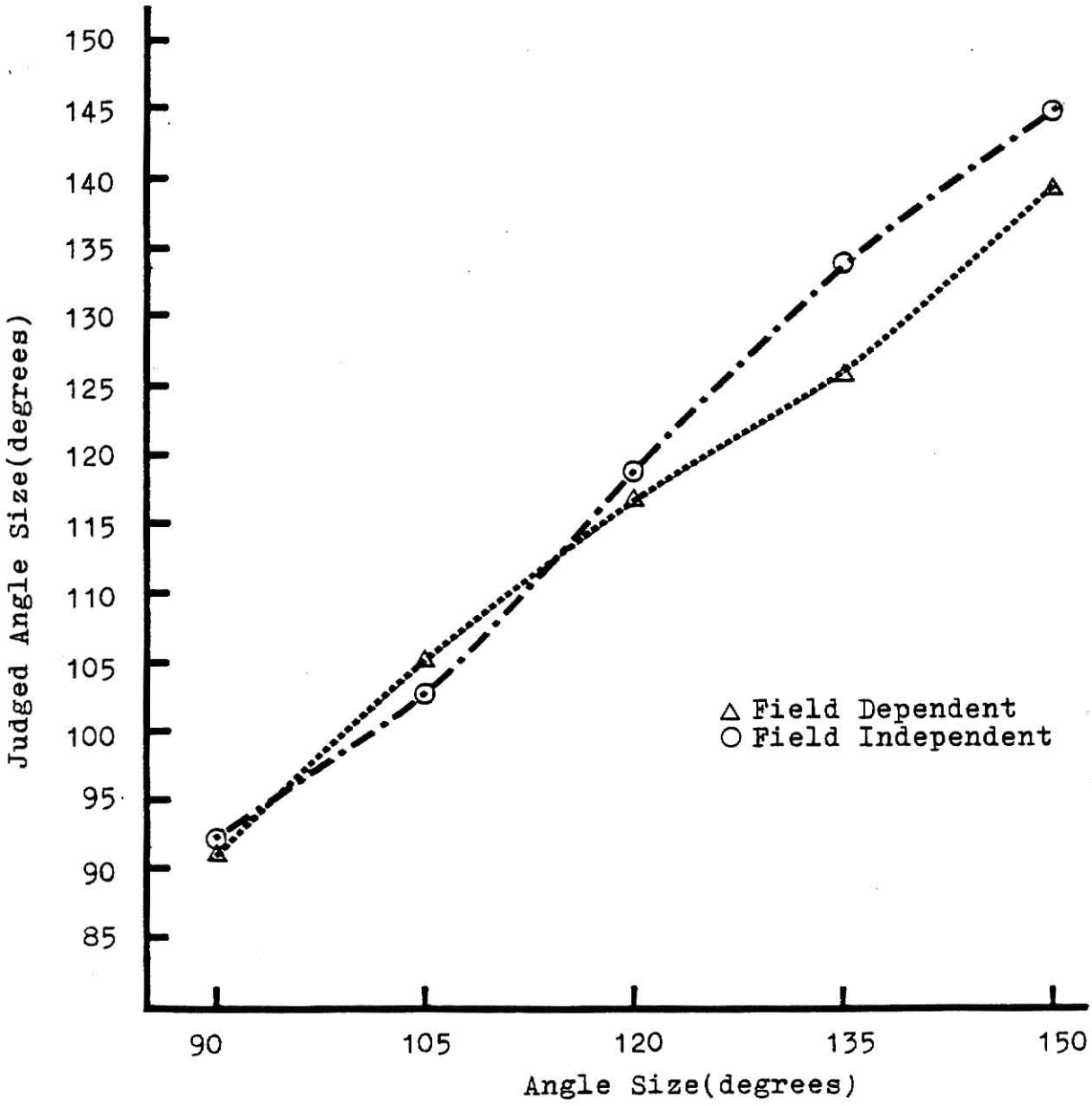


Figure 3. Angle estimation by FD and FI subjects given three dimensional high context stimuli and analytic instructions.

Table 5

Analysis of Variance Source Table
Three Dimensional-medium Context Analysis

OVERALL ANALYSIS

Source	Degrees of Freedom	Mean Square	F
FD/FI	1,24	3111.31	10.86**
Instruction	2,24	1797.93	6.28**
Angle	4,96	11041.01	294.67***
FD/FI x Angle	4,96	221.29	5.90***
Instruction x Angle	8,96	192.89	5.14***
FD/FI x Instruction x Angle	8,96	216.97	5.79***

OBJECTIVE INSTRUCTIONS

Source	Degrees of Freedom	Mean Square	F
FD/FI	1,8	6721.45	78.87***
Angle	4,32	2094.57	55.40***
FD/FI x Angle	4,32	609.37	16.12***

APPARENT INSTRUCTIONS

Source	Degrees of Freedom	Mean Square	F

ANALYTIC INSTRUCTIONS

Source	Degrees of Freedom	Mean Square	F
Angle	4,32	4978.08	126.90***

**$p < .01$
***$p < .001$

Place Figure 4 about here

The objective instruction condition was the only place where differences between FD and FI subjects occurred under medium context stimuli. Given apparent and analytic instructions, both groups judged angles veridically (see Figures 5 and 6). A main effect of angle was present in both conditions (see Table 5).

Place Figure 5 about here

Place Figure 6 about here

Low Context

Analysis of variance for three dimensional, low context stimuli, showed a main effect of field dependence and of angle. Unlike high and medium context analyses, no main effect of instruction was found. A significant interaction of field dependence x angle was found. The following separate analyses of instruction describe the source of the significant interaction. See Table 6 for a listing of *F* values for all low context analyses.

Place Table 6 about here

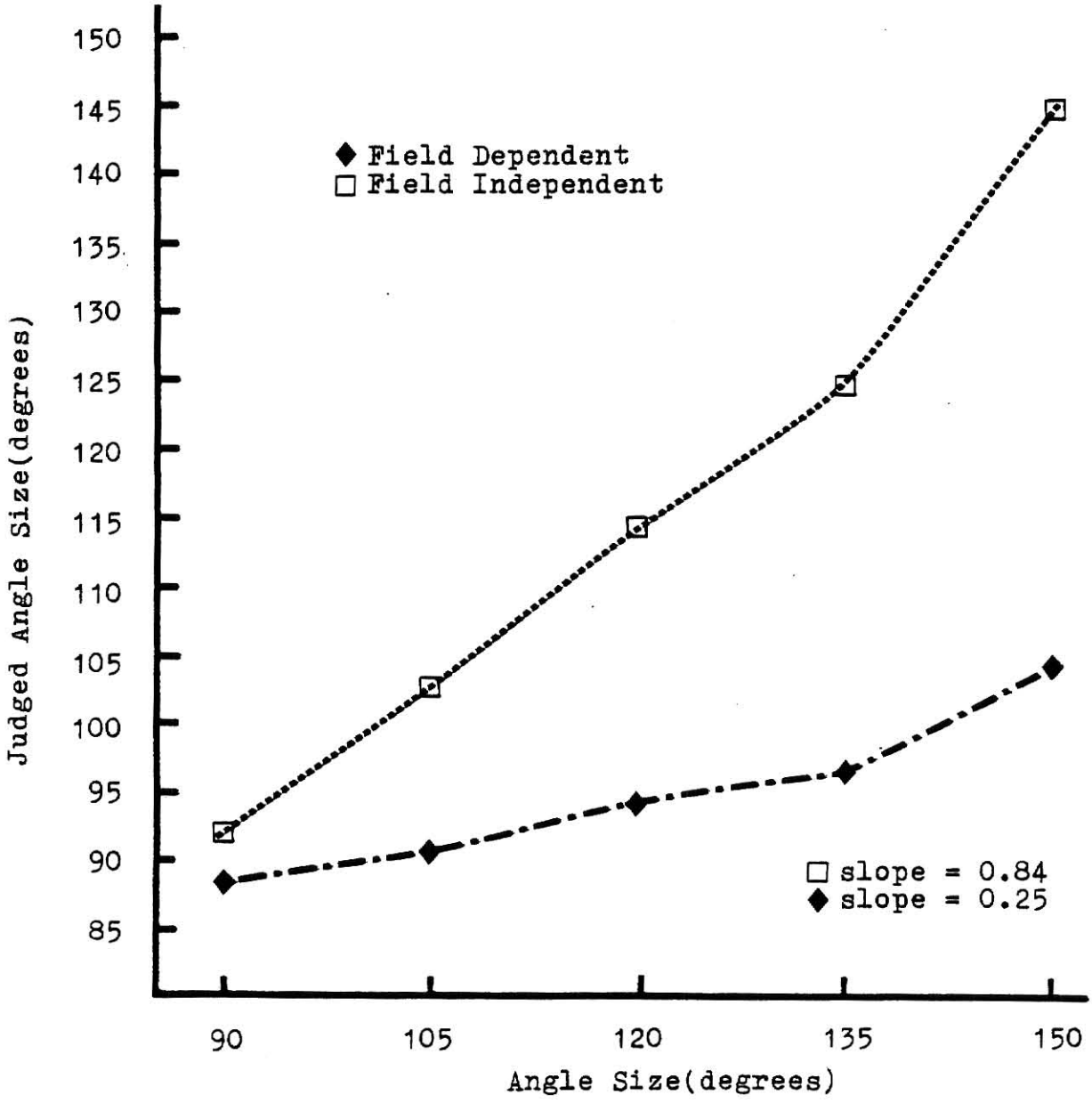


Figure 4. Angle estimation by FD and FI subjects given three dimensional medium context stimuli and objective instructions.

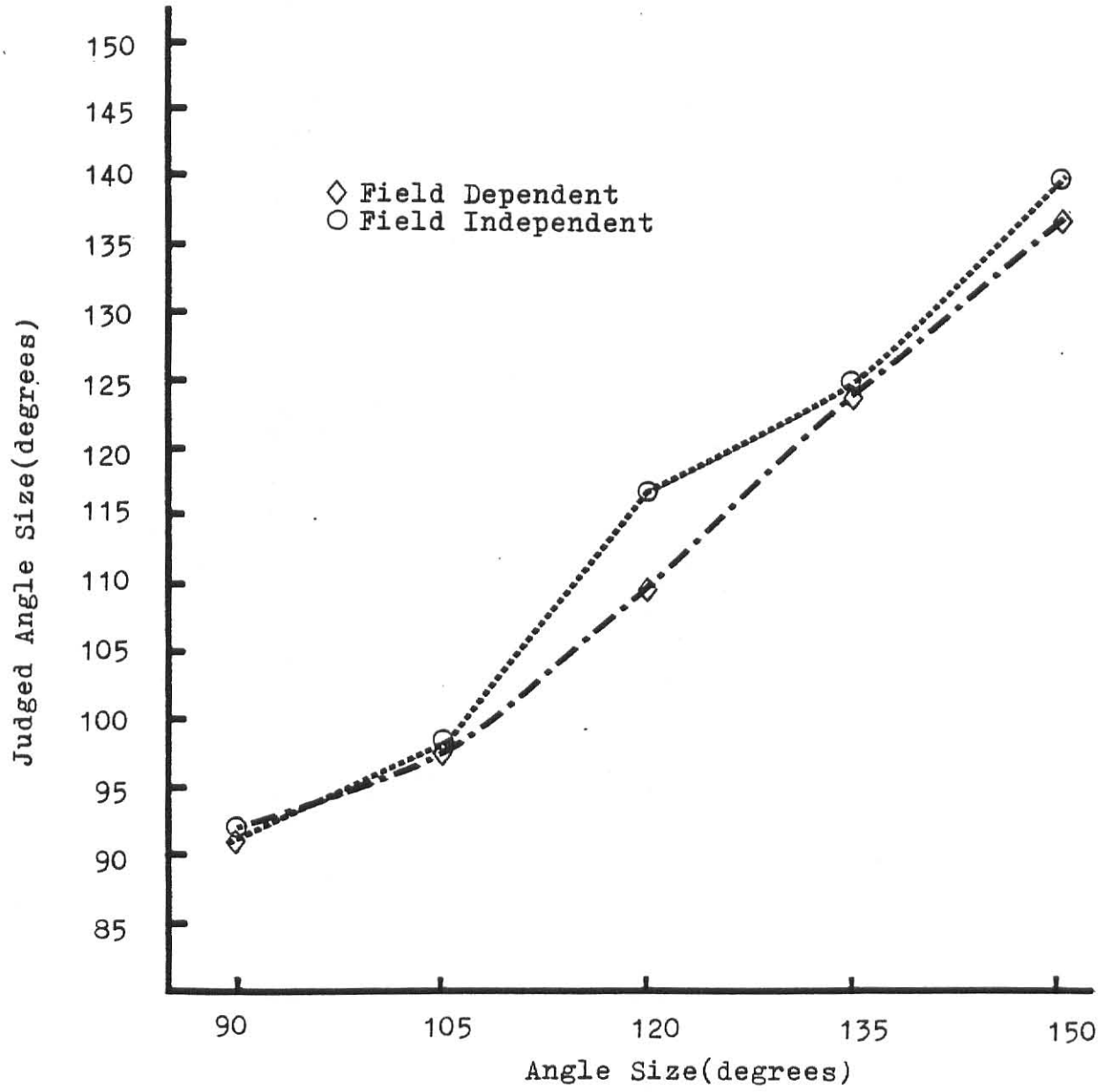


Figure 5. Angle estimation by FD and FI subjects given three dimensional medium context stimuli and apparent instructions.

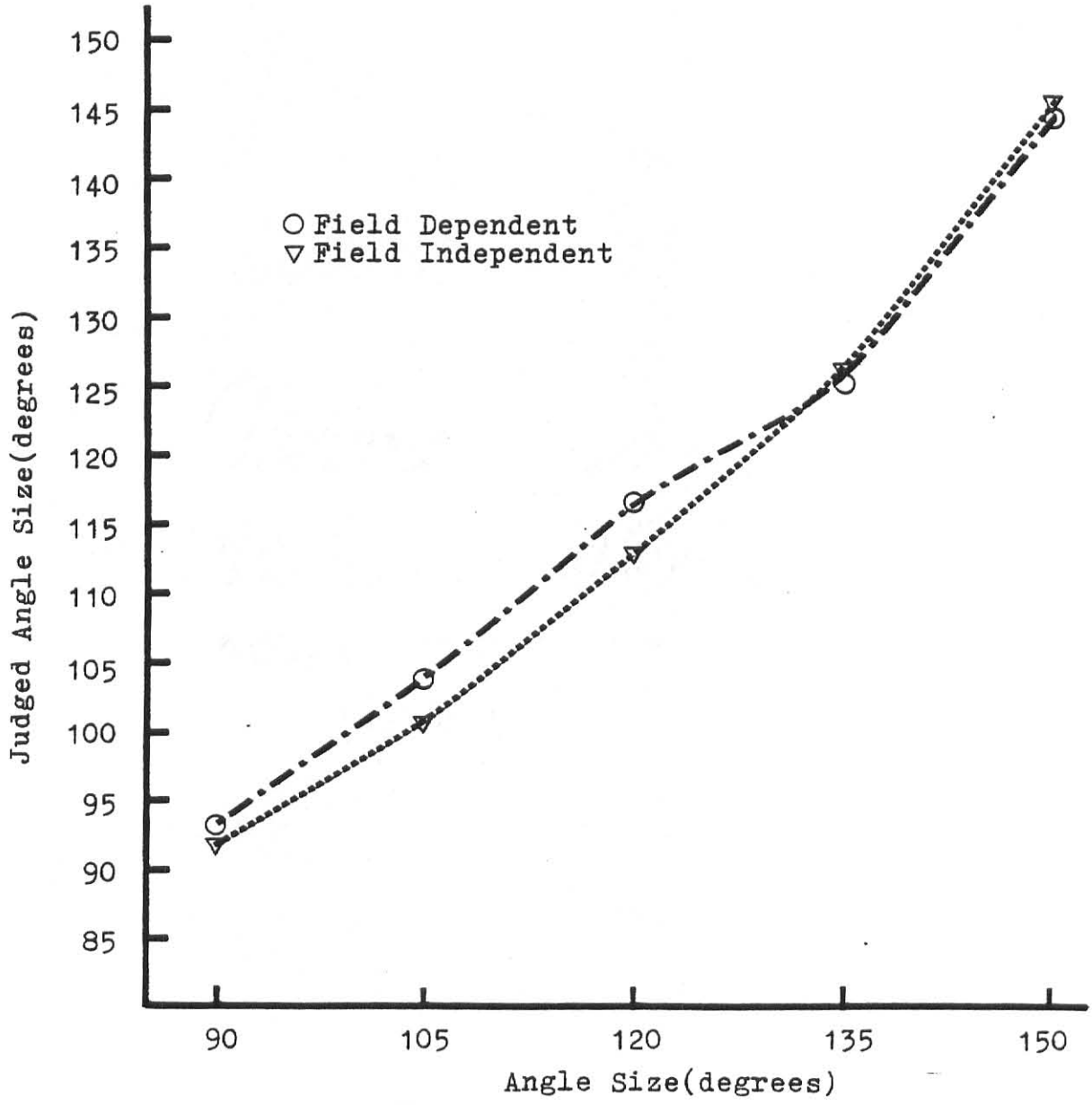


Figure 6. Angle estimation by FD and FI subjects given three dimensional medium context stimuli and analytic instructions.

Table 6

Analysis of Variance Source Table
Three Dimensional-low Context Analysis

OVERALL ANALYSIS

Source	Degrees of Freedom	Mean Square	F
FD/FI	1,24	1928.23	7.58*
Angle	4.96	14190.46	401.56***
FD/FI x Angle	4,96	94.32	2.67*

OBJECTIVE INSTRUCTIONS

Source	Degrees of Freedom	Mean Square	F
FD/FI	1,8	3949.54	18.04**
Angle	4,32	3579.89	85.69***
FD/FI x Angle	4,32	133.66	3.20*

APPARENT INSTRUCTIONS

Source	Degrees of Freedom	Mean Square	F
Angle	4,32	5626.44	173.61***

ANALYTIC INSTRUCTIONS

Source	Degrees of Freedom	Mean Square	F
Angle	4,32	5132.22	161.09***

*$p < .05$

**$p < .01$

***$p < .001$

Given objective instructions, field dependents showed different angle judgments from field independents (see Figure 7). also present was a significant main effect of angle and a field dependence x angle interaction (see Table 6). Both FD and FI subjects demonstrated close to veridical judgments. The field dependents, however, tended to underestimate angles relative to the field independents.

Place Figure 7 about here

Objective instructions was the only source of the field dependence x angle interaction. In both apparent and analytic instruction conditions the only main effect was of angle (see Table 6). Field dependent and field independent subjects judged angles veridically (see Figures 8 and 9).

Place Figure 8 about here

Place Figure 9 about here

Summary of Three Dimensional Analysis

The focus of the analyses was to determine differences in angle judgment between field dependent and field independent observers for three dimensional stimuli. The largest differences between these groups occurred when figures were embedded in a highly cubic context and when observers were given objective instructions. Field dependents demonstrated

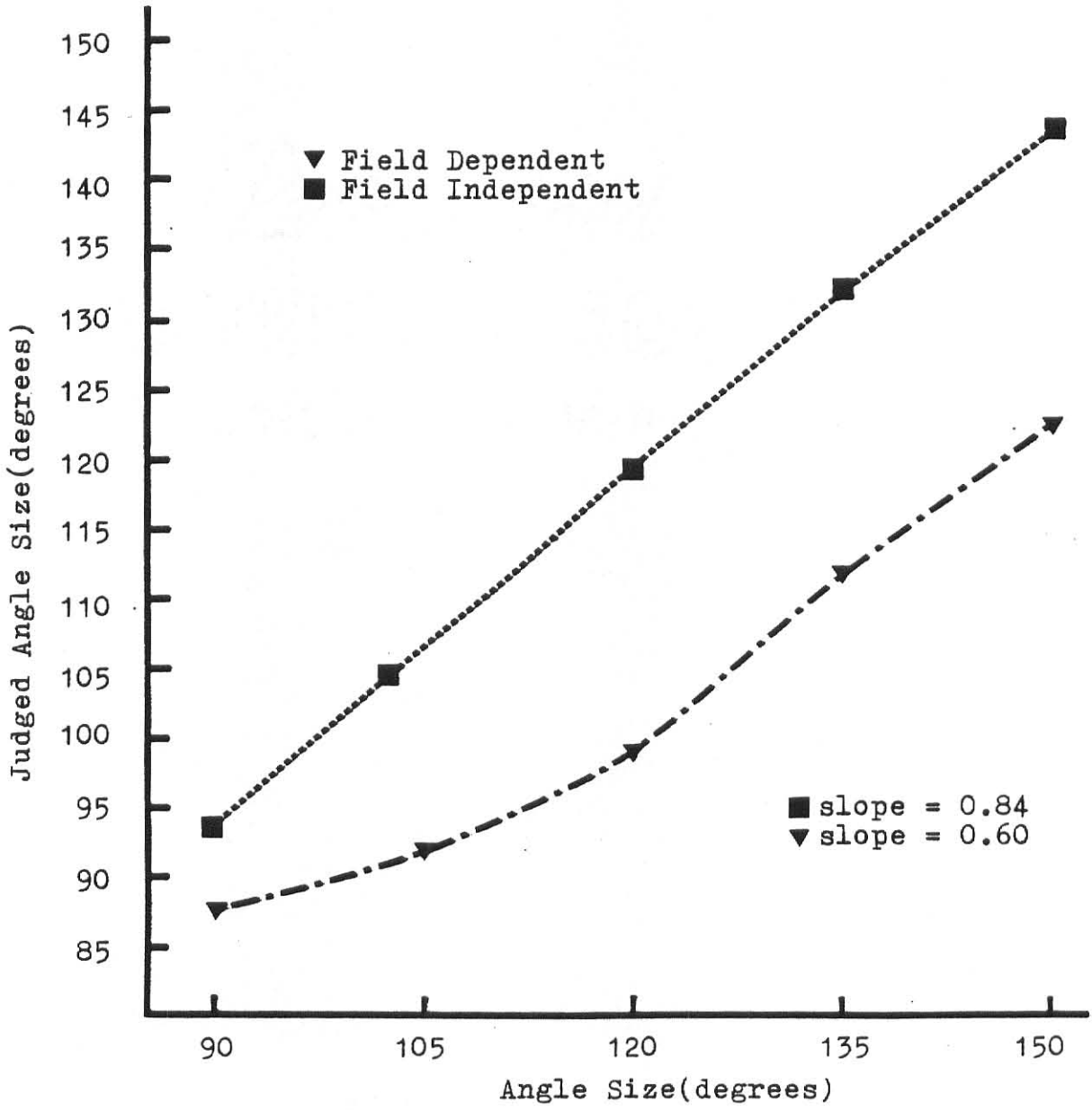


Figure 7. Angle estimation by FD and FI subjects given three dimensional low context stimuli and objective instructions.

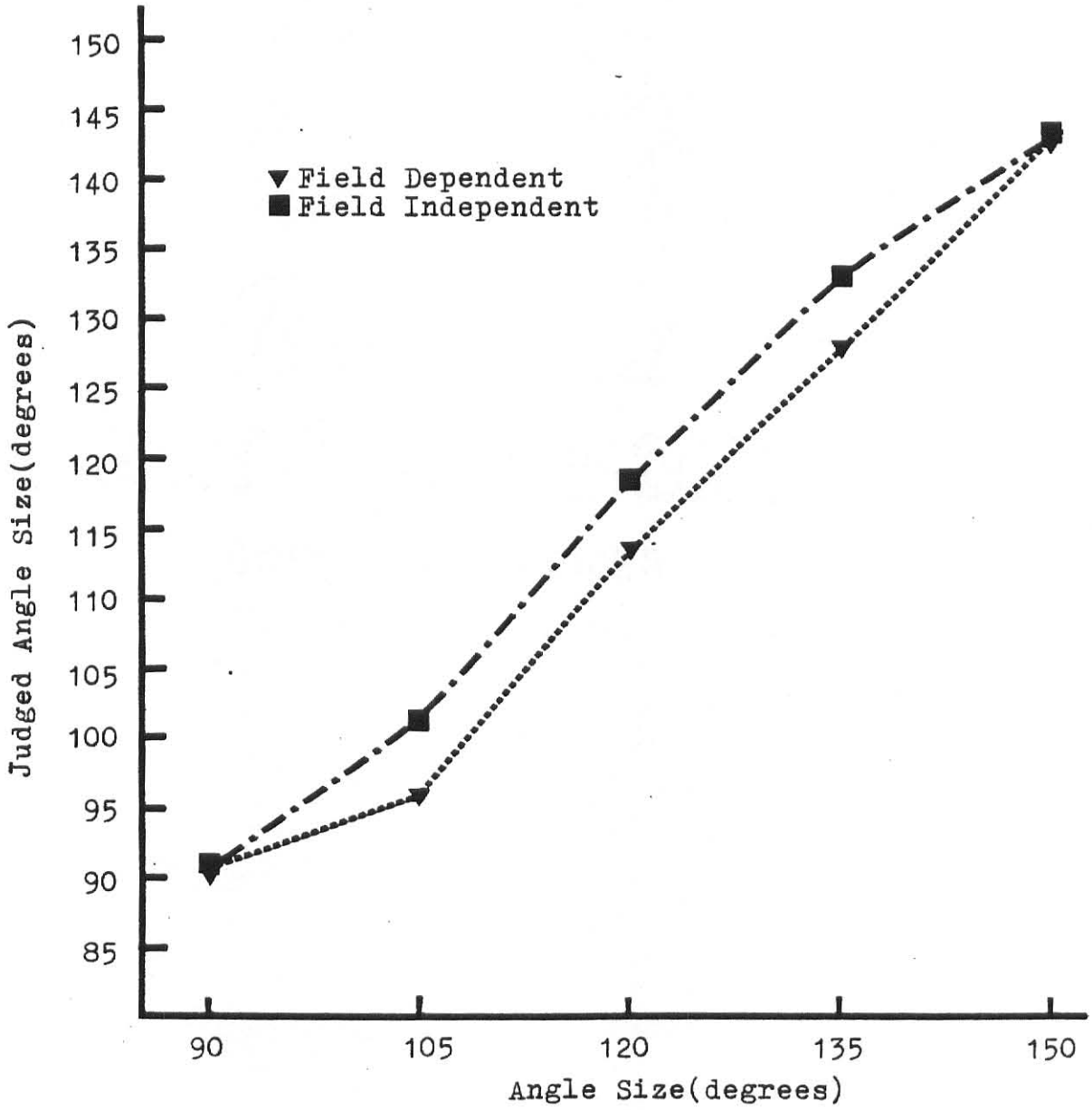


Figure 8. Angle estimation by FD and FI subjects given three dimensional low context stimuli and apparent instructions.

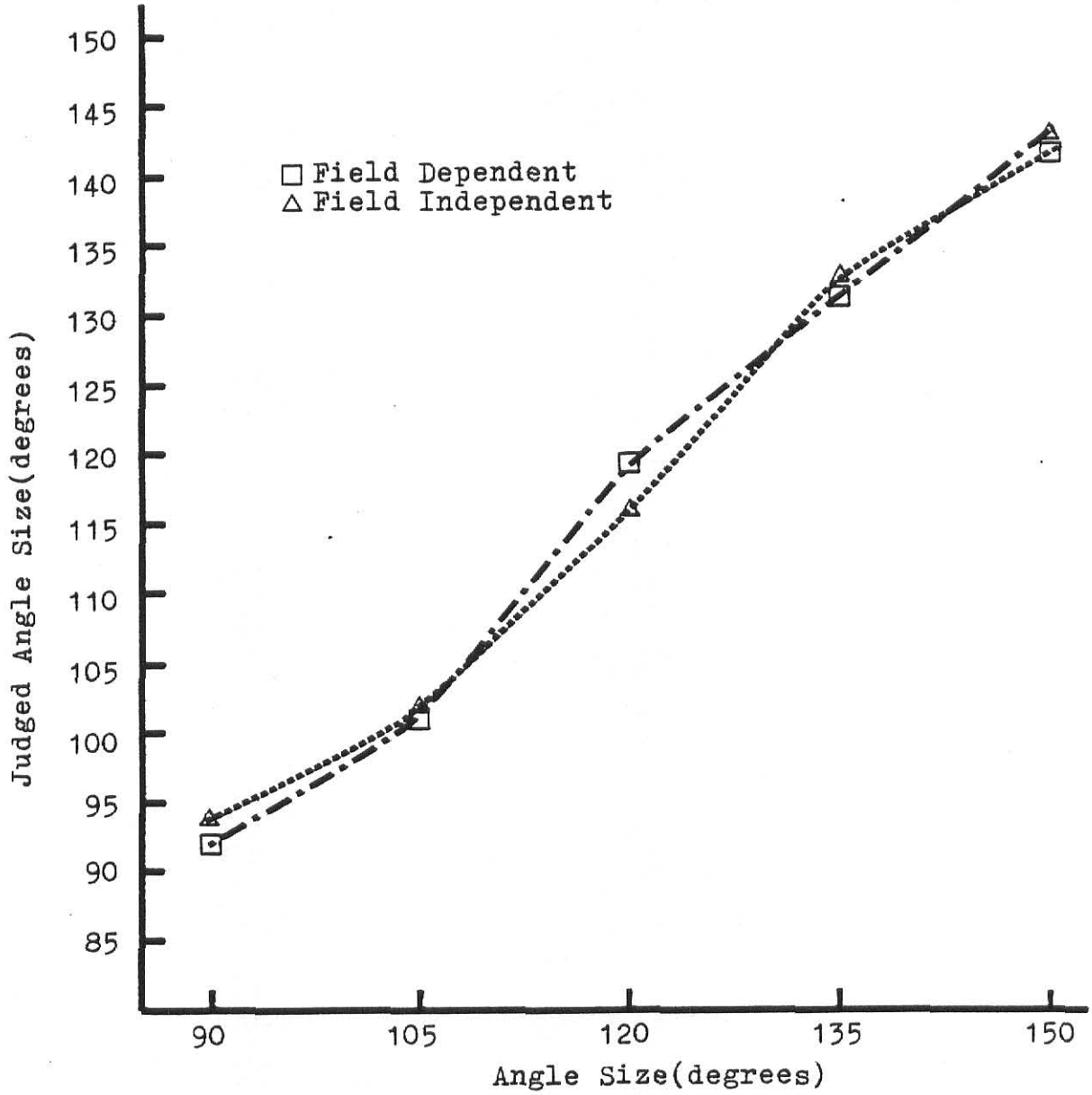


Figure 9. Angle estimation by FD and FI subjects given three dimensional low context stimuli and analytic instructions.

right angle constancy, while field independents judged angles veridically. These differences lessened under apparent instructions and were not evident under analytic instructions (see Figure 1, Figure 2, and Figure 3). This pattern was similar for medium and low context. Differences between groups lessened not only across instructions, but also across context. Medium and low context showed progressively less of a difference in angle judgment between field dependent and field independent observers.

Two Dimensional Analyses

Overall Analysis

The analysis of variance for two dimensional stimuli revealed significant main effects of field dependence, context, instruction, and angle. No significant main effect was found for sex of subject, nor did this variable enter into any significant interaction. Table 7 provides an analysis of variance source table for significant main effects and interaction effects in the overall two dimensional analysis (see Table 7). Due to the presence of significant higher order interactions, separate analyses have been conducted on individual cells in order to identify the source of each effect.

Place Table 7 about here

High Context

The analysis of high context judgments revealed significant main effects of field dependence, instruction, and

Table 7

Analysis of Variance Source Table
Two Dimensional Analysis

Source	Degrees of Freedom	Mean Square	F
FD/FI	1,24	2697.21	5.33*
Context	2,48	2823.27	53.95***
Instruction	2,24	12507.30	24.73***
Angle	4,96	33423.09	381.84***
FD/FI x Angle	4,96	408.98	4.67**
Instruction x Angle	8,96	1226.81	14.02***
Context x Angle	8,192	755.23	28.90***
Instruction x Context x Angle	16,192	178.46	6.83***
FD/FI x Instruction x Context x Angle	16,192	74.11	2.84***

*$p < .05$

**$p < .01$

***$p < .001$

angle. Significant interactions were field dependence x angle, instruction x angle, and field dependence x instruction x angle. Further analyses of each instruction revealed the source of the interaction effects. Table 8 provides analysis of variance source tables for all high context analyses (see Table 8).

Place Table 8 about here

Under objective instructions, there were no significant differences between field dependents and field independents. Figure 10 illustrates a high degree of right angle constancy for both groups of observers (see Figure 10). This is the only condition where both FD and FI subjects demonstrated constancy for either three dimensional or two dimensional stimuli. A marginally significant main effect of angle was present (see Table 8).

Place Figure 10 about here

The analysis of apparent instructions demonstrated more veridical judgments by both FD and FI subjects. Significant main effects of field dependence and angle, and a significant interaction of field dependence x angle were present (see Table 8). Field dependent subjects demonstrated a higher degree of right angle constancy than field independents (see Figure 11).

Table 8

Analysis of Variance Source Table
Two Dimensional-high Context Analysis

OVERALL ANALYSIS

Source	Degrees of Freedom	Mean Square	F
FD/FI	1,24	900.59	5.29*
Instructions	2,24	7997.85	47.05***
Angle	4,96	5787.95	194.81***
FD/FI x Angle	4,96	131.91	4.44**
Instruction x Angle	8,96	1060.04	35.68***
FD/FI x Instruction x Angle	8,96	162.49	5.47***

OBJECTIVE INSTRUCTIONS

Source	Degrees of Freedom	Mean Square	F
Angle	4,32	66.06	2.87*

APPARENT INSTRUCTIONS

Source	Degrees of Freedom	Mean Square	F
FD/FI	1,8	2152.56	21.87**
Angle	4,32	3568.94	213.29***
FD/FI x Angle	4,32	432.18	25.83***

ANLAYTIC INSTRUCTIONS

Source	Degrees of Freedom	Mean Square	F
Angle	4,32	4272.94	86.54***

*$p < .05$
**$p < .01$
***$p < .001$

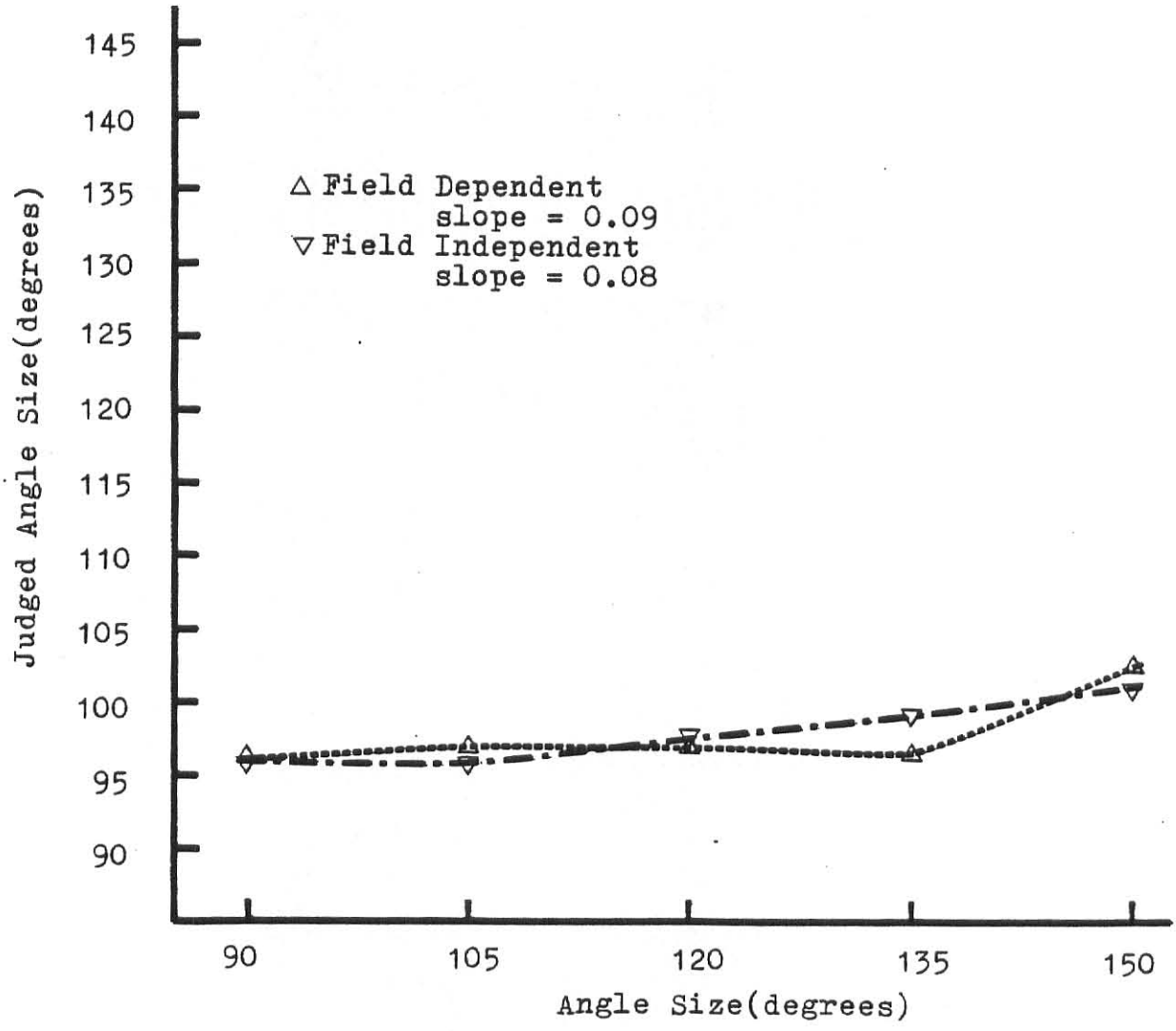


Figure 10. Angle estimation by FD and FI subjects given two dimensional high context stimuli and objective instructions.

Place Figure 11 about here

The trend toward veridical judgments continued under analytic instructions. Both field dependent and field independent subjects judged angles veridically (see Figure 12). A main effect of angle was present (see Table 8).

Place Figure 12 about here

Medium Context

The analysis of medium context data revealed main effects of field dependence, instruction, and angle. One significant interaction, instruction x angle, was present (see Table 9). The following analyses demonstrate the effect of instruction on the responses of FD and FI subjects given medium context stimuli.

Place Table 9 about here

Under objective instructions, main effects of field dependence and angle were found (see Table 9). There was no significant interaction present. In contrast with objective instructions under high context, the judgments of FD and FI subjects under medium context were more veridical (see Figure 13 and Figure 10). Field dependents demonstrated a greater degree of constancy than field independents.

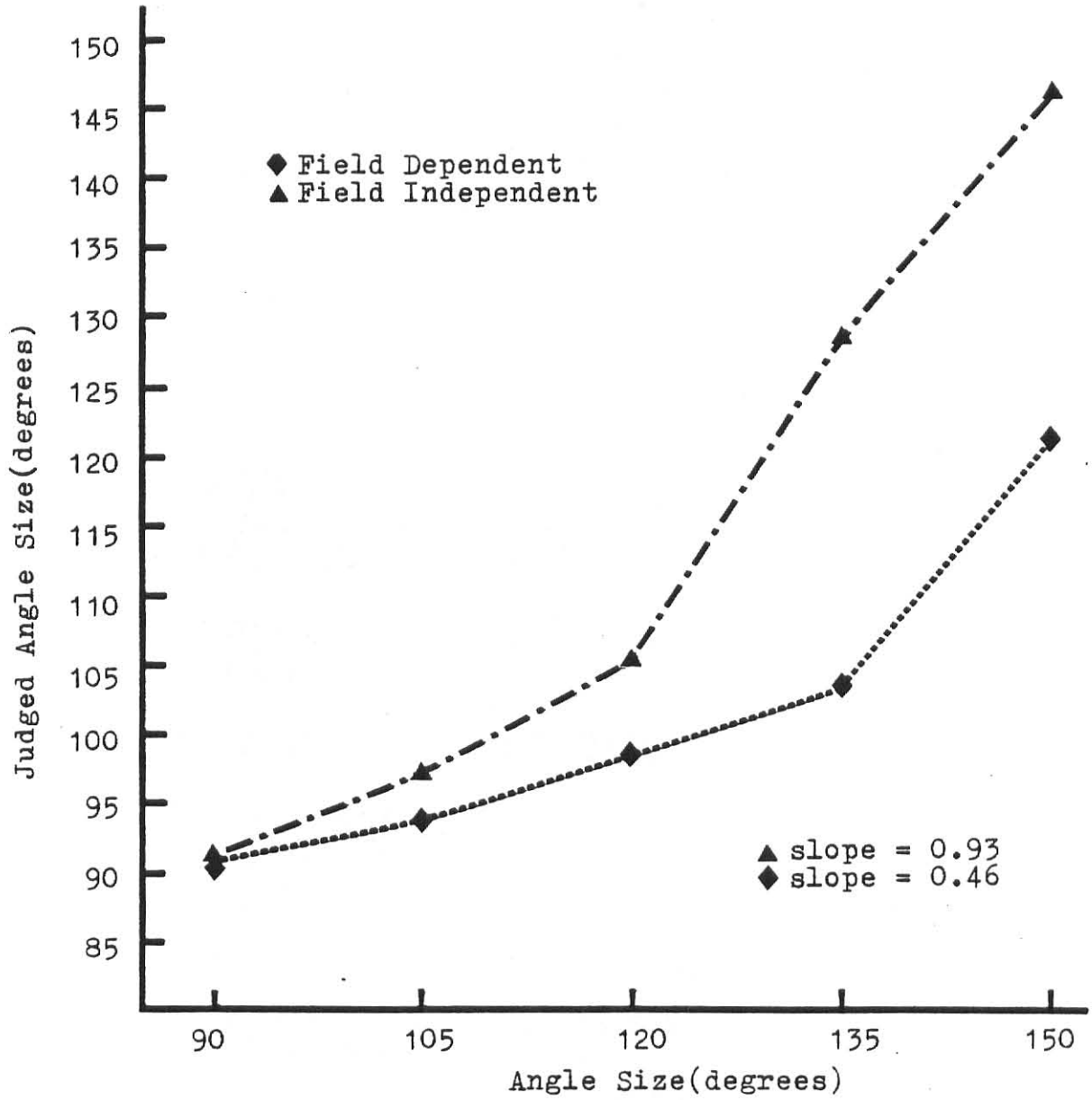


Figure 11. Angle estimation by FD and FI subjects given two dimensional high context stimuli and apparent instructions.

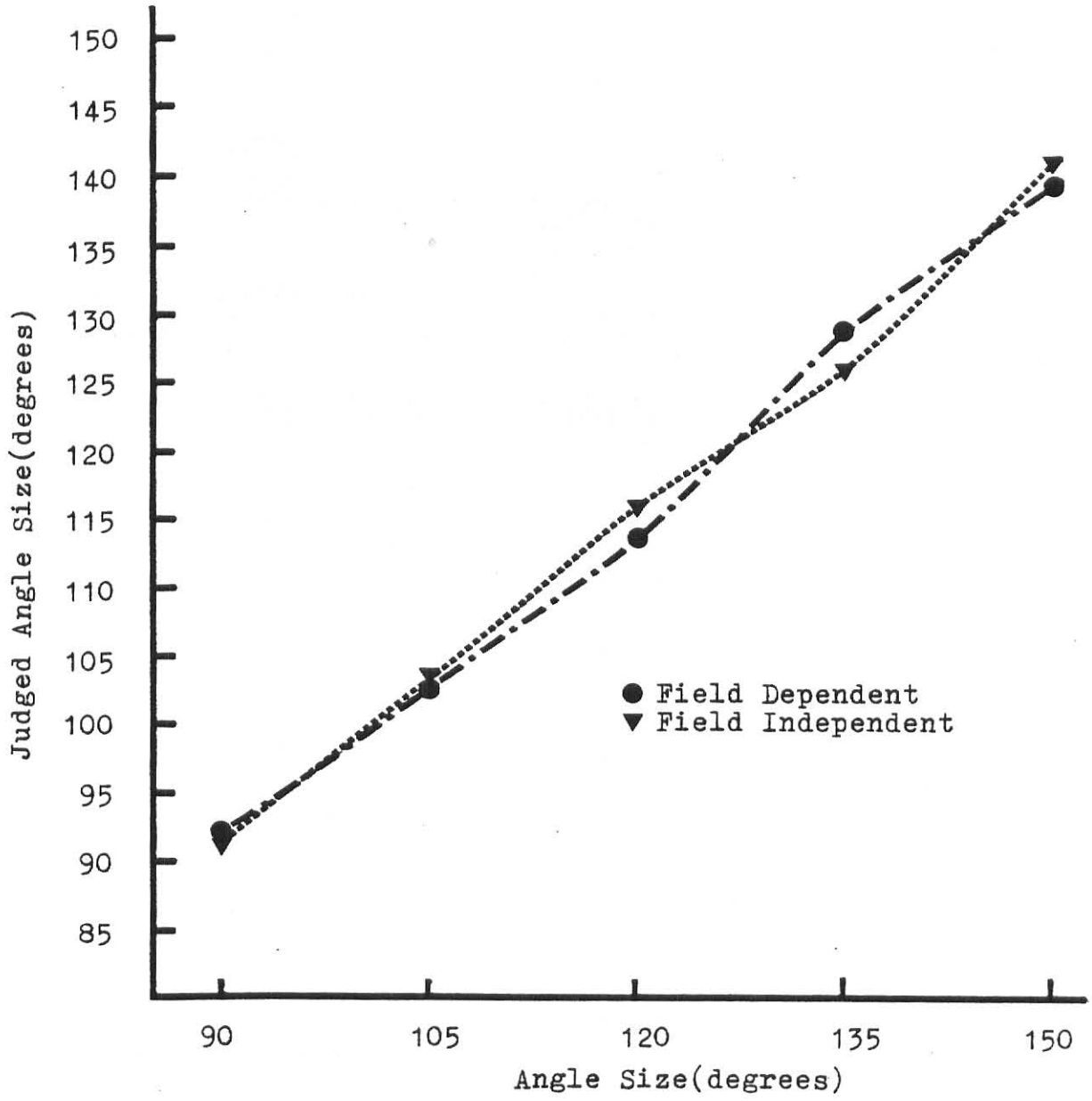


Figure 12. Angle estimation by FD and FI subjects given two dimensional high context stimuli and analytic instructions.

Table 9

Analysis of Variance Source Table
Two Dimensional-medium Context Analysis

OVERALL ANALYSIS

Source	Degrees of Freedom	Mean Square	F
FD/FI	1,24	1124.26	5.05*
Instruction	2,24	4118.44	18.49***
Angle	4,96	12410.36	178.11***
Instruction x Angle	8,96	426.30	6.12***

OBJECTIVE INSTRUCTIONS

Source	Degrees of Freedom	Mean Square	F
FD/FI	1,8	1656.79	10.33*
Angle	4,32	1815.53	18.11***

APPARENT INSTRUCTIONS

Source	Degrees of Freedom	Mean Square	F
Angle	4,32	5580.59	104.99***

ANALYTIC INSTRUCTIONS

Source	Degrees of Freedom	Mean Square	F
Angle	4,32	5866.78	105.39***

*$p < .05$

**$p < .01$

***$p < .001$

Place Figure 13 about here

The analyses of both analytic and apparent instructions revealed a significant main effect of angle for each (see Table 9). No interactions were present, both field dependents and field independents judged angles veridically (see Figure 14 and 15). This is a departure from two dimensional high context stimuli where apparent instructions produced greater constancy judgments by field dependents.

Place Figure 14 about here

Place Figure 15 about here

Low Context

The overall analysis of low context data showed significant main effects of instruction and angle. An interaction of field dependence x angle was present. The following separate analyses of instruction reveal the source of the interaction. Table 10 provides F values for the overall analysis and each analysis by instruction (see Table 10).

Place Table 10 about here

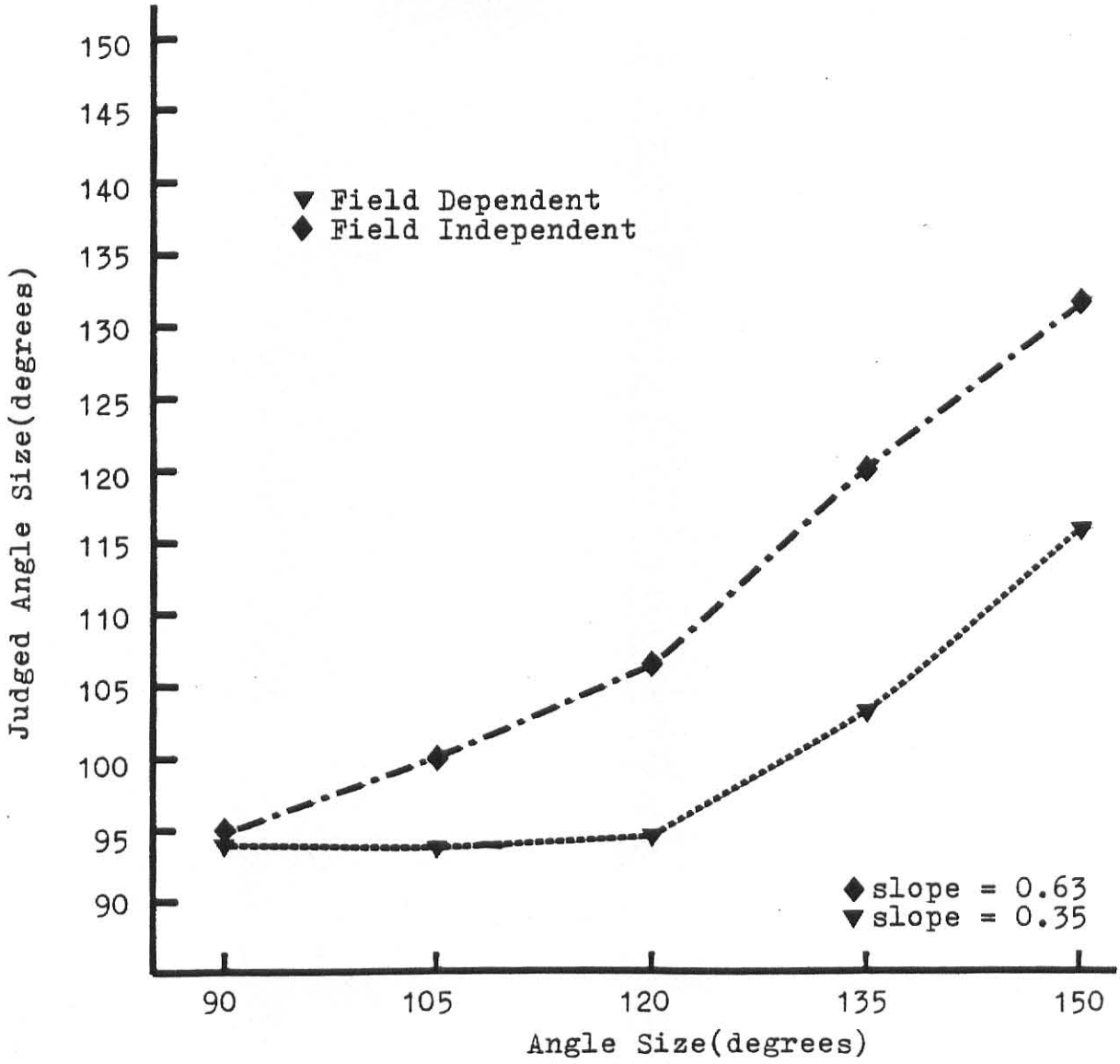


Figure 13. Angle estimation by FD and FI subjects given two dimensional medium context stimuli and objective instructions.

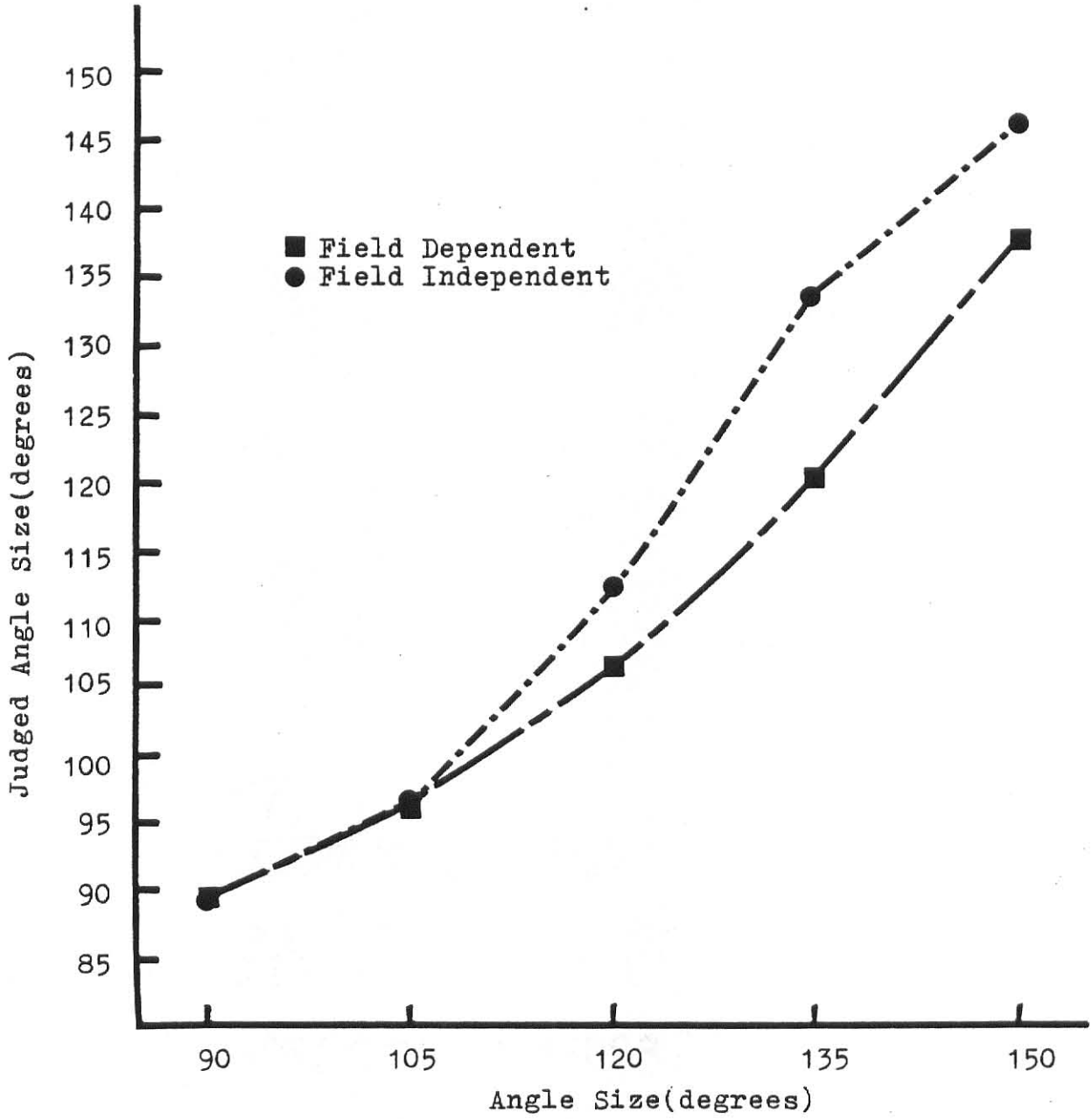


Figure 14. Angle estimation by FD and FI subjects given two dimensional medium context and apparent instructions.

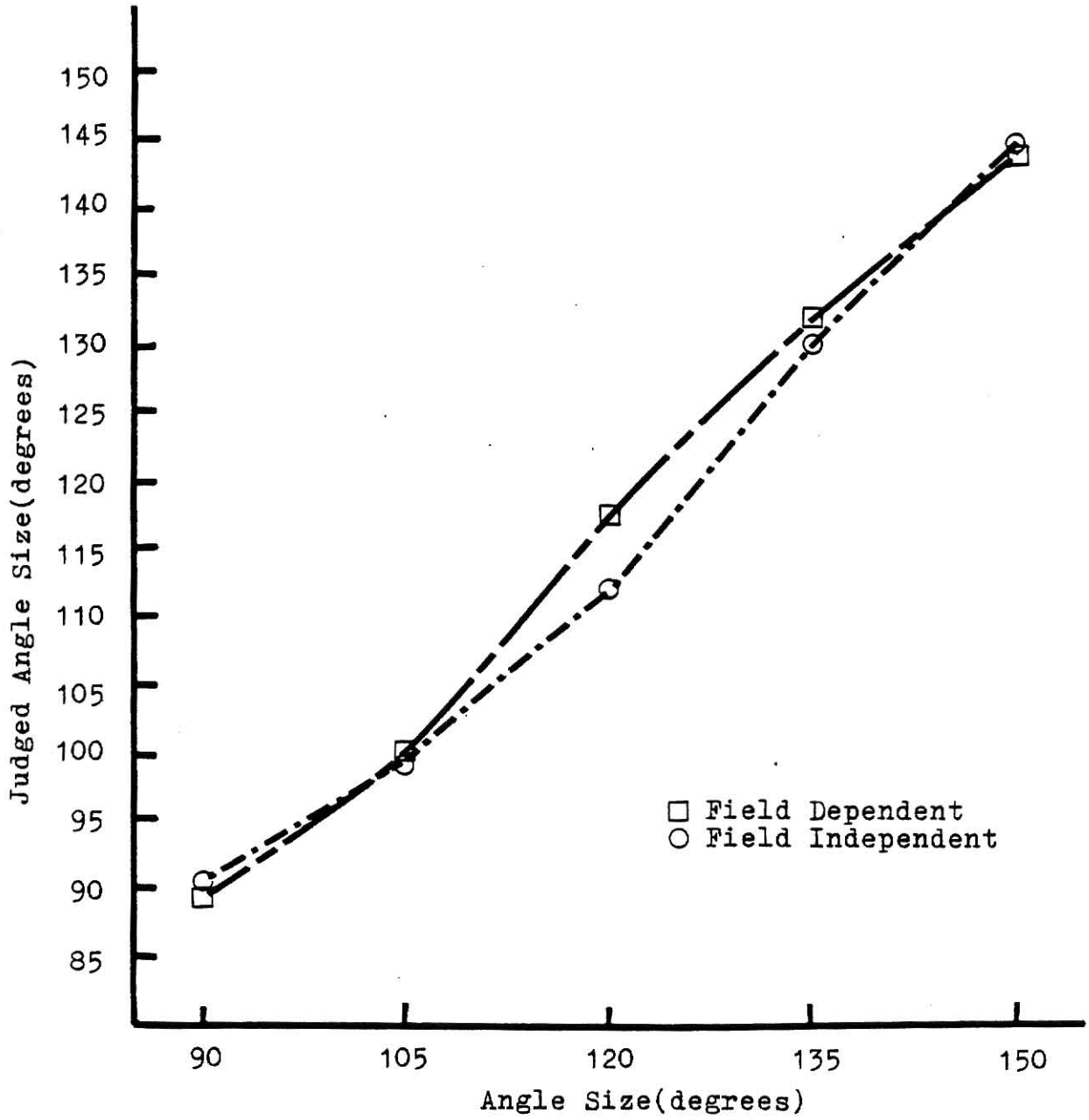


Figure 15. Angle estimation by FD and FI subjects given two dimensional medium context stimuli and analytic instructions.

Table 10

Analysis of Variance Source Table
Two Dimensional-low Context Analysis

OVERALL ANALYSIS

Source	Degrees of Freedom	Mean Square	F
Instruction	2,24	1665.31	7.65**
Angle	4,96	16735.34	412.49***
FD/FI x Angle	4,96	159.52	3.93**
Instruction x Angle	8,96	97.47	2.40*

OBJECTIVE INSTRUCTIONS

Source	Degrees of Freedom	Mean Square	F
FD/FI	1,8	1746.35	8.63*
Angle	4,32	4493.03	79.26***
FD/FI x Angle	4,32	235.14	4.15**

APPARENT INSTRUCTIONS

Source	Degrees of Freedom	Mean Square	F
Angle	4,32	6276.70	197.52***

ANALYTIC INSTRUCTIONS

Source	Degrees of Freedom	Mean Square	F
Angle	4,32	6160.51	184.93***

*$p < .05$

**$p < .01$

***$p < .001$

Objective instructions provided the only significant main effect of field dependence in the low context condition. A main effect of angle and a significant interaction of field dependence x angle was present (see Table 10). Both field dependent and field independent subjects demonstrated veridical judgments under objective instructions (see Figure 16). Field dependents, however, produced less veridical judgments than field independents.

Place Figure 16 about here

No difference between judgments of field dependents and field independents was found under analytic and apparent instructions. For both instructions, the only main effect was angle. No interactions were present (see Table 10). Both FD and FI subjects judged angles veridically (see Figure 17 and Figure 18). This is consistent with findings under medium context, two dimensional forms, and under low context, three dimensional forms.

Place Figure 17 about here

Place Figure 18 about here

Summary of Two Dimensional Analyses

The analysis of variance for two dimensional stimuli showed that the largest difference between field dependent

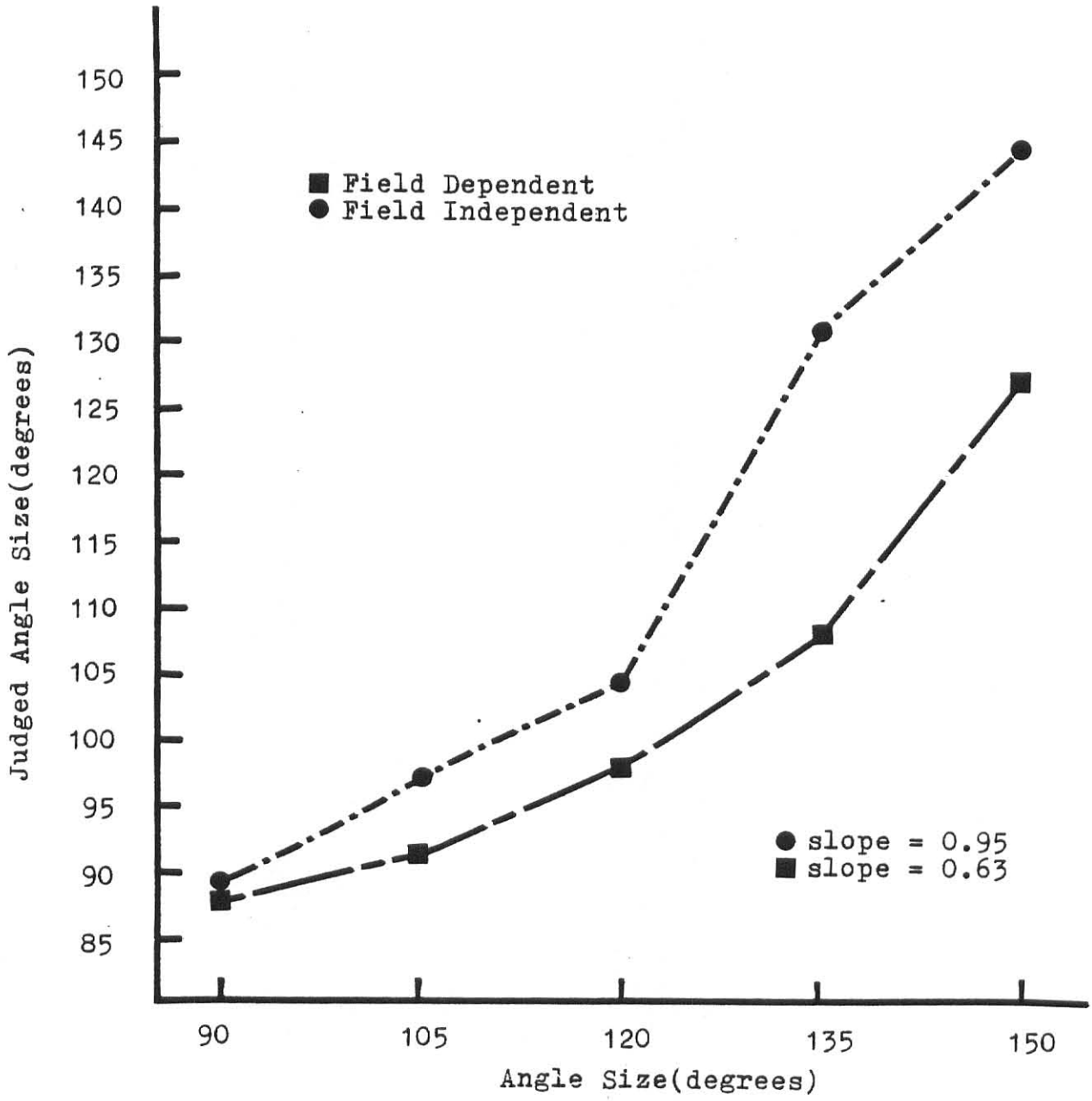


Figure 16. Angle estimation by FD and FI subjects given two dimensional low context stimuli and objective instructions.

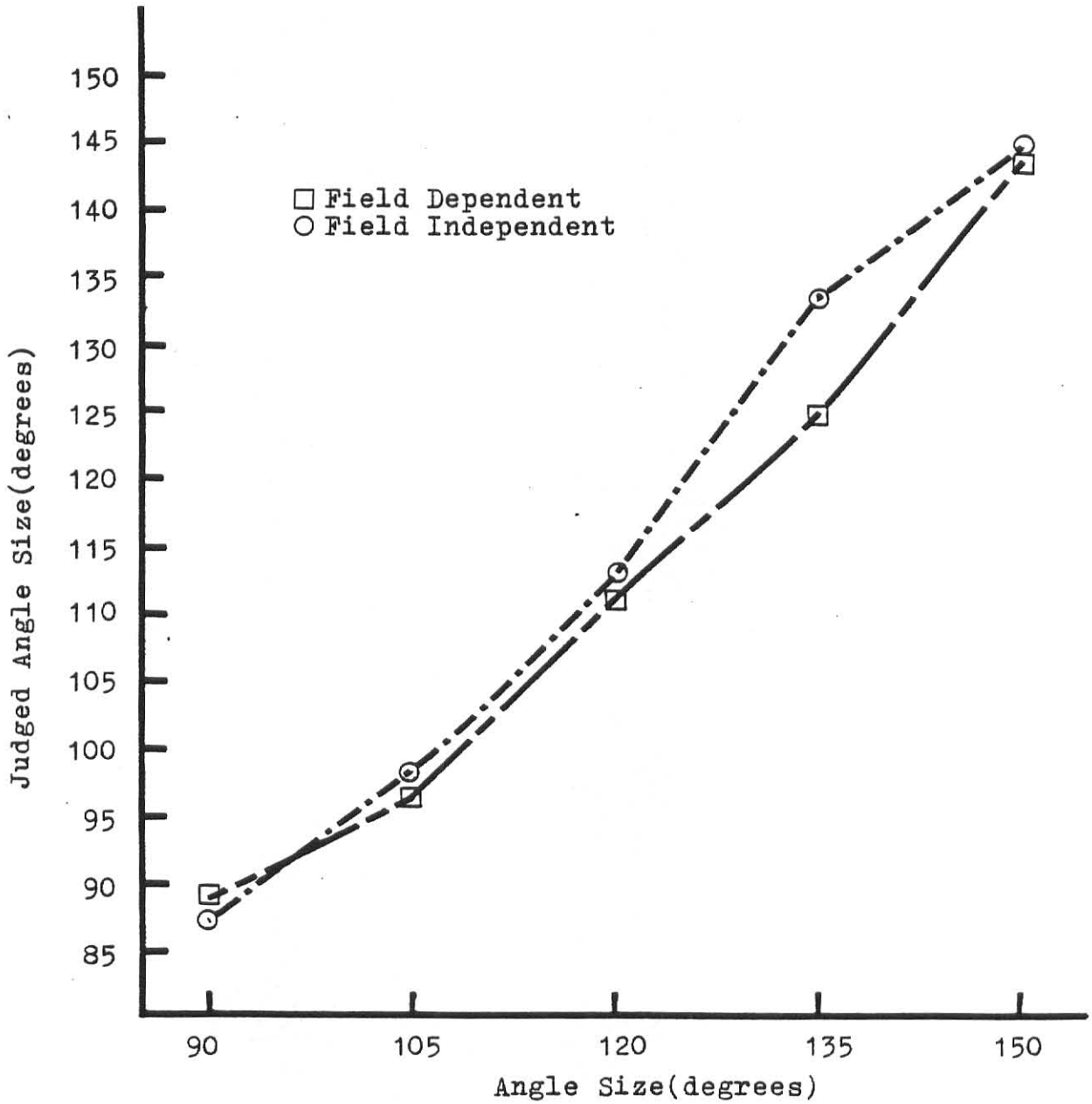


Figure 17. Angle estimation by FD and FI subjects given two dimensional low context stimuli and apparent instructions.

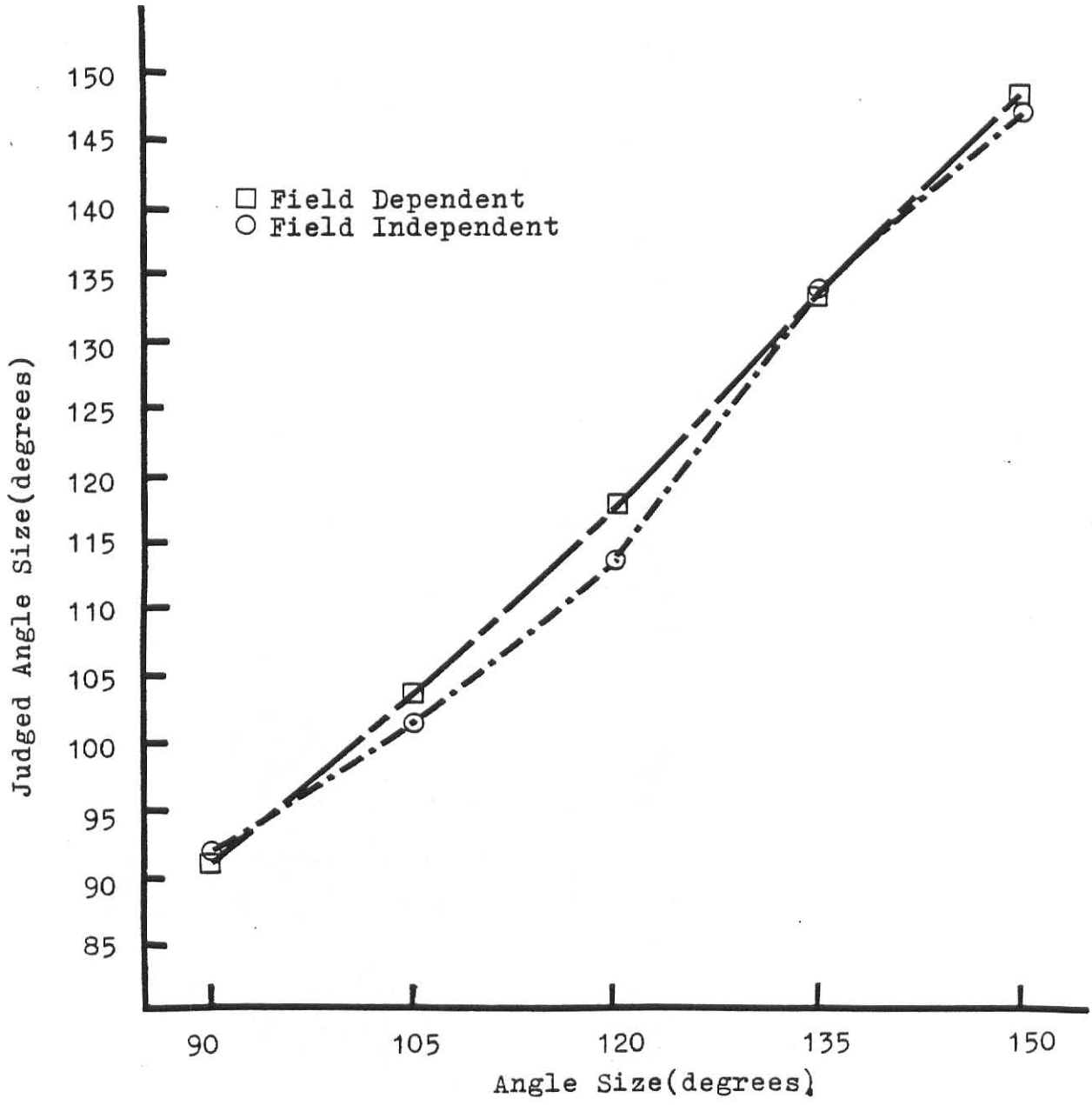


Figure 18. Angle estimation by FD and FI subjects given two dimensional low context stimuli and analytic instructions.

and field independent observers occurred when angles were embedded in a highly cubic context, and subjects were given apparent instructions. Objective instructions produced constancy judgments from both groups of observers. Analytic instructions, regardless of context, produced veridical judgments from all observers.

Discussion

The purpose of the present study was to examine differences in angle judgment between field dependent and field independent observers. The variable of stimulus dimension was designed to determine the effect of a more compelling three dimensional form over a two dimensional form. Three different levels of context were constructed such that the angles to be judged formed part of a figure which varied in cubic quality. Perceptual attitude was manipulated according to the three instructions outlined previously.

Three Dimensional Figures

High Context

The largest difference between judgments of field dependent and field independent observers occurred with the three dimensional figures. With these stimuli, high context produced the most interesting results. High context stimuli were constructions of half boxes, and were designed to appear as complete cubes. Perkins (1972) determined the dimensions of angles composing a two dimensional corner, such that the corner would appear cubic. Subjects judged stimuli as cubic when these three angles were in the range of 90 degrees to 150 degrees. Table 1 lists the corresponding angles used in the present experiment which fall in the range suggested by Perkins (1972). Angles used in the experiment were selected due to constraints in building three dimensional figures. The angles chosen minimized distortion and

bending of the box walls. In this way, the figures appeared cubic even though the angles composing them were not 90 degrees.

Objective instructions. Under objective instructions, observers were required to view and judge the embedded angles as they appeared in three dimensions. Field independent observers judged the angles veridically, the cubic context did not influence judgments toward right angle constancy. In contrast, field dependent observers exhibited right angle constancy. These results are consistent with Witkins (1954) theory of field dependence. With three dimensional stimuli, the distal image varies with physical angle. An angle interpretation based on the distal image, as objective instructions direct, would not produce constancy because the distal angle changes from 90 to 150 degrees. But if one bases his/her judgment on the cubic context, and not on physical properties, right angle constancy would result. As predicted from Witkins (1954) theory, field dependents took into account the cubic context of the angle. This cubic interpretation produced right angle constancy, since by definition, a cube must contain right angles.

Apparent instructions. Apparent instructions were constructed to create no external bias upon the perceptual attitude of the observer. Field independents maintained veridical judgment under these instructions, and this indicates a preference for an analytic perceptual attitude. The highly cubic context did not influence the judgment of angle size. This

is consistent with Witkin's (1954) theory, which states that field independents normally use an analytic attitude, and ignore extraneous information. Unlike field independents, the judgments of field dependents were not veridical. A slope of .43 (see Figure 2) obtained by computing a regression line, for field dependent subjects, suggests a tendency toward constancy. This value was intermediate between an objective and an analytic perceptual attitude. Thouless (1932) found such an intermediate response set under apparent instructions in shape constancy research. He termed this a perceptual compromise and found it to be, not an artifact of apparent instructions but a unique response independent from an objective or an analytic perceptual attitude. In the present experiment the data of each observer showed that all field dependent subjects tended to judge the angles as intermediate between 90 degrees and the physical size. If observers receiving apparent instructions gave a combination of objective and analytic responses, the variance of the responses would have been much greater than the variance of responses obtained under objective and analytic instructions. This was found by Lichte and Borresen (1967) and Landauer (1969) and contributed to a criticism on the use of apparent instructions. In the present experiment, it can be concluded that apparent instructions produced an attitude unique from objective or analytic. Table 11 lists the variance of responses for each angle under each instruction (see Table 11). Apparent instructions do not show consistantly greater between

subject variance than objective or analytic. The greater between subject variance that is present under apparent instructions would be expected due to the ambiguous nature of the instructions.

Place Table 11 about here

Analytic instructions. No differences were found in the responses of field dependents and field independents under analytic instructions. Both groups judged angles veridically. For field independents this is not a surprising finding as the analytic instructions were consistent with the preferred perceptual attitude. Field dependents, however, were expected to have difficulty maintaining an analytic attitude, especially given high context. The findings under high context show that field dependent observers may normally use contextual cues but are capable of an analytic attitude. That an analytic attitude occurs under high context provides important information on the nature of field dependence. A preferred perceptual attitude is not the only possible perceptual attitude.

Medium Context

Objective instructions. Medium context stimuli were designed to present an incomplete cubic context such as the corner of a box. The only difference between the judgments of field dependent and field independent observers occurred under objective instructions. As in the case of high context

Table 11

Between Subjects Variance S^2 Under Each

Angle and Instruction for Three Dimensional Stimuli

FIELD DEPENDENT OBSERVERS

Angle	Instructions		
	Apparent	Objective	Analytic
150	159.98	137.03	146.79
135	96.54	36.18	55.32
120	34.20	9.26	49.94
105	15.06	35.34	11.78
90	11.88	14.89	5.80
FIELD INDEPENDENT OBSERVERS			
150	14.20	19.08	93.05
135	16.00	27.73	217.30
120	7.74	28.85	136.94
105	19.17	37.28	51.59
90	22.20	9.25	21.45

stimuli, field independents judged angles analytically, not influenced by context. Field dependents showed right angle constancy. The slope for field dependent observers under medium context was steeper (.25) than the slope under high context (.12). This indicates that the medium context presented a less compelling cubic corner identity for field dependent observers.

Apparent instructions. Findings under apparent instructions support this idea. Field dependents, as field independents, judged angles analytically. Had medium context been as perceptually cubic as high context, an intermediate slope between analytic and objective would have occurred. Since constancy was found under objective instructions, it is evident that field dependent observers were able to interpret the medium context as cubic. The lack of constancy under apparent instructions, however, show that this interpretation was directed by the instructions rather than the observer's attitude.

Low Context

Objective instructions. In low context, as in medium context, the only differences between field dependent and field independent observers occurred under objective instructions. Here, instructions provided the only source of perceptual attitude because no context was present. While both groups of observers differed in angle judgment, neither exhibited constancy. Field dependents underestimated obtuse angles, but the obtained slope of .60 was too steep to indi-

cate right angle constancy. At best only a tendency toward constancy was indicated. Field independent observers showed analytical judgment.

The lack of any surrounding context eliminated the cues which the field dependent used in angle judgment. Objective instructions alone were insufficient in providing a basis for constancy. Objective instructions directed the observer to judge the angles as they appeared in the real world. Without surrounding context, this judgment would be veridical. The significant underestimation of angles by field dependents may be due to the three dimensional nature of the angle, or to an attitude conveyed by the instructions. This question will be discussed further in the discussion of two dimensional stimuli.

Apparent and analytical instructions. Under apparent and analytic instructions both field dependent and field independent observers judged angles veridically. This is consistent with the discussion above, that without cubic context there is no basis for constancy, and judgments will, therefore, be analytical.

Summary of the Three Dimensional Condition

With three dimensional stimuli, context and instruction were shown to be highly influential for field dependents. Figure 19 demonstrates the relationship of context and objective instructions. The degree of constancy was clearly related to the level of cubic context. Under apparent instruc-

Place Figure 19 about here

tions the influence of context changes (see Figure 20). The order of magnitude for the influence of each level of context remained the same as that of objective instructions. The degree of influence toward constancy, however, became much less at each level of context.

Place Figure 20 about here

Field dependents did not show the same complex relationship between instruction and context. Veridical judgments were made under each level of context and for each instruction. This difference between the field dependent observer and the field independent observer is consistent with Witkin's (1954) theory discussed earlier.

Two Dimensional Figures

High Context

Objective instructions. The two dimensional high context condition consisted of drawings of box figures. These were two dimensional representations of the three dimensional figures discussed earlier. With objective instructions observers were asked to judge angles as they would appear if the figures were three dimensional objects. These instructions produced right angle constancy in both field dependent and field independent observers. For field dependents, these results are consistent with those of the three dimensional

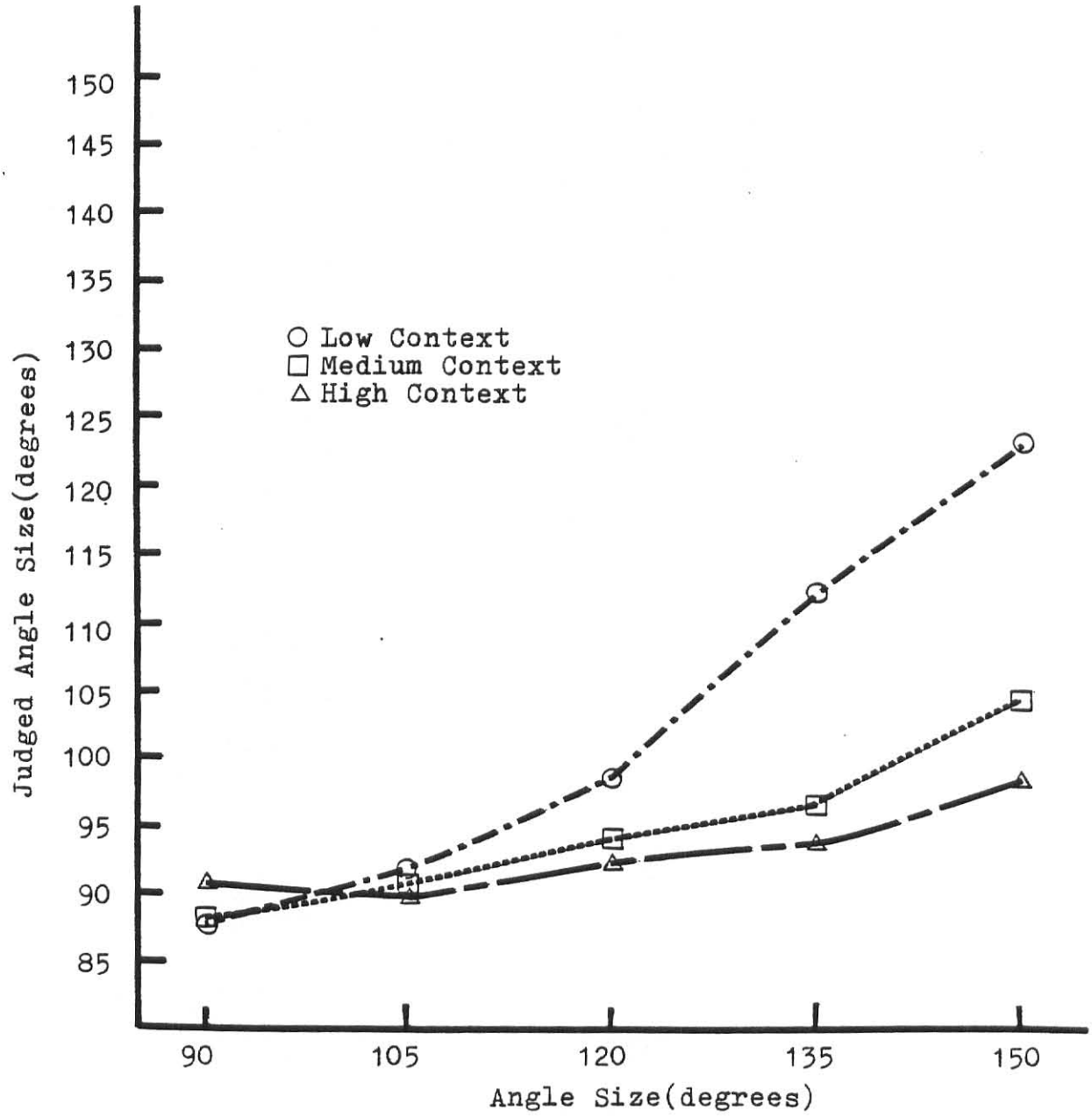


Figure 19. Angle estimation by Field Dependent subjects given three dimensional figures and objective instructions.

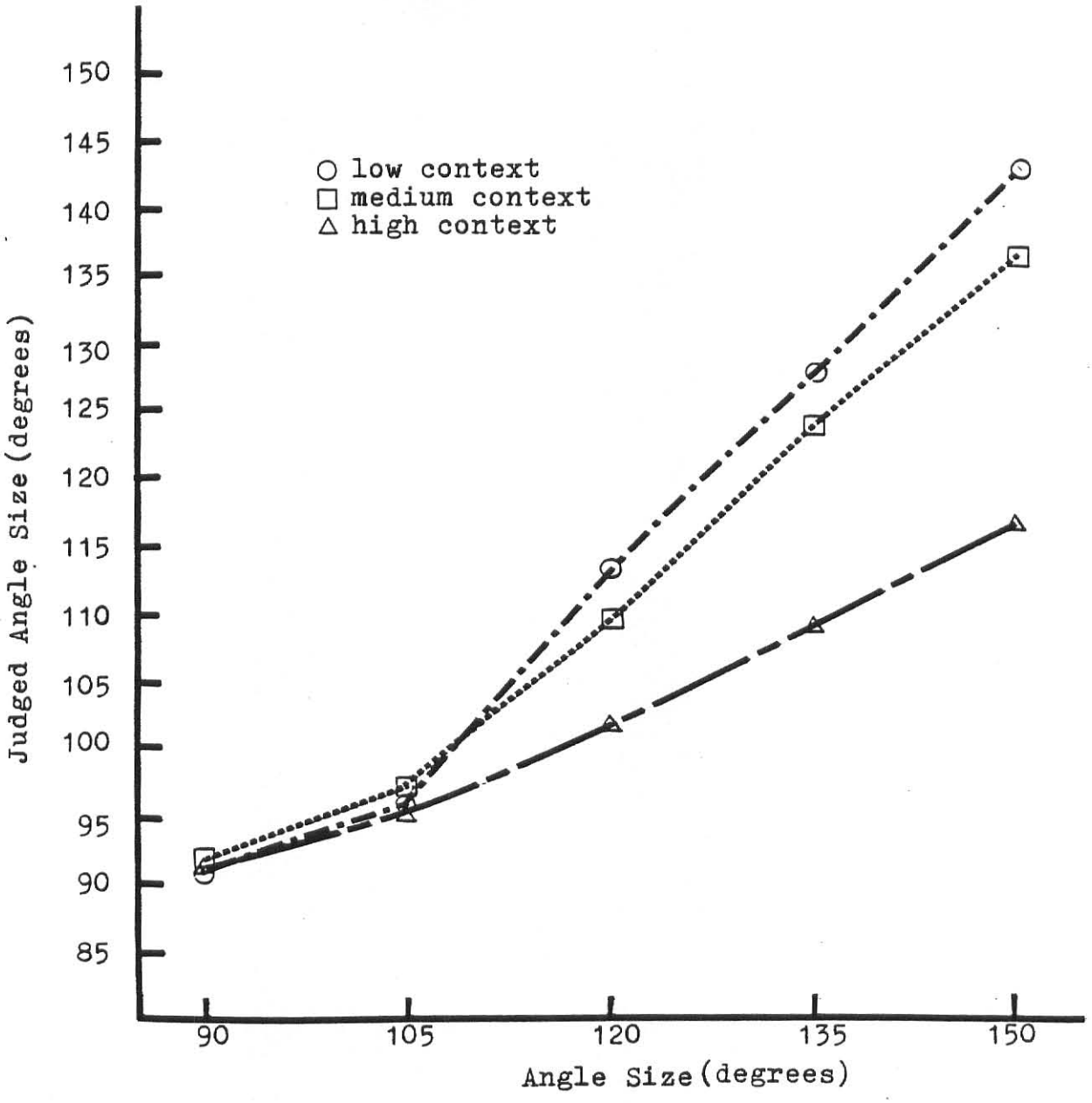


Figure 20. Angle estimation by field dependents given three dimensional figures and apparent instructions.

stimuli. The occurrence of constancy for field dependent subjects was predictable from Witkin's (1954) theory of field dependence. The cubic context in the two dimensional figures was influential in producing a cubic interpretation and, therefore, constancy. The similar results between two dimensional and three dimensional high context figures for field dependents indicate that context was the critical factor in angle judgment, not dimension.

Unlike field dependents, field independent subjects showed a large difference in angle judgments from three dimensional to two dimensional stimuli. The objective instructions induced an attitude in which the two dimensional drawings were interpreted as three dimensional objects. Given high context, this interpretation was cubic. Constancy resulted because the three dimensional cubic shape would remain constant regardless of the orientation depicted by the two dimensional projection. In the three dimensional condition, constancy did not occur for field independents because no three dimensional interpretation was necessary. As discussed earlier, the angles were judged as they physically were. In order to judge the two dimensional angles as they physically would be, the cubic interpretation, hence constancy, was necessary. That field independents did show constancy in the two dimensional judgments, demonstrates that this group is capable of using the contextual surround even though an analytical attitude may be preferred. This is not inconsistent with the theory of field independence,

since the context was an essential part in the interpretation of the two dimensional form as a three dimensional figure.

Apparent instructions. Apparent instructions allowed the observers to use the preferred interpretation of the stimuli. In high context field independent observers judged angles analytically. The veridical responses, and the slope of .93 demonstrate that this group judged the angles as they appeared on the flat surface. Field dependents showed an intermediate slope (.46) between analytic and objective perceptual attitudes. This is similar to the results of this group given the three dimensional stimuli. The compromise (Thouless, 1932) is, therefore, a consistent perceptual attitude. As with the three dimensional results, the two dimensional apparent instructions produced responses which were unique from analytic and objective attitudes. Table 12 shows the variance of each instruction in the two dimensional, high context, condition (see Table 12). The variance for apparent instructions is not consistently larger than that of the other instructions.

Place Table 12 about here

Given these findings it can be concluded that surrounding context is an important component in the perceptual attitude of field dependents. In contrast the perceptual attitude of field independents is analytical. These findings were consistent with those from three dimensional stimuli and with the theoretical formulations on field dependence (Witkin, 1954).

Table 12

Between Subjects Variance S^2 Under Each

Angle and Instruction for Two Dimensional Stimuli

Angle	Instructions		
	Apparent	Objective	Analytic
FIELD DEPENDENT			
150	65.09	91.36	22.54
135	21.49	10.23	141.73
120	14.20	18.48	61.14
105	15.95	7.56	34.31
90	3.74	13.58	17.62
FIELD INDEPENDENT			
150	13.95	112.16	56.39
135	17.22	71.96	149.52
120	108.74	26.70	124.15
105	34.12	5.20	36.73
90	5.54	9.70	25.04

Analytical instructions. Analytic instructions produced veridical judgments from both field dependent and field independent observers. This, again, is consistent with the three dimensional data. The analytic attitude on the part of the field independent observer is predictable from the results of the apparent instructions. The analytic attitude on the part of the field dependents demonstrates that this group may make judgments independent of contextual surround if directed to do so.

Medium Context

Objective instructions. Two dimensional, medium context stimuli were drawn to represent an incomplete cubic form such as a box corner, at various orientations in space. The only difference between field dependent and field independent observers occurred under objective instructions. Field independents demonstrated more of an analytic attitude than field dependents, but a slope of .63 indicates underestimation of obtuse angles. The analytic judgment was a sharp change from the objective judgment under high context which produced constancy. High context provided a surround which could be easily interpreted as cubic in three dimensions. This was not the case with medium context. Observers were directed to judge the angles as they would appear in three dimensions. Had the figures appeared cubic, judgments would have shown right angle constancy. Given that an analytic attitude is preferred by field independents (Witkin, 1954), a context which did not contribute to the form in a meaningful way would tend to be ignored.

Field dependent observers did not demonstrate constancy in any of the instruction conditions, but they were influenced more by context than field independents. The larger angles sharply departed from a constancy judgment, while angles 90 to 120 degrees were reported as right angles. Decreases in constancy with increasing angle of rotation from the frontal-parallel plane have been reported by Sheehan (1938) and Lichet (1952). Lichte stated that the extreme angle of rotation produced a force counteracting the tendency toward constancy. Given the less compelling cubic appearance of medium context, it is possible that the larger angles produced distortion on the cubic characteristics which were present. High context would have provided a strong enough cubic form to prevent this.

Apparent instructions. Under apparent instructions there were no significant differences between judgments of field dependents and field independents. Both groups judged angles analytically. The analytic attitude on the part of field dependent observers is an indication of the lack of cubic appearance in the medium context. Had this been more compelling, field dependents would have shown an intermediate response as that which occurred in the high context conditions.

Analytic instruction. Consistent with results discussed thus far analytic instructions produced veridical judgments in both groups of observers. The ability of field dependents

to adopt an analytic attitude, given high or medium context, shows that this is an enduring characteristic.

Low Context

In low context, as in medium context, the only significant difference in the angle judgment of field dependent and field independent observers occurred under objective instructions. Neither group, however, displayed constancy. Field dependents underestimated obtuse angles, but a slope of .63 is too steep to indicate constancy. Field independents were more veridical.

In low context instructions provided the only source of perceptual attitude because there was no context present which could create or influence a perceptual attitude. Three dimensional, low context stimuli produced a pattern of results similar as that in the two dimensional low context condition. The three dimensional nature of those stimuli could have added context which influenced the results of field observers. With two dimensional stimuli there was no context around the judgment angle. The perceptual attitude, produced by objective instructions, was the only factor available to produce the underestimation of obtuse angles by field dependents.

Summary of the Two Dimensional Condition

Context and instruction were shown to have a complex influence on the judgments of field dependent and field independent observers given two dimensional stimuli. For field dependents, the only clear evidence of constancy

occurred with high context stimuli and objective instructions. Medium and low context produced a departure from constancy, with progressively more veridical estimations (see Figure 21).

Place Figure 21 about here

This demonstrates the role of context on the cubic interpretation of the stimuli and supports the theory (Witkin, 1954) that field dependents use contextual cues in perceptual judgments.

Context, however, cannot be considered independently from instruction. As Figure 22 shows, apparent instructions produced more veridical judgments of the same stimuli by field dependents (see Figure 22).

Place Figure 22 about here

This indicates that without instructional bias, field dependents have a perceptual attitude which is intermediate that of objective and analytic. High context maintained a tendency toward constancy as predicted but not nearly as strong as that found under objective instructions.

Field independents demonstrated right angle constancy only under objective instructions with a high context surround. Figure 23 shows the effect of context on judgments under objective instructions (see Figure 23). That constancy was

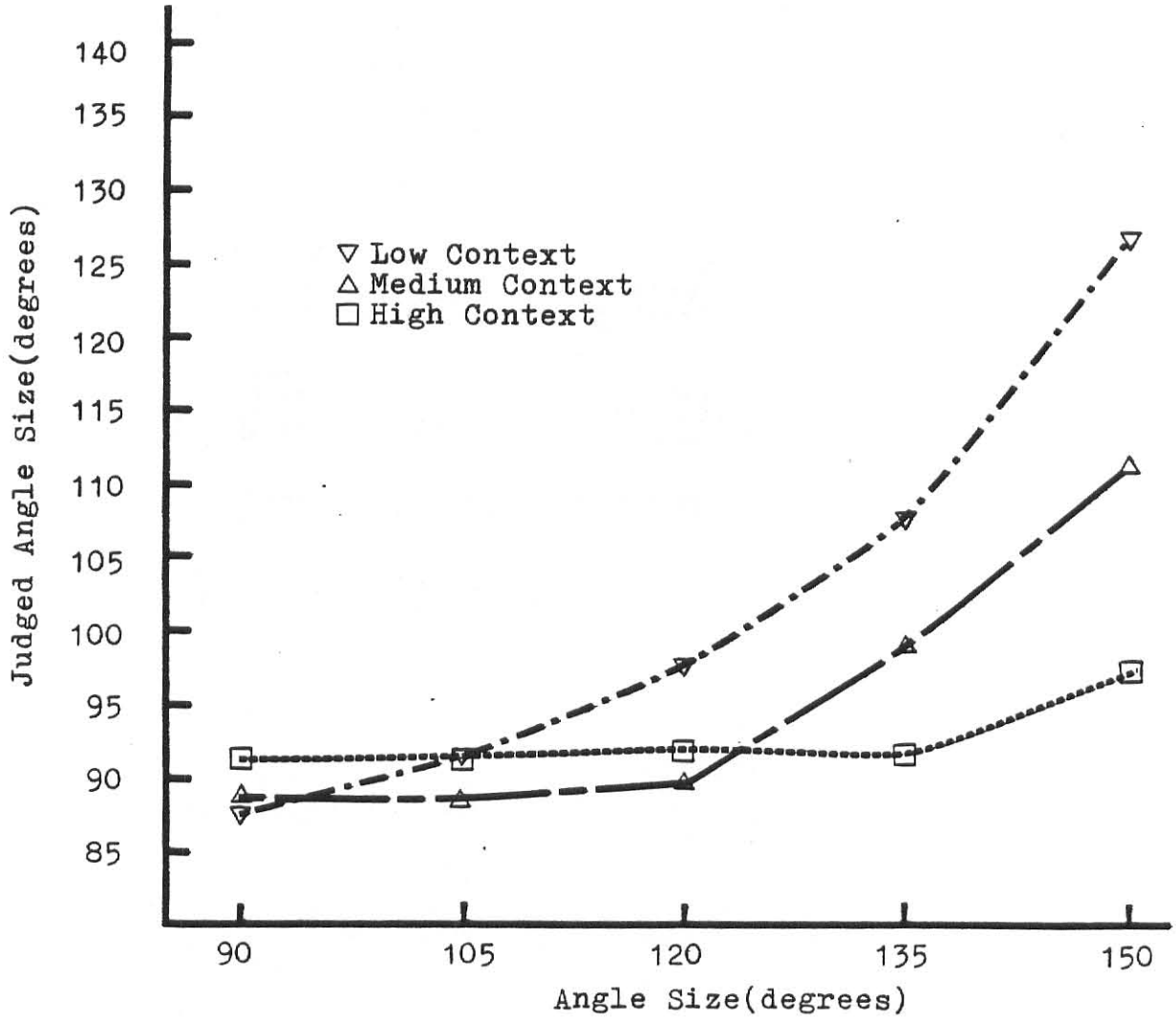


Figure 21. Angle estimation by Field Dependents given two dimensional stimuli and objective instructions.

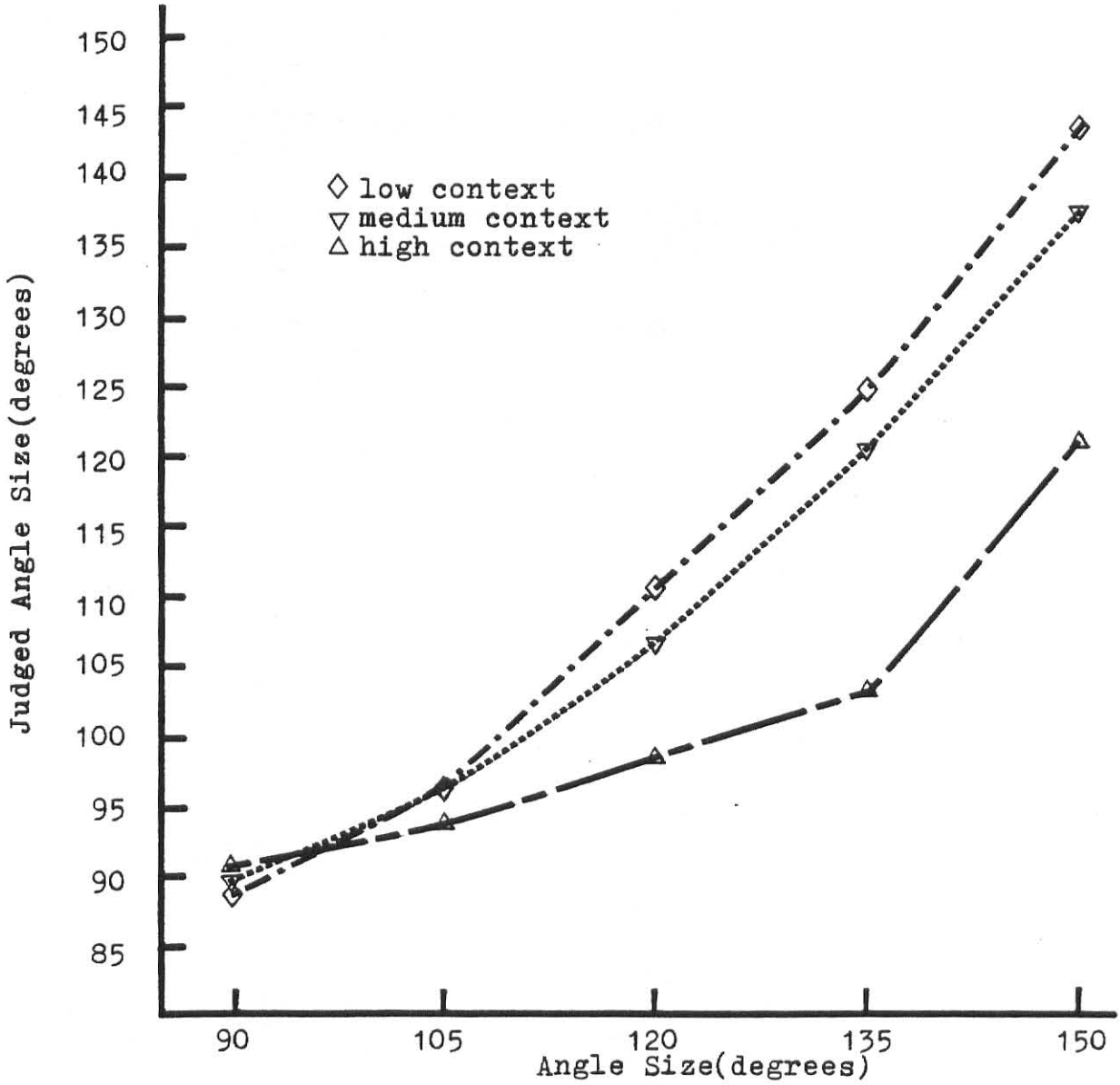


Figure 22. Angle estimation by field dependent subjects given two dimensional stimuli and apparent instructions.

Place Figure 23 about here

obtained only under objective instructions, and only with high context stimuli is important. These findings support the theory that field independents make judgments analytically without dependence upon contextual cues. This is clearly the case under apparent instructions. Here consistently veridical angle estimations were given by field independents, regardless of context. Since all three functions are virtually identical, no graph is provided for these data (see Figure 11, Figure 14, and Figure 17).

Angle Constancy: The General Case

The results of the present experiment show that regardless of individual differences angle constancy is a powerful perceptual phenomenon. Individuals tend to perceive an obtuse angle as 90 degrees given that the angle is embedded in a context which can be interpreted as cubic. The high context, two dimensional condition was an example of such a context and all observers demonstrated constancy in this condition. With medium and low context the stimuli did not have the cubic characteristics of high context and judgments were therefore more veridical. This demonstrates that observers use contextual cues in the processing of stimuli. The context provided meaning to the stimulus. As discussed earlier, Lappin and Preble (1975) found that meaningfulness contributed to constancy and shape judgment. The present experiment is in support of this conclusion because the high context was

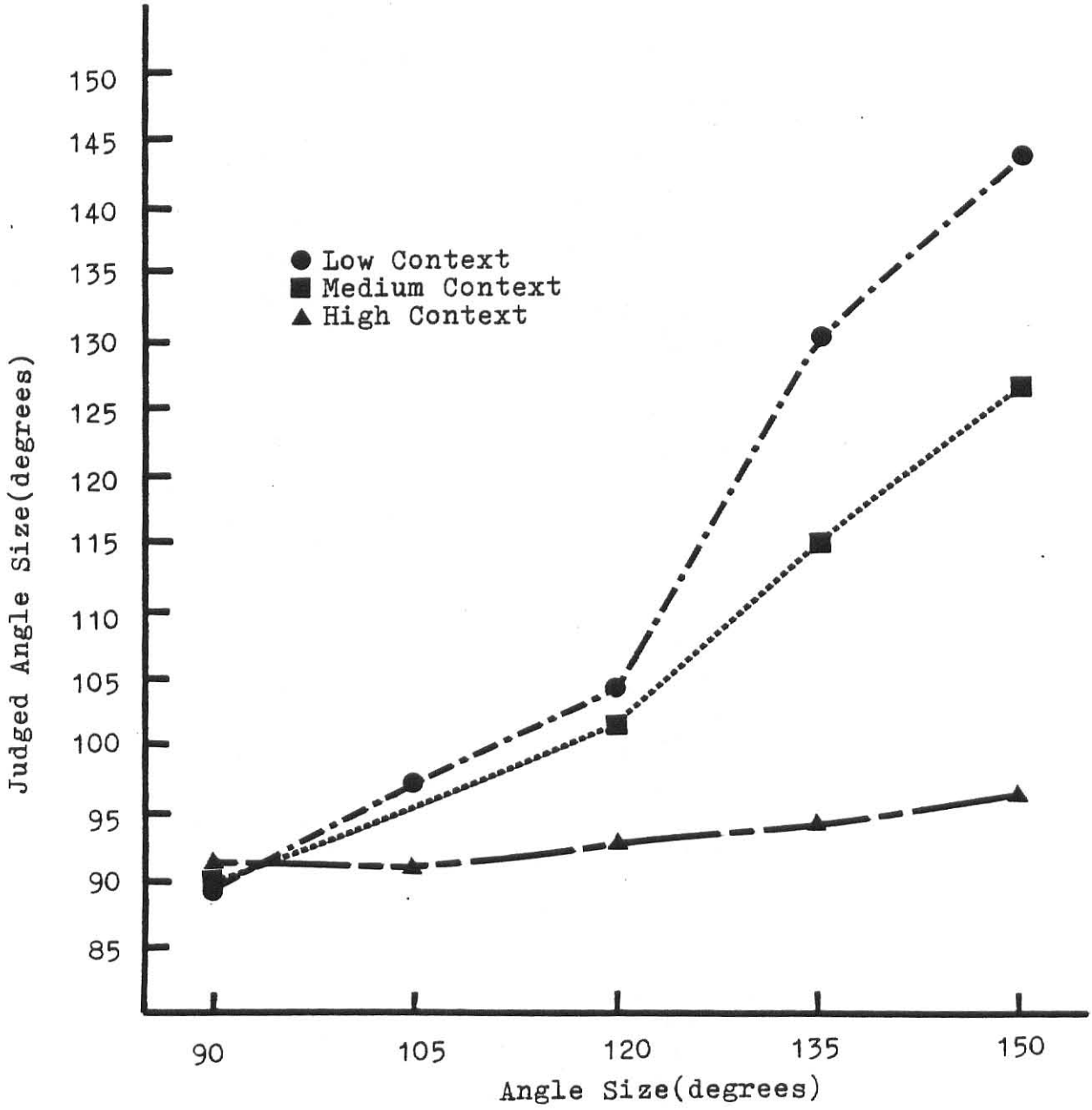


Figure 23. Angle estimation by Field Independent subjects given two dimensional stimuli and objective instructions.

more meaningful as a cubic form than the medium or low context. The importance of context in angle constancy must not be considered separately from instructions. The effect of analytic instructions was to completely erase the influence of context on angle judgment. Only with objective and apparent instructions did differential judgments occur between types of context. Each instruction directed the observer to different perceptual attitude. An observer with an objective attitude considers the distal image and therefore, shows constancy. An observer with an analytic attitude considers only the proximal image where constancy is not present. Perceptual attitude had this effect regardless of the contextual level. The stimulus percept, therefore, is not the determining factor in the perception of an object. Perceptual attitude plays a large part in how the stimulus is interpreted and may be induced either by instruction, or be allowed to occur naturally with personality differences such as field dependence.

Conclusions

Findings of the present experiment supported the hypothesis that field dependents would exhibit greater constancy than field independents. As predicted, this was contingent upon the dimension of the figure, the amount of context, and the instructions. The greatest differences between field dependent and field independent subjects occurred with three dimensional stimuli. Objective instructions, across each

level of context, found field dependents showing some degree of constancy, while field independents maintained veridical judgments. Field independent subjects judged angles analytically without consideration of context. The influence of context was clear for field dependents, since the greatest constancy under high context, and the least under low context. Apparent instructions in the high context three dimensional condition show this same trend of constancy for field dependents.

The two dimensional condition demonstrated that field independents would use context in the interpretation of stimuli. The high context in the objective instruction condition was an important element in providing a meaningful three dimensional interpretation. The constancy in the judgments of field independents shows that high context was a factor. This is supported by the more veridical judgments which were obtained with medium context stimuli. Had context not been important, results would have been replicated between levels of context as was the case with three dimensional stimuli.

Field dependents and field independents showed veridical angle estimation for all analytic instructions and for apparent instructions in low and medium contexts. It can be concluded from this that the influence of context on field dependents is specific and occurs neither where instructions direct otherwise, nor where context is minimal.

The findings of the two and three dimensional conditions showed that angle judgment and the occurrence of constancy was influenced by the field dependence of the observer, the instructions, and the level of context. The complex interactions between these variables demonstrated that the perception of geometrical forms was dependent on the physical characteristics of the stimulus environment and also upon characteristics unique to the perceiver. These findings lend support to the notion that perception involves cognitive processes.

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Footnotes

1. The projected image of a right angle can be determined through equation 1.

$$\cos \phi = \frac{\rho^2 \sin\beta\cos\beta\cos^2\theta - \rho^2\sin\beta\cos\beta}{\sqrt{\rho^2\cos^2\beta\cos^2\theta + \rho^2\sin^2\beta \cdot \rho^2\sin^2\beta\cos^2\theta + \rho^2\cos^2\beta}}$$

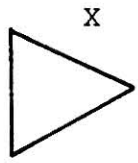
Where β is a constant at 45 degrees, ρ is a constant at 1, and θ equals the rotation of the right angle in degrees. This equation was derived by Dr. Shu, Department of Mathmatics, Kansas State University, in a personal communication.

Appendix A

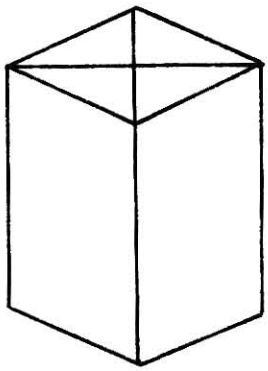
Group Embedded Figures Test*
A Sample Problem

This is a test of your ability to find a simple form when it is hidden within a complex pattern.

Here is a simple form which is labled "X":



This simple form, labled "X", is hidden within the more complex figure below:

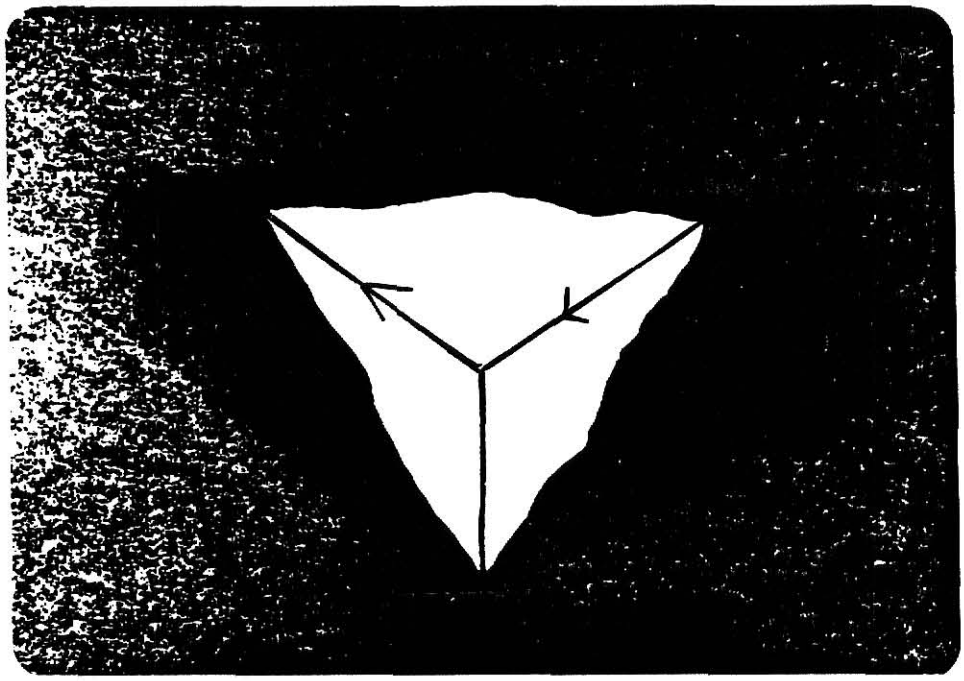


The simple form is traced by the subject directly over the lines of the complex figure. It appears as the same size, in the same proportions, and in the same direction within the complex figure as it does alone. The simple forms used in the test appear in the back of the test booklet.

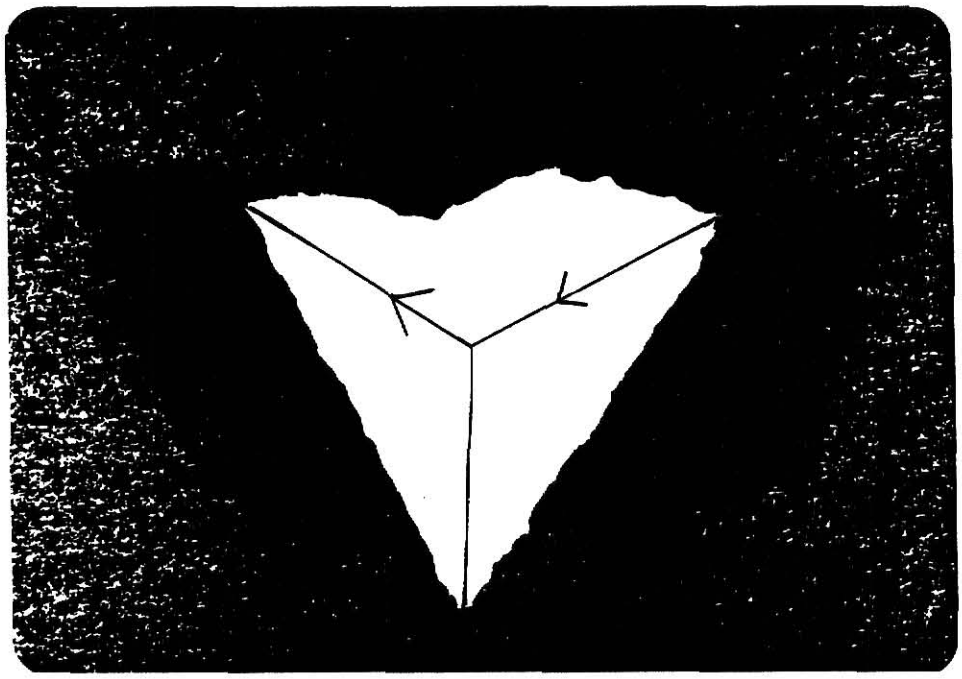
*Oltman, P.K., Raskin, E., Witkin, H.A. Group Embedded Figures Test. Palo Alto: Consulting Psychologists Press, 1971.

Appendix B

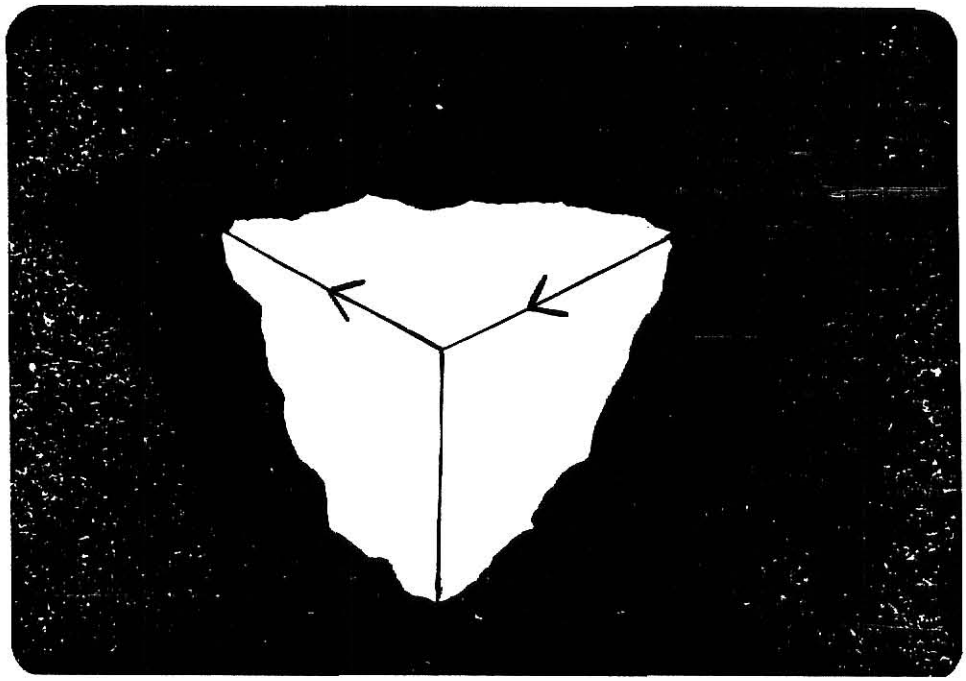
Following are photographs of three dimensional medium and high context stimuli. Low context three dimensional stimuli are identical to the top portion of the medium context stimuli and, therefore, are not shown separately.



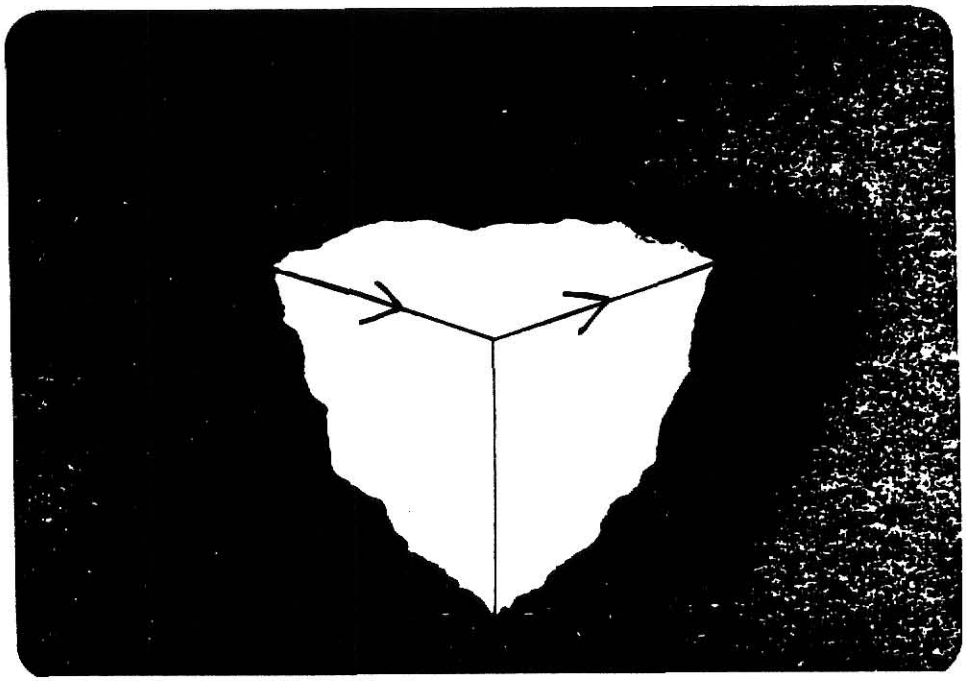
90 degrees, medium context



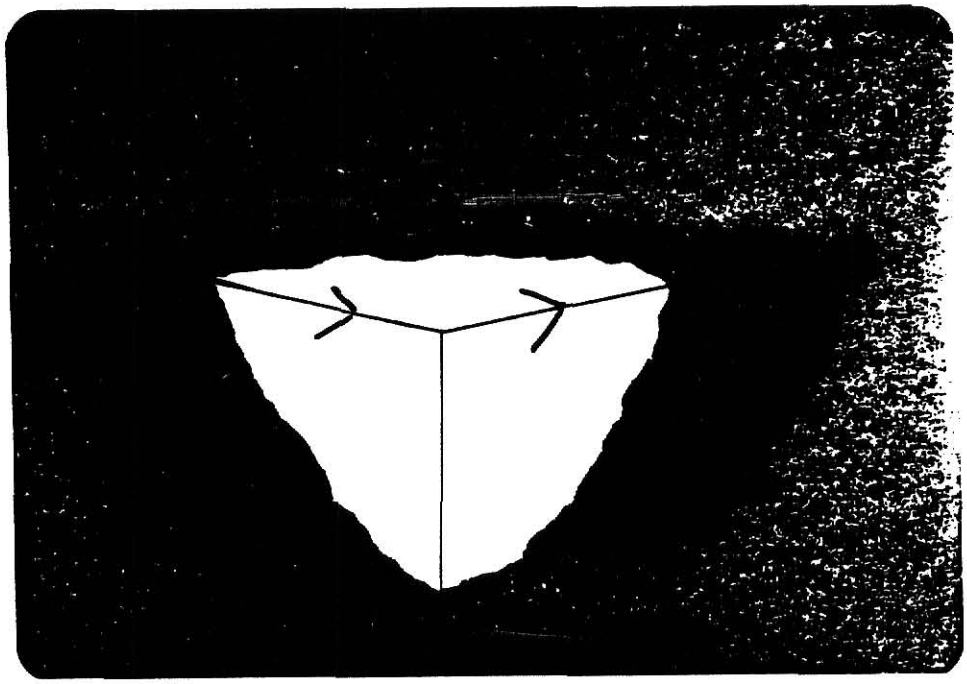
105 degrees, medium context



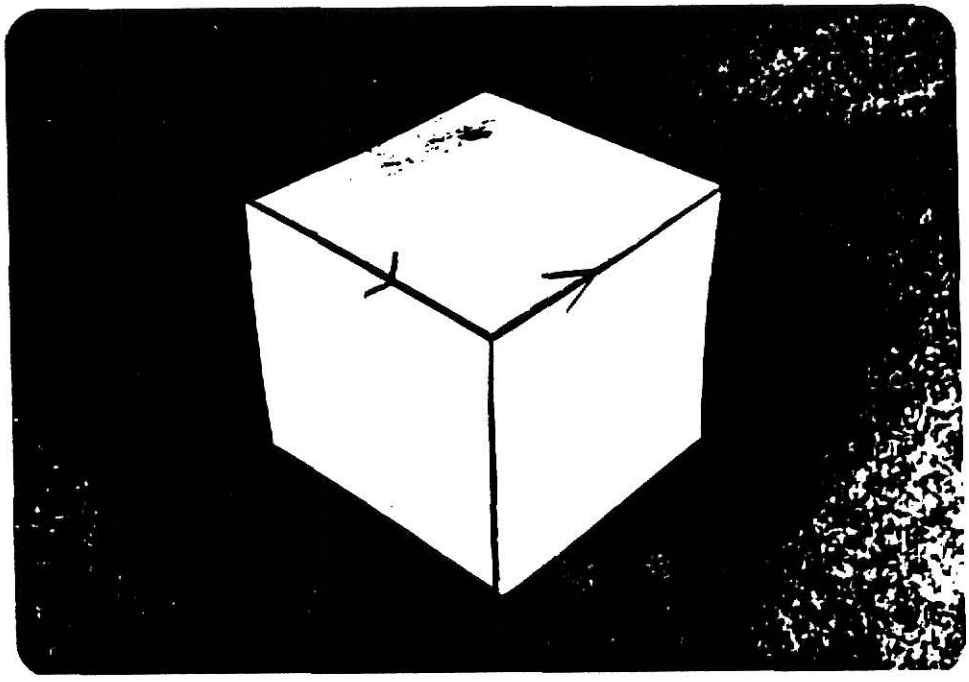
120 degrees, medium context



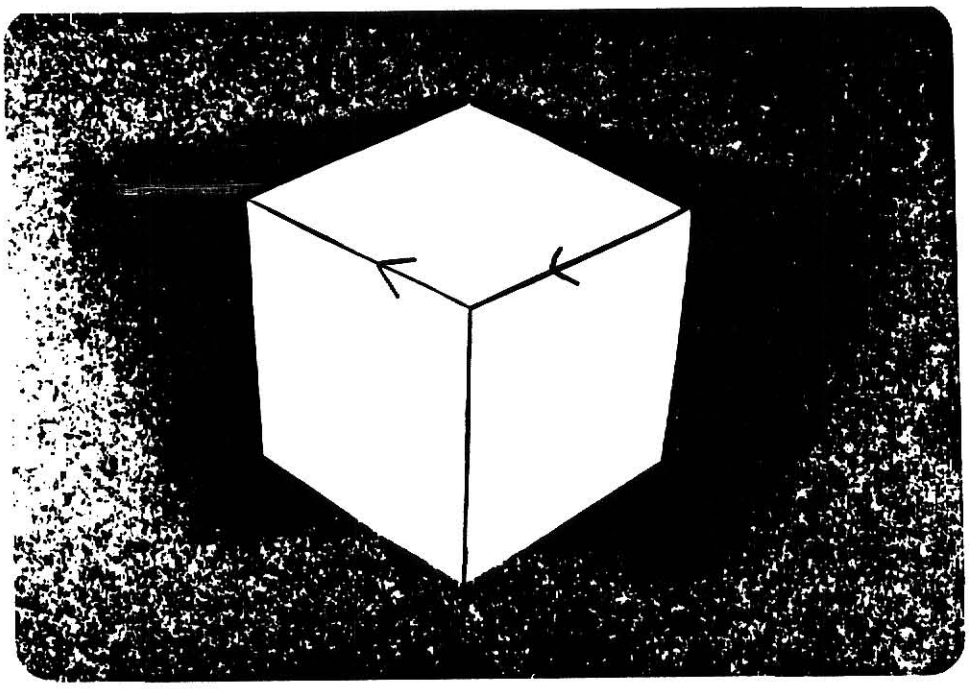
135 degrees, medium context



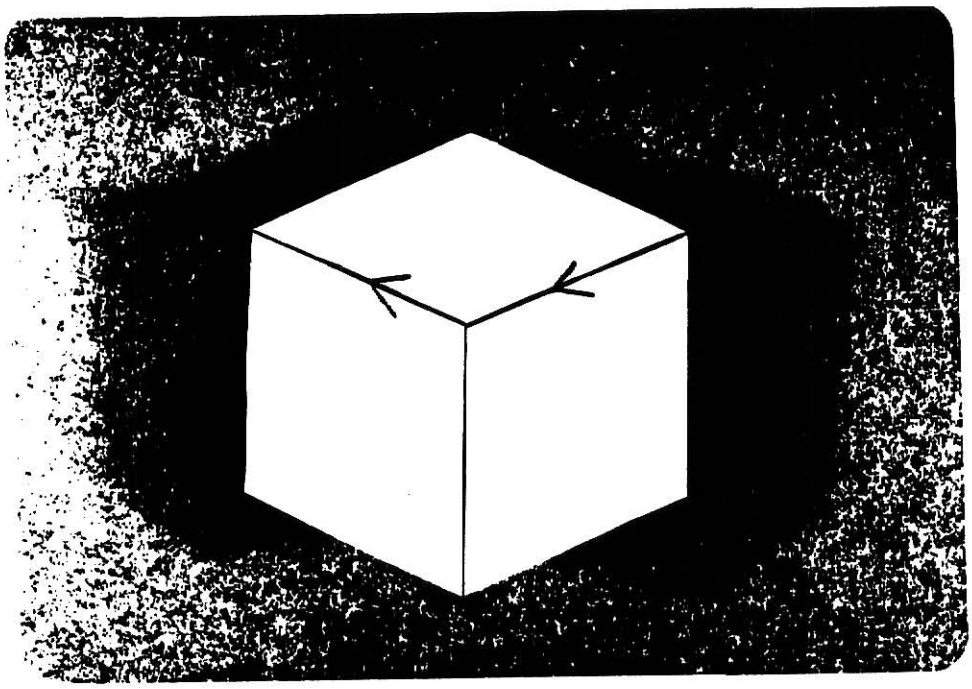
150 degrees, medium context



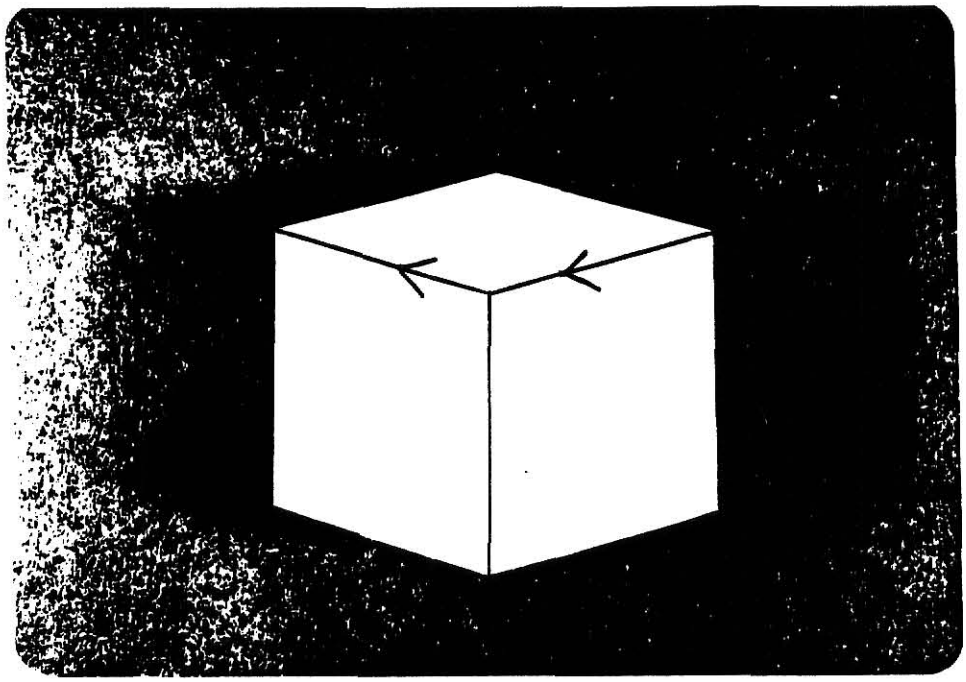
90 degrees, high context



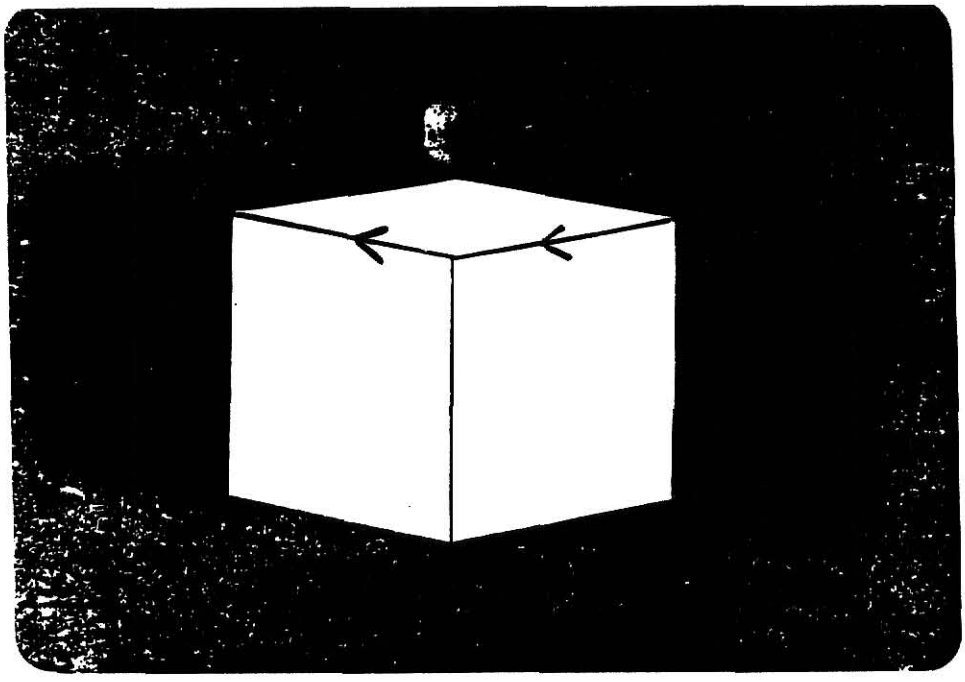
105 degrees, high context



120 degrees, high context



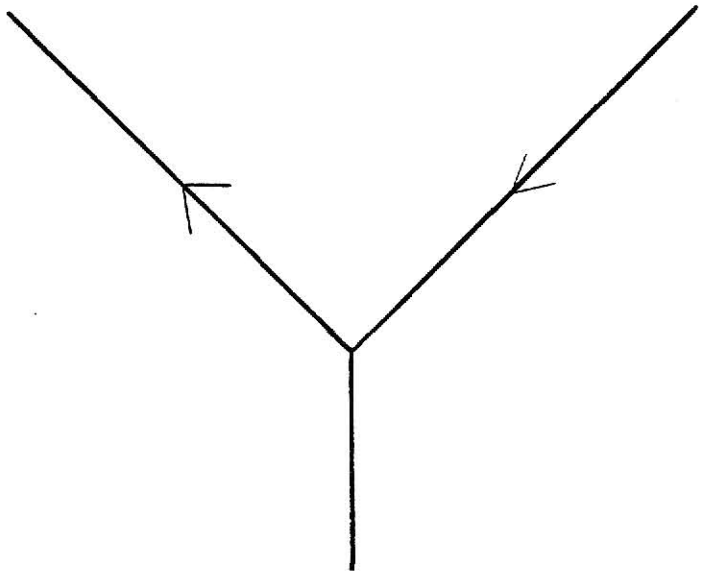
135 degrees, high context



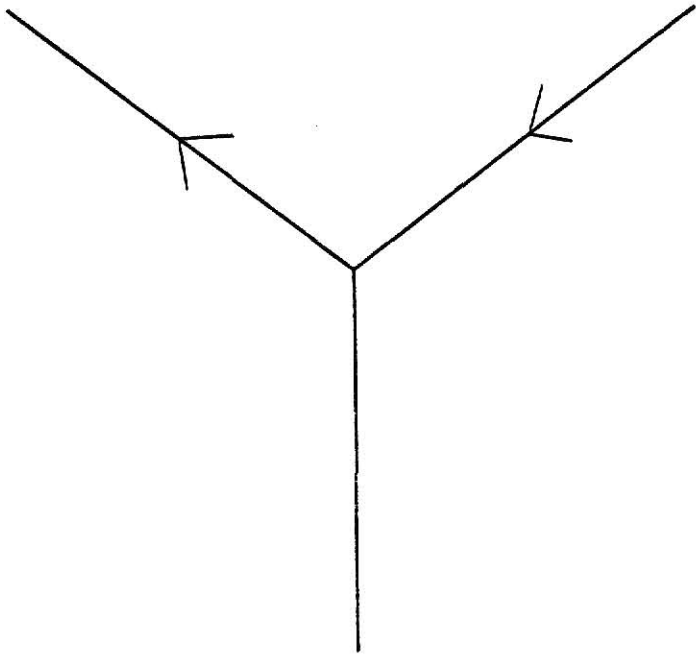
150 degrees, high context

Appendix C

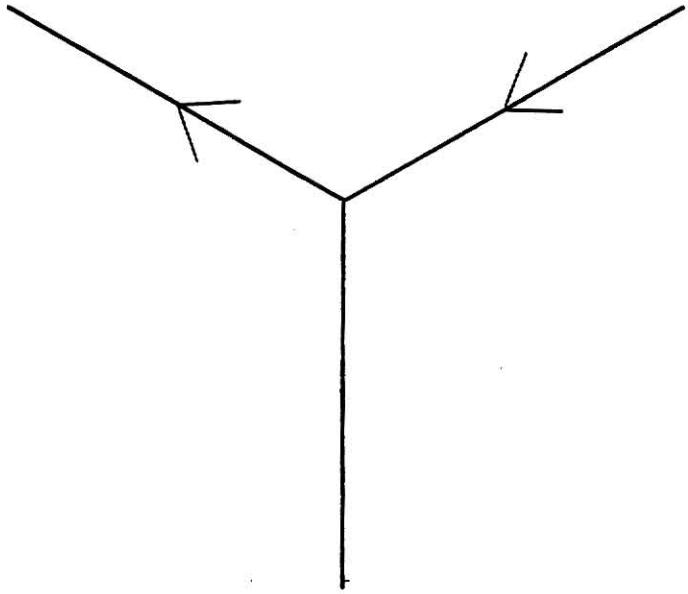
Following are drawings of two dimensional medium and high context stimuli. Low context two dimensional stimuli are identical to the top portion of the medium context stimuli and, therefore, are not shown separately.



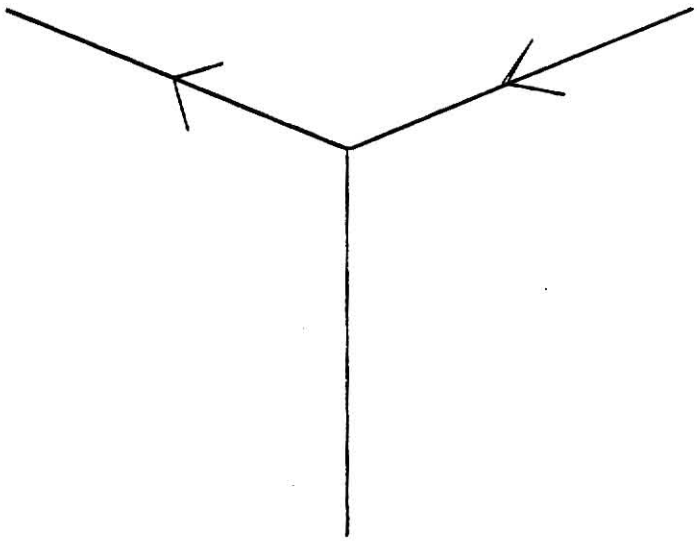
90 degrees, medium context



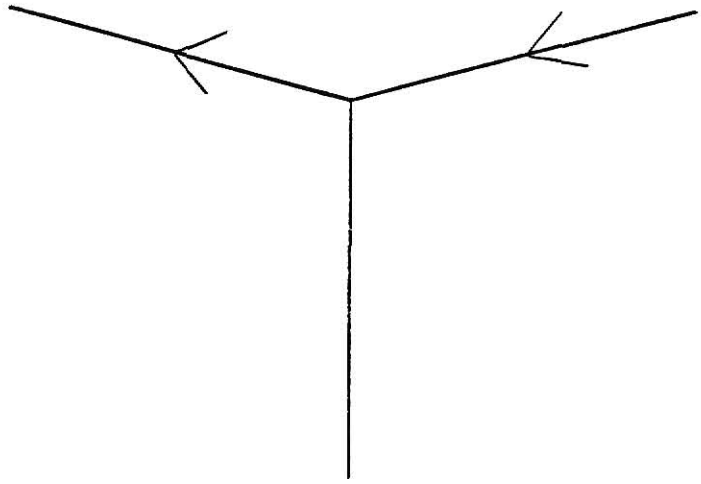
105 degrees, medium context



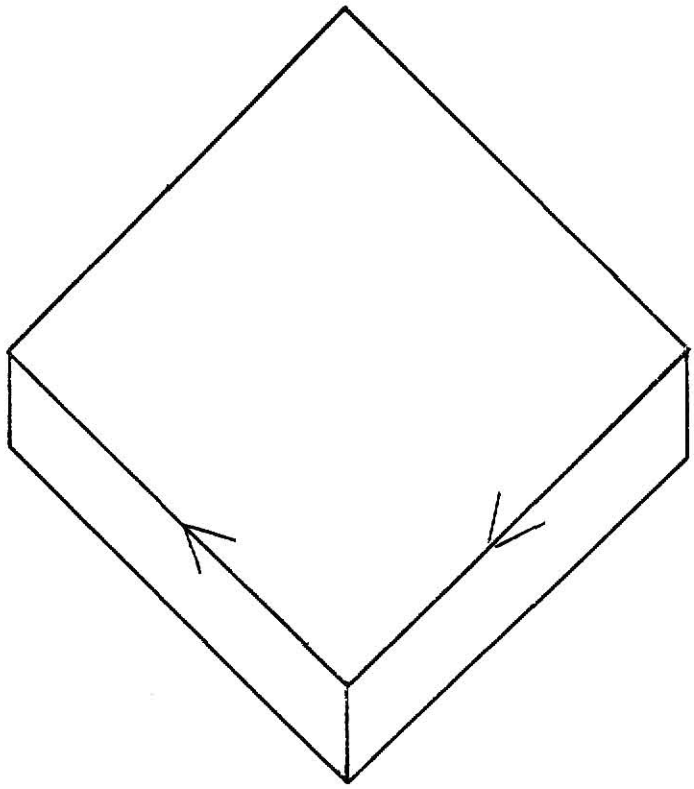
120 degrees, medium context



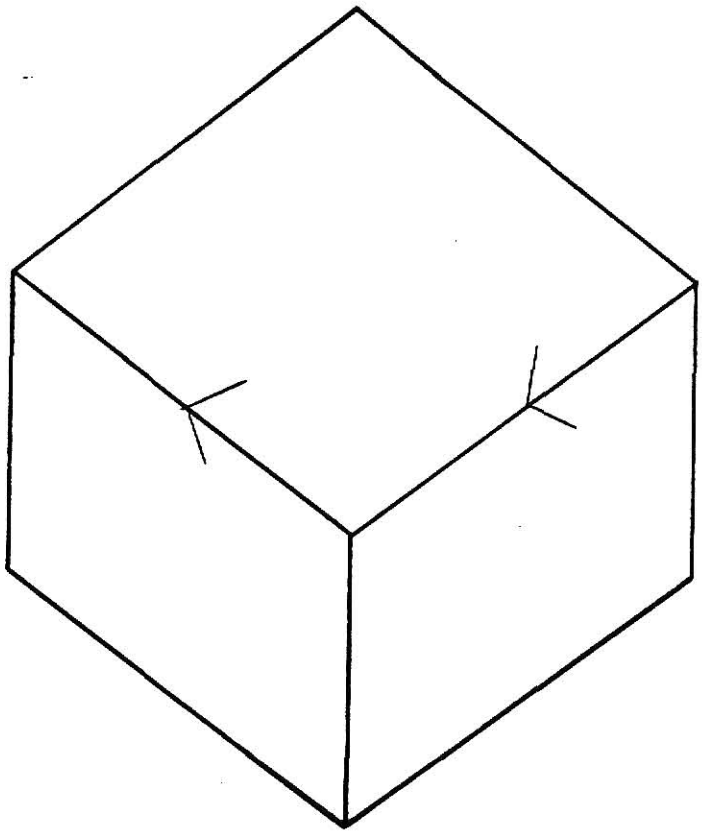
135 degrees, medium context



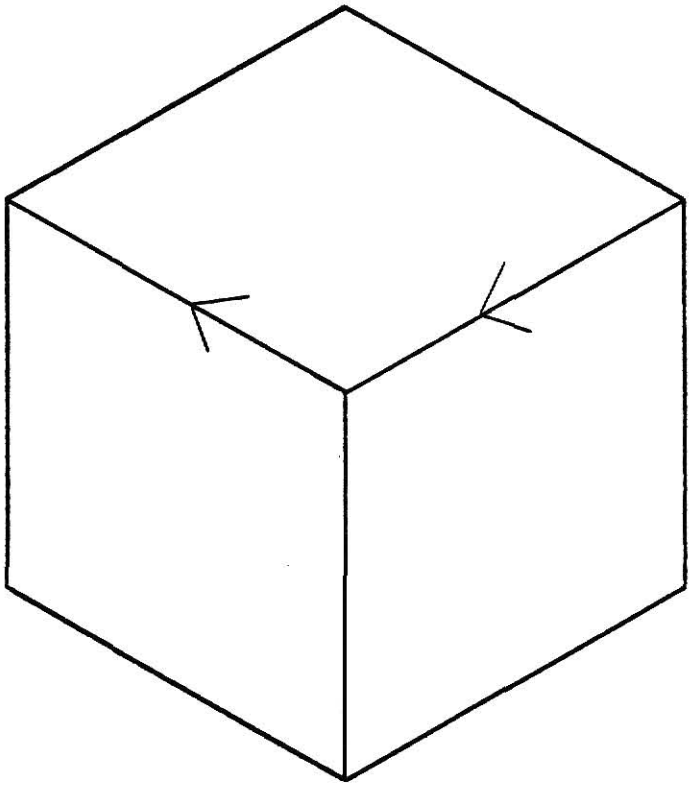
150 degrees, medium context



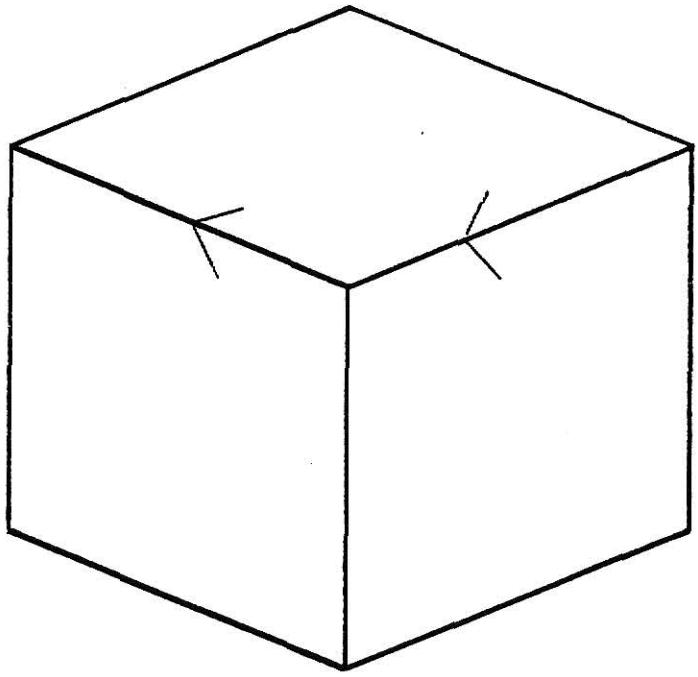
90 degrees, high context



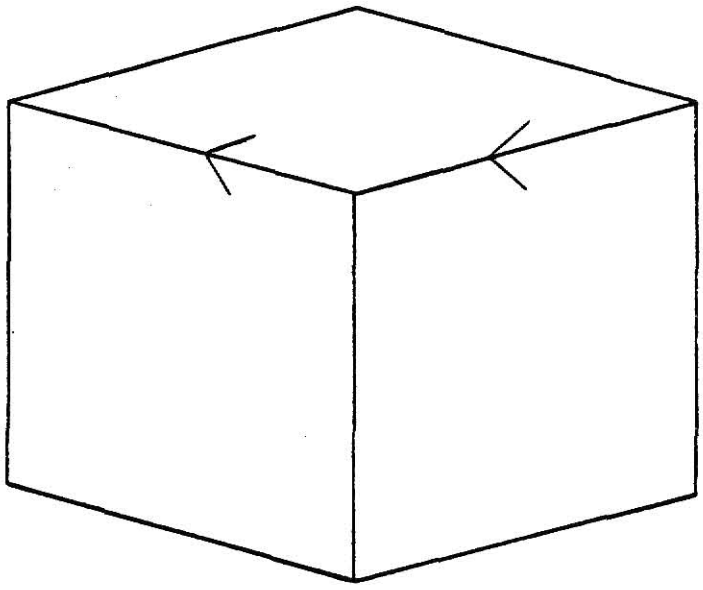
105 degrees, high context



120 degrees, medium context



135 degrees, high context



150 degrees, high context

THE EFFECTS OF INSTRUCTION AND STIMULUS CONTEXT ON ANGLE ESTIMATION IN FIELD DEPENDENT AND FIELD INDEPENDENT OBSERVERS

by

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Abstract

The present research investigated angle constancy in field dependent and field independent observers. Subjects viewed five angles; 90 degrees, 105 degrees, 120 degrees, 135 degrees, and 150 degrees. Each was embedded in three levels of context, which became increasingly more meaningful as a cubic interpretation. Angles were presented in a three dimensional form and a two dimensional form. Objective, apparent, and analytic instructions were used to produce and inhibit constancy judgments. An overall analysis found significant main effects for field dependence $F(1,24) = 14.22$ $p < .001$, instruction $F(2,24) = 17.44$ $p < .001$, dimension $F(1,24 - 8.13$ $p < .01$, and context $F(2,48) = 60.34$ $p < .001$. Given three dimensional stimuli, context and instruction were found to be influencial for field dependents. The degree of constancy was related to cubic context, the greater the context, the greater the occurrence of 90 degree constancy. Analytic instructions produced veridical judgments for all groups in all conditions. Field independents demonstrated veridical judgments under each instruction and contextual level. Given two dimensional forms, field dependents and field independents demonstrated 90 degree constancy only under objective instructions with highly cubic context. Some intermediate constancy judgments by field dependents were evident under apparent instructions. The differences between field dependents and field independents are consistent with Witkin's (1954) theory of field dependence. Field

dependent observers find the presence of an embedding context more influential on the perception of a target than do field independent observers. The cubic context around the three dimensional angles in the present experiment induced a 90 degree constancy response by field dependents, but not field independents. The figures were reported as cubic, even though the actual angles present contradicted a cubic design.