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Some Variables of Importance in Determining Reports
of Directional Apparent Movement

presented by

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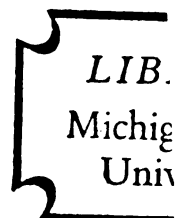
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ABSTRACT

SOME VARIABLES OF IMPORTANCE
IN DETERMINING REPORTS
OF DIRECTIONAL APPARENT MOVEMENT

by Martin Krampen

In a symmetric configuration of apparent movement stimuli, Ss tend to see bilateral apparent movement, when the light in the center is flashed first and rapidly followed by the two equidistant lights at both sides. This phenomenon is called "tendency to total assimilation." The hypothesis of this study was the following: Exposing Ss to active practice with one direction in the symmetric configuration (flashing first the center light and then one of the side lights) will increase on the posttest the number of reports expressing a directional preference (if such preference is solicited). The increase of preferential reports is expected for the direction which was practiced.

After Ss had been tested whether they saw apparent movement at all, they were exposed in a pretest to nine identical trials of the complete symmetric configuration. Ss were solicited to detect differences in the symmetrical pattern. The pretest was used to set a level of initial performance and to sort out Ss who were directionally biased to begin with.

Ss were then randomly assigned to one control and two experimental groups. One experimental group practiced apparent movement to the right, the other to the left. Both groups reinforced their directional experience by making lever movements in the direction of practice and pronouncing directional phrases. The control group received a time estimation task instead of directional practice.

On the posttest Ss were again exposed to the nine identical trials of the pretest. Again detection of differences in the symmetrical pattern was solicited.

A posttest check, an interview, and a questionnaire were used as controls, (for example, one would like to control whether Ss continued seeing apparent movement throughout the experiment and whether they were aware of E's hypothesis).

The data consisted of the number of preferential reports in the left or right direction. If there was an excess of more than one third of nine reports with specific directional connotation on the pretest, S was defined as biased.

A change score between pretest and posttest was computed by subtracting the number of preferential reports on the pretest from those on the posttest. The significance of the (mean) change between experimental groups and controls was tested by t test and chi square.

It was found that Ss with practice increased significantly the overall number of reports with directional connotations when they were not biased, whereas no such increase could be observed in biased Ss and controls. The variability seemed to increase in all groups.

Problems of interpretation of the results arise from the fact that unilateral practice did not increase the number of reports with connotations in the direction which was practiced.

While completely unbiased Ss reacted in the direction opposite to their practice, slightly and strongly biased Ss alike did not significantly exhibit such counter reaction.

When Ss were grouped in terms of their initial bias, it was found that practice did increase connotative responses in the direction of practice only when it worked against the direction of initial bias. When initial bias was reinforced by practice Ss acted against the direction of practice.

All groups exhibited a significant bias reversal from pretest to posttest. Practice thus interacted with bias reversal to produce the complexity of the above results.

SOME VARIABLES OF IMPORTANCE
IN DETERMINING REPORTS
OF DIRECTIONAL APPARENT MOVEMENT

by
Martin Krampen

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1. Introduction

1.1: Problem. In a symmetric configuration of apparent movement stimuli, when one light in the center of a screen is flashed and is followed rapidly by the flashing of two equidistant lights at both sides, Ss frequently report bilateral apparent movement. The hypothesis of this exploratory study was the following: Exposing Ss to active practice with one direction of the symmetric configuration (flashing at first the center light and then one of the lights at the side) will increase the number of reports of directional preferences in the bilateral apparent movement configuration. Ss were given a pretest to find out whether they were initially biased for one or the other half of the symmetric pattern. An apparatus was devised to allow Ss active practice while viewing one or the other half of the configuration. Then, the symmetric configuration was repeated in the posttest, and an attempt was made to assess whether practice had produced any change in perceptual reports.

The purpose of this introduction is to sketch the historical background of apparent movement research as it relates to the development of perceptual theory. Perceptual theory has developed from the earlier controversy between nativists and structuralists on one side and empiricists

on the other side to a more streamlined and synthetic view (Allport, 1955, pp. 86-89, 299-303). This development has brought about the theoretical framework for apparent movement research from which the basic hypothesis of this study was deduced.

The theoretical framework suggests that "meaningless" physiological receptor events get their "interpretation" through interaction with stored traces of past experiences. The present study is an attempt to test the plausibility of such a statement in the area of apparent movement.

1.2: Physiological hypotheses under criticism. Perception used to be regarded as a "stimulus-bound" functioning of innate mechanisms. The argument for this position went as follows: If a percept was not immediately given and veridical, the contact of the organism with the environment would have to be thought of as maladaptive; this concept is inconsistent with the functional point of view. Early perceptual investigations thus usually centered around certain aspects of perception with the intent of specifying their mechanism. Perception of space, for example, was examined in order to gain insight into the underlying physiology.

Another aspect of perception, the perception of movement, was linked to the beginnings of the Gestalt school. Wertheimer's classical paper (1912) focused on perceived stroboscopic movement and proposed a physiological

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"short circuit theory" as explanation.

Other neurophysiological theories such as Köhler's Stromfädentheorie were advanced later.

"Premature" neurophysiological hypothesizing in explaining apparent movement (especially Wertheimer's short circuit theory) has since been under criticism from several quarters. One kind of criticism comes from neurophysiologically oriented experimenters.

Bartley (1941) has summarized the evidence concerning the physiological mechanisms underlying apparent movement. Differential spread of activity in the retina furnishes a physiological counterpart to reports of different kinds of apparent movement. But, while they could not exist without the retinal distribution, not all forms of apparent movement depend to an equal extent on retinal factors.

The retinal conditions set the stage for movement itself, while in complex stimulus patterns the choice of which of the two directions it will be is effected elsewhere. (Bartley, 1941, p. 162f).

Where then is the locus of apparent movement? According to Wertheimer's theory, one would have to postulate a unified field in either of the cerebral hemispheres.

K. U. Smith (1940) has demonstrated that head nystagmus occurs as a response to both "real" and stroboscopic movement stimulation in guinea pigs before and after removal of the occipital lobes, hemidecortication, and complete bilateral decortication. In another extirpation experiment

K. U. Smith and Kappauf (1940) found persistence of optic nystagmus in cats after bilateral removal of the striate cortex, again under "real" and stroboscopic movement conditions. These authors conclude that the neural basis of apparent movement seems to be located in subcortical optic centers.

Shapiro (1954, p. 54) has criticized this view by calling attention to the possibility that in man, as opposed to lower vertebrates, the cortex may have taken over all optic functions (with the exception of the pupillary reflex to light).

An investigation of Teuber and Bender (1949, p. 41) using eleven war patients with injuries of the occipital lobes as Ss, seems to confirm Shapiro's criticism. The results showed for all Ss a conspicuous reduction in the ability to perceive apparent movement.

Since "satiation" (in the Köhler-Wallach sense) would reduce conductivity in the brain field (as would be the case in injured brain tissue) apparent movement should be found reduced after continuous stimulation too. Evidence for such a satiation effect was found by Deatherage and Bitterman (1952) and Shapiro (1954), whereas Brenner (1953, 1956) obtained results contrary to a satiation hypothesis.

Gengerelli (1948) found apparent movement reports with homonymous and heteronymous stimulation of the cerebral hemispheres. His technique was to direct the first of two flashes into one retina, the second into the other retina. A similar technique was used by K. R. Smith (1948).

He fastened two punctiform lights to the head at the temporal margin of the eye. Either light was visible only to its corresponding eye at the nasal end of the horizontal median. Assuming that there was no important neural interaction in the region of the chiasma, he concluded that he was not stimulating a unified neural field which would be implied by the short circuit theory. Nevertheless, seven out of ten of his trained observers reported apparent movement, mostly of the "phi" variety. A review of neurophysiologically oriented experimentation shows that at the present it is not possible to characterize precisely the neural process underlying apparent movement.

Another criticism of early neurophysiological theories came from investigations stressing the influence of "set." Various apparent movement experiences could be elicited under the same extra-organic conditions. Such findings soon led to scepticism toward exclusively neural hypotheses, especially in the United States. According to Neff (1936, p. 29), Titchener delegated one of his students, F. L. Dimmick, to investigate critically Wertheimer's theory (Dimmick, 1920). Dimmick and Sanders (1929), De Silva (1926), Higginson (1926), Kelly (1935), and in Europe, Neuhaus (1930), Piéron (1933), and others demonstrated that different "sets" or "attitudes," usually defined operationally as "different instructions," produced different movement experiences, although all external conditions were kept constant.

A further criticism was based on the argument that responses acquired in the past may interact with perception of apparent movement. How, and to what degree, this interaction takes place is not yet exactly known. That this question needs careful investigation was pointed out by Neff (1936). Neff discusses the major studies in apparent movement, beginning with Exner's article of 1875 and ending with studies from the early thirties. Then he reviews the variables investigated and the theories advanced. In his conclusions, he recommends the rejection of "mental entities" and premature neural hypotheses as explanations of apparent movement. He sees two major problems as guideposts for further research:

The first of these problems is to give a suitable account of the conditions (within and without the organism) which must be satisfied at the moment of perceiving. The second problem is concerned with the development of the performance. The fact that, in the adult human organism, perceptions of depth, form, color, movement, rate, change and other aspects of objects and occurrence may be called forth by a variety of conditions; and that, moreover, the same extra-organic conditions may lead now to one, now to another variety of perceiving, leads us to suspect that we must look into the past to complete our account --we must point to the obvious fact that earlier performance exerts some influence upon later performance.... (Neff, 1936, p. 41)

1.3: "Looking into the past" of the organism. One way of "looking into the past" of organisms would be to adopt a developmental approach. Is apparent movement different in children and adults? Meili and Tobler (1931) studied apparent movement in children. They found that children

have a lower apparent movement threshold than adults. Brenner (1957) repeated the experiment of Meili and Tobler. She studied 111 Ss from two and one half to 19 years old. The results of Meili and Tobler were, in essence, confirmed: Changes in threshold of apparent simultaneity and apparent movement were clearly a function of age. Both illusions were seen under objectively more difficult conditions (slower flash frequencies) by younger children. Brenner also found that the capacity of perceiving apparent movement and simultaneity decreased with age until a level was reached at 14 years. She attributes this detriment to an increase in discrimination capacity with age as against the explanation of Meili and Tobler that children form "Gestalts" more readily than adults. Another developmental study was carried out by Gantenbein (1952). She too found that the younger the children were, the more apparent movement they saw. For instance, younger children had apparent movement experiences of subjectively longer duration.

Werner and Thuma (1942) studied apparent movement in brain-injured children. Brain-injured children differed from their controls by failing to experience apparent movement although they were able to perceive some movement when the stimulus figure was "meaningful" or when they looked at "real" movement.

The extent to which earlier performance influences movement perception even in children is difficult to assess. A structuralist could maintain that at the age in which

apparent movement is studied in children the mechanism of perception has already matured to a certain degree. An empiricist, on the other hand, could postulate that movement perception habits are formed at an early age. It is obvious that, for our question of present performance as influenced by past performance, the developmental approach presents many difficulties.

Another way of "looking into the past" is through the use of "meaningful" stimulus material. The assumption in this approach is that meaning connotations of an object are the cumulative result of past dealings with that object. As Hastorf (1950, p. 213) puts it: "Attributing meaning is essentially the application of past experience to stimuli." In principle, then, it would be possible to test the influence of past performance upon present performance by comparing responses to a meaningful and a meaningless stimulus. We would expect apparent movement to be "different" with meaningful material when compared to a meaningless stimulus. The latter should trigger the perceptual mechanism in its purest form. It is difficult, however, to conceive what a strictly meaningless stimulus might be.

Meaningful stimulus figures have been used in apparent movement study from its very beginning in the 19th century. However, De Silva (1926, pp. 473, 480, 497) must be credited with having first demonstrated that meaningful figures give a clearer perception of movement than abstract patterns. Steinig (1928, p. 324-326) used pictures of familiar objects

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in an investigation on the perception of the passage of apparent movement between two end points. Bug (1932, pp. 292-297; 300-305) found that meaningful material not only increases the degree of apparent movement, but also confers directional connotation to the movement. Meaningful stimuli were also used in the developmental studies of Meili & Tobler and Werner & Thuma. (This detail is not mentioned in the discussion of these studies and may indeed add a new dimension to their interpretation.) Next, it was Piéron (1933, pp. 246, 248) who used meaningful figures in a critical investigation of the structuralist position. He stressed general attitude and "experience" as important determinants of apparent movement. Jones and Bruner (1954) compared the quality of movement in nonsense figures and meaningful stimuli. After the first trial, 15 of their 18 Ss reported that the figure of a running man moved faster than a comparison stimulus featuring a nonsense object. On the fifth trial, however, eight Ss saw the man and the nonsense object moving at equal speed, and eight of the remaining ten saw the nonsense object moving faster and further. Jones and Bruner suggest that:

Expectancy operates to accentuate the perceived velocity and distance of the man's movement relative to that of the nonsense object on the first trial when the actual spatial-temporal features are still equivocal, and when the objects are not yet clearly localized within a stable framework. When the framework is established there appears to be a tendency toward reversal. We do not know how to account for this effect save to suggest that Köhler-Wallach (1944) satiation may be operative in apparent movement. (Jones & Bruner, 1954, p. 159).

Brenner (1956a; 1956b) used a geometrical angle, an abstract design, the picture of a stick man and one of a pendulum clock as stimuli in her experiment on meaning and apparent movement. She labelled three types of apparent movement. The first type she called after Dimmick and Sanders (1929) "visible" apparent movement. Visible apparent movement is experienced when under certain conditions of duration and interval stimuli are flashed in a repeated cycle. It is not affected by meaningful stimulus figures. The second type of apparent movement was labelled "inferred" movement. According to Brenner, inferred movement is a reconstruction after the completion of the perceptual event. The object is first seen in one position and then in another. S "interpolates" the movement or "rationalizes" the change of the object's position by concluding that "it must have moved." The "interpolated" variety of inferred movement is produced when stimuli are flashed in a repeated cycle (as in the case of "visible movement") but at time intervals over 200 milliseconds. The "rationalized" variety of inferred movement is reported when only a single presentation of stimuli is used. While the effect of meaningful figures on "interpolated" movement is still unknown, Brenner finds that meaning plays a major role in determining the upper threshold of "rationalized" movement: The symbolic representation of the stimulus in terms of a moving figure enhances the facility to rationalize movement.

1.4: A re-definition of the role of past experience in apparent movement. Toch and Ittelson (1956) wrote an answer to the Jones and Bruner study. They took this occasion to review carefully the literature concerning the role of past experience in apparent movement. First they outlined the history of experimentation with meaningful stimulus material. Then they reviewed this type of experimentation in a larger theoretical framework, that of the debate between empiricism and structuralism. By quoting from Wertheimer and Metzger, they showed that even the Gestaltists were aware that "past experience" is a variable which merits consideration (although its importance is minimized by the argument that experience could never be gained without the operation of Gestalt mechanisms). Toch and Ittelson then continued:

In view of this position of Gestalt theories, and since no empiricist would deny the physiological substratum of perception, the fundamental question has been reduced to one of **relative primacy** or **importance of learning processes and physiological mechanisms** instead of one of **exclusive determination**. (Toch & Ittelson, 1956, p. 198).

They even conceive of the possibility that the experimentation with meaningful material might not be decisive for the isolation of the role of past experience. For an empiricist such experimentation might simply put in synchronism or antagonism two relative weights assigned to different experiences. One would be the rather deep-seated and heavily weighted assumption that rapid succession in stimulation of different locations in the retina corresponds to

"movement." The other would be a less heavily weighted assumption constituted by a particular meaning (e.g., directional connotation) connected to the stimulus figure. Structuralists, on the other hand, could use experimentation with meaningful stimuli as a means for testing to what extent the operation of the physical mechanisms of perception can be modified through "experience."

This moderate and refined empiricist position proposed by Toch and Ittelson requires a particular experimental design to be tested. In order to find out whether meaning is an effective variable, it must not be brought into antagonism with more powerful determinants. Rather, where apparent movement could occur without contradiction in several directions, one of these directions should be accentuated by meaning connotation; the test would be whether the movement in the accentuated direction is in some way perceived as "outstanding."

Following this rationale, Toch and Ittelson adapted a design used by Von Schiller (1933) for their purposes. Von Schiller's question, from a structuralist's point of view, was the following: Given a stimulus configuration in which alternative apparent movements could occur, which of the alternatives will be perceived by S? The hypothetical answer was that normally movement would be expected to occur in all of the possible alternative ways. Von Schiller called this a "tendency to total assimilation." Part of his experimentation was designed to explore how the manipu-

lation of structural variables (form, color, configuration) would alter this tendency. The particular design which Toch and Ittelson adapted was used by Von Schiller (1933, p. 185) in an exploratory study. A stimulus figure a was first flashed in the center of the other equidistant stimulus figures b_1 and b_2 . The question now became: Given the normal tendency to total assimilation in apparent movement, and keeping all structural variables constant, will meaning connotation be effective in offsetting total assimilation? For example: If the same figure of a jumping deer were flashed in a b_1 -a- b_2 sequence, would S perceive the movement in the direction of the jump as "outstanding?" Further questions arise immediately, e.g., what kinds of outstandingness would be experienced? Toch and Ittelson in their exploratory study used figures of a bomb and an airplane as stimuli with movement connotation; the control stimulus was the figure of a bottle, presumably without movement connotation. The results were in the expected direction. Movement connotation was effective in unbalancing total assimilation. Unilateral movement was reported either exclusively or with preferential expressions; with the control stimulus, instead, the tendency to total assimilation prevailed.

An experiment by Krampen and Toch (1960) followed essentially the same line of reasoning set forth in the exploratory study of Toch and Ittelson. The stimulus figures used were arrow designs ranging from a "perfect"

conventional arrow figure through several figures with decreasing "arrowness," to a completely symmetrical shape, similar to a barbell. "Arrowness" was decreased by mutilating or substituting such features as the tip and the tail of the arrow. In essence, the hypothesis of the effect of meaning in Von Schiller's total assimilation situation was confirmed. The effect was strongest for the "perfect" arrow design, but no regularly decreasing effect could be established for the figures with decreasing "arrowness." Directional connotation in arrow designs seemed to be somewhat an "all or none affair" depending on certain features (e.g., tip and tail) which mediate the recognition of the stimulus as an arrow.

1.5: How can "meaning" be built up? In summing up, it seems that both structuralists and empiricists would agree on the proposition that "acquired responses" or "past experience" enter in some way into the functioning of physiological perceptual mechanisms. The question of the "how" and the degree of interaction between past experience and apparent movement is still not answered. Experimentation with meaningful material can only establish whether there is or is not such an interaction in the presence or absence of other structural variables. The present exploratory study was devised to obtain more information on how this interaction actually occurs. If "meaning" is an application of past experience to stimuli, and this experience interacts

with perceptual mechanisms, then it should be possible to bring this process under control in a laboratory situation.

The first step would be "building up" a meaning (or connotation) for a previously relatively meaningless stimulus pattern. Using the Von Schiller design (b_1 -a- b_2), one could for instance flash repeatedly a unidirectional apparent movement (e.g., a- b_2) by omitting one of the b stimuli. The assumption would be that repeated presentations of a unilateral a- b sequence would be one possible method of developing meaning: S would perhaps experience such a sequence with some directional connotation. The second step then would be a test of whether meaning formation has in fact occurred. It would consist in presenting the full Von Schiller b_1 -a- b_2 pattern. Will S now perceive one part of the pattern endowed with some directional connotation?

There are at present several theories about how "meaning" can be built up. Some of these theories are reviewed by Osgood (1952, 1958) and Osgood, Suci, and Tannenbaum (1958). These authors refer to the naive application of Pavlovian conditioning principles as the "substitution theory" of meaning. Another theory (Ogden & Richards, 1923) holds that "ideas" are the essence of meaning. This theory is labelled by the above authors as "mentalistic." The same criticism is made against an early theory of Charles Morris (1938). In this theory Morris states that signs achieve their meaning by arousing responses that "take account of" the objects they refer to.

In a later theory, Morris (1946) modified his view, now the meaning of a sign consisted of a set or disposition to respond to it with any of the responses previously elicited by the object itself. Osgood himself proposes the hypothesis that meaning is a mediation reaction, which consists of some fractional part of the total behavior elicited by the object, and produces self-stimulation. The self-stimulation mediates responses which would not occur without previous association of nonobject and object patterns of stimulation.

The apparent movement study of Toch and Ittelson (1956, p. 199) was based on a transactional approach to meaning: Meaning is built up by looking at and dealing with a stimulus pattern. Repeated exposure to that pattern leads to the development of assumptions and sets. These "experiences" are brought into the experimental situation and are considered determinants of the response of record.

Since the aim of the present study was to produce experimentally an influence of "past performance" on "present performance" in perception of apparent movement, a combination of various meaning-building techniques seemed justified in order to make the "past performance" as impressive and relevant as possible. Thus S should not only look at a unidirectional apparent movement during practice. He should make motor and verbal responses as well.

Such a methodological decision would find the approval of transactionalists. For the pretest period of Kilpatrick's experiment on "two processes in perceptual learning" (1954) Ss viewed two distorted and one normally shaped room monocularly and did not see the distortions. During practice, one group was allowed to throw rubber balls and manipulate a stick in the interior of one of the distorted rooms. The other group viewed the same room passively, while E manipulated the stick and threw the ball for S. On the posttest both groups reported alterations in the appearance of the distorted room in which they had practiced (e.g., in slope of the floor, etc.). These alterations in appearance carried over to the other (not practiced) distorted room and to the normally shaped room. Perceptual alteration was slightly greater in the active than in the passive group. In active Ss alteration occurred in greater amount and there was somewhat more carry-over to the second room (distorted or normal). Although the difference between the two groups was only slightly in favor of active practice, the experimenter saw no reason to reformulate the role of action in perception as it had been proposed by transactional functionalists. He writes:

The author and others with a similar point of view have stated that actions and their consequences are instrumental in the "construction" of what we see. What exactly is meant by action has not been well specified, but the implication has always been, probably intentionally, that it means gross overt bodily activity, the doing of something....

Apparently, perceptual learning requires that a relevant set of sequential events be set in motion in such a way that successive impingements on the learning organism will be attended to and related over time to one another, to expectations, and to purposes. Only in rare circumstances, such as in an experiment, will these conditions even be approximated unless the learner is the operator. (Kilpatrick, 1961, pp. 176, 185).

Other support for the design of the present study comes from the theory of "active participation." This theory grew out of a series of studies on affective processes. Haggard and Rose (1944) and Haggard and Babin (1948) used active participation in the conditioning of autokinetic movement. It consisted of drawing arrows by pressing the pencil hard through several layers of carbon paper. For example, if S saw movement occurring to the right, he drew an arrow pointing to the right; if movement was perceived to the left, the arrow had to be drawn pointing to the left. Dependent variables in the first study were frequency of movement, direction of movement, magnitude (estimated in inches) of the movement, degree of confidence for seeing movement, and stability of the CR. "Active" Ss saw the light move more frequently and farther. They were more confident of their perception, and were conditioned more stably. In the second study, one group of Ss drew arrows pointing in the direction of the autokinetic movement. Another group drew arrows pointing in the direction opposite to the autokinetic movement. Further variables controlled in this study were reinforcement by reward and eye dominance. Effectiveness was expressed in terms of a

complex index of conditioning. Most effective was active participation (drawing arrows) in the direction of the autokinetic movement. Second most effective was active participation in the direction opposite to the autokinetic movement. No active participation was least effective. Both reward and eye dominance were less effective than active participation.

It is interesting to note that even active participation in the direction opposite to perceived autokinetic movement was effective in making Ss perceive autokinetic movement more frequently, of greater distance, and with more confidence. This indicates that active participation as such (even without directional synchronism) may be instrumental.

Further support comes from Von Schiller's (1933, p. 196) experiment. He found that a change in the direction of movement ("Kippenlassen") was accomplished most successfully, not when the new perception was visually imagined, but when an effort was made to experience it in terms of motor adjustment. Ss reported control over directional reversals by means of motor imagery.

1.6: Some final cautions. The meaning constructed in the present study had to be of a directional nature. Ss who supposedly follow at first the tendency to total assimilation are expected to change their perceptual performance into a directional one because they have been exposed to

directional practice. To be able to say that this perceptual change really has occurred, we must make the assumption that S starts "from scratch," that is, that S has at first the tendency to total assimilation. This assumption can only be made with caution. It is conceivable that S comes to the experiment with acquired directional biases of a heavy weight. Von Schiller himself talks about a "tendency" to total assimilation, which means that we have to expect deviations from this tendency. That there are directional preferences in apparent movement choice situations has been known for a long time. DeSilva (1926, p. 491-494) found that, although most Ss preferred counter-clockwise movement, some exhibited a bias for clockwise movement. Even Von Schiller (1933, p. 192) reports that Ss were influenced unequally by experimental variation of form and color in a choice situation. He found "two types" of Ss: Some saw movement more easily between stimuli of equal color, others between equal form. Willey (1936) undertook a larger study on individual differences in directional variations of apparent movement, by offering his Ss choice situations which were systematically varied. He concludes:

Perceptions of the direction of apparent movement have been found to be characterized by wide individual differences.... This diversity in individual observations indicates the extreme complexity of the interaction of the basic determinants of these perceptions. Lack of knowledge of the physiological processes underlying perceptual activity makes it impossible to explain these changes in perception, except as they can be related to the

influence of hypothetical "biases," "factors" and "tendencies." With the use of such concepts the results of experimentation on directional variations of apparent movement can be made more intelligible. Individual biases may include both a vertical or horizontal directional tendency and a rotational (clockwise or counterclockwise) directional tendency.... The relative strength of a perceptual bias can be estimated by the resistance it offers to a change in the perception of movement when the conditions of stimulation are modified to favor such a change. (Willey, 1936, p. 673)

Since the relative strength of perceptual bias is not known for each biased S, we have to restrict our predictions to relatively unbiased Ss. It may be thought that being unbiased may not mean exhibiting 100% perception of total assimilation. Such factors as set (instructions) may prompt S to see directional connotations when practice has not yet taken place. This set, however, should not be strong enough to weaken completely the tendency to total assimilation. Even if S is somewhat set to see differences to begin with, he should not show a strong bias for one direction or the other. A stricter definition of bias, ruling out even the slightest preference of one side over the other, is of course possible.

1.7: The hypothesis. With these cautions in mind, the hypothesis of this study can now be stated in a more succinct form:

(1) Unbiased Ss who, in a previous performance, looked repeatedly at unilateral apparent movement while actively reinforcing directionality with motor gestures and verbalization, will on a later performance, exposed to a

bilateral apparent movement pattern, increase the number of reports with connotation in the direction of practice.

(2) The null hypothesis can be stated as follows:

The proportion of Ss increasing the number of reports with specific directional connotation (left, right), and Ss responding in any other way, will not be significantly different between the unbiased experimental groups with unilateral practice and the unbiased control group without such practice. Also, the mean pretest to posttest change in reports with specific directional connotation (left, right) will not be significantly different between experimental and control groups.

2. Method

2.1: Apparatus. The experimental equipment, a modification of that used by Toch and Ittelson (1956, p. 203f), consisted of a viewing apparatus connected to a control apparatus, a lever apparatus, and a dark alley.

(a) The viewing apparatus was a rectangular box, resting with its longer side on a support which in turn was mounted on a table. The front of the box, facing toward S, consisted of a frame with a transparent mirror (screen). The inside of the box contained three separate compartments, 2.5 x 5 inches each, divided by tin partitions. These partitions were fronted by diffusion glass. Each of the compartments enclosed two 7.5-W filament bulbs. The sockets for the bulbs were mounted on the back of the box, which could be lifted from the viewing unit in order to inspect or exchange the light bulbs. The box could also be opened on one side. From this side, by means of guides, the diffusion glass on the inside and the transparent mirror on the frontside were slid in. Between diffusion glass and mirror there was room for a metal slide holder. This slide holder could contain three 2.5 x 2.5 "transparencies" in a row. Each transparency was thus centered in front of one of the three compartments. By opening the viewing box laterally, and pulling the

slideholder halfway out, the transparencies could be changed. From the back of the viewing unit wires led via a switch-board into the timing unit, thus connecting the light sockets to different timers.

(b) One part of the control apparatus was a timing unit, a larger box holding a set of electronic interval timers. These timers, produced by the Hunter Company, are silenced and can be hand-operated by means of switches. For the purpose of this experiment, three timers wired in series were sufficient to provide accurate control over

- (1) the sequence in which the bulbs in the compartments of the viewing unit were lit;
- (2) how long each pair of bulbs in one compartment were lit (flash-duration);
- (3) the interval between the lighting of each of the three compartments (flash-interval).

The first of the three timers regulated the duration of the first flash; the second regulated the interval between flashes; the third, the duration of the second flash.

Another part of the control unit was the variable transformer connected to a voltmeter. This transformer regulated the voltage of the current entering the timing unit and hence the brightness of the bulbs in the viewing unit. A constant voltage was set by turning a dial until the desired reading (100 volts) on the voltmeter was obtained.

(c) For the experimental groups of the present investigation, a lever apparatus was used. It consisted of a rectangular frame of approximately 3 x 2 feet, put on

four legs of approximately two feet in height (like a table without table top). S was to sit in front of one of the longer sides of the frame. Two levers were fastened on top of the frame, on the side opposite S. These levers reached approximately five inches over the front of the frame and could thus be comfortably grasped. Rotating in their fulcrum on the side opposite S, the levers could be slid over the top of the frontal side of the frame, one to the right, the other to the left. At both ends, on the front of the frame approximately 18 inches from the center, contact switches were fastened. These switches stopped the movement of the lever. At the same time an electric circuit was closed. As a result, a small pilot light at E's recording desk was lit, signalling that the lever movement had been executed. A door spring fastened to each lever made it snap back to its original position.

(d) Another part of the experimental equipment was a dark alley of approximately ten feet in length and four feet in width. The control apparatus and the viewing unit were placed on a table at one end of the alley, the lever apparatus and a chair for S at the other end. The alley was constructed by suspending, along both sides, a curtain of black fabric. The curtain hung by means of curtain rings from a tightened wire. Access to the alley was obtained by opening the curtain at either end. This allowed Ss to reach their seat at one end, and E to change the transparencies in the viewing box at the other end of the

Fig. 1 Dark alley, viewing box, and lever apparatus.

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Fig. 1



alley. Experimental Ss were seated in front of the lever apparatus, at one end of the dark alley, in a chair fixed to the wall. The chair was provided with a head rest in order to keep S's gaze approximately directed toward the center of the viewing unit (screen). The fixed position of the chair kept S at a distance of seven feet from the screen. The timing unit was placed at the end of the alley opposite S's chair. The timer switches faced E, sitting outside of the alley at his recording desk. This desk was provided with a lamp, containing a red bulb. The lamp illuminated only the immediate area of the recording sheet on the table.

2.2: Stimuli. The stimuli were slides, one featuring a set of two, and another a set of three, circular yellow lights. They were prepared by punching equidistant circular holes in black cardboard of 2-1/2 x 7-1/2 inches. The holes, 1/2 inch in diameter, were lined up horizontally with a distance of 1-5/8 inches between them, and were centered over the three (or two) bulb compartments in the viewing box. In order to reduce brightness, a yellow Ozalit filter was fixed behind each hole. This filter lowered the brightness by ca 7%.

The brightness of the three stimuli was assessed by a Macbeth illuminometer. The circle centered over the middle bulb compartment measured 2.03 c/ft² without filter and 1.38 c/ft² with filter. The circles centered over the

left and the right bulb compartments measured 1.76 c/ft^2 without, and 1.20 c/ft^2 with filter. This brightness level was maintained by the variable transformer set at 100 volts. By lighting the two bulbs in the center compartment, the central yellow light was flashed first with a duration of 250 ms. After an interval of 12 ms, by lighting the right and the left compartment at the same time and for the same duration, the two outside lights were flashed for 250 ms. These durations and this interval were used by Von Schiller with Ss who had difficulty in perceiving apparent movement under the normal conditions of his experiment. Pilot work had shown that more Ss reported apparent movement with short flash durations and interval.

2.3: Subjects. One hundred and ten male and female Ss participated in the experiment. They were mostly college freshmen, students in introductory psychology courses at Michigan State University during the summer of 1960. Most Ss were obtained by passing out signup sheets in classes enabling Ss to make appointments at their convenience. By varying experimental and control conditions frequently, Ss were randomly assigned to these conditions. None of these Ss had served before in a similar experiment nor did any of them have sophistication in experimental psychology. Ss can thus be classified as "naive" observers. For various reasons to be considered later, many Ss had to be discarded. The data of 63 out of 110 Ss are considered in the present study.

2.4: General procedure. The design of the experiment was of the "before-after" variety. It consisted of a preliminary phase, a screening phase, a pretest, a practice period, a posttest, a posttest check, a posttest interview and a questionnaire. The whole procedure lasted approximately 30 to 35 minutes: circa five-ten minutes preliminaries, screening phase and pretest, circa five minutes practice, and circa five-ten minutes posttest and posttest check and circa five-ten minutes posttest interview and questionnaire. This design imposed itself after considering that the dependent variable was not perception of apparent movement as such. It was the number of times "qualitative connotations" in perceived apparent movement were reported, or more precisely, the number of times S reported a difference in the apparent movement pattern given by the Von Schiller conditions. This difference was expressed in terms of a qualitative preference. A typical verbal response would be: "The movement to the right is quicker." The likelihood that at least some apparent movement would be perceived was maximized by choosing appropriately short, standard flash durations and intervals, which would presumably be successful with a majority of Ss. In addition, the initial instructions were aimed at setting S for perception of apparent movement. Many investigators, as mentioned before, from Wertheimer to De Silva to Dimmick and Kelly have emphasized the importance of "set," "instruction," and "suggestion" in maximizing perception of apparent move-

ment.

However, the introduction of such a set increased the possibility that results favorable to the hypothesis might be due to unintended cues presented by E or to the compliance of S who could "see through" the experimental design. In order to minimize this effect, the practice period was presented to S as an experiment in its own right, using the same apparatus but unrelated to the "differentiation hypothesis." It became an "experiment in reaction time and coordination of response." The pretest which was to be used to establish a baseline of perceptual performance, had to become a "rehearsal" of an experiment in "seeing small differences in apparent movement." The post-test had to become the latter experiment itself. Since the "differentiation experiment" was preceded by a rehearsal, the "reaction time experiment," too, had to have its rehearsal. If S did not see through the design, he perceived the situation as consisting of the following phases:

- (a) General introduction
- (b) Introduction to the phenomenon of apparent movement
- (c) Rehearsal of experiment 1
- (d) Rehearsal of experiment 2
- (e) Experiment 1
- (f) Experiment 2
- (g) General interview

More specifically, the procedure of the experiment was as follows:

(a) In the preliminary phase, S was introduced to the experimental room, seated, and told in which direction to look. Then the experimental room was completely darkened

except for the red recording light at E's desk. While S was dark-adapting, E recorded name and sex of S and assigned S to one of the two experimental or to the control conditions. S was made to feel as comfortable and relaxed as possible under the circumstances.

(b) The screening phase was aimed at establishing whether S saw apparent movement at all. Only Ss with an apparent movement threshold compatible with the standard conditions could be valuably retained for practice. After the preliminary instructions, Ss were told that they were participating in two separate experiments, but that the same apparatus was used in both. This apparatus was said to produce apparent movement stimuli. Ss were asked whether they knew what apparent movement was. If Ss did not know the expression "apparent movement," the phenomenon was carefully explained. After this explanation, the first trial of the screening phase was presented. The center light in the viewing box was flashed and followed by a flash to the right (a-b₂ sequence). S was asked: "What did you see?" After S's report, the center light was flashed again, this time followed by a flash to the left (b₁ -a sequence). S was asked again to report on his perception. Finally, the last trial of the screening phase was shown: The center light was flashed first and was followed by the simultaneous flashing of lights to the right and the left (b₁ -a- b₂).

(c) The screening phase was divided from the pretest by a "rehearsal" of the training phase. The experimental group was led to believe that the training phase was an "experiment in reaction time and coordination." The "rehearsal" consisted of making a quick lever movement in synchronism with a perceived apparent movement. Ss in experimental subgroup I were given one trial with an apparent movement stimulus to the right (the same as the first trial of the screening phase). They had to move the right hand lever to the right. Ss in experimental subgroup II were given one trial with an apparent movement stimulus to the left (the same as the second trial of the screening phase). They had to move the left hand lever to the left. Ss in both experimental subgroups were told that in the "real" experiment they would have to say a phrase indicating the direction of their movement. Ss in the control group were told they were participating in an "experiment on time perception." They were instructed to pay attention to two "clicks" of a stopwatch, one of which signaled the beginning and the other the end of a time interval. Then they reported their estimate of the length of that interval. For all groups, the "rehearsal" consisted of one trial only in order to minimize the possibility of a "practice effect" on the subsequent pretest. The control group received instructions and one trial of fifteen seconds between "clicks" as a rehearsal of their time estimation experiment.

(d) The pretest was masked as rehearsal of a second, different experiment aimed at assessing S's "accuracy in perceiving small differences in quality" of apparent movement. The true function of the pretest was to obtain an initial level of perceptual performance. By repeating the same test later, after the practice phase, every change in the level of performance could be attributed to the intervening practice. The pretest was also used to separate Ss without initial "directional bias" from Ss biased to the left or right side. S was designated "biased" if he reported in more than three out of nine trials a difference in quality in one direction of the bilateral Von Schiller condition. "Unbiased" Ss were expected to report bilateral movement at least one-third of the time. The pretest consisted of ten presentations of an identical stimulus condition. The first trial served as "warm-up" trial, leaving a total of nine trials for the test proper.

The instructions contained the hint that the presentations of the pretest might be different. In reality, on each of the ten trials of the pretest, the light in the center was flashed first for 250 milliseconds and was followed after 12 milliseconds by the flashing of the two lights, to the right and to the left, for 250 milliseconds (b_1 - a - b_2 sequence as in the third trial of the screening phase). S reported after each trial whether he saw any difference in quality between the left and right side of the bilateral apparent movement. The trials were given

every three seconds, leaving enough time for S to respond and E to record the response. Also, an interruption was needed in order to avoid a "carry-over" of the preceding perception to the next trial.

(e) After the pretest, each experimental S received fifty directional practice trials. One experimental subgroup practiced exclusively to the right, the other exclusively to the left. A single trial consisted of S's observing the viewing unit and moving the lever to the right (left) as soon as an apparent movement to the right (left) was perceived. At the same time S had to pronounce the phrase "to the right" ("to the left"). S was thus to make three different responses at the same time, a perceptual response, a motor response, and a vocal response. Hence, the representation of the training phase as an "experiment in coordination of responses and reaction time" was probably convincing to S. Unilateral apparent movement was produced by flashing only two of the three lights, the central one first, followed by the light to the right for one group, the light to the left for the other group. When moving the lever in synchronism with his perception in the given direction, S had to hit the contact switch at the end of either front of the lever-apparatus. This was said to "register" S's reaction time. In reality, the contact switch lit up a pilot light at E's desk and indicated that the lever was pushed by each S as quickly as possible and for a standard distance of about

15 inches from the center of the apparatus. Ss were encouraged to move the lever vigorously and to pronounce the phrase loudly and clearly. After each lever movement, they had to let the lever snap back into the original position and to initiate each lever movement by grasping the lever anew. The practice period lasted about five minutes.

The equivalent, in the control group, of the practice period, was an "experiment in time estimation." After the instructions and the aforementioned preliminary trial of 15 seconds, Ss were now presented with four time intervals of one minute each. The beginning and end of the intervals was marked by the "click" of a stopwatch. S had to give his estimate of the length of the interval immediately after the second "click" marked the end of the interval. By its very nature as a "time experiment," it was easy to equate the duration of the control treatment with the average duration of the experimental practice phase.

(f) The posttest was an exact replication of the pretest. S was given the same instructions, and the same ten trials of the bilateral Von Schiller condition (spaced three seconds apart) were presented again.

(g) The posttest interview was held in order to obtain further information from S on how "real" his experience of qualitative differences within the Von Schiller pattern had been and whether he continued seeing apparent

movement during the tests. The experimental room was lighted completely and the interview was initiated by E asking S whether the "first or the second experiment" had been "more difficult." The purpose of the interview was to obtain more information on the nature of S's experience following practice. After consulting the posttest record, a typical question E could have asked was: "You reported on one of the last trials that the movement toward the right side was faster. Could you tell me a little more about how that looked?" If the description of S's experience was not enlightening enough, drawings were sometimes elicited during the questionnaire period. The last question of the interview was aimed at assessing whether the apparent movement experience as such continued throughout the experiment. E may have phrased his question: "Did you continue seeing apparent movement all the time?" Written records were kept on S's responses to the interview questions.

(h) A check on the posttest was given in order to see how persistent any change in perception due to practice was. At the end of the interview, E remarked casually, "By the way, would you mind looking at one more of the trials from the second experiment?" Then the light was turned off and S was quickly dark-adapted and presented with the Von Schiller situation again. After the presentation of the trial, E asked "What did you see?" and recorded the response. Then the light was turned on again.

(i) The questionnaire was given to S after the posttest check. It was aimed at finding out whether S had seen through the experimental design and what his level of awareness and attitude was with respect to the whole task. The questionnaire was of the sentence completion variety, but provided space for spontaneous comments of S. The instructions read: "Please complete the following sentences and add as much as you can." The first sentence started: "The purpose of this experiment was..." The second sentence was: "My evidence for this is..." The third sentence read: "My attitude toward this experiment was..." S was completely alone when filling out the questionnaire. Either E left the experimental room while S was working on the questionnaire, or S was instructed to fill out the form outside of the experimental room while E continued the experiment with the next S. This was deemed to be a necessary control in order to avoid any suggestive influence by E.

2.5: Analysis of Data. In before-after designs, the pretest has the function of setting a baseline to which an eventual change (due to experimental treatment) can be compared. It was assumed that training might affect initially biased Ss (preferring one or the other direction) differently from unbiased Ss. S was designated unbiased if, given the Von Schiller situation, he made his reports in the pretest by guessing on a chance basis and/or if he

reported no directional connotation most of the time. That S might report some connotations in the pretest should be expected since he was instructed to look for differences. In a lenient definition of bias Ss with a very slight bias might be included among the unbiased Ss, attributing the slight bias to chance rather than to preference. An unbiased S would then be one who in nine trials reported connotations to the left three times or less, while reporting connotations to the right three times or less. A typical series of reports from such an unbiased S might look like this:

1. "no difference"
2. "no difference"
3. "quicker to the right"
4. "no difference"
5. "faster to the left"
6. "faster to the left"
7. "no difference"
8. "faster to the right"
9. "quicker to the left"

S would have to produce on the pretest one of the results presented in Table 1 in order to be included among the "unbiased." Since the same pretest was given to the control group, the proportion of Ss with no bias and Ss with a slight bias should not initially differ significantly for the experimental and control groups. If the result of a chi square test between the two groups is not significant, it may be assumed that they are random samples from the same population. Conversely, if training were effective, one would expect a significant difference between experimental Ss and their controls on the posttest.

Ss were classified as "biased" if they reported connotation in a specific direction more frequently than they would if guessing at random. A typical record of such a S might look like this:

1. "no difference"
2. "no difference"
3. "more movement to the right"
4. "more movement to the right"
5. "no difference"
6. "more movement to the right"
7. "quicker to the left"
8. "more movement to the right"
9. "faster to the right"

Such a bias, whatever its specific nature may be, presumably interacts as an organismic variable with practice. Thus practice might on the whole decrease bias. Or practice in the direction opposite to the bias might conceivably increase the bias ("boomerang effect"). It might also decrease the bias (but not increase connotations in the trained direction); or it might provoke some kind of "reversal effect," replacing the original bias with another equally, or nearly equally, as strong bias. All these hypothetical reactions would make a biased S a bad candidate for this experiment. Fortunately, these Ss can be detected through the pretest. Unfortunately, however, the proportion of biased and unbiased Ss in our population is unknown. The bias itself may come from different sources such as eyedness, handedness, having learned to read from left to right (or right to left), etc. Short flash durations and a short interval may on one hand enhance perception of apparent movement as such; on the other hand they may increase the

Table 1

Number of connotations to be reported on pretest by relatively
unbiased Ss

degree of bias	Connotations		
	left	none	right
no bias	3 1 0	3 7 9	3 1 0
slight bias	2 1 0 3 3 3 0 1 2 0	4 5 6 4 5 6 8 8 7 7	3 3 3 2 1 0 1 0 0 2

proportion of biased Ss by making the stimulus pattern more ephemeral and unstable (and thus open to S's preferential interpretations).

Since the proportion of biased and unbiased Ss cannot be known in advance, it is difficult to specify a particular statistical test before the data are collected. The nature of the data suggests at first look a nonparametric technique. If a large enough group of unbiased Ss were obtained, then the posttest data could be subjected to a chi square test for independent samples (experimental vs. control group). If the number of unbiased Ss is small, Fisher's exact probability test would be appropriate. As a control for the interpretation of the results the number of unbiased Ss must be divided into three different treatment groups (left practice, right practice, no practice). This makes the available N so small that, in the chi square tests, Yates's correction for continuity becomes necessary.

On the other hand, computing a difference score based on the number of responses with directional connotation before and after practice, would allow for a t test (provided the distribution of the difference scores is not seriously skewed).

To assess whether practice had any effect in terms of increase in directional connotation, the test would be the following:

Initially unbiased experimental Ss who increase the number of reports with connotation on the posttest are tested against the unbiased controls who increase the number of reports with directional connotation on the posttest. A difference score is computed for each S by subtracting the sum of directional connotations (right plus left) on the pretest from the sum of directional connotations on the posttest. If the difference is positive, an increase has taken place. If the difference is negative, the number of scores with directional connotation has decreased. If the difference is zero, S has not changed the total number of scores with directional connotation (although he may have regrouped the scores as to their specific direction, left or right).

A chi square test may be used to test the proportion of the Ss with positive difference scores and Ss with negative and/or zero scores in the experimental group against the proportion of Ss in the control group with positive scores and Ss with negative and/or zero scores.

The difference between the mean difference scores of the experimental and the control group S may be tested for significance with the more powerful t test.

With either technique, results significant at the $\alpha = .05$ level should be interpreted as supporting the hypothesis.

The following two tests would be necessary for the acceptance of the major hypothesis:

(1) Initially unbiased right trainees who increased the number of reports with directional connotations to the right after practice are compared with controls who increased, without practice, reports with directional connotations to the right.

(2) Initially unbiased left trainees who increased the number of reports with directional connotations to the left after practice are compared with controls who increased, without practice, reports with directional connotations to the left.

"Increase" is defined as any deviation from the baseline established in the pretest. An increase score is computed for each S by first computing a base score for the pretest, from which a posttest score is subtracted. For Ss with right practice, the pretest score is obtained by subtracting the number of initial reports with left-side connotation from the number of reports with right-side connotations. A negative difference would indicate a slight left bias, a positive difference a slight right bias, a zero difference complete absence of bias. For Ss with left-side practice, the pretest score is obtained by subtracting right-side responses from left-side responses.

In the same way a posttest score is computed for Ss in both groups. Then pre- and posttest scores are compared. If the posttest score is a higher numerical value than the pretest score, an increase of directional connotation in a specific direction is said to have taken

place. This increase can be expressed as a change score from which an average change can be computed. This average change score may be compared with the average change in the same direction in the control group (t test). A less powerful test would be a chi square comparison between number of experimental Ss changing in the specific direction of the practice vs. control Ss changing in the direction of practice.

With both techniques, results significant at the $\alpha = .05$ level can be interpreted as support for the basic hypothesis and for the explanation that practicing a specific direction (viz., left or right) increases directional connotation in that specific direction.

3. Results

3.1: Biased and Unbiased Ss. The pretest was devised, in part, to single out Ss who, given the standard experimental conditions, were directionally biased to begin with. Ss were classified as unbiased when the distribution of their preferences appeared to be random or when they did not exhibit marked preference at all. Out of 63 male and female Ss who saw apparent movement, only 40 were unbiased. This relatively low percentage includes five Ss who did not see apparent movement during the screening phase but said in the posttest interview that they had seen apparent movement throughout the experiment. The other 23 Ss, who all saw apparent movement during the screening phase, exhibited a strong bias in one direction or the other during pretest.

3.2: Pretest to posttest change in directional connotation. The results of the experiment are reported in Table 2. Of the 40 unbiased Ss, 23 were assigned to the experimental condition and 17 to the control condition. Out of 23 unbiased experimental Ss, 17 increased, two decreased, and three did not change the number of reports with directional connotation from pretest to posttest.

Out of 17 unbiased control Ss, six increased, five decreased and six did not change the number of reports with directional connotation from pretest to posttest.

Out of 15 biased experimental Ss, three increased, seven decreased, and three did not change the number of reports with directional connotation from pretest to posttest.

Out of eight biased control Ss, three increased, four decreased and one did not change the number of reports with directional connotation from pretest to posttest.

Inspection of the data suggests that there is a difference in pretest to posttest change between unbiased and biased Ss. Whereas unbiased Ss increase their number of directional connotations, biased Ss seem to decrease or not change the total number of directional reports. This hypothesis was tested by applying a chi square test to the data presented in Table 2 (Ss who increased vs. Ss who did not change or decreased.) The chi square results were significant beyond the .01 level. The hypothesis that there was a difference in effectiveness of the experimental treatment between unbiased and biased Ss is strongly supported.

The data also suggest that unilateral practice was effective in increasing directional connotation for unbiased Ss. A chi square test applied to the change data for unbiased Ss in Table 2 resulted in significance beyond the .05 level. The hypothesis that active unilateral practice with apparent movement increases the directional connotation in perception of bilateral apparent movement patterns gains support.

Mean difference scores between pretest and posttest were computed for the unbiased experimental and control groups. The significance of the difference of the two

Table 2

Pretest to posttest change in number of reports with directional
connotation for unbiased and biased Ss

Groups	N	incr.	decr.	no change
unbiased	40	23	7	10
exp.	23	17	2	4
contr.	17	6	5	6
biased	23	5	12	6
exp.	15	3	7	5
contr.	8	2	5	1

means was then tested by a t test. The t was significant beyond the .05 level and the hypothesis that the mean change score in directional connotation is a result of practice with unilateral apparent movement receives further support.

The results of statistical tests are presented in Table 3.

Table 4 presents central tendencies and variability in the number of reports with directional connotation from pretest to posttest. The data suggest that the variability among Ss in the number of reports with directional connotation increased in all unbiased and biased groups alike.

3.3: Pretest to posttest change with specific directional connotation. What is there about practice that made experimental Ss increase the number of reports with directional connotation more often and on the average more than their controls? Was it the specific direction of unilateral practice (to the right or to the left) as predicted in the major hypothesis of this study? The increase of the number of reports with specific directional connotation is shown in Table 5.

Out of nine unbiased Ss with practice to the right, two increased the number of reports with connotation in the direction they had practiced, whereas five changed in the direction opposite to that practiced. One S, while decreasing the total number of directional connotation reports, nevertheless increased the number of reports with connotations in the direction opposite to his practice. One S did not change at all.

Table 3

Summary of chi square and t tests for differences between groups

groups	chi square	df	M ₁	M ₂	SD ₁	SD ₂	t	df
unbiased vs. biased	7.563**	1	1.48	- .61	2.62	1.71	3.878**	61
unbiased exp. vs. controls	4.490*	1	2.22	.47	2.06	1.98	2.629*	38
biased exp. vs. controls	.170	1	-.60	6.63	1.86	1.49	.038	21
unbiased rt. pract. vs. lf. pract.	1.483	1	-.56	1.00	2.46	1.78	1.699	21
unbiased rt. pract. vs. controls	2.056	1	.56	.24	2.46	1.83	.901	24
unbiased lf. pract. vs. controls	3.648	1	1.00	.24	1.78	1.83	1.149	29
totally unbiased rt. pract. vs. lf. pract.			2.00	-1.00	.82	.82	3.676*	6

* Significant at the .05 level.

** Significant at the .01 level.

Table 4

Central tendencies and variability of the number of
directional connotations reported by unbiased
and biased Ss

groups	N	pretest		posttest	
		Q ₂	Q	Q ₂	Q
unbiased	40	1.94	1.07	3.50	2.00
pract. rt.	9	2.33	1.33	4.50	1.73
pract. lf.	14	1.50	.93	4.50	1.44
experim.	23	1.92	1.11	4.40	1.48
control	17	2.00	.81	2.50	1.61
biased	23	6.00	1.11	5.67	1.55
pract. rt.	7	7.00	1.52	6.75	2.19
pract. lf.	8	6.50	1.17	6.00	1.25
experim.	15	6.67	1.40	6.33	1.47
control	8	5.75	.63	4.50	1.08

Table 5

Increase of number of reports with specific directional
connotation

groups	N	incr. rt.	incr. lf.	other
unbiased	40	13	14	13
pract. rt.	9	2	6	1
pract. lf.	14	8	3	3
experim.	23	10	9	4
control	17	3	5	9
biased	23	7	8	8
pract. rt.	7	2	3	2
pract. lf.	8	2	2	4
experim.	15	4	5	6
control	8	3	3	2

Out of 14 unbiased Ss with practice to the left, three increased the number of reports with connotation in the direction they had practiced, whereas eight changed in the direction opposite to that practiced. Two Ss increased the number of reports with directional connotation equally in both directions. One S did not change at all.

Out of 17 unbiased Ss who received no directional practice, three increased the number of reports with directional connotation to the right, five increased to the left, five increased the number of reports without directional connotation, and four did not change at all.

Out of seven biased Ss with practice to the right, one increased directional connotation in the direction practiced; one increased the number of reports with connotation in the direction of practice, but also decreased the total number of reports with directional connotation. Three Ss increased the number of reports to the direction opposite practice. Two Ss increased the number of reports without directional connotation (one of them at the expense of both right and left connotations, the other at the expense of right connotation only).

Out of eight biased Ss with practice to the left, two increased the number of reports with directional connotation in the direction practices. Two Ss increased directional connotation opposite to the direction practiced. Three Ss increased the number of reports without directional connotation (one of them at the expense of both right and

left connotations, the other at the expense of right connotation only). One S did not change at all.

Out of eight biased Ss who received no practice, one increased the number of reports with directional connotation to the right; two increased the number of reports with connotation to the right and increased also the number of reports without directional connotation (both at the expense of left connotation). Two Ss increased the number of reports with directional connotation to the left; one increased to the left but also increased the number of reports without directional connotation (both at the expense of right connotations). Two increased the number of reports without directional connotation (one at the expense of right connotation, the other at the expense of left connotation).

The data suggest that practicing a specific direction did not increase the number of reports with directional connotation in that direction. There seems to be rather a tendency to the contrary in the unbiased experimental group; practicing a specific direction apparently increases the number of reports with directional connotation in the direction opposite of practice.

To test whether practicing a specific direction was effective in producing any increase in reports with specific directional connotation (be it in agreement with or opposite to practice) the mean increase in specific directionality for unbiased Ss with left practice was compared with the

mean increase in specific directionality for unbiased Ss with right practice. A t for the difference of means was computed and found not significant.

Then the proportion of Ss with right practice who increased the number of reports opposite to the direction of their practice was compared with the proportion of Ss in the control group who increased the number of reports with left connotation. The computed chi square was not significant. When, however, the proportion of Ss with left practice increasing connotations opposite to their practice was compared with the proportion of control Ss who increased reports with connotations to the right, the computed chi square just failed to reach the .05 level of significance. Such a result might possibly indicate a trend in the left trained group to react in the direction opposite to training.

Could the reason for the fact that the trend does not reach significance be found in the lenient definition of bias? Even the slightest initial bias, that is, any net excess of directional connotation in one direction or the other, might in fact interact with training.

In order to test this after the fact hypothesis, a t test was applied to the mean difference scores of the totally unbiased Ss. The number of totally unbiased Ss was very small. The mean increase of reports with left connotations for the three unbiased Ss with practice to the right was +2, while it was -1 for the three unbiased Ss

with practice to the left. A t for the difference of these two means is significant well beyond the .05 level. For the few totally unbiased S s in this experiment, practice in a specific direction did have an effect in the opposite direction of training. Given the small N , however, this result should be interpreted with caution.

How did specific directional practice affect slightly biased and strongly biased S s? The distribution of their reaction to specific training is shown in Table 6.

In the group with slight bias, five S s increased in the direction of their practice after they had practiced the direction opposite to their initial bias; only one S behaved to the contrary. S s who practiced the direction of their initial bias increased their connotations in the direction opposite to what they had practiced (no S behaving to the contrary). Under both training conditions, a total of three S s did not change at all.

Ruling out the three S s who did not change, the hypothesis that such a distribution of cases could happen by chance was tested. The computed chi square, corr., was significant beyond the .01 level. One can have confidence in the after the fact hypothesis that for slightly biased S s practice was effective in increasing directional connotation in the direction of practice when it was against initial bias, but when it reinforced initial bias, S s changed in the direction opposite to practice.

Table 6

Interaction of practice and bias

practice and bias	increase in direction of practice	increase in direction opposite practice	no increase
slight bias			
Practice against bias	5	0	2
Practice in direction of bias	1	8	1
Strong bias			
Practice against bias	5	1	—
Practice in direction of bias	2	5	2

The strongly biased group exhibits the same tendency, although the computed chi square, corr., is not significant. Combining both biased groups, chi square, corr., is significant far beyond the .01 level. Any degree of bias then seems to interact with training. Biased Ss practicing in the direction of their initial bias increase connotation in the direction opposite to their practice, while Ss practicing the direction opposite their bias increase connotation in the direction of practice.

3.4: Pretest to posttest decrease of bias. Inspection of the control group data indicates that, although Ss did not practice any direction, they changed from pretest to posttest. This change could be described as "decrease in bias." While generally decreasing the total number of reports with directional connotation, these control Ss increased the number of reports with connotation opposite the direction of their initial bias, mostly at the expense of the number of biased responses. Often these Ss actually reversed their initial bias, or became "unbiased," reporting an equal number of connotations in both directions.

Any net excess of reports in the direction opposite the initial bias on the posttest may be defined as "decrease of bias." In the control group with slight bias, nine Ss exhibited decrease, two increased in bias, and one did not change. A sign test applied to these data is significant beyond the .05 level. In the control group with strong initial bias, all eight Ss decreased in bias. A sign test applied to these data is significant beyond the .01 level.

A sign test applied to the pooled control groups with slight and strong bias is significant beyond the .001 level.

Did this decrease in initial bias also occur in the experimental groups which increased their total number of reports with directional connotations? Thirteen of the slightly biased experimental Ss decreased in bias, one S increased and three did not change the number of initially biased reports. A sign test applied to these data is significant at the .001 level.

In the strongly biased experimental group, ten Ss decreased in bias, three Ss increased in bias and two did not change. A sign test applied to these data is significant beyond the .01 level. If the sign test is applied to the posttest data of the pooled experimental groups with slight and strong initial bias, the outcome is significant beyond the .001 level.

What happened to the initial bias in experimental and control groups with slight and strong bias? Out of the total of 52 initially biased Ss, 20 reversed their bias in the opposite direction, 13 became unbiased, reporting an equal number of connotations in both directions, eight simply decreased bias (five of these were Ss with particularly strong initial bias), five Ss did not change, and six Ss increased their initial bias. The tendency of most Ss to reverse the initial bias is equally strong in experimental and control groups; the tendency to become unbiased is the second most frequent of both groups.

3.5: Homogeneity of the groups. One of the questions one might ask in looking at the pretest data is whether the assumption is tenable that the "unbiased" experimental and control groups were selected at random from the same population. If they were, in fact, selected from the same population, then any difference between experimental and control Ss from pretest to posttest could be interpreted as an effect of the experimental treatment. The hypothesis that all Ss who underwent the pretest were from the same population can be tested at least in a limited sense. We could, for instance, single out a common characteristic among unbiased experimental and control groups which gives some assurance that they were drawn from the same population. Such a characteristic could be that the groups do not exhibit a significant difference in the proportion of Ss with no bias and Ss with slight bias. We would then test the hypothesis "experimental and control groups differ with respect to their proportion of unbiased and slightly biased Ss in the pretest" against the null hypothesis "experimental and control groups do not differ with respect to their proportion of unbiased and slightly biased Ss."

A chi square test was first applied to the pretest data of both experimental groups. Chi square, corr., was not significant. The null hypothesis cannot be rejected for the two experimental groups. The pretest results of the two experimental groups were then pooled and another chi square test was applied to the pooled data of the two

experimental groups vs. the control group data. Chi square corr., was not significant. The null hypothesis that "experimental and control groups do not differ with respect to their proportion of unbiased and slightly biased Ss" cannot be rejected.

3.6: Ss seeing through the experimental design. S's level of awareness was one of the problems of experimental control. If Ss were aware of E's hypothesis, their verbal report could be viewed as a result of compliance or opposition rather than an indication of their perception. It turned out, however, that out of the 63 Ss only one gave evidence, in the questionnaire response, that she did understand the hypothesis of the experiment. This S wrote: The purpose of these experiments was:

to see if the idea of the direction 'right' would carry over (by continuous repetition) to an experiment which obviously didn't contain those movements. My evidence for this is the fact that the lever experiment came before the direction one. My attitude toward this experiment was very neutral; it seemed confusing.

Six other Ss expressed curiosity, doubt or speculations as to whether E's instructions actually presented the real purpose of the experiment. One typical control S wrote that the purpose of the experiment was:

to determine perception of time and small differences. However, I do not know what or if there was an underlying purpose, but I feel that there was. My evidence for this is (1) tests (2) these tests didn't seem to be lending[?] to just the purposed conclusion. They seemed to be getting at something deeper than the announced.

Another S wrote:

I did not get the full benefit of the second test because I was not sure what was trying to be proved. I definitely felt that the two tests were exact opposites....

Another S, though accepting E's instructions as the "real purpose" of the experiment, mentioned a "carry over" from the first to the second experiment. S wrote: The purpose of these experiments was:

to measure my ability to coordinate my verbal hand reactions to the perception of stimuli by eye. The second experiment was designed to measure my perception of differences in a stimuli [stimulus] with two reactions. (I felt a carry-over from the first experiment to the last in the form of increased awareness of the experimental material) after thought.

Another revealing comment as to the expectation Ss may have had, despite the instructions, was given by an S who received right side practice:

My attention was not completely on movement to the right because my left hand became tense in anticipation of any movement to the left.

Most Ss accepted the "purpose" given in the experimental instructions readily as the "real purpose" of the experiment. It can be concluded that the "rigging" of the experiment by the instructions was, on the whole, successful.

3.7: Attitude. Even if S did not see through the design of the experiment, a neutral, positive, or negative attitude toward the experiment could have resulted from the different treatments. To control for such an influence, the last sentence to be completed in the questionnaire asked for S's attitude toward the experiment. It was found that Ss

pronounced in their writing either a general attitude toward the experiment as a whole, or used preferential statements to express a differential attitude toward "both experiments." Of the first group of 45 Ss, 29 Ss expressed a positive attitude toward the experiment as a whole. One typical S wrote: My attitude toward this experiment was "excellent. I tried to cooperate to the best of my ability." Sixteen Ss expressed attitudes other than positive. A few Ss expressed an obviously negative attitude. Here is an example: My attitude toward this experiment was:

that I thought it was quite difficult to detect any differences + it is hard to be positive in such an experiment.

Other Ss expressed an attitude of indifference as, for example, this: My attitude toward this experiment was:

one of indifference since there wasn't much time put into it.

"Ambiguous" was the classification applied to some mixed comments as the following: My attitude toward the experiment was:

one of nervousness: I thought it was very interesting.

Some Ss evaded stating their attitudes by writing comments like the following: My attitude toward this experiment was:

I'll bet this research could be used by people in advertising or public safety in determining the effectiveness of using 'moving' lights to capture the people's attention (e.g., for advertisements or road signs.)

Out of 17 expressed preference, 15 were in favor of the "first experiment" (the practice period, or, for control Ss the time estimation task). These Ss made comments like

this: My attitude toward this experiment was:

the first part was more fun; the more I concentrated, the faster I could respond. During the second experiment, I was uneasy because I could hardly perceive the small differences and would feel nervous while waiting for the lights to flash.

Only two Ss preferred the "second experiment" over the first. One of these Ss, from the control group, commented: My attitude toward this experiment was:

In the time lapse exp. there was a little pressure and unrest because there was nothing concrete to grasp, but the sound of the click of the stopwatch. The second experiment was pleasant. There was the blinking light to observe, wasn't left in the dark.

The question is whether different attitudes may have been influenced by the particular treatments of the experiment. Such a hypothesis can be tested against the null hypothesis that the unbiased "experimental and control groups were drawn at random from the same population with a particular proportion of positive and other than positive attitudes." A chi square test was applied to the attitudinal data of all three unbiased groups. Chi square, corr., was significant beyond the .02 level. The null hypothesis can be rejected; the hypothesis that the unbiased experimental and control groups came from different populations, as far as attitude is concerned, is supported. Did both unbiased training groups come from populations with different attitudes? Can failure to obtain any particular directional trend in the right-practicing group be accounted for, in part, by lack of a positive attitude in that group? Such a hypothesis can be tested against the null hypothesis

that both training groups came from one population in which positive and negative attitudes were represented in certain proportions. If both groups were random samples from the same population their proportion of positive and negative attitudes should not differ significantly. Fisher's exact probability was computed from the attitudinal data of both experimental groups. The probability was .400, hence, the null hypothesis cannot be rejected. The hypothesis that the two groups stem from populations which differ fundamentally in the proportion of Ss with positive attitude is not supported.

Was there a significant difference in attitude between the left practicing and the control group? This hypothesis can be tested against the null hypothesis that attitudes did not significantly differ between left practicing and control groups. A chi square test was applied to the attitudinal data of the left practicing group and the control group. Chi square, corr., was significant beyond the .02 level. The null hypothesis must be rejected; left trainees and control Ss seem to stem from different populations with respect to the proportion of positive vs. nonpositive attitudes. An overall difference in attitude then seems to exist between left trainees and right trainees on one hand and control Ss on the other hand; but only the left practicing group contributes significantly to this difference.

3.8: Posttest check. If practice had produced some change in S's perception of directional connotation, this change could vary in its persistence over time. It could, for example, be a short-lived set, dissipating quickly; or it could be a more stable change, persisting over a certain period of time. The posttest check, a one trial repetition of the Von Schiller pattern, was given after the posttest interview to obtain information on the persistence of the posttest results. If experimental Ss reported in the posttest check more directional connotations than control Ss the increase measured in the posttest could be said to be a stable one. Out of 23 unbiased experimental Ss, 12 reported directional connotations on the posttest check, whereas only three out of 17 unbiased control Ss reported directional connotations. A chi square test was applied to these data. Chi square, corr., just fails to reach the .05 level of significance. The increase in directional connotation measured in the posttest does not persist, although there seems to be a tendency in that direction. One trial only could be, of course, regarded as insufficient.

3.9: Ss reporting apparent movement. In a preliminary study, results other than those immediately connected with the hypotheses are of interest. For instance, knowing what proportion of Ss see apparent movement under the described experimental conditions may be of value for further investigation.

Out of the 110 male and female Ss, 86 reported apparent movement during the screening phase. In the posttest interview, 96 Ss said that they saw apparent movement throughout the experiment. The capacity of Ss to see apparent movement seems to have increased slightly from the screening phase to the posttest interview. Out of the 13 Ss who reported in the posttest interview that they seldom or never saw apparent movement, seven had not been able to see apparent movement during the screening test. Some Ss perhaps "learned" to see apparent movement during the experiment as a result of repeated exposure to apparent movement stimuli. On the other hand, only few Ss reporting apparent movement during the screening phase, said in the interview, that they were not convinced of perceiving movement throughout the experiment.

3.10: Kinds of apparent movement experience. When Ss reported apparent movement, they did not always report bilateral movement. Out of the total of 110 Ss who participated in the experiment, the data of only 63 Ss could be used. The reasons for discarding data were manifold. Six Ss were eliminated because they were left-handers. Some Ss presented scoring difficulties. But most eliminated Ss did not report seeing apparent movement in the expected way. Some discarded Ss reported movement in one direction only. Many others reported movement in one direction, followed by a second movement which began at the terminal

of the first movement and went in the opposite direction. Generally this movement was described as "crossing the center and ending up in another terminal." A typical report was: "The movement went first from the center to the right and then all the way over to the left." Very few Ss reported a "lingering" of the terminals and/or of the lights in the center. Some of these Ss with "deviant" perceptual resolution of the Von Schiller pattern changed during the experiment. Others maintained their mode of resolution throughout. Others doubted whether they saw movement at all. Often Ss who were discarded also exhibited strong bias in the pretest.

3.11: Kinds of "connotations" reported. The instructions called for a differentiation of qualities within an apparent movement pattern. In order to avoid "forcing" the response, no qualitative categories were suggested to S. Ss were thus thrust into a relatively uncomfortable situation, not knowing what "qualities" they had to look for. Some Ss attributed exclusiveness to the preferred direction. They reported typically: "Moves to the right only." One S reported: "I think I see more the right one than the left one." Other reports attributed longer duration to the preferred movement. Others reported the light in the preferred direction "flashing back and forth." The preferred movement was also called "smoother." Sometimes a report was simply of the order "more movement to the right." This kind of criterion was similar to the one in which Ss

reported seeing "two bounces" on one side. Sometimes a particular "brilliance" was attributed to movement in the preferred direction. Ss reported "brighter movement" or a "streak of light" in one of the two directions. More often an "intensity criterion" was adopted. One movement component was said to be "predominant," "stronger," "better," or "more positive" than the other. The criteria most frequently adopted were those of distance-moved and speed. The criterion of distance-moved was adopted by 23 out of 63 Ss at least once, the criterion of speed by 29 at least once. Typical reports were: "The right one moved farther" or "The one on the left went faster." Often the two criteria were used together as in a phrase like: "the left one moved further and quicker." Fortunately, most of the unbiased Ss adopted the criterion of speed or distance-moved in their reports. Only reports which revealed a typical "stimulus error" were not scored. We define a **stimulus** error as reports reflecting experience with the light sources ("dots") rather than with the movement. Thus phrases like: "The circle on the right looks bigger" or "The left light goes on before the right one" were not scored. When Ss reported connotations which were not directional (e.g., "jumping up and down"), the report was not scored. Similarly, contradictory reports were omitted ("The one on the left goes quicker and the one on the right goes farther").

4. Discussion

4.1: Interaction of practice and bias. In this study a group of Ss, relatively unbiased directionally, practiced directionality by looking at unilateral apparent movement while actively reinforcing the direction of that unilateral movement. It was found that Ss with practice, when looking again at bilateral apparent movement, increased their number of reports with directional connotation significantly over Ss without practice.

When Ss had a strong initial bias in any direction, practice did not produce this effect.

Whereas the average frequency of reports with directional connotation increased in unbiased experimental Ss (and did not significantly increase in biased or control Ss), the variability of the number of reports seemed to increase in all groups, biased and unbiased.

Problems of interpretation of the results arise from the fact that practicing unilateral apparent movement did not increase the number of reports with connotations in the direction which was practiced. While completely unbiased Ss reacted in the direction opposite to their practice, slightly and strongly biased Ss alike did not exhibit significant counter reaction, although, at least among Ss with left practice, there appears to be such a trend.

When Ss were grouped in terms of their initial bias, it was found that practice did increase connotative responses in the direction of practice only when it worked against the direction of initial bias. When the initial bias was reinforced by practice, Ss increased connotative responses against the direction of their practice.

Matters are complicated further when it appears that Ss without directional practice change from pretest to posttest, not by increasing the total number of reports with directional connotation, but by redistributing the initial number in a direction opposite to their bias. Most control Ss reversed their initial bias from pretest to posttest, others simply decreased in directional bias. The same tendency appears in experimental Ss.

Obviously, then, the effect of practice was superimposed on a second effect due to another factor (or factors) within the experimental situation. This other effect can best be observed in the control group, and consists in a decrease and/or reversal in initial bias. What are the factors which could be responsible for such a reaction? It could be merely the repetition of the Von Schiller test, or it could be the repetition of the instructions. Also, Ss who were set by the instructions to see directional differences within the bilateral apparent movement pattern may have reversed their bias simply because they expected that the "rehearsal" could not be the same task as the "real experiment." Such expectancy of a difference in

directionality between "rehearsal" and "experiment" could have possibly interacted with specific directional practice.

When this practice reinforced S's hypothesis that the "rehearsal" could not be the same as the "experiment," practice became effective. For instance, Ss who exhibited right bias on the pretest would have reversed or decreased this bias as a result of expectations aroused by some factor in the experimental situation whether they practiced or not. They would have increased the number of reports with left connotations (probably at the expense of the initial excess of report with right connotations). If these Ss in addition received left practice, their expectation would be reinforced and they may have added further left responses by diminishing the pool of responses without any directional connotation.

If practice, however, would counteract the expectation of bias reversal, by reinforcing the direction of initial bias, one might predict a subtraction from the effectiveness of practice since it interferes with expectation. If practice was altogether a weak factor in this experiment--for reasons to be considered later--it might even have been overpowered by the expectation that the "experiment" had to be different from the "rehearsal." In this case practice would almost seem to "boomerang." All that practice did then was to heighten generally the expectation of directional connotations. If this expectation conformed to other directional expectations aroused

by factors other than practice, the result was an increase of reports with connotations in the direction of practice. Otherwise practice of a specific direction appeared to have almost the opposite effect. This speculation seems to coincide nicely with the results of Haggard and Babin (1948). It will be remembered that they found active participation (drawing arrows) in the direction of perceived autokinetic movement was most effective in enhancing autokinetic movement direction. But even active participation in the direction opposite to the perceived autokinetic movement made Ss perceive movement of greater distance, more frequently and with more confidence.

Thus, in the present study, practice was significantly effective in producing more directional connotation whether it was done in the same or the opposite direction of the "reversal effect" (produced by other factors in the experimental situation).

4.2: Practice. It has already been suggested that practice might have been an intrinsically weak factor in the experimental situation. This weakness could have several causes. First of all, the number of practice trials may not have been sufficiently large. In human conditioning the number of necessary trials is extremely variable, depending on the complexity of the conditioned response. For example, in their experiment on conditioning of the autokinetic phenomenon, Haggard and Babin (1948) used

five sessions with thirty trials each. In the present study, the number of trials was kept at fifty because it had been noticed in pilot work that the monotony of the task negatively influenced the motivation of naive Ss. On the other hand, it is conceivable that the mechanism underlying the tendency to total assimilation cannot be that easily modified. Thus, with motivation kept constant by other means (e.g., payment or change in the task), a larger amount of practice, perhaps protracted over a number of days, might have been more successful.

Furthermore, the type of "participation" chosen in this study may not have been realistic enough to keep S actively involved in practice. Most Ss mastered the task as required by the instructions after a few trials. For instance, one S mentioned that the number of trials was excessive compared with the ease of the task; this circumstance created suspicion about the real purpose of the experiment.

It could in fact be maintained that Ss did not acquire any new responses during the practice phase. Unilateral apparent movement, for instance, could be conceived of as a Gestalt in itself which need not be "learned." Repeated presentation of that Gestalt could then be designated as "familiarization," but might not transfer to another Gestalt (the Von Schiller pattern). The motor response made during practice can be conceived of as a skill already present in S's repertoire or at least capable of being rapidly mastered.

This motor response was aroused by instructions at the same time S was being familiarized with the apparent movement pattern. The saying of the directional phrase too was brought about by E's instructions. While in the traditional definition of paired associate learning, S originally makes errors which are gradually eliminated until a criterion of mastery is reached, the practice period of the present study hardly contained any of the ingredients necessary for that definition of learning. The test was not a discrimination task in the usual sense because there were no physical differences to discriminate. Also, over a period of time, no forgetting in the usual sense could be expected to occur.

All these characteristics of practice in the present experiment may have weakened its relevance for the performance on the posttest. What practice probably did was to produce a light set or expectancy for directional connotation in general, much as other factors in the experimental situation produced the bias reversal effect. The short-livedness of the state induced by practice is highlighted by the posttest check. A brief interview period, the switching on and off of the light helped to dissipate the effect of practice rather quickly (although a one trial check on the posttest is not too reliable).

In this context, it should be further noted that the variable of handedness may have contributed to the contamination of the results. That handedness and eyedness

may be involved in directional choice was discovered early by De Silva (1926, p. 498f).

The question of right-handedness and right-eyedness seemed an interesting cue and two lefthanded students were induced to observe. Experimentation with equivocal situations demonstrated a preference for movement in a clockwise direction. In other words, the directional compulsoriness of the movement in the case of left-handed Os was found to be exactly the reverse of that in right-handed Os, a discovery which indicates that the directional compulsoriness of clockwise movement or of counter-clockwise movement may be due to "handedness" or "eyedness."

As far as attitude is concerned, left practice for right-handed Ss could be expected to be more of a challenge than right practice. There seemed to be, in fact, a difference in attitude between the right and left practice groups although this difference was not statistically significant. The attitudes toward the experiment were more positive and less ambiguous in the left practice group than in the right practice group and the control group. The attitudes in the latter group may have been strongly provoked by the posttests: No practice or experience with apparent movement could be brought to bear on this rather frustrating repetition of physically identical trials; and still the task was to detect differences!

4.3: The test. This brings up the question of whether the test should have contained actual differences such that Ss with practice had a more realistic chance to use their experience in the test situation. Color differences had been found ineffective in pilot work. Perhaps a re-

inforcement of the practiced directional connotation by means of enhanced brightness or equal stimulus form would have been more successful. For example, on the pretest, Ss might not have overcome the tendency to total assimilation, although two of the three stimulus members b_1 -a- b_2 , viz. a- b_2 , were equal in form, whereas b_1 was different. Practice of the direction a- b_2 (right) might have endowed this direction with a special connotation on the posttest. Also, since Ss expressed directional connotations in terms of "faster" or "further," they could have been trained to discriminate actually between "faster" or "further" apparent movement. The test could have contained stimulus situations relevant to that training; transfer from unilateral training patterns to the Von Schiller bilateral pattern could thus have been studied.

4.4: The role of awareness. The design of the present study prevented all Ss but one from seeing any clear connection between what they perceived as the first experiment and the second experiment. This precaution had been necessary to counter, at least in part, the argument that the verbal reports were made up by Ss to either help or defeat E. Bartley (1958) states that:

One of the greatest desires of the naive observer is to be "right": that is, to act in such ways as not to come into conflict with physical externality, or with custom ... the attempt to be "right" is injected into laboratory behavior and often runs counter to laboratory instructions and invalidates the experimentation. (p. 29)

Had the naive Ss understood that they were tested on whether they were able to transfer directional connotations from practice to posttest, they might have felt tempted to report not what they saw but what they thought they should see. Through the rigging of the experiment, an attempt was made to guarantee that the verbal reports reflected, in fact, perceptual experience. This attempt seems to have succeeded.

4.5: Economy of experimental design. A further discussion of the present study, given the nature of its results, should center also around the question of how the experimental design can be improved and what can be learned for further research. One decisive drawback of the present design has been the uneconomical way of obtaining unbiased Ss. Instructing Ss to see apparent movement was a legitimate way of augmenting the number of usable Ss. This procedure is consistent with what we know about the influence of set and instructions on perception of apparent movement, especially the work of Kelly (1935). The percentages of 110 Ss reporting apparent movement during the screening phase (82%) and in the posttest interview (88%) do not differ significantly from those reported by Kelly. He used flashlight bulb patterns with 60 msec intervals. His Ss were four hundred students from elementary psychology classes. About 50% of the Ss reported movement spontane-

ously when the lights were presented flashing alternately. When Ss were told what to look for, 94% reported apparent movement. The somewhat lower percentage obtained in the present study may be due to the somewhat more difficult task of seeing movement in the Von Schiller bilateral pattern.

A serious loss of Ss (roughly 21%) was brought about by the Ss' failure to follow Von Schiller's "tendency to total assimilation" when they reported seeing apparent movement in the screening phase. Von Schiller had obtained his optimal effect with flash durations of 500 to 800 msec and intervals of 10-25 msec. He recommends, however, that if Ss are not able to see apparent movement under these conditions, the flash duration and interval be shortened to 100-200 msec and 10-15 msec respectively. His recommendations were followed after pilot work had indicated that shorter flash duration and interval tended to maximize the number of Ss seeing apparent movement. But there is a possibility that these short durations also increase deviation from the "tendency to total assimilation." The introduction of a fixation point might possibly reduce the number of deviations, although it is known to reduce apparent movement experience.

The most serious loss of Ss is, of course, due to bias in directional connotation exhibited on the pretest. Only 37% of the total number of Ss who saw apparent movement were also relatively unbiased and hence eligible for

directional practice. This finding is not too surprising if we recall Willey's (1936) study on individual differences in directional variations of apparent movement. Both Von Schiller (1933) and Willey (1936) report that it is possible to "retrain" biased Ss. Voluntary control of directionality in a choice situation is possible, especially if this control is exerted in terms of motor imagery (Von Schiller, 1933, p. 18). The difference between Von Schiller's and Willey's situation and the present study is, of course, that in the latter case naive observers were used. Nevertheless, there is significant evidence from the present study that bias decreases from pretest to posttest whether Ss practiced one or the other direction or not.

The design of the present experiment would have been generally more efficient had it been an analysis of variance. Interaction of practice direction, weak and strong bias, and other variables could have been analyzed in a more convenient fashion.

4.6: Definition of Connotation. In keeping with the preliminary character of this study, response categories were not prescribed for S. This caution, however, was not necessary. The majority of Ss given the instruction to make qualitative discriminations tended to adopt spontaneously the categories "faster" and/or "farther." These categories are reported in the literature. Thus De Silva (1928) lists the following connotations in apparent movement:

1. Existentialtiy (continuity of passage, most real, least inferred)
2. Swiftiness (apparent velocity)
3. Smoothness (or jerkiness)
4. Filling of Zwischenraum (greyness, color, brightness, and/or saturation of Zwischenraum)
5. Liveness (Zwischenraum flashy or glittery)
6. Homogeneoususness of Zwischenraum (uniformly lighted or patchy)
7. Outline of Zwischenraum (straight or constricted)
8. Reverse movement (stimulus flashed second appears to jump back toward the one flashed first)

Other authors, such as Jones and Bruner (1954), and Toch and Ittelson (1957), found that Ss used only "farther" and "faster" when they reported on qualitative differences. Haggard and Rose (1944) used S's estimate of movement magnitude (in inches) as a parameter of their dependent variable in an experiment on the conditioning of the autokinetic phenomenon. Von Schiller (1933) divided qualitative responses into two categories, which he called "Fassung x" and "Fassung y," respectively (version x and version y). He characterized as version x such responses as "Schöne glatte Bewegung" (beautiful, smooth movement), "Gute ruhige Drehung" (good, calm turning around), "Klappt schön, sicher" (works well, secure), "Einwandfreie, vollkommene Bewegung" (impeccable, perfect movement). Version y is exemplified by the following responses: "Ruckartiges, unnatürliches Springen" (jerky, unnatural jumping), "Auf-fallend schlecht, unerklärlich" (remarkably bad, inexplicable),

"Widerliche, sonderbare Bewegung" (repugnant, strange movement), "Etwas ist nicht in Ordnung" (something is not in order), "Es geht los, dann ist es plötzlich ganz anderswo and ganz anders ohne "Übergang" (it starts and then it is suddenly somewhere else and something else without transition).

In comparing the findings of all these authors, responses like "faster," "farther," "smoother," etc., emerge as the more frequent ones. Other responses, if they referred to movement in a horizontal direction and not to the stimulus lights, were scored according to Von Schiller's technique of classifying responses into positive and negative versions.

5. Summary

Apparent movement has been a focus of interest in perceptual theory since the early days of the Gestalt school. Wertheimer's short circuit theory of apparent movement was early criticized from many quarters. The discovery of such factors as attitude and set made premature physiological explanations doubtful and directed attention toward other determinants of apparent movement. The variability of experiences under standard external conditions suggested the necessity of investigating the past history of an organism. Past experiences, it was postulated, must interact with the physiological mechanism of movement perception. Heavier and lighter weighted past experiences could be experimentally manipulated by using meaningful stimulus material in synchronism with or antagonism toward deep-seated movement "assumptions." A symmetrical stimulus pattern ($b_1 - \underline{a} - b_2$), used first by Von Schiller to demonstrate what he called "tendency to total assimilation," was now used with meaningful figures to demonstrate the effect of meaning in offsetting total assimilation.

The next step in this development was to bring the concept of "meaning connotation" under laboratory control.

An attempt in this direction was made in the present study. The Von Schiller b_1 -~~a~~- b_2 sequence was presented to Ss in a pretest with relatively meaningless circular lights. The pretest was used to single out Ss who were relatively unbiased directionally and exhibited a tendency to total assimilation. These Ss were given intensive experience with only a part of the b_1 -~~a~~- b_2 pattern. One group looked repeatedly at the ~~a~~- b_2 sequence to the right, another group the ~~a~~- b_1 sequence to the left. While looking at apparent movement to the right, or to the left, Ss manipulated a lever apparatus in the corresponding direction. Ss also verbalized the direction of the apparent movement. The hypothesis was: Unbiased Ss who, in a previous performance, looked repeatedly at unilateral apparent movement while actively reinforcing that direction with motor gestures and verbalization, will on a later performance, exposed to a bilateral apparent movement pattern, increase the number of reports with connotation in the direction of practice. This hypothesis was not substantiated by the experiment. No specific directional effects were found, although Ss tended to report more connotations in the direction opposite to that of practice. Interaction of bias reversal and practice, insufficient intensity of practice and attitudinal differences between the experimental groups were counted among the reasons for the inconclusiveness of the results. It was, however, found that practice did increase significantly the overall number of reports with directional

connotation in unbiased experimental Ss. This was interpreted as a heightening of directional expectancy due to exposure to directionality in practice. More work in the framework of the hypothesis proposed by the study is necessary.

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APPENDIX I

Specific Procedure and Instructions.

(a) Preliminary instructions. As S entered the room, E introduced himself and invited S to sit down in the experimental chair. S was told to keep his head in the headrest, to watch the center of the screen, and to find a comfortable position. Then, pointing at the levers, E said:

You will have to use these levers during one of the experiments. Put the apparatus in such a position that you can comfortably move the levers out to the side until they hit the switch. Try to do this without moving your head in the headrest.

E waited until S had found a comfortable position and then continued:

I will now turn off the light and give you some time to get used to the dark.

E turned off the light and said:

I will use this time in which your eyes get used to the dark to prepare the experiment. But first, would you please spell your name for my records.

E wrote down the name. Then he asked:

Are you comfortable?

After a while, E continued the instruction:

(b) Introduction to the "experiments".

Now, let me tell you a little about these experiments. You will actually participate in two separate studies. The first one is designed to

measure your ability to coordinate your perception with a hand movement and with your verbal reaction (to perceive time intervals correctly). The second is designed to test how accurate you are in perceiving small difference in quality. In both (one) experiments lights will be flashed on the screen in front of you. A set of electronic timers regulates, to very small fractions of a second, how long the lights are on the screen. With this equipment, we can produce apparent movement. Do you know what apparent movement is?

If S indicated that he knew what apparent movement was,

E pressed for an example by saying:

Yes; can you give me an everyday practical example?

If S's example did not demonstrate knowledge of the phenomenon or if he had responded negatively to E's question, it was explained to him as follows:

Well, apparent movement is a technical term in experimental psychology. And I would like to give you a practical example of what it stands for. Have you ever seen those neon arrows flashing back and forth at a filling station or in outdoor advertising?

E waited for an answer, then continued:

Now, when you looked at these arrows, did you have the feeling that they made some kind of a movement as if they were pointing at something or flashing back and forth?

E waited for an answer, then continued:

Well, this particular impression of movement you had is what we call apparent movement. I guess you see now that apparent movement is a similar, but not the same kind of experience which you would have when you look at a ping pong ball going back and forth. Only the neon arrows at the filling station appear to be moving. That's why their movement is called 'apparent.' But, let me show you an example of what I mean. Would you please watch the screen and just tell me what you see.

E showed the three test slides. First test slide: apparent movement left to right. E asked:

What did you see?

E waited for an answer. If S reported apparent movement, E showed the second test slide: Apparent movement right to left. He said:

What about this one?

E waited for an answer. If S reported apparent movement, E continued:

And this one?

E showed the third slide: Apparent movement from center to both sides. After S had reported apparent movement, E continued instructions. If S did not report apparent movement consistently, E asked:

When you looked at those neon signs, did you really have the impression that something was moving?

If the answer was negative, E marked the record with a minus sign. If the answer was positive, E continued:

Then look at this again and tell me whether what you see is similar to that experience with the neon signs.

E repeated the last test slide. If the answer was again negative, E marked the record with a minus sign. If the answer was positive, E marked a plus sign. Then E concluded the introductory instructions for all Ss as follows:

I have shown you these examples. Do you think that we have now a common understanding of what I mean by apparent movement?

E waited for the answer and then continued the instructions:

Then, let me tell you now how we'll proceed. I think that, before taking the two experiments, you should really have the opportunity to get familiar with your task. So we'll start out by rehearsing the first experiment. Then we'll rehearse the second experiment. After both rehearsals, you will take the first one and then the second one. After the experiments, then I would like to ask you still a few questions.

(c) "Rehearsal" of practice (experimental groups)

Now let's rehearse the first test. As I said, this test will measure your reaction time, and your ability to coordinate your responses. So we'll first try out what I mean by coordination of responses. Would you please take the right (left) lever in your right (left) hand. O.K.? Now release the lever; let it snap back. O.K.? Now I would like you to make the same lever movement together with apparent movement to the right (left). I will flash light on the screen and you start the lever movement when you see the apparent movement start. Try to hit the switch and release the lever as soon as the apparent movement is over. Any questions? Ready?

E prepared the apparatus for apparent movement to the right (left) and gave one or two trials until S understood the task. Then he continued:

What you have just tried is the coordination of two responses, watching the apparent movement and moving the lever. In the test, I will complicate the task a little more by adding a third response. This will be a verbal response. Everytime you see the apparent movement and you move the lever, you also say the phrase, "To the right (left)." That is all you have to do in the first experiment. I will count the number of trials you need to come up with a good and stable reaction time and coordination. Any question?

For the control group, the instructions were:

Now let's rehearse the first experiment. As I said, this experiment will measure how accurate you are in estimating the duration of time intervals. All you have to do here is to give me your impression

how long a certain time interval appears to you. After I say "ready" you will hear the "click" of a stopwatch which is a signal for you that the interval has begun. Then you simply sit back and relax until you hear the second "click" which marks the end of that interval. At the end of the interval, I will say "now", and you give me immediately your impression how long the interval appeared to you. The intervals may be longer or shorter. Do not count or reason your answer out. I am only interested in your first impression. Do you have any question? Now let's try it once. Are you ready? (Clicks)
 "Now!"

E concluded the first rehearsal for experimental and control group alike:

That is all you have to do in the first experiment. Do you have any questions?

After this question ending the first period of rehearsal, E waited for an answer. If there were any questions, E answered them by paraphrasing the instructions or by saying "Yes" or "No." Then E continued:

O.K. Then let's rehearse now the second experiment.

(d) "Rehearsal" of second experiment (pretest)

This is an experiment in perception of small differences. (So you can for the time being forget about levers.) I will flash light which should give you an apparent movement splitting from the center to the right and the left. I am going to measure whether you can perceive small differences in quality between the two halves of the movement. Let me set the apparatus for you.

E set the apparatus and then continued:

The apparatus is now set in such a way that you should be able to see these small differences which could appear on each trial. Since these differences should be there, make no attempt to guess, but just tell me what kind of differences you see between the right and the left half of the movement. Every detail you should observe is very important. Please report it at once. If you do not see any difference admit it by saying "can't

tell." So all you have to do now is to look very hard comparing the two halves of the movement as to their quality. And please rely always on your very first impression. Any question?

If S had questions, E answered them by paraphrasing the instructions or by saying "Yes" or "No." The instructions continued:

Since this test is not as easy as the first one, I would like to give you a series of practice trials. Are you ready?

E showed ten pretest trials. Each presentation was preceded by "ready" and a three-second pause after "ready" before the trial was given. Then E waited for a response. If, after the first trial, the response showed that S did not understand the instructions, E paraphrased the relevant part of the instructions. If only bilateral movement was reported, E might have probed to obtain more detail by saying:

Was there any difference between the two halves of the movement?

After the pretest, E said:

Well, do you now have a good impression how the second test will be?

E waited for an answer, then he continued:

(e) Practice (experimental groups only).

Alright, then let's stop rehearsing and start out with the first test.

E prepared apparatus for practice and said:

Remember, you have to watch apparent movement to the right (left), say the phrase "to the right (left)," and move the lever to the right (left). It is important that you hit the switch everytime because the switch is connected to a recorder. And now I will start counting the trials. Ready?

E presented the first group of twenty-five trials. The trials were given at regular intervals, After each response, E waited three seconds before presenting the next trial. If S did not respond correctly, E let S know that he had detected the mistake and asked for correction. After the first group of trials, E said:

Are you getting tired?

E waited for an answer and then continued:

Well, this is a pretty monotonous task. But I think you could make your verbal response (your lever movement) still closer together with the apparent movement. Would you mind making another set of trials?

E gave the second set of twenty-five trials in the same fashion as the first and then continued:

That's enough now. You did a very good job. We have only one more experiment to go.

For the control group the same instructions as in the rehearsal were repeated.

(f) Posttest.

Let me repeat the instructions of the second test. Remember, this is an experiment in perception of small differences (so you do not move the levers). I will flash light which should give you an apparent movement splitting from the center to the right and to the left. I am going to measure whether you can perceive small differences in quality between the two halves of the apparent movement. Now, let me set the apparatus for you.

E set the apparatus and then continued:

This apparatus is now set in such a way that you should be able to observe these small differences on each trial. Since the differences should be there, make no attempt to guess, but just tell me what kind of difference you observe between the right and the left half of the apparatus movement. Every single detail you observe is important. If you do not see any difference, admit it by saying "can't tell." So all you have to do now is to look very hard comparing the two halves of the apparent movement on their quality. And please rely always on your very first impression. Ready?

E showed ten posttest trials. The trials followed three seconds after E had announced them by saying "ready."

After each trial, E waited for the response. If S still showed misunderstanding of the instructions, E might here have paraphrased the relevant part of the instructions in between the trials. If the movement was reported without difference, E might probe deeper by asking:

Was there any difference between the two component movements?

(g) Posttest interview and check. After the last posttest trial, E turned on the light and said:

Well, that's all. Thank you again for your cooperation. By the way, did you find this last test difficult?

E waited for an answer and then continued:

That is interesting! Do you mind if I ask you a few questions?

E waited for an answer and then continued:

When you saw these differences between the two movements, which you reported as smoother (faster, brighter, etc.), how did this really look to you? Can you give me some more details of what you saw?

E recorded the answer and then continued:

You know, I was thinking of what you said before about the movements. Can I show you one more trial? Just tell me what you see. O.K.?

E waited for an answer and then turned off the light and, after a short period of dark-adaptation, said:

Ready?

Then E showed the posttest trial again and waited for a response. If S did not mention movement, E said:

Did you see movement?

If S did not report differences, E asked:

How about the movement to the right and to the left? Did you see any difference between them?

E repeated the trial in order to obtain a clear response.

After the response was obtained, E turned on the light again and said:

Well, it was a pleasure to work with you. Before you go, would you please write a few comments about the experiments in this form. Just continue the phrase which you find begun and write as much as you want.

E answered questions about the questionnaire if necessary before dismissing S.

APPENDIX II
CHI SQUARE TABLES

Table 7

Posttest increase of unbiased vs. biased Ss

<u>Ss</u>	increased	other	both
unbiased	23	17	40
biased	5	18	23
totals	28	35	63

chi square, 7.563 1 df. .01 > P

Table 8

Posttest increase of unbiased Ss reporting directional
connotations

<u>S</u> s	increased	other	both
experimental	17	6	23
control	6	11	17
totals	23	17	40
chi square, corr.,	4.490	1 df	.05 > P > .02

Table 9

Posttest increase of biased Ss reporting directional
connotations

<u>Ss</u>	increased	other	both
experimental	3	12	15
control	3	5	8
totals	6	17	23

chi square, corr., .17 1 df .7 > P > .5

Table 10

Increase in connotations to the right, Ss with practice
to the right vs. Ss with practice to the left

<u>Ss</u>	increased rt.	other	both
practice rt.	2	7	9
practice lf.	8	6	14
totals	10	13	23

chi square, corr., 1.483 1 df .3 > P > .2

Table 11

Posttest increase of unbiased Ss reporting
connotations to the left after right practice

<u>Ss</u>	increased lf.	other	both
practice rt.	6	3	9
controls	5	12	17
totals	10	16	26

chi square, corr., 2.056 1 df .2 > P > .1

Table 12

Posttest increase of unbiased Ss reporting
connotations to the right after left practice

<u>Ss</u>	increased rt.	other	both
practice lf.	8	6	14
controls	3	14	17
totals	11	20	31

chi square, corr., 3.648 1 df .1 > P > .05

Table 13
 Interaction of training and bias in slightly
 biased Ss

Practice	increase in direction		both
	of practice	opposite practice	
against bias	5	0	5
in direction of bias	1	8	9
totals	6	8	14

chi square corr., 7.058 1 df .01 > P

Table 14

Interaction of training and bias in strongly biased Ss

Practice	increase in direction		both
	of practice	opposite practice	
against bias	5	1	6
in direction of bias	2	5	7
totals	7	6	13

chi square, corr., 2.006 1 df .2 > P > .1

Table 15

Interaction of training and bias in all biased Ss

Practice	increase in direction		both
	of practice	opposite practice	
against bias	10	3	13
in direction of bias	1	13	14
totals	11	16	27

chi square, corr., 10.858 1 df .01 > P

Table 16

Proportion of completely unbiased and slightly
biased Ss in the relatively unbiased
experimental groups

<u>Ss</u>	practice rt.	practice lf.	both
compl. unbiased	3	3	6
slightly biased	6	10	17
totals	9	14	23

chi. square, corr., .022 1 df .90 > P > .80

Table 17

Proportion of completely unbiased and slightly biased Ss in the relatively unbiased experimental and control groups

<u>Ss</u>	practice	control	both
completely unbiased	6	5	11
slightly biased	17	12	29
totals	23	17	40

chi square, corr., .016

1 df

.95 > P > .90

Table 18

Difference in attitude between experimental and control
groups

attitudes	practice	no practice	totals
positive	14	6	20
other	2	9	11
both	16	15	31

chi square, corr., 5.696 1 df .02 > P > .01

Table 19

Difference in attitude between experimental groups

attitudes	practice		both
	right	left	
positive	3	11	14
other	1	1	2
totals	4	12	16

P = .400

Table 20

Difference in attitude between Ss practicing to the left
and Ss without practice

attitude	practice lf.	no practice	both
positive	11	6	17
other	1	9	10
totals	12	15	27

chi square, corr., 5.577 1 df .02 > P > .01

Table 21
Posttest check

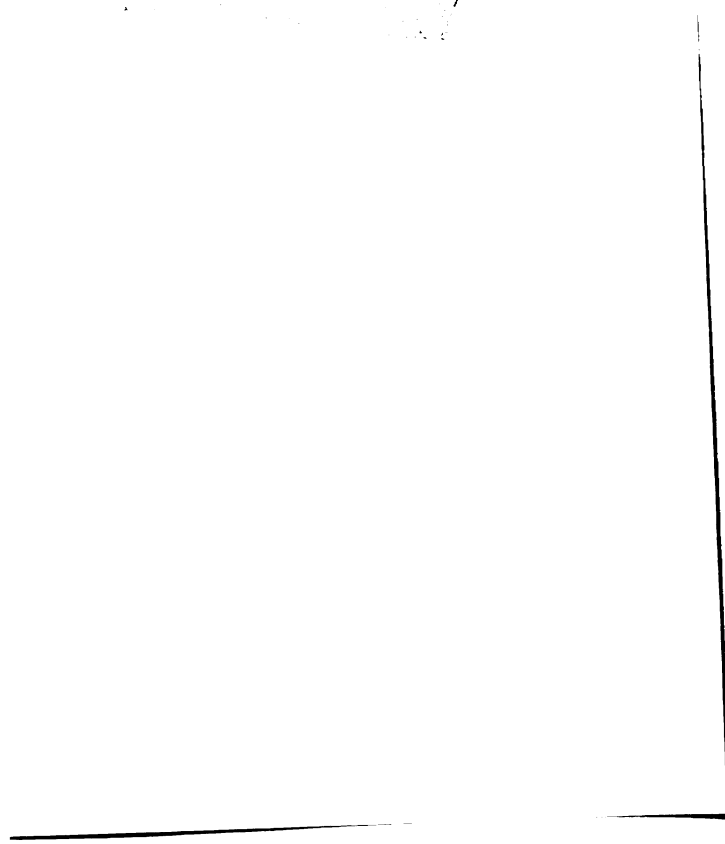
<u>Ss</u>	directional conn.	no conn.	both
experimental	12	11	23
controls	3	14	17
totals	15	25	40

chi square, corr., 3.607 1 df

.10 > P > .05

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