An Analysis of Transfer Effects Among the Continua of Line Length, Dot Density, and Proportion

by

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ABSTRACT

Judgments of simple, unidimensional stimuli by the human observer can be affected by a variety of biases (Poulton, 1979). In particular, the transfer bias may occur when judgments of two sets of stimuli are required of the rater in succession. By manipulating either the range or type of continua employed, judgments of the first set may lead to contrast or assimilation of second set judgments (Schroeder, 1982; 1984a; 1984b; 1986). Considering what proportion of a continuum's dynamic range (Teghtsoonian, 1971) is encounterable by the human observer, Aftanas and Schroeder (personal communications, 1982 to 1986) proposed that two types, or classes, of stimuli emerge. Finite-range continua, such as angle and proportion, possess a full range of humanly encounterable values. Infinite-range continua, such as line length and dot numerousness, possess ranges that extend beyond the human judge's sensory capacity. It was postulated that finite-range continua would be more resistant to transfer bias, as they have a more salient internal frame of reference than infinite-range continua. However, as infinite-range continua extend beyond the human's observational capacity, judgments of encounterable magnitudes were expected to be made more in relation to contextual cues.

A series of five experiments was conducted, using various ranges and types of continua in a transfer paradigm judgment task. Experiment 1 required 80 subjects to judge two sets of line length or proportion stimuli in succession. A significant transfer effect ($p < .05$) was displayed for all intracontinuum judgments, regardless of whether medium values were preceded by a low or a high first set. In Experiment 2, 100 subjects were assigned to one of four intercontinuum judgment tasks employing the continua of line length and proportion. The order of continuum presentation was significant ($p < .05$), but the range factor was not. Experiment 3 was a replication of Experiment 2, but the continua of proportion and dot density were used. In this case, no significant transfer effects were discovered when the range values were manipulated.

Experiments 4 and 5 employed 75 and 49 subjects respectively to further investigate how transfer effects might be occurring differentially as a function of continuum. Experiment 4 required raters to judge medium range values of either line length, proportion, or dot density stimuli. These ratings were then compared with the appropriate judgment conditions from Experiments 2 and 3 to determine the direction and degree of transfer. Although there were no significant trends between the finite-range continua of proportion and dot density, a contrast-assimilation pattern was displayed when line length and proportion continua were combined. Thus, low-valued first sets led to contrast, while high-valued first sets led to assimilation. The same pattern was exhibited for proportion to line judgments in Experiment 5 when low to high and high to low range values were used.

In general, it was found that intracontinuum transfer led to a contrast effect, both for infinite-range line length and finite-range proportion. When the finite-range continua of proportion and dot density were combined, no significant transfer effects were incurred. However, when infinite-range line length and finite-range proportion were combined, both significant and nonsignificant trends toward contrast and assimilation were observed. It was postulated that significant transfer effects resulted only when both continua were unfamiliar on the basis of range or type. Further studies should investigate this hypothesis using all possible combinations of different continua and range values.

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CHAPTER I

Introduction

Although the study of psychophysics has generated a great volume of literature, there are particular concerns common to all research in this field. Of primary importance is the relationship between the physical magnitude of a simple, unidimensional stimulus and its subsequent subjective estimate by a human judge. The validity of this relationship will depend upon the response mode employed (i.e., comparative judgments, rating scales, or magnitude estimates), the preconceived rules of judgment brought into the situation by the human observer (i.e., the logarithmic use of numbers; the centering bias), and the interaction of these components with the stimuli to be judged (Poulton, 1979). By employing various stimuli, presentation methods, and response modes, the experimenter may manipulate the rating situation in hopes of analyzing the operating characteristics of the human observer.

The Rater and the Response Mode

Psychophysical research has been conducted on the premise that meaningful subjective estimates based on physical stimulus magnitudes may be obtained from the human observer (Marks, 1974). However, the translation of a physical stimulus into a subjective estimate is not necessarily a one-to-one transformation of information. The relationship between the stimulus and its estimate depends to a great extent upon the operating characteristics of the transducer, which in this case is the human observer.

Aftanas (1985a; 1985b) has expanded upon the uses of a human observer as a measurement instrument. He states that the human is merely one kind of measurement device which can be used to encounter denotable quantities of the property or attribute being measured. He cites the human observer as one of a set of possible standard systems, which may be "...any device, mechanism, or discriminative process that may be used to denote and indicate extent of magnitude or differences between magnitudes of a property" (Aftanas, 1985a, p.8). In psychophysical measurement, the properties to be assessed are those of simple, unidimensional stimuli. It is assumed that the human standard system can distinguish between varying degrees of the stimulus continuum presented. However, the way in which the human observer expresses these measurements is also dependent upon the response mode employed.

There are three major classes of methods by which the human standard system may report judgments. Perhaps the most elegant of these employs the method of paired comparisons, which can lead to metric information using Thurstone's (1927) law of comparative judgment. Using this method the experimenter presents two stimuli for judgment on a unidimensional attribute. The subject is required to indicate which stimulus has a greater magnitude of the specified attribute over numerous trials. Under these forced-choice conditions, the judgments will indicate what percentage of the time one stimulus is judged to be greater than another. Theoretically, two stimuli of the same subjective magnitude will yield a 50-50 split over a series of trials. By using a specified range of stimuli, it is then possible to scale the series on the basis of these discriminal judgments.

The remaining two classes of judgment techniques are the category methods and the magnitude estimation procedures. Category methods require the subject to select a specific class or category for the magnitude. The procedure can lead to some loss of information as discrimination between individual stimuli may produce more estimates of subjective magnitudes than there are available categories. Thus the method is considered to be indirect, in that it does not allow the subject to indicate an exact number when relating a subjective estimate, but rather to group several ratings into one category. The most commonly used form of this method is the rating scale. As the rating scale categories are preconstructed by the experimenter to appear as equal intervals, the method has been criticized as being somewhat imprecise (Stevens & Galanter, 1957).

However, the magnitude estimation procedures are not without their own problems. This method requires that the judgment of magnitudes be made in relation to an initial stimulus. This first stimulus may be assigned a number either by the experimenter or by the subject, after which subsequent judgments must be a ratio of the first value given. This enables the subject to produce a number which he or she feels is a direct representation of the subjective magnitude experienced. The method is thus called direct because a precision of response is maintained which is unavailable to rating scale formats. Unfortunately, the difficulty of the task can introduce procedural problems and affect the results (Ekman & Sjoberg, 1965). Assuming that the subject has mastered either the rating scale or the magnitude estimation technique, results are related in the form of a mean or a median, usually averaged over subjects.

The Relationship of Stimulus and Estimate

Magnitude Estimation and the Power Law

Magnitude Estimation and the Power Law. S.S. Stevens (1960) ushered in a new era of psychophysics by devoting a lifetime to compiling an extensive body of research on magnitude estimates. He believed that magnitude estimates were direct representations of sensation, and entrenched the technique as the yardstick by which all other methods might be compared. This enabled Stevens to postulate a general rule of operation for the human standard system, based upon the way in which estimates of intensity grew in relation to physical increases of stimuli. He called this rule the psychophysical power law which proposed that "equal stimulus ratios produce equal subjective ratios" (Stevens, 1957, p.153). His energetic pursuit of this fact (Stevens, 1957; 1960; Stevens & Galanter, 1957) led to repeated validation of the law. However, it has since been noted (Ekman & Sjoberg, 1965) that studies vindicating the power law have been based upon the assumed validity of magnitude estimation as a direct method.

Aside from these criticisms, the power law yielded an exponent which supposedly indicated the rate of growth between subjective estimate and physical magnitude. Studying over two dozen continua, Stevens (1957; 1960; Stevens & Galanter, 1957) provided exponents for each, ranging from 0.33 for brightness to 3.5 for tactile acuity. These exponents were considered to be characteristic of the continuum employed, and were offered as strong support for the power law. Comparing magnitude estimation to category scaling, Stevens discovered that the two forms did not yield similar results, but were logarithmically related. He attributed these discrepancies to a natural inferiority of the rating scale format. Because differential sensitivity to stimuli is lost as physical magnitudes increase, it becomes more difficult to categorize stimuli into equal intervals at the upper end of the scale. Thus, Stevens claimed, information obtained from category scales were by necessity inferior to the magnitude estimation process (Stevens & Galanter, 1957).

Stevens found further support for power law exponents by requiring subjects to produce cross-modality matches. In this task, the human standard system is asked to produce an equivalent magnitude on one continuum to reflect another. An example of this would be to draw a line of a certain magnitude to reflect the intensity of a light brightness. By using the theoretical exponents to predict functions for these cross-modal matches, Stevens (1960) obtained further evidence for the validity of the power law. In a typical cross-modality matching experiment, Root and Ross (1965) found that the function relating loudness and brightness could be predicted by their respective exponents, 0.30 and 0.33. In this manner, evidence in support of the power law and its exponents continued to grow.

<u>The Defense of Rating Scales</u>. Stevens' criticism of rating scales did not go unchallenged. Other theorists rose to defend category scaling as a method in its own right. Miller (1956) began by pointing out that 5- to 9-category rating scales provided an efficient response mode for the human observer. Any fewer categories would lead to a lack of information; additional categories would make the scale

more precise than the discriminatory capacity of the subject warranted. Montgomery (1975) conducted an elaborate study to determine which methodological differences between category scaling and magnitude estimation produced discrepant results. In considering four different procedural assumptions, he discovered that two factors significantly influenced the magnitude estimates. These were the freedom to choose the range of responses and the ability to fix this range by selecting the highest number to be used. These variables combined to produce a nonlinear function between the two formats.

Criticism of Stevens' stance later became focused on the validity of the actual exponents. Several studies (c.f. Ekman & Sjoberg, 1965; Kunnapas, 1960; McBride, 1983a; Poulton, 1968; Poulton & Simmonds, 1963; Zinnes, 1969) began to expound upon the notion that magnitude estimation exponents were influenced by the range of stimuli employed, their spacing and frequency, and choice of the first, or standard, stimulus. Poulton and Simmonds (1963) claimed that the predictability of the exponents was merely a result of training observers to match modalities appropriately. As a result, the numerous exponents for different sense modalities as reported by Stevens (1957; 1960; Stevens & Galanter, 1957) came under direct attack by Poulton (1967; 1977) and Teghtsoonian (1971; 1973).

Listing Stevens' exponents for 21 sensory modalities, Poulton (1967) calculated the tau coefficient of correlation between each characteristic exponent and the range of stimuli presented. Results indicated that 36% of the variance was attributable to the range of stimuli employed for each study. Continuing in this vein, Teghtsoonian (1971) took into account the fact that Stevens did not always report ranges and exponents based upon a standard unit of measurement. Rather, Stevens would change this unit (i.e., using either amplitude or power) depending upon the exponent in question. Correcting for this factor, Teghtsoonian reported that 87% of the variance could be accounted for by the range variable. A recalculation of the data led Poulton (1977) to modify his estimate to 83% of the variance being associated with range. It was therefore noted that larger exponents reflected smaller ranges, to the extent that a reported exponent was a nearly exact indication of the range of stimuli employed (Poulton, 1977; Teghtsoonian, 1973). As a result of the criticisms, category scaling might be considered as appropriate a method of obtaining judgments as magnitude estimation.

The Prothetic-Metathetic Distinction

Although the power law and its exponents were now considered inadequate as an all-encompassing rule to explain the operating characteristics of the human standard system, the magnitude estimation technique survived. Stevens had provided a viable alternative to soliciting assessments of magnitudes from human raters. His study of the relationship between magnitude estimation and category rating eventually led him to propose a system for the classification of stimuli. He called this scheme the prothetic-metathetic distinction.

Stevens (1957; 1960; Stevens & Galanter, 1957) attempted to categorize stimuli into two classes on the basis of a theoretical distinction at the physiological level. Class I, or prothetic stimuli, were processed in an additive manner, where excitation was added to excitation to correspond with increases in magnitude. Class II, consisting of metathetic stimuli, were processed by a relocation of excitation, corresponding to a change in stimulus intensity. Stevens (1957) described this dichotomy as a question of "how much" as opposed to "where" neuronal activity occurred. However, Stevens recognized that he must support this classification scheme with more substantial proof. With this goal in mind, he established four functional criteria to distinguish between prothetic and metathetic stimuli.

The first criterion proposed was the subjective size of the just noticeable difference, or jnd. For prothetic continua, the sizes of the jnd's varied with the extent of the range; for metathetic continua, the jnd's were equal.

The second criterion consisted of the relationship between category scales and magnitude estimates. When the two methods were plotted against each other, the functions yielded for prothetic stimuli were nonlinear, whereas for metathetic stimuli they were linear. The third and fourth functional criteria were called the time-order error and hysteresis, both of which occurred when using prothetic stimuli, but not metathetic. Time-order error resulted when the second stimulus presented was rated as larger than the first, regardless of the value of the first stimulus. Hysteresis, in turn, was apparent in bisection and equisection experiments. If prothetic stimuli were presented in ascending order, the subject would place the midpoint higher than necessary; the midpoint was placed too low if the series descended in order.

Stevens and Galanter (1957) proceeded to categorize a number of continua into either class by using these four criteria. Those continua classified as prothetic included line length, numerosity, visual area, lifted weights, loudness, brightness, and lightness of grays. Metathetic continua consisted of visual position (azimuth), visual inclination, proportion, and pitch. The prothetic-metathetic distinction generated research focusing upon the functional criteria, such as hysteresis (Eisler & Ottander, 1963), as well as the classification of other types of judgments, such as the credibility of test items (Pine & Stone, 1970).

Unfortunately, Stevens' theoretical and functional bases for distinguishing between the two classes was abandoned rather quickly. Warren and Warren (1963) outlined criticisms for each of the functional criteria, which led to the prompt dismissal of the physiological processing theory. First, there was no evidence available to suggest that jnd's were subjectively equal for metathetic continua. An S-shaped function obtained for color mass (the proportion of blue to green dots) precluded the notion that metathetic functions were linear when category ratings were plotted against magnitude estimates. Color mass data also indicated that the time-order error did occur using a metathetic continuum. Finally, only the metathetic continuum of visual position lacked evidence of hysteresis; this was not found for any other metathetic continuum.

Ekman and Sjoberg (1965) suggested that the view of the prothetic-metathetic distinction as two separate classes be discarded in favor of a bipolar conceptualization. They advised the use of the term <u>protheticness</u> to describe the degree to which a continuum possessed the attribute, thereby retaining the essence of the theory. However, the physiological processing of information could no longer be the basis of a dichotimized stimulus categorization as the power law exponents could not directly reflect the intensity of neuronal activity (Weiss, 1981).

The Dynamic Range Theory

Although Stevens' reported exponents had been sharply criticized by his peers, it was also recognized that they possibly did exhibit some relation to the rating paradigm. The continued study of exponents now carefully considered the range of stimuli to be employed. An attempt was made to not only discover the thresholds of sensation, but to chart their ceilings (Marks, 1974).

In one study, Eisler (1965) asked subjects to give magnitude estimates of the amount of force they used to push a pedal with their foot. The upper limit of force applied was easily discerned for this type of continuum, as the ceiling obtained for each subject (that is, the point at which the foot pedal could not be moved) was not physically dangerous. Eisler obtained a consistent power function for this task, and concluded that the exponent was valid because the entire range of the continuum had been employed. However, he did note that the threshold point needed to be adjusted to obtain a truly linear function, and postulated that it was this factor which contributed to the variation of reported exponents. A later study conducted by McBride (1983b) found the power law to be totally inadequate in explaining taste intensities. Exponents for several taste stimuli indicated that the linear replotting of log-log coordinates would reveal positively accelerating growth curves. Instead, the replotted data failed to conform to the predicted power functions for several taste concentrations including sucrose, maltose, and fructose.

By reviewing both positions, it was apparent that power law exponents were neither perfect representations nor total inaccuracies in explaining the growth of sensation. Teghtsoonian (1971; 1973; Teghtsoonian & Teghtsoonian, 1970; 1979; Teghtsoonian, Teghtsoonian, & Karlsson, 1981) attempted to retrieve the power law exponents by placing them within a larger framework. His dynamic range theory consisted of two basic postulates, one concerning the subjective range of the individual, and the other dealing with the range of stimuli employed. The first he called the constant subjective range (Teghtsoonian, 1973), which stated that the human observer possessed a constant, stable range of subjectivity. The second factor, the dynamic range, consisted of a ratio of the largest to the smallest stimulus magnitude encounterable by the human standard system. Exponents supposedly reflected the dynamic range characteristic of each continuum. By combining these two theorems, Teghtsoonian (1971) developed the dynamic range theory which involved the mapping of all these different dynamic ranges onto the one, constant subjective range.

Of primary importance to this theory were the physical limits imposed upon selection of stimulus ranges by the observer's sensitivity. It was already understood that as the stimulus range increased, the size of the exponent decreased, as exhibited for judgments of apparent distance (Teghtsoonian & Teghtsoonian, 1970), and perceived exertion for a cycling task (Teghtsoonian et al., 1981). However, damage to the subject's sensory apparatus would further limit the choice of the highest intensity by the experimenter. Teghtsoonian et al. (1981) pointed out that few studies had taken this limiting factor into account when studying exponents, and little attention was paid to establishing either lower or upper boundaries.

Teghtsoonian's theory, which maintained the viability of exponents as indexes of sensitivity, did not go unchallenged. Poulton (1968) claimed that the exponents indicated nothing more than the stimulus range employed since the observer's judgmental range remained constant. Teghtsoonian (1973) pointed out that if this assumption was correct then exponents should be influenced in the same manner, regardless of whether stimulus range variations occurred either within a continuum or across continua. An analysis of Stevens' work on exponents led Teghtsoonian to conclude that the exponents were not influenced in the same fashion under the two types of conditions. Although the constant subjective range - fixed judgmental range controversy is still being debated, evidence is being gathered in favor of the general tenets of Teghtsoonian's dynamic range theory.

Biases

Poulton's greatest contribution to the study of psychophysics has been in his work on biases. He has outlined a number of possible sources of bias which could affect subjective estimates in a series of papers (Poulton, 1968; 1977; 1979; 1984; Poulton & Simmonds, 1985). It had long been recognized by other researchers that context effects, involving both the spacing and frequency of stimuli, could influence subsequent judgments (c.f., Parducci, 1963; Parducci & Perrett, 1971). Poulton considered how the context could be created by biases introduced into the situation by the subject, the response mode, and the interaction of the two, as well as offering suggestions on how to minimize these biases.

Poulton (1977; 1979) noted that the subject's familiarity with two components of the rating task affected the amount of bias which could occur in the judgment situation. The first component was the subject's exposure to the type of stimulus to be judged. As an observer might be more familiar with the continuum of line length than that of light intensity, judgments of the second set of continua might be more easily biased than the first. The second source of variability consisted of the type of response format employed and its relation to the continuum to be judged. It is known that a verbally anchored rating scale format is much easier for the subject to use than a magnitude estimation procedure. Thus, it would be optimal for an observer to rate a normally encountered stimulus, such as a line length, on an easily manipulated rating format, such as a category rating scale, with a minimum chance for the occurrence of biases. However, even these kinds of judgments are subject to a multitude of potential biases.

Poulton (1979) categorized the sources of bias into three classes: range biases, nonlinear biases, and transfer biases. Several of these biases are particularly noteworthy. The most common variety of range bias is the centering bias, where the human standard system centers his or her responses onto the stimulus range presented. Poulton suggested two methods to counteract this tendency; either provide a response format without an obvious center, or solicit only raters' first judgments. Of the nonlinear biases, the most common, yet most easily correctable, were the stimulus spacing and the logarithmic biases. The stimulus spacing bias occurs as a result of a preconceived notion on the part of the observer, who expects to be presented with geometrically equally spaced stimuli which are presented with equal frequency. This bias can be eliminated by presenting the stimulus range in the manner anticipated by the rater. The logarithmic bias occurs when the observer is required to use numbers which entail a change in the number of digits, i.e., one-, two-, or three-digit numbers used in conjunction. The observer then treats these numbers as logarithmic, rather than linear, which shrinks the upper portion of the rating scale. This problem is easily avoided by limiting responses to either one-digit or two-digit numbers, a technique which has been found to be effective in judgments relating loudness and decibels (Poulton, 1984).

The final class of biases, transfer, involves all previous experience with any component of the rating process, such as instructions, stimuli, and response modes. Although it is recognized that all subjects bring some sort of prior context into the rating situation, it is assumed that averaging data over a large enough sample of observers will yield representative results (Poulton & Simmonds, 1985). Poulton (1968; 1979) has sharply criticized Stevens' use of practiced observers in his work, and has found in his own studies that the inducement of transfer led to a contrast effect between two judgment situations. Stevens (1957) himself noted that abberations in ratings occurred when a person was unusually familiar with a particular stimulus dimension and its physical measurement, as in the case of a sound engineer estimating decibel levels. In these circumstances, the human standard system behaves more like a calibrated technological instrument than like the average human observer. Nevertheless, regardless of how transfer enters the situation, little work has been conducted in the field to better understand how it operates and affects judgments.

The Frame of Reference

By taking into account how the relationship between a stimulus magnitude and its estimate can be affected by the previous considerations, it is apparent that there is no clear, single source of variance. The judgment situation entails a multitude of influencing factors. Only a few attempts have been made in the literature to explore these factors within a more general theory of context.

It is known that the judgment of a stimulus is always dependent upon its relation to the larger group (McKenna, 1984). This judgment is thus based upon a relative sensitivity, which can be created, up to a point, by choices the experimenter makes (Marks, 1974). As McKenna (1984) points out, these context effects have direct repercussions for theory, as they preclude the entrenchment of a unitary psychophysical power law as proposed by Stevens (1957). The relative sensitivity to stimuli possessed by the observer could lead to one of two variations in rating results. The first variation, contrast, occurs when the stimuli to be judged are perceived as farther apart than normal in comparison with an anchor. The resulting judgments are thus displaced away from the stimulus or stimuli which serve as the anchor. Assimilation, on the other hand, results when stimuli are perceived as significantly closer than normal in relation to the anchor. In this case, judgments are displaced toward the initial judgment of the anchor (Helson, 1964).

These results due to bias may be obtained for either two discrete stimulus ranges, or, if the number of stimuli and rating categories are large enough, for subsets of the range. Phillip (1947a; 1947b) found that subjects who were required to rate a set of 11 color mass stimuli on an 11-point category rating scale tended to divide their task into smaller segments. At the ends of the scale, ratings tended to be more precise due to the anchoring effects of the lowest and highest stimuli. Phillip named these the terminal frames of reference, but concluded that they were not salient enough to provide a frame of reference for the center of the series. It appeared that subjects created their own reference points in the middle of the scale, resulting in a central tendency effect where discrimination became more difficult. An assimilation effect was thus displayed for stimuli congregated around these two midpoints (specifically at 4.5 and 7.5) as a result of the large range of stimuli and categories employed.

These data illustrate the need for the experimenter to manipulate the frame of reference so as to study such biases. Mori (1984) attempted to study how the frame of reference could be affected by velocity judgments. By presenting observers with two points travelling at different velocities (one in a straight line and one following a circular path), he concluded that the relative velocity of a point determined to a large extent the frame of reference chosen.

One further study of note (Aftanas & Rule, 1968) examined how the frame of reference could be altered within a set by introducing a cross-continuum anchor into the series. Four groups of subjects were presented with a set of five line lengths in combination with a varying number of dot numerousness slides. It was found that including a 200-dot display in the series led to a decrease of line length judgments. However, including the 23-, 68-, and 200-dot displays led to an increase of line length judgments. Aftanas and Rule thus displayed that it was possible to create a frame of reference by obtaining anchors from a second continuum.

Further Evidence and a Theory. A series of unpublished experiments conducted by Schroeder (1982; 1984a; 1984b; 1986) attempted to create a situational frame of reference by using different types of continua. This body of preliminary research differed from the previous investigation (Aftanas & Rule, 1968) in that it required subjects to judge two independent sets of stimuli in succession. The studies employed the transfer paradigm outlined by Poulton (1979) to see if one set of judgments would transfer to the next set across continua. If this occurred, then it could be said that frames of reference might be altered by a previous, unrelated type of judgment situation.

By selecting different ranges of physical values for each stimulus continuum, it had been observed that judgments of line length did not transfer to those of dot numerousness (Schroeder, 1984a), although dot numerousness did affect ratings of line length (Schroeder, 1982). Neither of these studies found differential transfer effects due to gender. Recent results (Schroeder, 1986) have shown that the order of presentation between two continua significantly affects judgments of the second set. In this study, showing the continuum of line length first led to higher ratings of dot numerousness than when dot numerousness preceded judgments of line length. However, the results did not exhibit a significant range effect when using low to medium and medium to medium range values. Another study (Schroeder, 1984b) found an attenuation in ratings of line lengths when preceded by proportion stimuli (proportion of dots to dashes in a 100-point stimulus configuration). For the reverse situation, no transfer was found when presentation of line lengths were followed by proportion stimuli.

In accordance with this research, Aftanas and Schroeder (personal communications, 1982 to 1986) began to develop a more holistic theory of human standard system operation.

Although the research indicated that transfer effects had a significant impact on ratings, the evidence was inconclusive as to how and when this occurred. In line with Teghtsoonian's dynamic range theory (Teghtsoonian, 1973), Aftanas and Schroeder postulated that the experience of the individual with the continuum's dynamic range was of chief importance. However, they took this concept one step further and divided available stimuli into two separate classes, much as Stevens (Stevens & Galanter, 1957) had done 30 years earlier. Aftanas and Schroeder discovered that the two classes of stimuli proposed by Stevens could be distinguished on a level not previously mentioned. For the eight prothetic continua whose category scales exhibited a regular concave downward relationship to magnitude estimates, they found that six possessed ranges which potentially extended to infinity. Thus, Aftanas and Schroeder's first class involved continua which were, by nature, infinite, so that their full ranges could never be entirely experienced by the human standard system. For three of the four metathetic continua it was discovered that the ranges of possible values were finite in addition to an unusual relationship displayed between category ratings and magnitude estimates. Therefore, the second class of continua proposed by Aftanas and Schroeder contained all those continua whose ranges might be fully encountered by the observer. Aftanas and Schroeder believed that those continua with a fully encounterable range (i.e., proportions) would be less susceptible to transfer effects, as they had a more salient frame of reference based upon knowledge of the entire range. On the other hand, it was speculated that the unfamiliarity with the full range of an infinite continuum (such as line length) would lead to a more easily influenced judgment situation. For these stimuli, the frame of reference depended much more on their relation to surrounding factors, which would serve as rating cues. Therefore, Aftanas and Schroeder's theory would predict that within a transfer experiment employing two types of continua, judgments of those with a fully experienced range (finite) would not be prone to transfer bias, while those with an unencounterable range (infinite) would be subject to alteration.

Hypotheses

Building upon Aftanas and Schroeder's predictions, the present study consisted of five experiments to address the following hypotheses.

1) Transfer would occur within the continua of line length (an infinite-range continuum) and proportion (a finite-range continuum) when different ranges of stimulus values were employed.

2) Transfer would occur between the continua of line length (an infinite-range continuum) and proportion

(a finite-range continuum) when different ranges of stimulus values were employed and the order of presentation was varied.

3) Transfer would not occur between the continua of proportion (a finite-range continuum) and dot density (a finite-range continuum) when different ranges of stimulus values were employed and the order of presentation was varied.

CHAPTER II

Method

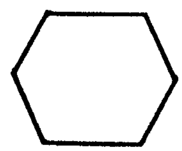
Experiment 1

Subjects. Eighty students were recruited from the University of Manitoba Introductory Psychology Pool. Subjects obtained course credit for participating, but were restricted from selection if they had previous experience in any study involving psychophysical judgments.

Apparatus. A screen measuring 127 X 88 cm was located in the center of a 30.8 X 7.6 m room. A Kodak Ektagraphic III AT projector was placed 254 cm behind the screen. A table and two chairs were located on the other side of the screen, with a distance of 91 cm from the screen to the edge of the table. Figure 1 illustrates the experimental room setup. During experimental sessions, the room's lights were turned off so that the only source of illumination came from a small reading lamp placed beside the projector.

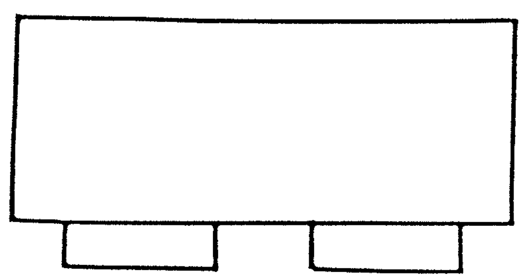
Figure 1: Block diagram of the experimental room setup.

PROJECTOR



SCREEN

TABLE



The stimuli consisted of 15 line length slides and 15 proportion slides, each projected as a white figure on an opaque background. To ensure that slide values were perceived as approximately subjectively equal by subjects, a previous experiment had been conducted using the method of paired comparisons. Ten volunteers were asked to indicate which of two medium-valued stimuli appeared to have a greater magnitude over a series of 40 presentations. Mean ratings were then obtained over subjects to determine which stimulus pairings yielded an equally split number of greatness judgments. After the middle slide values of each continuum were matched as being subjectively equal, other slide values were extrapolated from these middle values so that they were equally spaced with logarithmic intervals of 0.05 (See Table 1 for stimulus values). The stimuli for each continuum were then divided into three groups of five slides each to obtain low, medium, and high range groups. Each group was then separated from the next range set by a step change in logarithmic spacing equal to 0.10.

TABLE 1

Actual Values of Stimuli

Range	Line Lengths[a]	Dots[b]	Proportions[c]
	Continua		
Low	14 (1.15)	13 (1.13)	13 (1.10)
	16 (1.20)	15 (1.18)	14 (1.15)
	18 (1.25)	17 (1.23)	16 (1.20)
	20 (1.30)	19 (1.28)	18 (1.25)
	22 (1.35)	21 (1.33)	20 (1.30)
Medium	28 (1.45)	27 (1.43)	25 (1.40)
	32 (1.50)	30 (1.48)	28 (1.45)
	35 (1.55)	34 (1.53)	32 (1.50)
	40 (1.60)	38 (1.58)	35 (1.55)
	45 (1.65)	43 (1.63)	40 (1.60)
High	56 (1.75)	54 (1.73)	50 (1.70)
	63 (1.80)	60 (1.78)	56 (1.75)
	71 (1.85)	68 (1.83)	63 (1.80)
	80 (1.90)	76 (1.88)	71 (1.85)
	89 (1.95)	85 (1.93)	80 (1.90)

Note.

Figures in brackets represent the logarithmic values of stimuli.

a Values given in millimeters.

b Values given for number of dots.

c Values given for number of dots to 100 dashes.

The slides were individually rear-projected onto the screen every 15 s for a 1 s presentation time using a timing device. The group of five slides was ordered randomly for each presentation for a total of four presentations for each continuum range. The order of the 20 slides was then held constant over all ranges for both continua.

Procedure. Twenty subjects were assigned to each of the four conditions. The conditions showed two sets of continua, varying in their order of presentation and the range of values employed. The resulting groups were required to judge (a) low lines followed by medium lines, (b) high lines followed by medium lines, (c) low proportions followed by medium proportions, and (d) high proportions followed by medium proportions. All the conditions required the subjects to judge 20 slides of the first continuum followed by five slides of the second set.

Two subjects were seated at the table for each session. They were provided with two forms consisting of 20 5-point rating scales and a pencil. They were then asked to indicate their subjective assessments of stimulus magnitudes on these scales, so that the number 1 indicated a low magnitude and the number 5 indicated a high magnitude judgment. Instructions were read to the subjects before each continuum set was presented (See Appendix A for instructions). After the subjects' questions had been answered the room's lights were turned off and the first stimulus was projected onto the screen. Subjects were debriefed at the conclusion of the session.

Two 2 (Range) X 5 (Judgment) ANOVA's were used to analyze the individual ratings of the second set of continua for each subject. Comparisons were made between the two line conditions and the two proportion conditions.

Experiment 2

Subjects. One hundred subjects were recruited for Experiment 2 under the same guidelines provided in Experiment 1.

Apparatus. The apparatus was consistent with Experiment 1. In Experiment 2, the slides for each continuum were equivalent to the line length and proportion stimuli used in Experiment 1.

Procedure. The procedure for Experiment 2 was the same as that for Experiment 1, with the exception of the order of stimulus presentation. Thus, the conditions for Experiment 2 included (a) low lines followed by medium proportions, (b) high lines followed by medium proportions, (c) low proportions followed by medium lines, and (d) high proportions followed by medium lines. Twenty-five subjects were assigned to each condition. (See Appendix A for corresponding instructions).

A 2 (Order) X 2 (Range) X 5 (Judgment) ANOVA was conducted for Experiment 2 by analyzing the individual ratings of the second set of continua for each subject.

Experiment 3

Subjects. One hundred subjects were asked to participate under the same restrictions as for Experiments 1 and 2.

Apparatus. The apparatus used for Experiments 1 and 2 was used for Experiment 3, with the exception of the continua employed. If Experiment 2 had not yielded any significant results, Experiment 3 would have used stimuli from the continua of line length and proportion. However, as Experiment 2 did prove to be significant, Experiment 3 was conducted using stimulus values from the continua of proportion and dot density. (See Table 1 for stimulus values).

Procedure. The procedure for this experiment remained the same as for Experiments 1 and 2 with the exception of stimulus presentation. Twenty-five subjects were assigned to each of the four conditions. If the results from Experiment 2 had been nonsignificant, then different ranges of line lengths and proportions would have been used in Experiment 3. The conditions would have then been run as follows: (a) low lines followed by high proportions,

(b) high lines followed by low proportions, (c) low proportions followed by high lines, and (d) high proportions followed by low lines. However, this method was not implemented, as the results of Experiment 2 exhibited a significant order effect. Therefore, the stimulus conditions consisted of combinations of the continua of proportion and dot density. The conditions for Experiment 3 thus included (a) low dots followed by medium proportions, (b) high dots followed by medium proportions, (c) low proportions followed by medium dots, and (d) high proportions followed by medium dots (See Appendix A for corresponding instructions).

A 2 (Order) X 2 (Range) X 5 (Judgment) ANOVA was conducted for Experiment 3 using the same method as described in Experiment 2.

CHAPTER III

Results

Experiment 1

Results.

The first 2 X 5 ANOVA, comparing the individual ratings of the second set of continua in the low and high line length conditions, found that Range was statistically significant, F (1, 38) = 154.28, p < .05. The Judgment and Judgment X Range interaction factors were also significant at the .05 level, F (4, 152) = 82.34, and F (4, 152) = 7.12, respectively. Initial presentation of low line lengths led to increased judgments of medium lines (M =4.12), while judgments of high line lengths led to attenuated judgments of medium lines (M =2.09).

The second 2 X 5 ANOVA, which compared the individual ratings of the second set of continua in the low and high proportion conditions, also found that Range was statistically significant, F (1, 38) = 81.01, p < .05. The within factor of Judgment was significant, F (4, 152) = 9.92, p < .05, but the Judgment X Range interaction was not, F (4, 152) = 1.31, p > .05. Judging low proportion values first led to an increase in judgments of medium proportions, $\underline{M}$ =3.34. Conversely, presentation of high proportions led to attenuated judgments of medium proportions, $\underline{M}$ =1.59. (See Appendix B for mean ratings of individual stimuli). Figures 2 and 3 illustrate the mean stimulus ratings of individual physical values for line lengths and proportions, respectively.

Figure 2: Mean ratings of line length stimuli preceded by low and high stimulus ranges.

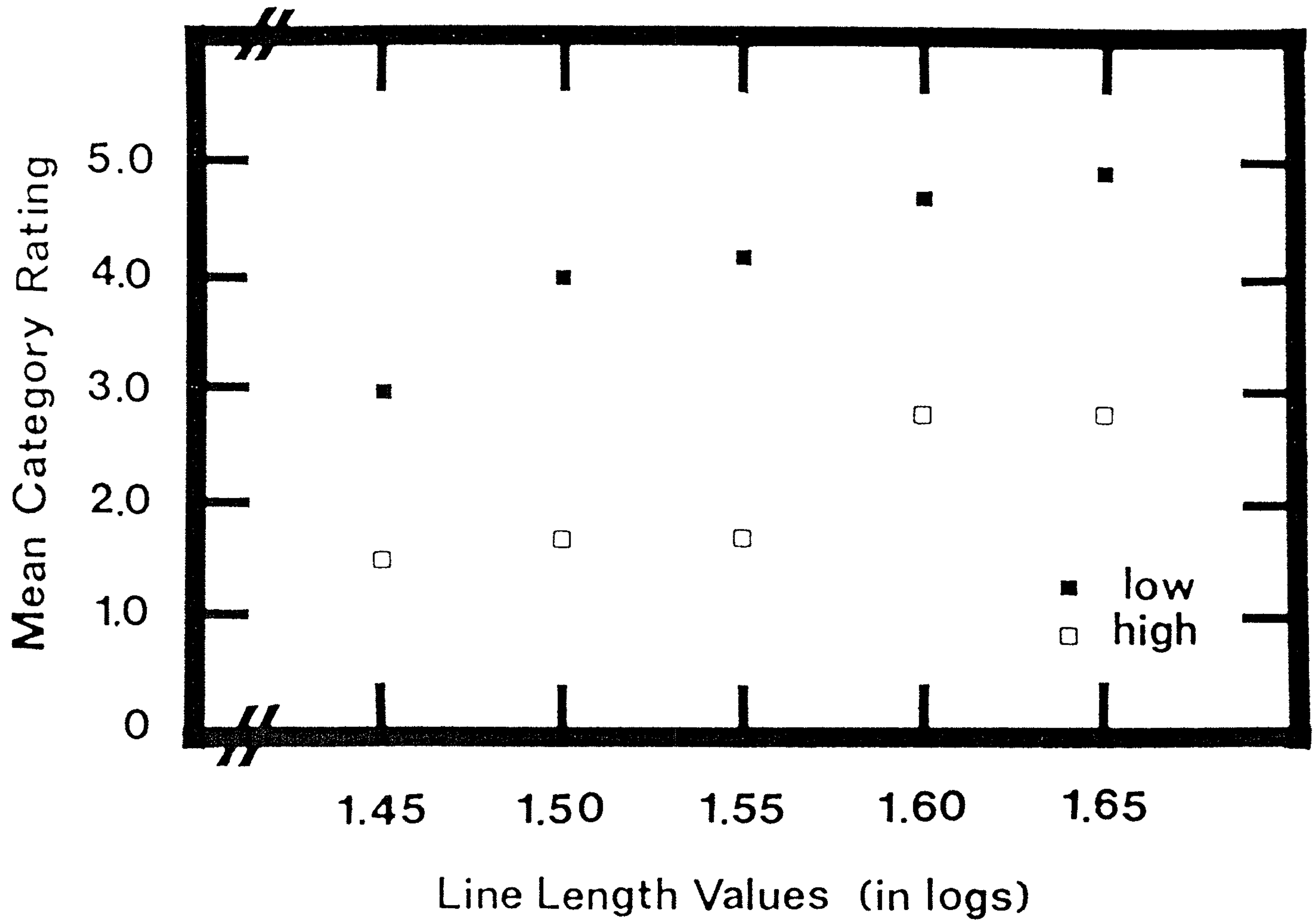
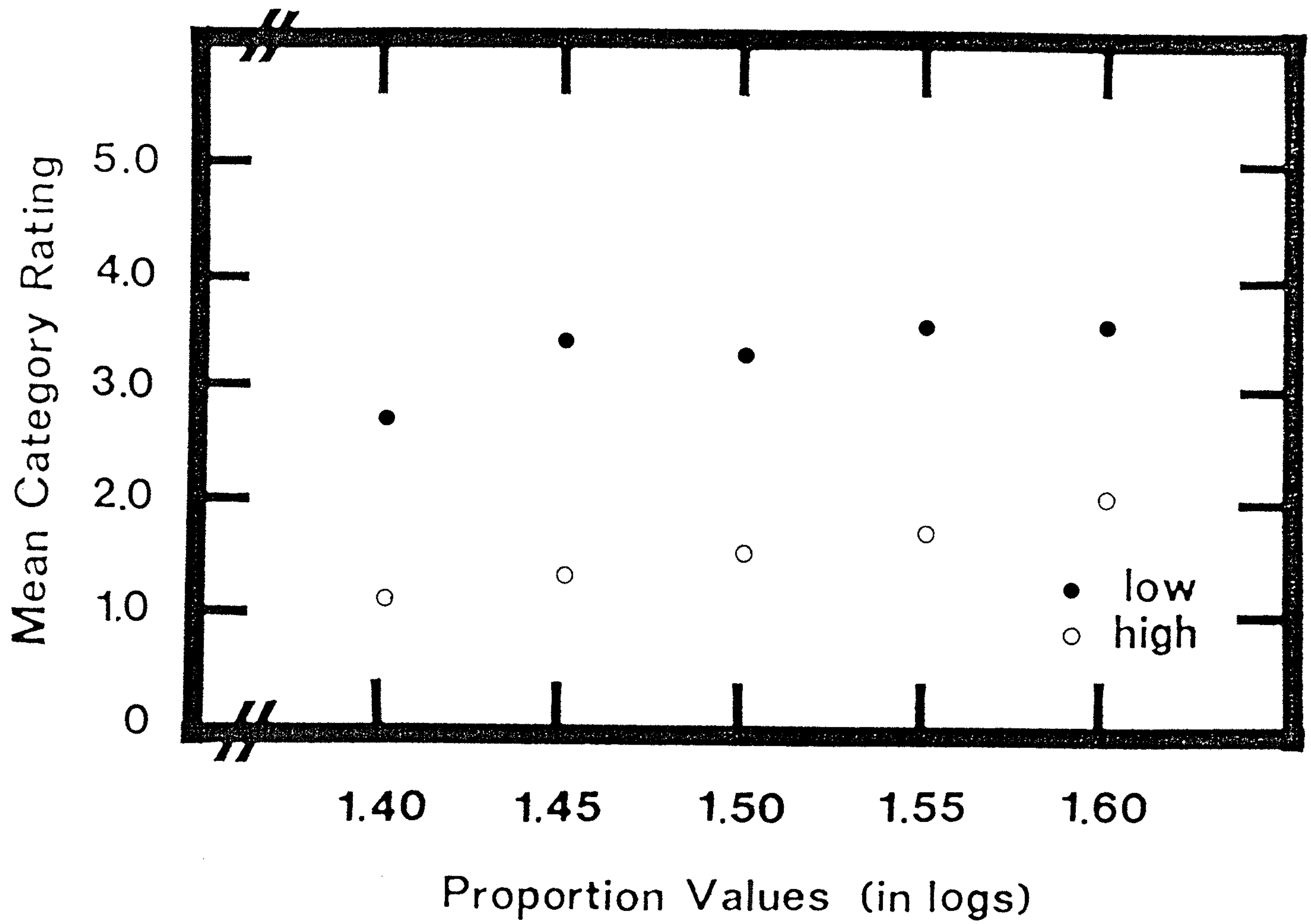

Mean Category Rating
5.0
4.0
3.0
2.0
1.0
0
low
high
1.45
1.50
1.55
1.60
1.65
Line Length Values (in logs)

Figure 3: Mean ratings of proportion stimuli preceded by low and high stimulus ranges.


Mean Category Rating
5.0
4.0
3.0
2.0
1.0
0
1.40
1.45
1.50
1.55
1.60
Proportion Values (in logs)
low
high

Discussion.

The results of Experiment 1 confirmed the first hypothesis, as differential transfer occurred within either continuum when the ranges of stimulus values were manipulated. The resulting transfer effects were observed for the infinite-range continuum of line length as well as for the finite-range continuum of proportion. Thus, it may be concluded that a finite-range continuum is not impervious to context effects.

Of particular interest is the regularity of the findings in both conditions, regardless of the continuum employed. The intracontinuum transfer from a low to a medium range of values always led to an increase of judgments, while a high to medium transfer condition led to a decrease. This contrast effect is consistent with Poulton's (1968; 1979) findings of contrast when an intracontinuum transfer paradigm is used.

Experiment 2

Results.

A 2 X 2 X 5 ANOVA indicated that the order of continuum presentation was statistically significant, F (1, 97)= 27.04, $p < .05$. The range of stimulus values employed was not significant, F (1, 97)= 1.26, $p > .05$. Similarly, the Order X Range interaction was not significant, F (1, 97)= 1.26, $p > .05$. At an alpha level of .05, Judgment was significant, F (4, 388) = 59.01, as was the Judgment X Order interaction, F (4, 388) = 13.09. However, the Judgment X Range and Judgment X Order X Range interactions were not significant, each yielding values of F (4, 388) = 0.58. When low stimulus ranges were judged first, mean judgments of 2.80 and 3.49 were obtained for the line to proportion and proportion to line conditions, respectively. In the high range conditions, a mean rating of 3.01 was exhibited in the line to proportion condition, in comparison to a mean rating of 3.54 for the proportion to line condition. (See Appendix B for mean ratings of individual stimuli). Figures 4 and 5 show the mean ratings of individual stimuli in the low and high range conditions.

Figure 4: Mean ratings of line length and proportion stimuli preceded by a low stimulus range.

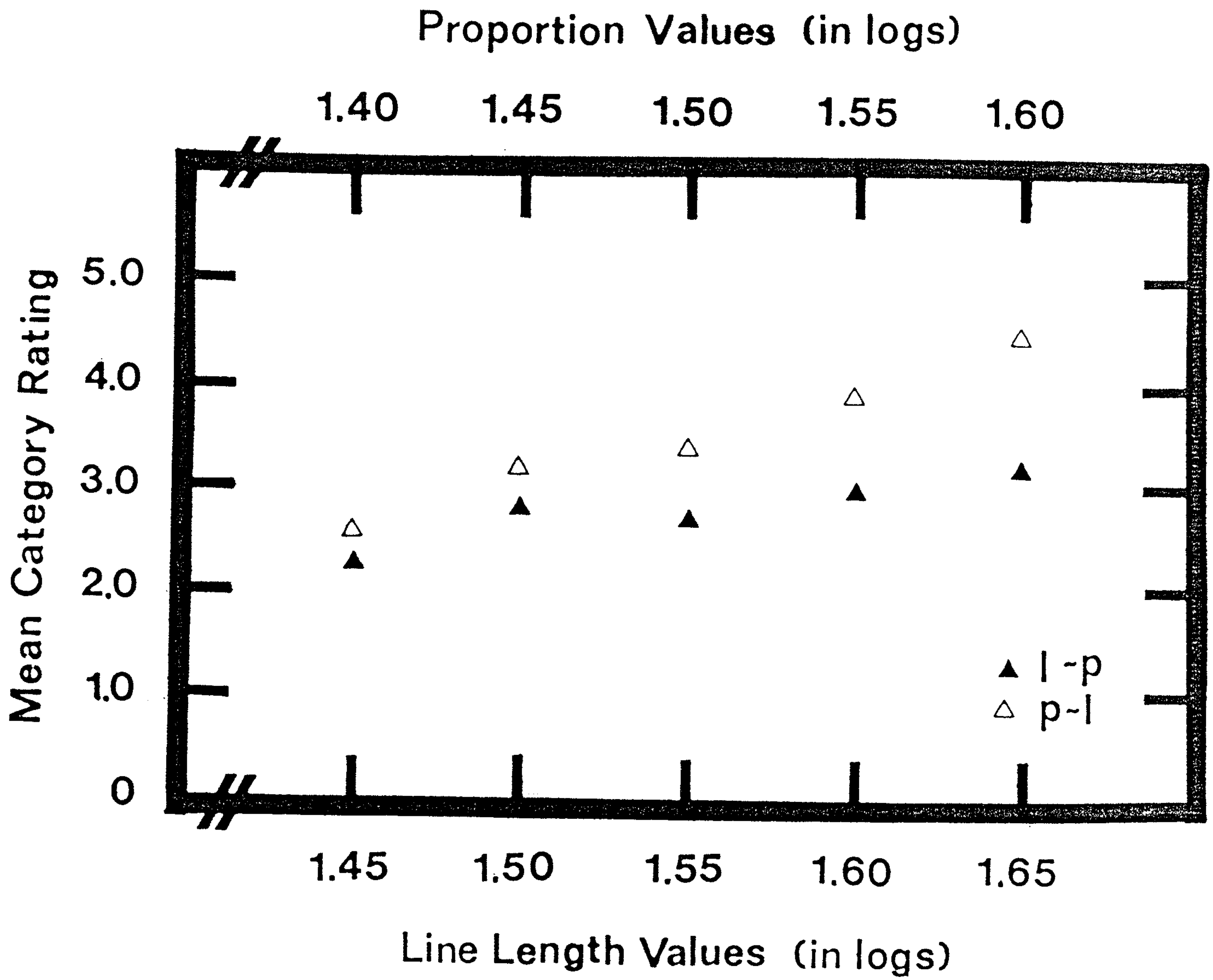
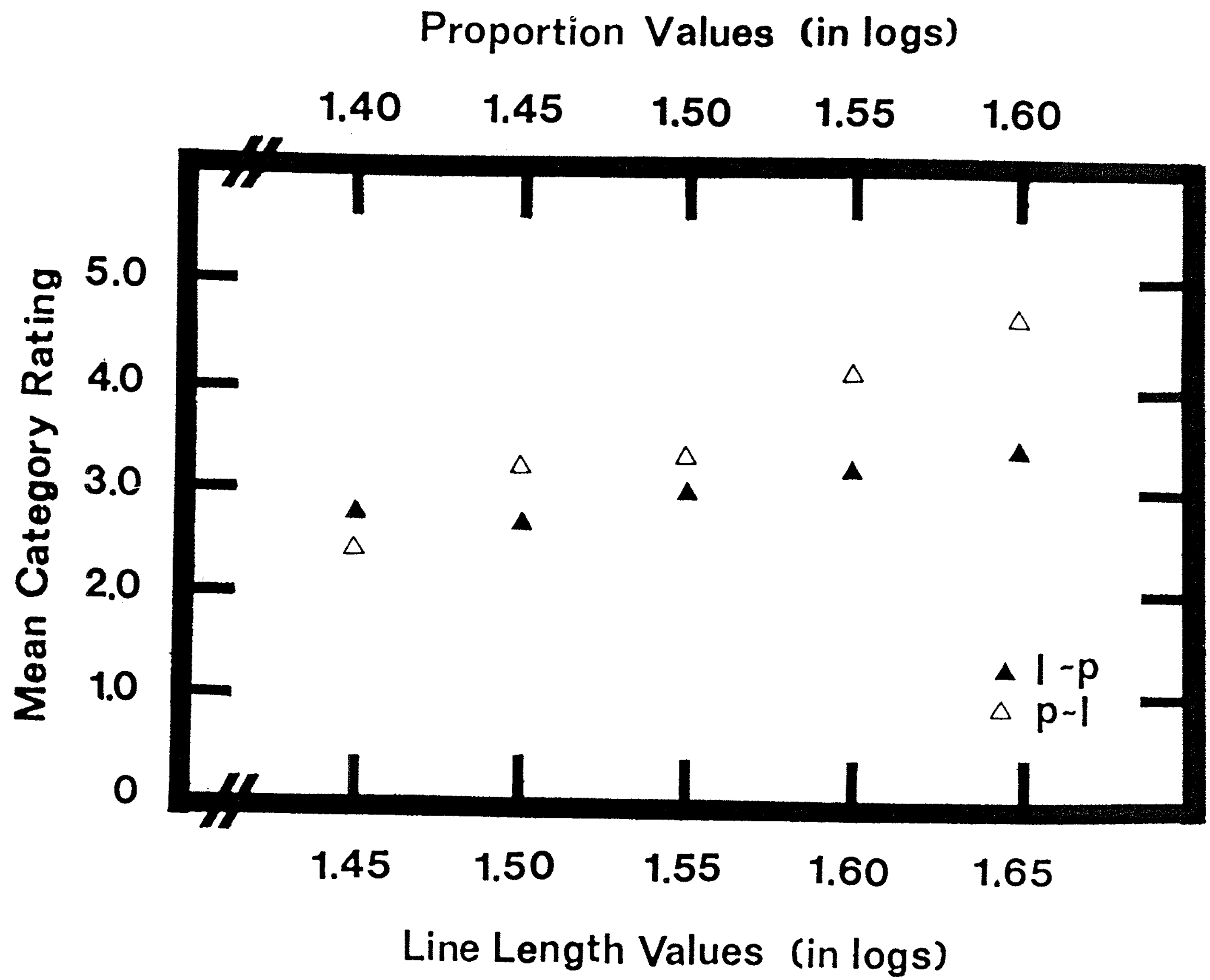

Proportion Values (in logs)
1.40
1.45
1.50
1.55
1.60
Mean Category Rating
5.0
4.0
3.0
2.0
1.0
0
1.45
1.50
1.55
1.60
1.65
Line Length Values (in logs)
l -p
p-l

Figure 5: Mean ratings of line length and proportion stimuli preceded by a high stimulus range.


Proportion Values (in logs)
1.40
1.45
1.50
1.55
1.60
Mean Category Rating
5.0
4.0
3.0
2.0
1.0
0
l -p
p-l
1.45
1.50
1.55
1.60
1.65
Line Length Values (in logs)

Discussion.

As in Experiment 1, the results of Experiment 2 exhibited a pronounced difference when various sets of continua were manipulated. However, the resulting difference was dependent on the order of continuum presentation rather than on the range of physical stimulus values employed. Figures 4 and 5 illustrate the results of this order effect. In both the low- and high-range conditions, judgments of the first three stimuli tend to be fairly close. However, as the physical magnitudes of the stimuli increase, the judgment points begin to diverge. In addition, mean ratings of line lengths are slightly higher than those of proportion judgments in all but one case. The combination of these two factors produces proportion functions which are flat relative to the line length judgments.

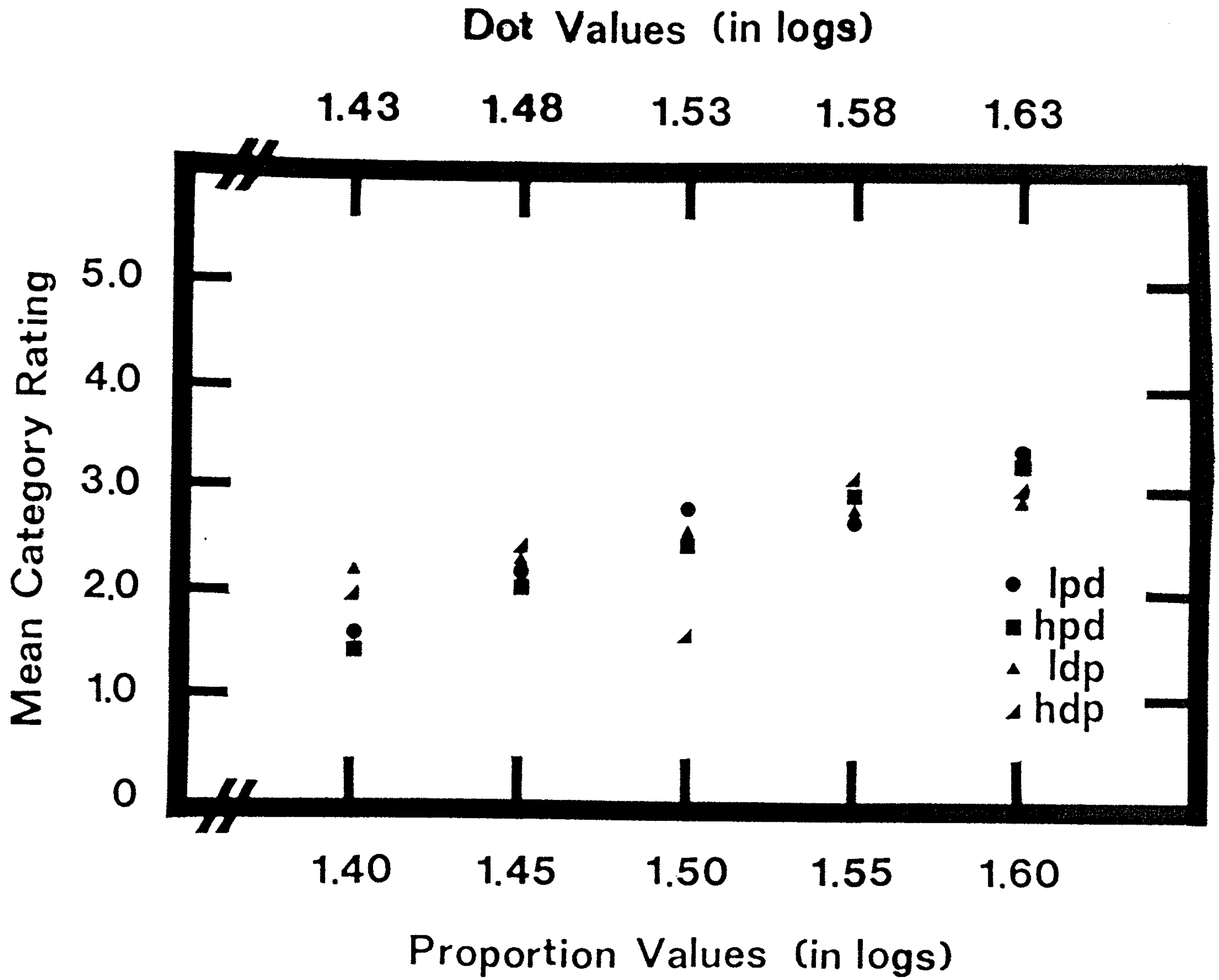
It was unusual that no range-induced contrast effects were observed, while the order variable proved to be significant. It could be the case that the order of presentation was so salient that it overrode the actual physical values of stimuli. However, it is also possible that some other, less obvious factor or factors were operating to bring about this effect. While this question demanded further study, Experiment 3 was conducted in light of the significant results obtained in Experiment 2. Therefore, the study of intercontinuum judgments was continued using the continua of proportion and dot density, two finite-range continua.

Experiment 3

Results.

A 2 X 2 X 5 ANOVA failed to yield any significant results at a probability level of .15 for the variables of Order, F (1, 97) = 0.63, p = .4295, Range, F (1, 97) = 0.74, p = .3906, or Order X Range F (1, 97) = 0.74, p = .3906. However, Judgment and all subsequent interaction effects were significant at the .15 level, which was expected as a function of the different physical magnitudes of the stimuli employed. The resulting statistical values were as follows: Judgment, F (4, 388) = 62.79, p = .0001, Judgment X Order, F (4, 388) = 9.72, p = .0001, Judgment X Range, F (4, 388) = 4.99, p = .0006, and Judgment X Order X Range, F (4, 388) = 4.99, p = .0006. Mean judgments of the four groups were 2.54 for the low dot to proportion condition, 2.39 for the high dot to proportion condition, 2.58 for the low proportion to dot condition, and 2.53 for the high proportion to dot condition. (See Appendix B for mean ratings of individual stimuli). Figure 6 displays the mean ratings of individual stimuli for each judgment condition.

Figure 6: Mean ratings of proportion and dot density stimuli preceded by low and high stimulus ranges.


Dot Values (in logs)
1.43
1.48
1.53
1.58
1.63
Mean Category Rating
5.0
4.0
3.0
2.0
1.0
0
lpd
hpd
ldp
hdp
1.40
1.45
1.50
1.55
1.60
Proportion Values (in logs)

Discussion.

In accordance with the third hypothesis, there was no difference in transfer across continua when the two finite-range continua of proportion and dot density were used. Figure 6 shows that the mean judgments of individual stimuli in each condition are relatively close. None of the functions are particularly flat, nor are there any extreme outliers. Generally, mean ratings of individual stimuli over the four conditions appear to be conservative estimates of physical magnitudes. These judgments fell mostly within the lower mid-range of the rating scale (ranging from ratings of 1.8 to 3.2), with an overall total estimate of 2.51. On the basis of this evidence, it may be concluded that intercontinuum transfer is not possible when the two finite-range continua of proportion and dot density are shown in succession.

CHAPTER IV

Follow-Up Studies

It is apparent from Experiments 2 and 3 that intercontinuum transfer is dependent on the types of continua employed. Using the two finite-range continua of proportion and dot density did not lead to any contrast effects. Evidently, the saliency of their frames of reference precluded the occurrence of transfer in either direction. However, it is not totally clear how the frame of reference created by the finite-range continuum of proportion interacted with the one created by the infinite-range continuum of line length in Experiment 2. In view of this, several follow-up studies were conducted to further investigate transfer effects between the two continua.

Experiment 4

Subjects. Seventy-five subjects participated under the same conditions as in the previous experiments.

Apparatus. The apparatus used in Experiments 1 to 3 was also used in Experiment 4. However, the stimulus sets were selected so that only the first five slides of the medium range values were displayed for each continuum. Thus, the resulting groups of stimuli chosen from the continua of line length, proportion, and dot density were exactly the same as the second continuum sets in Experiments 2 and 3.

Procedure. Twenty-five subjects were assigned to one of three rating conditions. In each condition, subjects were required to rate five medium-ranged stimuli in a simple, straightforward judgment task. Otherwise, the procedure was consistent with that used in Experiments 1 to 3. The conditions for Experiment 4 included displays of either (a) five medium line lengths, (b) five medium proportions, or (c) five medium dot densities. (See Appendix A for corresponding instructions).

Four 3 (Condition) X 5 (Judgment) ANOVA's were then used to analyze individual ratings of the five medium-ranged stimuli across Experiments 2, 3, and 4, with Experiment 4 results serving as the control conditions. Thus, the medium line length group was compared with the low proportion to medium line and high proportion to medium line groups from Experiment 2. The medium proportion group was compared with the low line to medium proportion and high line to medium proportion groups in Experiment 2, as well as with the low dot and high dot to medium proportion groups in Experiment 3. Finally, the medium dot density group was compared with the low proportion and high proportion to medium dot groups from Experiment 3. Any significant differences were further analyzed using Neuman-Keuls tests.

Results. The first ANOVA compared the medium line length group ($M = 3.23$) with the low proportion to medium line ($M = 3.49$) and high proportion to medium line ($M = 3.54$) conditions. (See Appendix B for mean ratings of individual stimuli). Assignment to judgment condition was not statistically significant, F (2, 72)= 2.65, $p > .05$. Judgment was significant, F (4, 288) = 118.23, $p < .05$, but the Judgment X Condition interaction was not, F (8, 288) = 0.97, $p > .05$. Figure 7 displays the mean ratings for individual stimuli in each of the three groups.

The second ANOVA compared the medium proportion condition with the low line to medium proportion and high line to medium proportion groups. The groups were significantly different, F (2, 72)= 3.22, $p < .05$. Judgment was also significant, F (4, 288) = 12.78, $p < .05$, although the Judgment X Condition interaction was not,

F (8, 288) = 0.56, $p > .05$. A Neuman-Keuls test revealed that judgments in the high line length to medium proportion condition (M = 3.01) were significantly greater than those in the control condition (M = 2.50), $p < .05$. Neither group significantly differed from the low line to medium proportion condition (M = 2.80). Figure 8 shows the mean ratings of individual stimuli in each condition.

The last two ANOVA's, which compared Experiment 3 results with Experiment 4's control groups, did not find that assignment to judgment condition was statistically significant. The first analysis, comparing low vs. high vs. no dots followed by medium proportions yielded F (2, 72) = 0.30, $p > .05$. The corresponding mean ratings for each group were 2.54, 2.39 and 2.50. Both the Judgment and Judgment X Condition interaction factors were significant at an alpha level of .05, with F (4, 288) = 21.88, and F (8, 288) = 3.54, respectively.

Similarly, a comparison of low vs. high vs. no proportions followed by medium dot densities generated no difference due to group assignment, F (2, 72)= 0.08, $p > .05$. Mean ratings for these three groups were 2.58, 2.53 and 2.54, respectively. Judgment was significant, F (4, 288) = 60.01, $p < .05$, as was the Judgment X Condition interaction, F (8, 288) = 2.00, $p < .05$. Figures 9 and 10 illustrate the mean judgments of individual stimuli for the proportion and dot density conditions.

Figure 7: Mean ratings of line length stimuli preceded by low vs high vs no proportion.

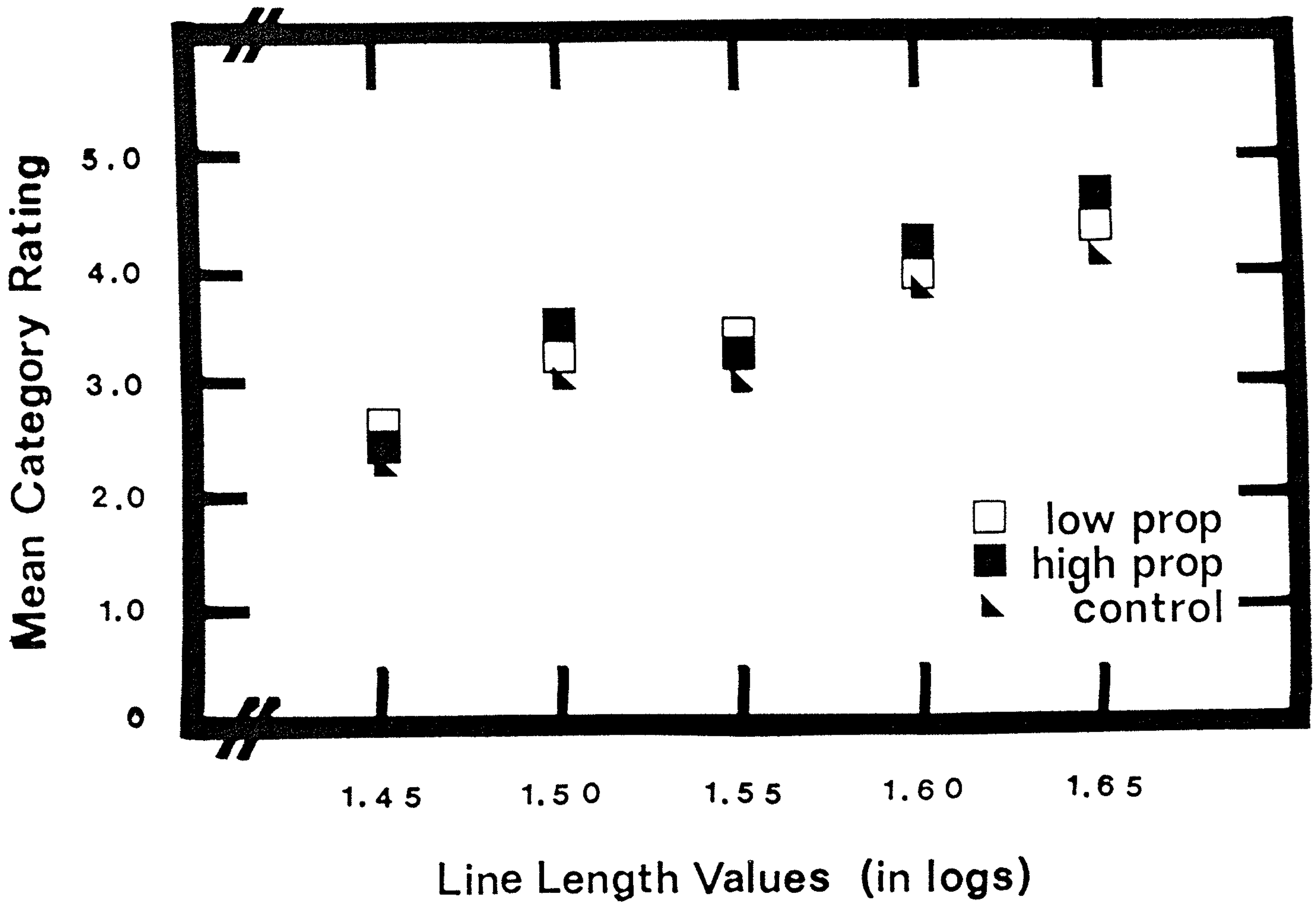

Mean Category Rating
5.0
4.0
3.0
2.0
1.0
0
1.45
1.50
1.55
1.60
1.65
Line Length Values (in logs)
low prop
high prop
control

Figure 8: Mean ratings of proportion stimuli preceded by low vs high vs no line length.

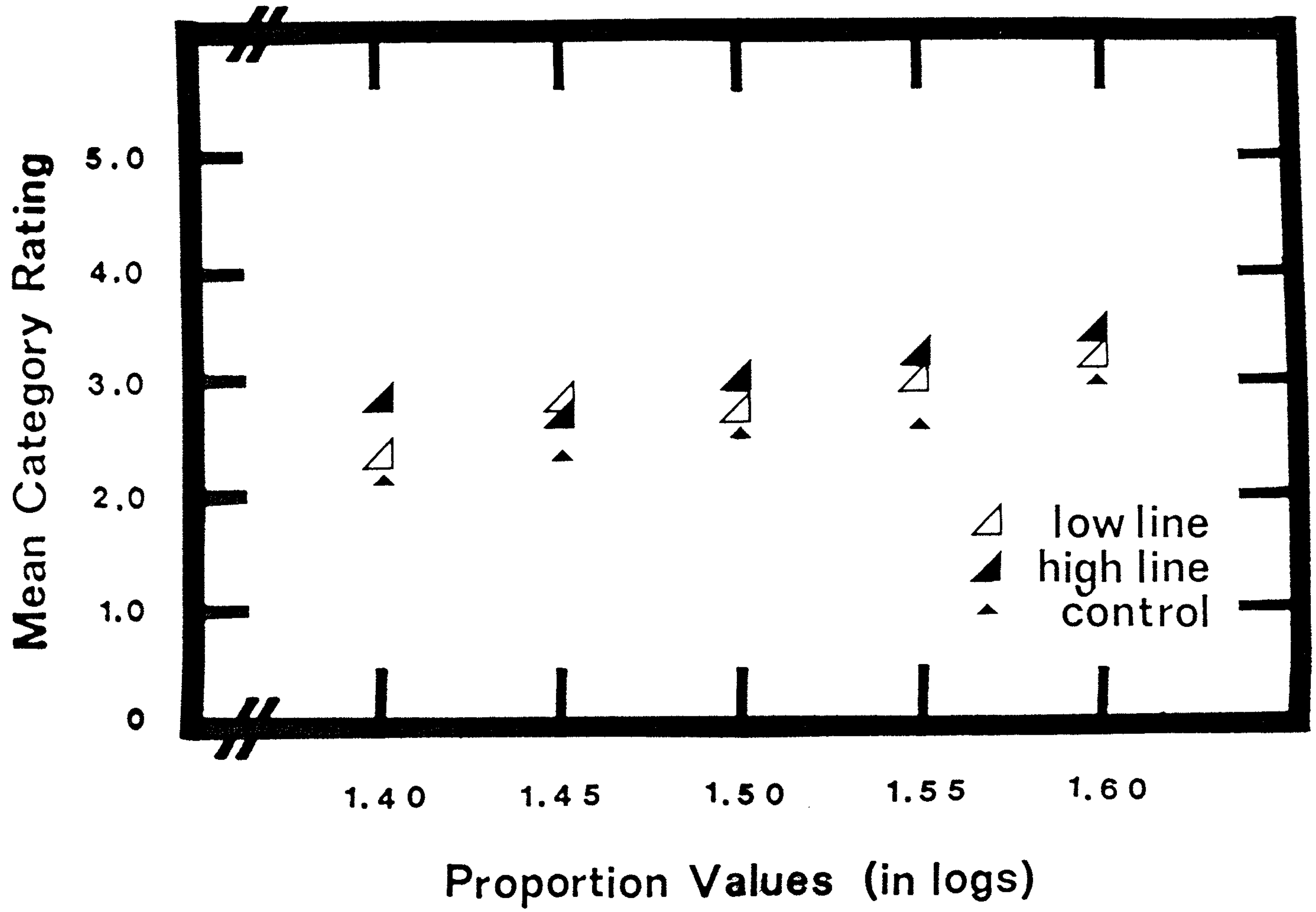

Mean Category Rating
5.0
4.0
3.0
2.0
1.0
0
1.40
1.45
1.50
1.55
1.60
Proportion Values (in logs)
low line
high line
control

Figure 9: Mean ratings of proportion stimuli preceded by low vs high vs no dot density.

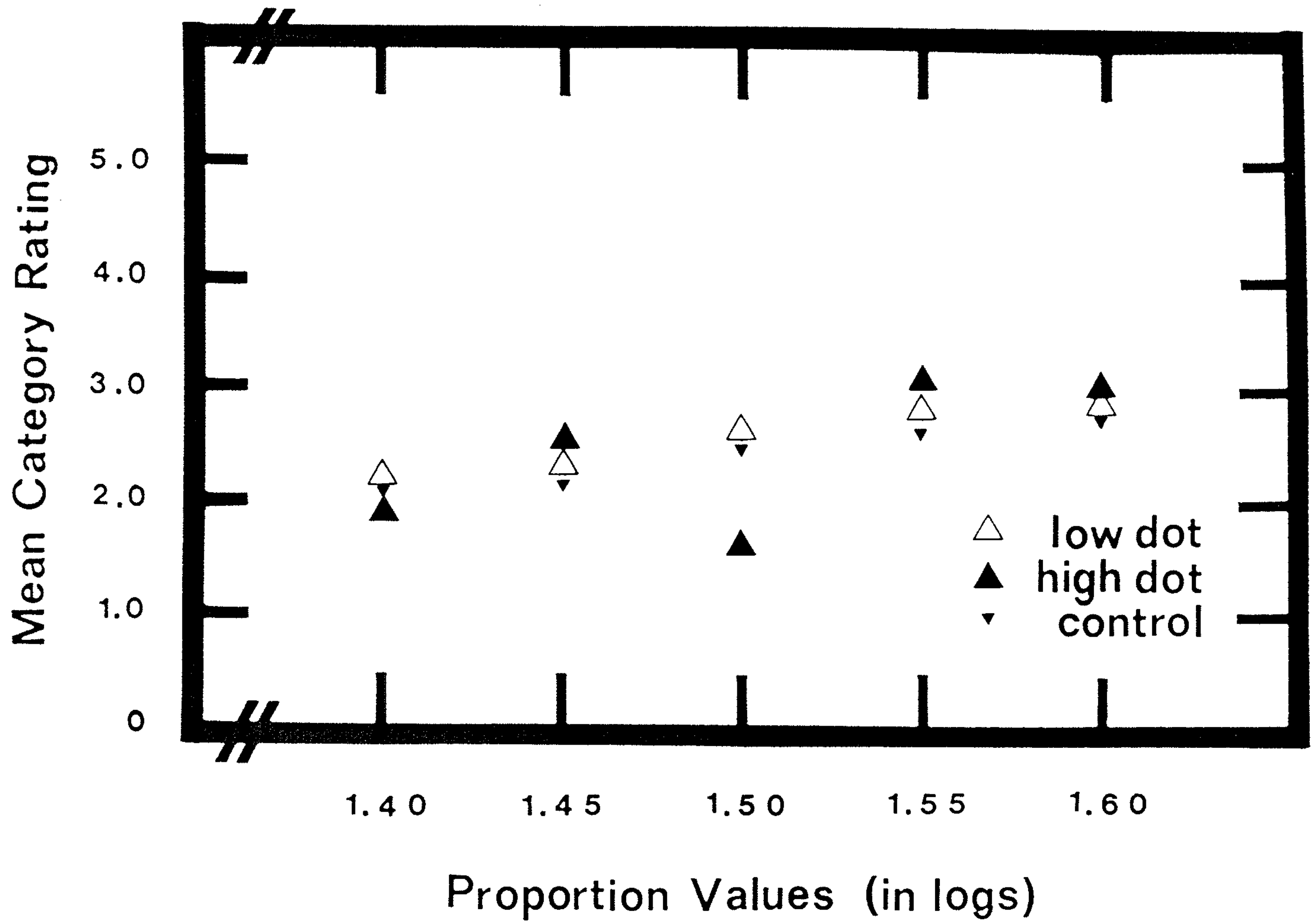
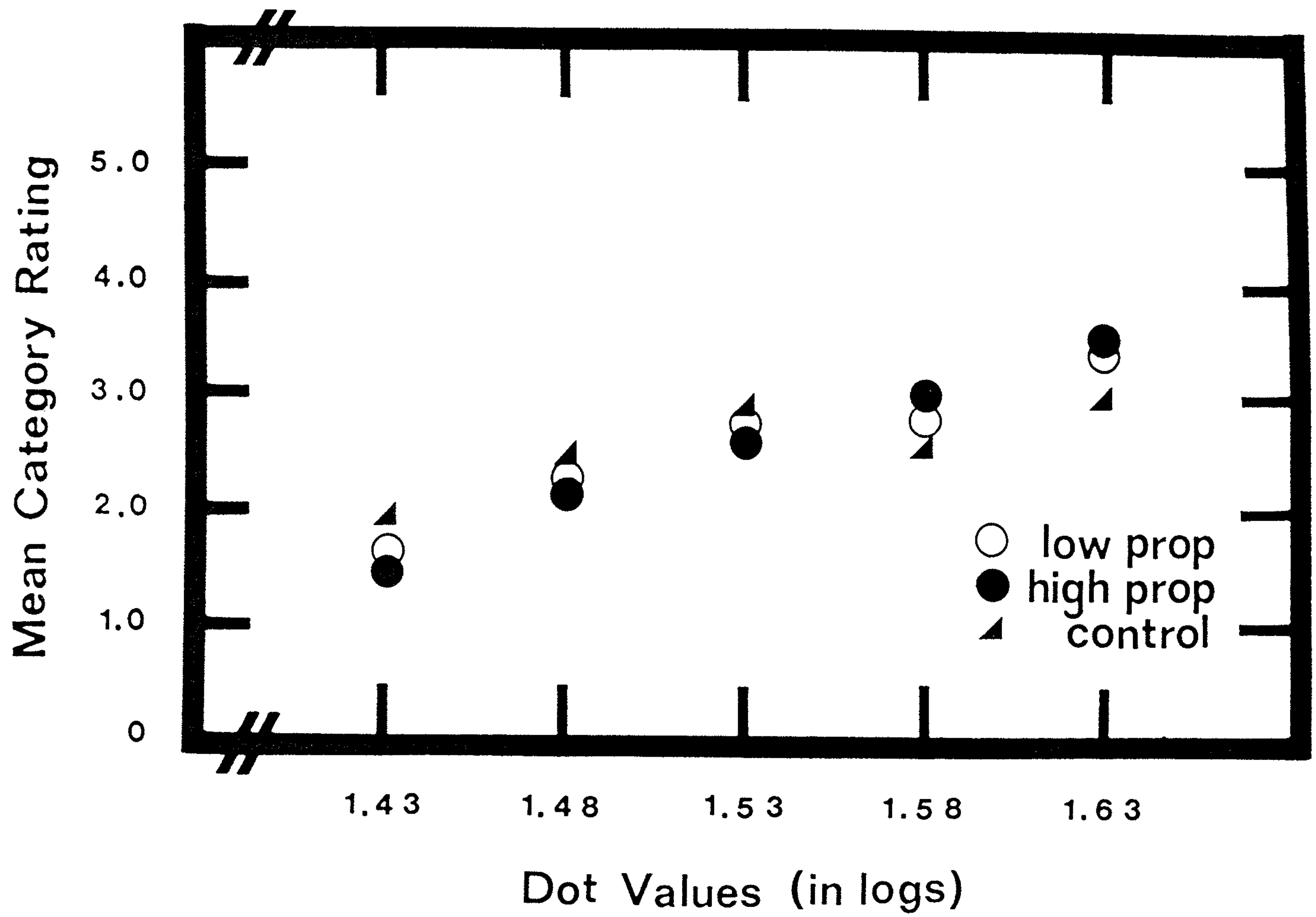

Mean Category Rating
5.0
4.0
3.0
2.0
1.0
0
1.40
1.45
1.50
1.55
1.60
low dot
high dot
control
Proportion Values (in logs)

Figure 10: Mean ratings of dot density stimuli preceded by low vs high vs no proportion.


Mean Category Rating
5.0
4.0
3.0
2.0
1.0
0
1.43
1.48
1.53
1.58
1.63
Dot Values (in logs)
low prop
high prop
control

Discussion. The results of Experiment 4 proved to be somewhat conflicting. With regard to the comparisons made between Experiment 3 and the control conditions of Experiment 4, we are provided with fairly conclusive evidence that proportion and dot density do not exhibit any significant transfer effects when shown in succession. This is not surprising in light of the frame of reference theory (Aftanas & Schroeder, personal communications, 1982 to 1986), which states that continua of a finite nature are less easily influenced due to their inherent stability.

However, the results of the first two analyses were somewhat unexpected with regard to the direction in which transfer took place. Comparing the low, high and no line length to proportion conditions, it appears that transfer can occur from an infinite- to a finite-range continuum. Yet this phenomenon may very well be restricted by range values, so that only a high-valued set of an infinite-range continuum (line length) will lead to significant transfer in a finite-range continuum of lower value (proportion). Furthermore, the order of transfer brought about an assimilation effect, as opposed to the usual contrast displayed when two sets of the same continua were shown in succession. What is unusual is that the same magnitude of assimilation did not occur when a high range of proportion preceded a medium range of line length, although there was a trend in the predicted direction ($p = .0778$). Thus, although the difference between the low, high and no proportion conditions was not statistically significant, it did approach significance.

An inspection of Figures 7 and 8 reveals how ratings of high- to medium-valued stimuli yield greater judgments for each stimulus than the respective control condition ratings. In a similar fashion, judgments in the low to medium stimulus conditions are rated as greater than their control group judgments, although this orientation towards contrast is not statistically significant.

As the results of Experiment 4 provided some indication that a transfer effect might be occuring from a finite- to an infinite-range continuum, a final experiment was conducted to investigate this pattern. Thus, Experiment 5 employed extended ranges of stimuli from the continua of line length and proportion to assess whether any transfer effects would be incurred.

Experiment 5

Subjects. Forty-nine subjects were recruited to serve in this experiment under the same guidelines provided in Experiment 1.

Apparatus. With the exception of the stimulus sets chosen, all apparatus was retained and employed as described in Experiment 1. Stimuli were selected from the continua of proportion and line length. Only the low and high range values were employed in this study.

Procedure. The general transfer procedure used in Experiments 1 to 3 was again employed in Experiment 5. The first condition employed 24 subjects, while 25 subjects were assigned to the second condition. The first condition required subjects to make judgments of 20 low proportion stimuli, followed by five slides of high line lengths. In the second condition, 20 presentations of high proportion stimuli were followed by five slides of low line lengths. The random order of stimulus presentation was held constant over all experiments and all conditions. (See Appendix A for instructions).

In each condition, individual ratings of the second set of continua were obtained for each subject. Using two 2 (Condition) X 5 (Judgment) ANOVA's, results were then compared with the first five judgments of stimuli in the first set for two conditions in Experiment 2. Thus, first judgments of high line and low line lengths served as the control conditions for this experiment.

Results. The first 2 X 5 ANOVA, comparing ratings of high line lengths in the low proportion (n = 24) vs. no proportion (n = 25) conditions, found that Condition was statistically significant, F (1, 47) = 8.14, $p < .05$. The Judgment factor was also significant, F (4, 188) = 70.23, $p < .05$, but the Judgment X Condition interaction was not,

F (4, 188) = 0.67, $p > .05$. The mean rating for the low proportion condition was 3.97, while for the no proportion condition a mean rating of 3.55 was obtained. (See Appendix B for mean ratings of individual stimuli). The second 2 X 5 ANOVA, comparing the high proportion (n = 25) and no proportion to low line (n = 25) groups, found that Condition was not significant, F (1, 48) = 3.53, $p > .05$. Judgment was significant, F (4, 192) = 124.23, $p < .05$, while the Judgment X Condition interaction was not, F (4, 192) = 0.58, $p > .05$. The mean rating of the high proportion condition was 3.04, while the control group yielded a mean rating of 2.62. Figures 11 and 12 display the mean ratings of individual stimuli for each set of comparisons.

Figure 11: Mean ratings of high line length stimuli preceded by low vs no proportion.

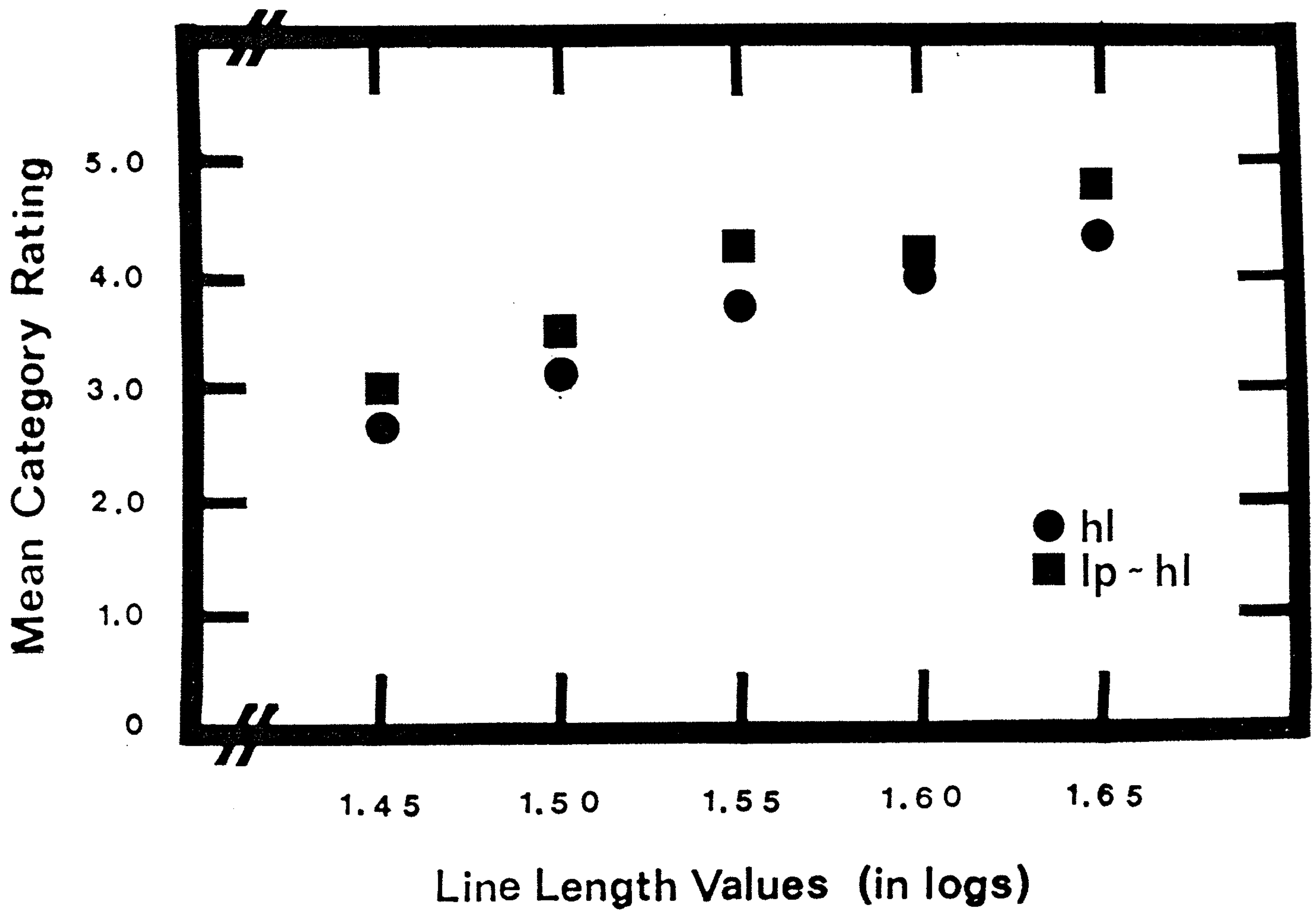
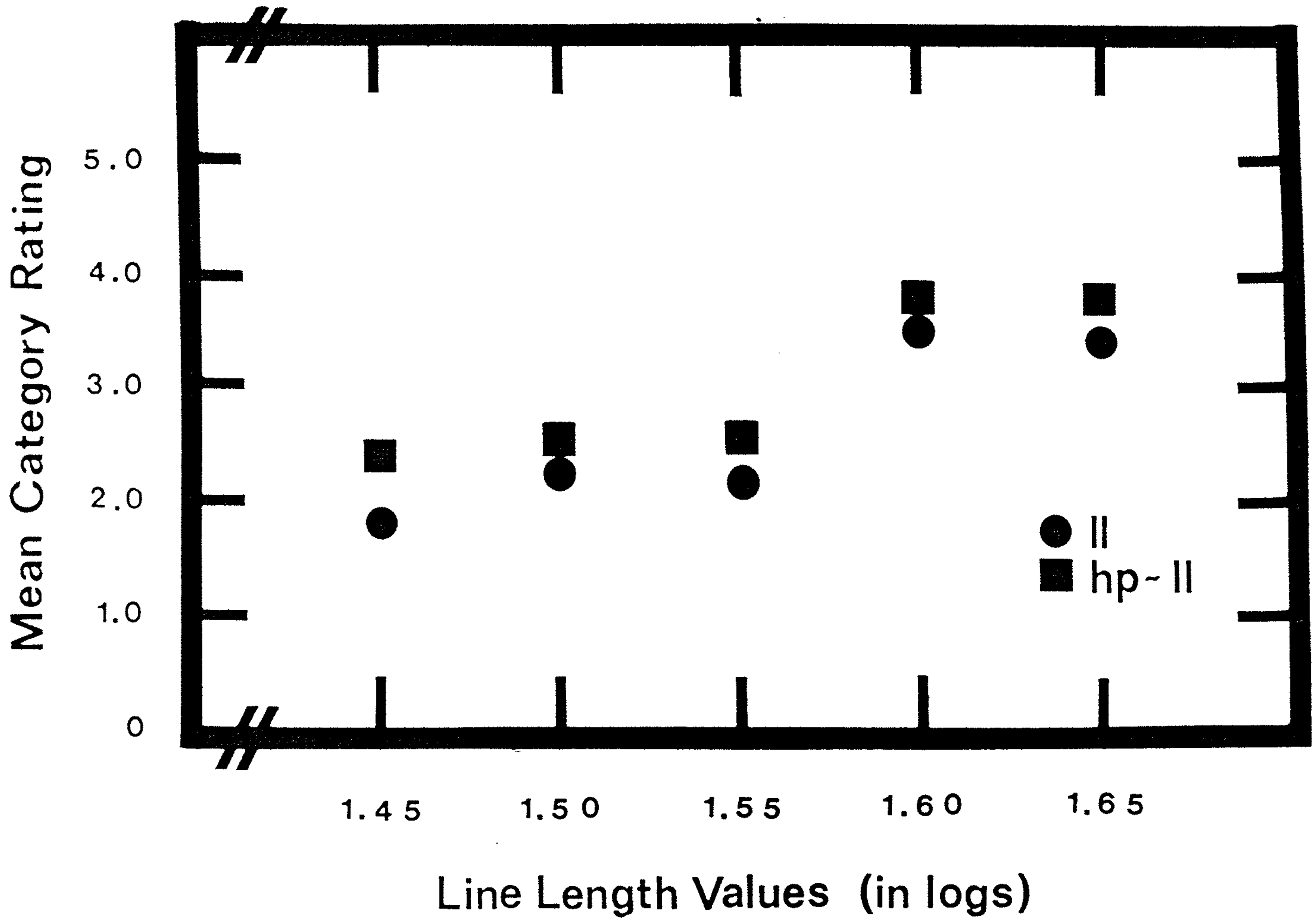

Mean Category Rating
5.0
4.0
3.0
2.0
1.0
0
1.45
1.50
1.55
1.60
1.65
Line Length Values (in logs)
hl
lp ~ hl

Figure 12: Mean ratings of low line length stimuli preceded by high vs no proportion.


Mean Category Rating
5.0
4.0
3.0
2.0
1.0
0
1.45
1.50
1.55
1.60
1.65
Line Length Values (in logs)
ll
hp-ll

Discussion. A preliminary examination of the results obtained in Experiment 5 proves to be somewhat contradictory, as only one of the two comparisons was statistically significant. Unlike the significant assimilation effect found in Experiment 4 when the first stimulus set judged was of a high range, using a high to a low range in this experiment did not yield any significant transfer effects when the order of continua was reversed. However, the trend in Experiment 4 of low-valued stimuli leading to a contrast of judgments in a second set was confirmed in Experiment 5. In this case there was a statistically significant contrast effect when low proportion was followed by high line. An examination of Figure 11 shows the nature of this contrast effect, resulting in low proportions making high lines appear even greater than those in the control condition.

Of further interest is a similar deployment of judgments in Figure 12. Here, high proportions led to higher judgments of low lines than for those in the control group, indicating a trend toward assimilation (p = .0663). Thus, when the order of transfer is from proportion to line length, there is a tendency for second judgments to be rated as higher than the control group judgments, regardless of range. For the low proportion to high line length condition, a significant amount of contrast is incurred, while the high proportion to low line length condition shows a nonsignificant pattern of assimilation.

One possible explanation for this nonsignificant pattern involves the ranges of stimuli employed. It is possible that as the low lines are sampled near the initial end of the range, previous stimuli cannot alter them much as they are more firmly anchored to one end of the frame of reference. However, this still would not explain why high proportion followed by medium line length did not create a greater assimilation effect. Perhaps medium lines are still too close to the lower absolute end of the frame of reference. If so, it might be possible to induce a significant assimilation effect by providing an anchor of low value before requesting judgments of higher-valued stimuli. Alternately, all ranges could be increased so that medium-valued stimuli would be less likely to be identified with the low end of the range.

CHAPTER V

General Discussion

Overview of the Results

Originally, three hypotheses were postulated about the existence of transfer effects among different continua in order to construct a new theory of context. The subsequent answers obtained from this series of experiments addressed three general principles upon which the development of the frame of reference theory relies.

The first question was whether transfer occurred within a continuum when the stimulus ranges were altered, and whether resulting transfer acted differently for infinite- and finite-range continua. The results of Experiment 1 confirmed the existence of intracontinuum transfer for both infinite-range line length and finite-range proportion. However, the nature and degree of transfer did not distinguish between the two types, as a steady, significant level of contrast was displayed in all the conditions. These contrast effects followed from the ranges of stimuli used, so that low-valued first sets led to higher second judgments, while high-valued first sets led to attenuated second judgments.

The second question asked whether transfer occurred across continua, and if so, whether the resulting judgments were influenced in a systematic manner. Up to this time, published research involving the transfer paradigm has not been used to study this specific question, so that the issue has never been properly addressed. The closest past research has gotten to this problem is the use of cross-continuum anchors interspersed in the judgment series - an approach exemplified in studies by Aftanas and Rule (1968), and others (Behar & Bevan, 1962; Bevan & Pritchard, 1964). Thus, the second and third hypotheses proposed were designed to study this second principle. Hypothesis 2 addressed the issue of intercontinuum transfer between an infinite- and a finite-range set of stimuli, while the third hypothesis studied transfer effects between two finite-range continua.

Experiment 2 was the first of several experiments aimed at exploring the transfer relationships between an infinite- and a finite-range continuum. A significant order effect was indicated, representing the judgment pattern of stimuli seen in Figures 4 and 5. Visual inspection of these graphs reveals that the resulting trend was for judgments in the line length to proportion conditions to be rated as lower than those obtained in the proportion to line conditions. The finite-infinite transfer relationship appeared to be a more complex one than originally thought, resulting in further analyses to discover other contributing factors.

In contrast with the first two experiments, Experiment 3 found that there were no significant differences when the transfer paradigm employed two different sets of finite-range continua. The results indicated that the third hypothesis was correct, as significant transfer did not occur when the continua of dot density and proportion were shown in conjunction.

The third general question asked was whether differential transfer effects occurred as a function of the type of continua used. The answer to this query was mixed. Regarding Experiments 1 to 3, no overall pattern of significance was identified. However, variations in the conditions studied in Experiments 2 and 3 pointed to the existence of certain nonsignificant trends. Although not statistically significant in themselves, it did appear that a more subtle context effect was being created. Thus, it seemed reasonable to assume that manipulations of range values were still influencing judgments to a lesser extent. In order to examine these subtler spheres of influence, Experiment 4 was designed to investigate these factors more closely.

Turning first to intercontinuum transfer between two finite-range continua, the nonsignificant results obtained in Experiment 3 were confirmed in Experiment 4. However, the irregularity of judgments displayed in Figures 9 and 10 indicated that context effects might possibly be affecting second judgments. Unfortunately, there was no consistent pattern of effects, so that in the final analysis, all judgment conditions are relatively indistinct from each other. Knowing that intracontinuum judgments are heavily affected by contrast, the lack of discrimination between the intercontinuum judgment conditions was somewhat unusual in itself. An examination of Figures 9 and 10 reveals an irregular relationship between groups on the first 3 stimuli. For the dot density to proportion conditions (Figure 9), judgments appear to be truly random. However, when judgments were from proportion to dot density (Figure 10), both the low and high conditions were rated as lower than the control condition. For the fourth and fifth stimuli in Figures 9 and 10, both the low and high judgment groups yielded greater ratings than their respective control groups. This particular effect can be seen to occur with greater regularity in Figures 7 and 8, using the continua of line length and proportion. The general pattern in these figures was for low-valued first sets to lead to contrast, while high-valued first sets led to assimilation.

Apparently, intercontinuum transfer opens the door for assimilation effects, which are more pronounced when an infinite-range continuum is paired with a finite-range one. For two finite-range continua there is no consistent pattern of assimilation and contrast, nor a one-to-one correspondence of transfer paradigm judgments being rated as higher than controls on the graphs. Possibly, these results are due to the flatter, slower growth curves exhibited for finite-range continua. As a result, the interpretation of possible transfer between dot density and proportion must be guarded, as the effects are so irregular. Insofar as there were no significant effects exhibited, the third hypothesis was retained, indicating that finite-range continua are relatively more resistant to transfer than infinite-range continua in an intercontinuum situation. The nonsignificance of Experiment 3 results support this theory, although the atypical pattern of judgments shows that finite-range continua are not necessarily totally immune to context effects.

For transfer between an infinite- and a finite-range continuum, Experiment 4 showed that range values were of continued importance, while the order of presentation had little impact. Regardless of order, a lower-valued set followed by a higher-valued set led to contrast, while a higher range followed by a lower one resulted in assimilation. Thus, unlike Experiment 1, consistent contrast was not observed. Rather, the range of values dictated what would occur, whether it be contrast (low to high) or assimilation (high to low). Figures 7 and 8 show that in all cases both the low and high conditions yielded ratings which were higher than those of the respective control groups. In Figure 7, there was some confusion between the low and high groups for the first and third stimuli, so that mean judgments were reversed in order of succession. This was again seen for the second stimulus in Figure 8. However, the general effect was the same, resulting in nonsignificant differences between the low and high judgment conditions for both presentation orders.

Experiment 5 also indicated that there was a consistent trend for judgments obtained in a transfer situation to be rated as higher than control group judgments. Although only the low to high condition proved statistically significant, when proportion and line length were shown in succession, both the low to high and high to low range manipulations led to an increase in judgments compared to the controls. Thus, a low range followed by a high range led to a contrast effect, while a high range followed by a low range led to assimilation.

In brief, Experiments 1 to 5 revealed that intracontinuum transfer resulted in contrast for both infinite- and finite-range continua. No distinguishing features were displayed when intercontinuum transfer was studied using two finite-range continua. However, when an infinite- and a finite-range set of stimuli were combined, the general rule was for lower to higher ranges to lead to contrast, and for higher to lower ranges to produce assimilation.

What lacks an adequate explanation are the significant and nonsignificant judgment trends obtained in Experiments 4 and 5. Comparing the line to proportion and proportion to line conditions, all rating trends indicated that lower first sets led to contrast, while higher first sets led to assimilation. However, of the six experimental conditions employing these continuum orders, only two proved to be statistically significant. Thus, the high line to medium proportion condition in Experiment 4 produced assimilation ($p < .05$), while the low proportion to high line condition in Experiment 5 resulted in contrast ($p < .05$). Comparing the low line to medium proportion (n.s.) and high line to medium proportion ($p < .05$) conditions in Experiment 4, it seems reasonable to postulate that high stimulus ranges presented first are even more impressive than low ones, resulting in greater transfer. Yet inspection of the proportion to line order in Experiment 5 showed that the low to high condition was significant ($p < .05$), while the high to low condition was not. Closer scrutiny of the four conditions reveals that significant transfer was incurred only when high line was included in a transfer paradigm. Knowing that high ranges of the continuum of line length are more unfamiliar than lower values (Poulton, 1977; 1979; Stevens & Galanter, 1957), it is possible that the inclusion of such a set could produce confusion in the labelling of subjective impressions. If so, any combination of more familiar stimulus sets (either lower values of line length or finite-range continua with stronger internal frames of reference) would not lead to any significant transfer effects. However, the introduction of a less familiar stimulus set (in this case, high ranges of line length) might invite significant transfer. In order to study the entire picture of trends, it will be necessary in the future to study cross-continuum transfer with wider stimulus ranges and intermediate sets. Possibly, further investigation may justify the assumption that familiarity of range is critical in transfer. Future research should focus on intra- and intercontinuum transfer, using both infinite- and finite-range continua.

Theoretical Implications

Transfer depends, to a certain extent, upon several factors. The occurrence of significant transfer between two different continua appears to depend upon the inclusion of an infinite-range continuum in the transfer paradigm. After this, the range variable becomes important. As Poulton (1977; 1979) and Stevens and Galanter (1957) have pointed out there is greater familiarity with lower ranges of well known continua, a case in point being line length. As the ranges increase in magnitude, the stimuli become more unfamiliar and harder to assess. These stimulus sets are then more easily influenced by previous stimuli, even when they are of lower value. Experiment 5 results confirmed this assumption when low-valued proportion preceding high-valued line length led to a significant contrast effect. For the high proportion to low line condition, the nonsignificant results may also be taken to suggest that lower-ranged lines are more familiar and firmly entrenched in the subject's experience. If correct, then the conditions in Experiments 4 and 5 provide additional support, as none of the conditions using low to medium line values as a second set led to statistical significance. This evidence presupposes that the medium-ranged line length values are subjectively close enough to lower values to retain their familiarity. If so, this familiarity would serve to deflect any significant transfer effects.

Conversely, the low line to medium proportion condition had little impact on second judgments, but the high line to medium proportion condition yielded a significant assimilation effect. In this instance, a low first set was not overly influential, while the high-valued set had a much more apparent impact. These results could again reflect that when a stimulus set such as line length is familiar on two dimensions (both range and type of continuum), then the increased knowledge serves to isolate the set as a separate judgment task. Thus, there is a partition of the first set from the second set of stimuli, which yields nonsignificant transfer effects. However, there is still some effect, as indicated by visual inspection of mean stimulus ratings.

Therefore, if a low to medium range is combined with the familiar continuum of line length, then as a first judgment set it would be somewhat removed from the transfer paradigm, while as a second set it would be more impervious to transfer. When the continuum is more unfamiliar (i.e., proportion), its range becomes important in dictating contrast and assimilation effects only when it is joined with a second unfamiliar set (i.e., high-ranged line length). Table 2 displays the resulting predictions for different conditions based on this theory.

TABLE 2

Predictions and Existing Supportive Evidence

	Effects	
Source	Nonsignificant Trend	Significant Transfer
Theoretical Prediction	low line to low, medium and high proportion	high line to low, medium and high proportion
	medium line to low, medium and high proportion	low, medium and high proportion to high line
	low, medium and high proportion to low line	
	low, medium and high proportion to medium line	
Thesis Data	low line to medium proportion	high line to medium proportion
	low proportion to medium line	low proportion to high line
	high proportion to medium line	
	high proportion to low line	

The data obtained from Experiments 1 to 5 support these predictions for the conditions sampled. Within this framework, then, the ranges of proportion stimuli used are not as important as the judgment tasks they are paired with.

It has already been stated elsewhere (Helson, 1964; Marks, 1974; McKenna, 1984; Parducci, 1963) that judgments are relativistic, depending not only on the relation of individual stimuli to the larger group, but also on the rater's historical familiarity with the continuum (Poulton, 1977; 1979). The alteration of context using anchors is a well known phenomenon (e.g., Aftanas & Rule, 1968; Behar & Bevan, 1962; Bevan & Pritchard, 1964). However, it has generally been assumed that anchors close to the end of a stimulus set always produce assimilation, while those farther away lead to contrast. This theorizing does not totally correspond with the present results using a cross-continuum design. As Experiment 5 revealed, a low to a high range produced significant contrast, whereas a high to a low condition led to a nonsignificant assimilation pattern. The present proposed set of predictions would account for these occurrences, while Helson's (1964) explanation would not.

Perhaps proportion, because it is a more unfamiliar continuum demanding a more complex type of evaluation, is not as salient as was first proposed. It is known that metathetic types of continua (i.e., color mass and pitch) can be distorted by introducing anchors and interfering stimuli into the task (Stevens & Galanter, 1957). It may be that as instances of a familiar continuum (such as line length) become more unfamiliar at higher ranges, a sort of confusion ensues, making contextual effects more likely. Because a corresponding level of confusion does not emanate from proportion judgments, only a nonsignificant trend is incurred in the transfer paradigm. In this instance, both sets would be judged more confidently by using internal frames of reference, created by the limitation of physical ranges (as for finite-range continua) or historical familiarity (for infinite-range continua). This would explain why there were no significant transfer effects until an infinite- and a finite-range set of continua were paired for judgment purposes. When combined, the amount of induced confusion would rely on unfamiliarity with proportion type judgments in general, and the high ranges of line length in particular. The two sources of confusion would thus lead to a significant transfer effect.

These predictions could be explored by combining two familiar sets of infinite-range continua for judgment purposes. If this were done, we would expect that judgments from a a low to a high or a high to a low set of stimuli would not lead to significant transfer, due to the comfortableness with the low values of one of the continua. The same would be expected if two low-valued sets were paired in a transfer situation. However, if two high-ranged sets were used, the theory would predict that the unfamiliarity with both ranges would result in significant transfer. Predicting effects on the basis of Experiments 4 and 5, the trend for a low to high range would be contrast, while assimilation would be expected for a high to a low range.

In conclusion, it may still be possible to categorize continua on the basis of trends and significant results, using both the range and type of continuum as starting points. The proposed model is still in its infancy, and the present set of experiments have only begun to illuminate the possible patterns of transfer. It is therefore still premature for a total, holistic theory of context, as more research in the area is required. However, it is apparent that a simple contrast-assimilation pattern theory is not able to predict the significance of results, although it is sufficient in explaining trends. A more complex theory, based on the subject's familiarity with range and type of continuum, would be able to account for the significance of results as well.

Practical Applications

In future studies, there is a general need to consider several factors and variations. Extended study should employ both full extensions and partial samplings of range values in order to truly sample the limits of the human standard system's processing capacity. Such samplings of range for infinite-range continua should take into account the perceptual limitations of the human standard system. This would involve consideration of limiting factors particular to different modalities, such as the field of vision in judgments of line length. Finally, all possible combinations of continua and range should be assessed in a systematic manner to reveal any patterns. Once these factors have been studied, an appropriate model might be constructed. If such a model were to be established, more complex questions could be addressed, such as the differences between the transfer paradigm studied here versus the interspersal of cross-continuum anchors (e.g., Aftanas & Rule, 1968), and cross-modal transfer effects.

The ultimate purpose of such research would be to discover if the frame of reference can be lawfully altered, and obtain a basic set of principles which would predict effects and be generalizable to other fields of study.

By understanding the nature of human assessment processes, this approach could extend the application of psychophysics into other arenas. Helson (1964) has already pointed this out, and cites the adaptation of such research in the fields of personality assessment, interpersonal interactions, and clinical populations. He also addresses the issue of context and range factors, representing the human rater as an assessment device who carries about internal norms, which can be influenced to a certain extent by situational factors. With regard to the upper and lower ends of the range, he postulates that internal norms are maintained as an adaptive function, serving to recalibrate the human standard system. External factors are thus negated, as "There is survival value in remaining aware of such extremes in the environment as the deafening roar of an explosion or the quiet hiss of a rattlesnake" (Helson, 1964, p.50).

Goldstone (1962) has related these concepts to clinical usage, where the loss of internal norms by the mentally ill leads to dysfunctional perception and behavior. For schizophrenic and toxic groups, he reviews accumulated evidence that judgments are almost totally related to situational context at the expense of an historically formulated internal framework. He shows how the use of absolute judgments can detect the ahistoric judgment patterns of these clinical populations, and how this contributes to the production of hallucinatory experiences (see Goldstone, 1962, for a review of this process). Unfortunately, 25 years after this essay was published, little has been done in the area to further explore this phenomenon.

Conclusions

The sum of the conclusions drawn about transfer point to certain patterns emerging, based on both the type and range of continua employed. On the basis of the evidence obtained from Experiments 1 to 5, the following conclusions were drawn.

1) Intracontinuum transfer does exist. Experiment 1 showed that contrast occurs when range values are manipulated, both for infinite- and finite-range continua.

2) Intercontinuum transfer between infinite- and finite-range continua (line length and proportion, respectively) also exists, but appears to be more dependent on range than on order. Experiments 2, 4 and 5 indicated that familiarity with type of continuum and range values employed seems to play a part in determining the significance of transfer effects. However, when nonsignificant trends are taken into account, there is a general pattern of transfer effects, where lower first sets lead to contrast, and higher first sets lead to assimilation.

3) Intercontinuum transfer between two finite-range continua (dot density and proportion) does not occur in a consistent and lawful manner. Experiments 3 and 4 indicated that no pattern of effects emerged which was either predictable or significant.

4) On the basis of the evidence supplied in Experiments 2 to 5, a two-factor theory of transfer is proposed. It is suggested that stability of reference frame depends on the familiarity with the type of continuum and the range of values employed. Within the transfer paradigm, if both stimulus sets are unfamiliar on either count, then statistically significant transfer will result. If the rater is familiar with both aspects of either set, then nonsignificant judgment patterns may emerge.

5) The direction of significant and nonsignificant transfer is dependent on the type of continua combined. For intracontinuum transfer, a significant contrast effect results for both infinite- and finite-range continua, regardless of range values of first sets. For intercontinuum judgments between one infinite- and one finite-range continuum, the range factor becomes more important. Thus, lower to higher sets result in contrast, while higher to lower sets lead to assimilation. For intercontinuum transfer between two finite-range continua, the inherent stability of their frames of reference prevent the emergence of any strong trends toward either contrast or assimilation.

6) It is further predicted that studies of intercontinuum transfer between two familiar infinite-range continua will lead to nonsignificant trends in three out of four conditions. Significant transfer effects are only

expected when both continua are sampled from the higher ranges of encounterable stimuli. The resulting unfamiliarity emanating from both stimulus sets should lead to a significant transfer effect.

7) By standardization of methods and continued study of transfer patterns, it may be possible to produce a typology of continua. The ultimate purpose would be to see if the frame of reference can be lawfully altered, and eventually related to other fields of study.

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Appendix A

RATING INSTRUCTIONS

LINE LENGTH TO LINE LENGTH

Instructions

This is a study of how students make judgments about different kinds of things. We want to see how students rate the sizes or magnitudes of a set of stimuli. The kinds of stimuli we want you to rate will be projected onto the screen in front of you. There will be two parts to this session. Let's go on to the first part in which I want you to judge the magnitudes of a set of stimuli.

The first set of stimuli will consist of line lengths. You must determine the relative magnitude of each line length. You are to make your judgments on the rating scale in front of you. Each line is numbered from <u>one</u> to <u>five</u>. If you feel that the length of the line is low, you should place an X on number 1. If you feel that the magnitude of the line length is high, you should place an X on number 5.

If the magnitude of the line length is between low and high, you should place an X on one of the remaining numbers which you feel represents that subjective magnitude. Use each line on your rating scale only <u>once</u>. The first line for the first stimulus, the second for the second, and so on. When you come to the bottom of the page, turn it over, and start at the next page. <u>Please judge every stimulus</u>. <u>If you are not certain, guess</u>. Try to make your judgments as quickly as possible. You will be given about 10 seconds to make this judgment. Check one of the numbers of the rating scale within that period. Are there any questions?

--Let's begin, then.

Second Part

Now I would like you to judge the magnitudes of a second set of stimuli. In this part the stimuli will also consist of line lengths. You must determine the relative magnitude of each line length. Once again, if you feel that the length of line is low, place an X on number 1. If you feel that the magnitude of the line length is high, place an X on number 5. If the line length is between low and high, place an X on the corresponding number which you feel represents that subjective magnitude. Your responses should be recorded on the sheets in the same way as you did before. Any questions?

--Let's begin.

PROPORTION TO PROPORTION

Instructions

This is a study of how students make judgments about different kinds of things. We want to see how students rate the sizes or magnitudes of a set of stimuli. The kinds of stimuli we want you to rate will be projected onto the screen in front of you. There will be two parts to this session. Let's go on to the first part in which I want you to judge the magnitudes of a set of stimuli.

The first set of stimuli will consist of a number of dots to lines, or the proportion of dots to lines. You must determine the relative magnitude of the proportion of dots to lines. You are to make your judgments on the rating scale in front of you. Each line is numbered from one to five. If you feel that the proportion of dots is low, you should place an X on number 1. If you feel that the magnitude of the proportion of dots is high, you should place an X on number 5. If the proportion of dots to lines is between low and high, you should place an X on one of the remaining numbers which you feel represents that subjective magnitude. Use each line on your rating scale only once.

The first line for the first stimulus, the second for the second, and so on. When you come to the bottom of the page, turn it over, and start at the next page. Please judge every stimulus. If you are not certain, guess. Try to make your judgments as quickly as possible. You will be given about 10 seconds to make this judgment. Check one of the numbers of the rating scale within that period. Are there any questions?

--Let's begin, then.

Second Part

Now I would like you to judge the magnitudes of a second set of stimuli. In this part the stimuli will also consist of a number of dots to lines, or the proportion of dots to lines. You must determine the relative magnitude of the proportion of dots to lines. Once again, if you feel that the proportion of dots is low, place an X on number 1. If you feel that the magnitude of the proportion of dots is high, place an X on number 5. If the proportion of dots to lines is between low and high, place an X on the corresponding number which you feel represents that subjective magnitude. Your responses should be recorded on the sheets in the same way as you did before. Any questions?

--Let's begin.

LINE LENGTH TO PROPORTION

Instructions

This is a study of how students make judgments about different kinds of things. We want to see how students rate the sizes or magnitudes of a set of stimuli. The kinds of stimuli we want you to rate will be projected onto the screen in front of you. There will be two parts to this session. Let's go on to the first part in which I want you to judge the magnitudes of a set of stimuli.

The first set of stimuli will consist of line lengths. You must determine the relative magnitude of each line length. You are to make your judgments on the rating scale in front of you. Each line is numbered from <u>one</u> to <u>five</u>. If you feel that the length of the line is low, you should place an X on number 1. If you feel that the magnitude of the line length is high, you should place an X on number 5. If the magnitude of the line length is between low and high, you should place an X on one of the remaining numbers which you feel represents that subjective magnitude. Use each line on your rating scale only <u>once</u>. The first line for the first stimulus, the second for the second, and so on. When you come to the bottom of the page, turn it over, and start at the next page. Please judge every stimulus. If you are not certain, guess. Try to make your judgments as quickly as possible. You will be given about 10 seconds to make this judgment. Check one of the numbers of the rating scale within that period. Are there any questions?

--Let's begin, then.

Second Part

Now I would like you to judge the magnitudes of a second set of stimuli. In this part the stimuli will consist of a number of dots to lines, or the proportion of dots to lines. You must determine the relative magnitude of the proportion of dots to lines. Once again, if you feel that the proportion of dots is low, place an X on number 1. If you feel that the magnitude of the proportion of dots is high, place an X on number 5. If the proportion of dots to lines is between low and high, place an X on the corresponding number which you feel represents that subjective magnitude. Your responses should be recorded on the sheets in the same way as you did for line lengths. Any questions?

--Let's begin.

PROPORTION TO LINE LENGTH

Instructions

This is a study of how students make judgments about different kinds of things. We want to see how students rate the sizes or magnitudes of a set of stimuli. The kinds of stimuli we want you to rate will be projected onto the screen in front of you. There will be two parts to this session. Let's go on to the first part in which I want you to judge the magnitudes of a set of stimuli.

The first set of stimuli will consist of a number of dots to lines, or the proportion of dots to lines. You must determine the relative magnitude of the proportion of dots to lines. You are to make your judgments on the rating scale in front of you. Each line is numbered from <u>one</u> to <u>five</u>. If you feel that the proportion of dots is low, you should place an X on number 1. If you feel that the magnitude of the proportion of dots is high, you should place an X on number 5. If the proportion of dots to lines is between low and high, you should place an X on one of the remaining numbers which you feel represents that subjective magnitude. Use each line on your rating scale only <u>once</u>.

The first line for the first stimulus, the second for the second, and so on. When you come to the bottom of the page, turn it over, and start at the next page. <u>Please judge every stimulus</u>. <u>If you are not certain, guess</u>. Try to make your judgments as quickly as possible. You will be given about 10 seconds to make this judgment. Check one of the numbers of the rating scale within that period. Are there any questions?

--Let's begin, then.

Second Part

Now I would like you to judge the magnitudes of a second set of stimuli. In this part the stimuli will consist of line lengths. You must determine the relative magnitude of each line length. Once again, if you feel that the length of line is low, place an X on number 1. If you feel that the magnitude of the line length is high, place an X on number 5. If the line length is between low and high, place an X on the corresponding number which you feel represents that subjective magnitude. Your responses should be recorded on the sheets in the same way as you did for proportion. Any questions?

--Let's begin.

DOT DENSITY TO PROPORTION

Instructions

This is a study of how students make judgments about different kinds of things. We want to see how students rate the sizes or magnitudes of a set of stimuli. The kinds of stimuli we want you to rate will be projected onto the screen in front of you. There will be two parts to this session. Let's go on to the first part in which I want you to judge the magnitudes of a set of stimuli.

The first set of stimuli will consist of a number of dots. You must determine the relative magnitude of the density of the dots. You are to make your judgments on the rating scale in front of you. Each line is numbered from <u>one</u> to <u>five</u>. If you feel that the density of the dots is low, you should place an X on number 1. If you feel that the magnitude of the dot density is high, you should place an X on number 5. If the magnitude of the density of the dots is between low and high, you should place an X on one of the remaining numbers which you feel represents that subjective magnitude. Use each line on your rating scale only <u>once</u>. The first line for the first stimulus, the second for the second, and so on. When you come to the bottom of the page, turn it over, and start at the next page. Please judge every stimulus. If you are not certain, guess. Try to make your judgments as quickly as possible. You will be given about 10 seconds to make this judgment. Check one of the numbers of the rating scale within that period. Are there any questions?

--Let's begin, then.

Second Part

Now I would like you to judge the magnitudes of a second set of stimuli. In this part the stimuli will consist of a number of dots to lines, or the proportion of dots to lines. You must determine the relative magnitude of the proportion of dots to lines. Once again, if you feel that the proportion of dots is low, place an X on number 1. If you feel that the magnitude of the proportion of dots is high, place an X on number 5. If the proportion of dots to lines is between low and high, place an X on the corresponding number which you feel represents that subjective magnitude. Your responses should be recorded on the sheets in the same way as you did for dot density. Any questions?

--Let's begin.

PROPORTION TO DOT DENSITY

Instructions

This is a study of how students make judgments about different kinds of things. We want to see how students rate the sizes or magnitudes of a set of stimuli. The kinds of stimuli we want you to rate will be projected onto the screen in front of you. There will be two parts to this session. Let's go on to the first part in which I want you to judge the magnitudes of a set of stimuli.

The first set of stimuli will consist of a number of dots to lines, or the proportion of dots to lines. You must determine the relative magnitude of the proportion of dots to lines. You are to make your judgments on the rating scale in front of you. Each line is numbered from one to five. If you feel that the proportion of dots is low, you should place an X on number 1. If you feel that the magnitude of the proportion of dots is high, you should place an X on number 5. If the proportion of dots to lines is between low and high, you should place an X on one of the remaining numbers which you feel represents that subjective magnitude. Use each line on your rating scale only once.

The first line for the first stimulus, the second for the second, and so on. When you come to the bottom of the page, turn it over, and start at the next page. Please judge every stimulus. If you are not certain, guess. Try to make your judgments as quickly as possible. You will be given about 10 seconds to make this judgment. Check one of the numbers of the rating scale within that period. Are there any questions?

--Let's begin, then.

Second Part

Now I would like you to judge the magnitudes of a second set of stimuli. In this part the stimuli will consist of a number of dots. You must determine the relative magnitude of the density of the dots. Once again, if you feel that the density of the dots is low, place an X on number 1. If you feel that the magnitude of the dot density is high, place an X on number 5. If the density of the dots is between low and high, place an X on the corresponding number which you feel represents that subjective magnitude. Your responses should be recorded on the sheets in the same way as you did for proportion. Any questions?

--Let's begin.

LINE LENGTH

Instructions

This is a study of how students make judgments about different kinds of things. We want to see how students rate the sizes or magnitudes of a set of stimuli. The kinds of stimuli we want you to rate will be projected onto the screen in front of you.

The first set of stimuli will consist of line lengths. You must determine the relative magnitude of each line length. You are to make your judgments on the rating scale in front of you. Each line is numbered from <u>one</u> to <u>five</u>. If you feel that the length of the line is low, you should place an X on number 1. If you feel that the magnitude of the line length is high, you should place an X on number 5. If the magnitude of the line length is between low and high, you should place an X on one of the remaining numbers which you feel represents that subjective magnitude. Use each line on your rating scale only <u>once</u>. The first line for the first stimulus, the second for the second, and so on. When you come to the bottom of the page, turn it over, and start at the next page. <u>Please judge every stimulus</u>. <u>If you are</u>

not certain, guess. Try to make your judgments as quickly as possible. You will be given about 10 seconds to make this judgment. Check one of the numbers of the rating scale within that period. Are there any questions?

--Let's begin, then.

DOTS

Instructions

This is a study of how students make judgments about different kinds of things. We want to see how students rate the sizes or magnitudes of a set of stimuli. The kinds of stimuli we want you to rate will be projected onto the screen in front of you.

The first set of stimuli will consist of a number of dots. You must determine the relative magnitude of the density of the dots. You are to make your judgments on the rating scale in front of you. Each line is numbered from <u>one</u> to <u>five</u>. If you feel that the density of the dots is low, you should place an X on number 1. If you feel that the magnitude of the dot density is high, you should place an X on number 5. If the magnitude of the density of the dots is between low and high, you should place an X on one of the remaining numbers which you feel represents that subjective magnitude. Use each line on your rating scale only <u>once</u>. The first line for the first stimulus, the second for the second, and so on. When you come to the bottom of the page, turn it over, and start at the next page. Please judge every stimulus. If you are not certain, guess. Try to make your judgments as quickly as possible. You will be given about 10 seconds to make this judgment. Check one of the numbers of the rating scale within that period. Are there any questions?

--Let's begin, then.

PROPORTION

Instructions

This is a study of how students make judgments about different kinds of things. We want to see how students rate the sizes or magnitudes of a set of stimuli. The kinds of stimuli we want you to rate will be projected onto the screen in front of you.

The first set of stimuli will consist of a number of dots to lines, or the proportion of dots to lines. You must determine the relative magnitude of the proportion of dots to lines. You are to make your judgments on the rating scale in front of you. Each line is numbered from one to five. If you feel that the proportion of dots is low, you should place an X on number 1. If you feel that the magnitude of the proportion of dots is high, you should place an X on number 5. If the proportion of dots to lines is between low and high, you should place an X on one of the remaining numbers which you feel represents that subjective magnitude. Use each line on your rating scale only once. The first line for the first stimulus, the second for the second, and so on. When you come to the bottom of the page, turn it over, and start at the next page. Please judge every stimulus. If you are not certain, guess. Try to make your judgments as quickly as possible. You will be given about 10 seconds to make this judgment. Check one of the numbers of the rating scale within that period. Are there any questions?

--Let's begin, then.

Appendix B

MEAN RATINGS OF INDIVIDUAL STIMULI BY EXPERIMENTAL CONDITION

EXPERIMENT 1

1.

low line length to medium line length

3.0	4.0	4.2	4.7	4.9

2.

high line length to medium line length

1.5	1.7	1.7	2.8	2.8

3.

low proportion to medium proportion

2.8	3.5	3.3	3.6	3.6

4.

high proportion to medium proportion

1.2	1.4	1.6	1.8	2.1

EXPERIMENT 2

1.

low line length to medium proportion

2.3	2.8	2.7	3.0	3.2

2.

high line length to medium proportion

2.8	2.7	3.0	3.2	3.4

3.

low proportion to medium line length

2.6 3.2 3.4 3.9 4.4

4.

high proportion to medium line length

2.4 3.2 3.3 4.2 4.6

EXPERIMENT 3

1.

low dot density to medium proportion

2.2 2.3 2.6 2.8 2.9

2.

high dot density to medium proportion

2.0 2.3 1.6 3.1 3.0

3.

low proportion to medium dot density

1.6 2.3 2.8 2.8 3.4

4.

high proportion to medium dot density

1.5 2.2 2.6 3.0 3.4

EXPERIMENT 4

1.

first judgments of line length

2.3 3.0 3.0 3.8 4.1

2.

first judgments of proportion

2.1 2.3 2.5 2.6 3.0

3.

first judgments of dot density

1.9 2.4 2.8 2.6 3.0

EXPERIMENT 5

1.

first judgments of low line length

1.8 2.2 2.2 3.5 3.4

2.

high proportions to low line length

2.4 2.6 2.6 3.8 3.8

3.

first judgments of high line length

2.6 3.1 3.7 4.0 4.3

4.

low proportions to high line length

3.0 3.5 4.3 4.2 4.8

Note. Mean ratings are given in order from the lowest to the highest physical values.

Appendix C

RATING FORM

LOW 1 2 3 4 5 HIGH

LOW 1 2 3 4 5 HIGH

LOW 1 2 3 4 5 HIGH

LOW 1 2 3 4 5 HIGH

LOW 1 2 3 4 5 HIGH

LOW 1 2 3 4 5 HIGH

LOW 1 2 3 4 5 HIGH

LOW 1 2 3 4 5 HIGH

LOW 1 2 3 4 5 HIGH

LOW 1 2 3 4 5 HIGH