Seen and felt length¹

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Abstract

Apparent length of rods was scaled by a method of magnitude estimation. Observers judged the rods on two occasions, once presented visually and again kinesthetically. Length seen and length felt are both related to physical length by a power function with an exponent of unity.

Problem

The relation between sensory and stimulus magnitudes has been studied with the use of the direct scaling techniques described and classified by Stevens (1957). For a wide variety of continua a power relation, $\Psi = kI^n$, is found (Stevens & Galanter, 1957): the exponent n indicates whether sensory magnitude Ψ increases more or less rapidly than stimulus magnitude I by taking values greater or less than unity, respectively. The special, and relatively rare, case of $n=1$ denotes a linear relation. A number of reports (Ekman & Junge, 1961; Kunnapas, 1958; Stevens & Galanter, *op. cit.*; Stevens & Guirao, 1963; Teghtsoonian, 1965) are in agreement that visual judgments of length are linearly related to physical length. Variations in technique, in instructions, and in stimulus material have been plentiful; yet, in spite of these variations, the reported exponent of the power function has varied only from 0.95 to 1.11.

However, linear extent is not limited to visual experience. An observer can estimate the distance between two points on his skin surface, or a separation bounded by his two hands, or even the distance between two sources of sound. Boring (1933), summarizing the available evidence, thought that all senses but olfaction are organized in the dimension of extensity. The only modern study we can find in which linear extents have been presented for judgment in a non-visual manner is that of Stevens & Stone (1959), who scaled finger span, obtaining a power function with an exponent of 1.33 relating apparent thickness to width of block. It is unclear whether the exponent, higher than those obtained in other studies of judged length, is due to the mode of presentation, to a relatively restricted range of length, or to other factors. The question naturally arises whether judgments of length obtained when other sensory systems are stimulated resemble judgments obtained with visual presentation.

Method

The same Os judged the length of a set of rods on one occasion from visual, and on another occasion from kinesthetic, cues. The stimuli were cut from lengths of 3/8 in. aluminum dowel, polished to be free of identifying marks. There were eight rods, ranging in length from 0.7 to 33.0 in in approximately equal logarithmic steps. For visual presentation the rods were placed in the center of a table 3 by 6 ft, parallel to the long edge;

the table was covered with a black cloth. For kinesthetic presentation, the rod, horizontally oriented, was clipped on a stand 10 in from the table-top. The blindfolded O allowed E to place her index fingers, one at either end of the rod. O never saw the rods she was to judge kinesthetically in a given session; nor in the other session did she touch the rods she was to judge visually.

The instructions, with appropriate modifications, had the same form for both sessions. O was asked to assign numbers to represent how long the rods looked, or felt, to her. She was encouraged to use any numbers which seemed appropriate. The instructions did not suggest that the same rods were being presented each time, nor were they designed to set O toward identifying rods seen, or felt, in the previous session. However, the absence of an assigned modulus, together with the stress on assigning numbers to represent the subjective impression of length, should lead to comparable numbers being assigned when one rod looks as long as another feels.

The rods were presented one at a time for judgment; the rate was determined by O. Each rod was presented twice, in a randomly-determined order, in each session.

A total of 15 Os, students in an introductory psychology course at Smith College, served for two sessions one week apart. Seven judged rods presented visually in the first session, and presented kinesthetically in the second session. For eight, the order was reversed. (The data for a sixteenth were discarded because of their atypicality: this O assigned numbers to kinesthetically-judged rods about 100 times the magnitude of the numbers she used for visually-judged rods.)

Results

Both types of judgment are linear functions of physical length; in both cases the linear fit of log magnitude estimation against log length has a slope of approximately one. To examine the relation between the two kinds of judgments as they occurred in single individuals, the judgments of each O under each condition were subjected to a log transformation and a linear relation to log length determined by least squares. Two constants are thus generated for each O (the additive constant is the log of the estimated value assigned to a length of 1 in; the multiplicative constant is the exponent of the power function relating judged to physical length); these constants were treated as scores. Neither for distributions of additive nor multiplicative constants was the difference due to order of task reliable ($p > 0.05$, Mann-Whitney U test). For visual judgments, the median exponent was 0.995; for kinesthetic judgments, 0.966. Alternatively, the judgments may be pooled over Os and

geometric means calculated for each stimulus length. The least-squares fits were obtained for log geometric mean against log length: for visual judgment, the exponent is 1.007 ($\sigma_{yx} = 0.027$); for kinesthetic judgment, it is 0.983 ($\sigma_{yx} = 0.028$). The close correspondence between these two functions is illustrated in Fig. 1, where kinesthetic judgments are plotted against visual judgments, on doubly logarithmic coordinates, for each stimulus. The open circles are geometric means of judgments from all Os. The line was drawn to have a slope of one and a y-intercept of zero; that is, it represents perfect correspondence between the two kinds of judgments. The filled circles are means of the two judgments per stimulus made by each O; the product-moment correlation coefficient between log visual and log kinesthetic judgments is +0.946.

Also apparent is the fact that the numbers assigned by Os correspond closely to length in inches; small arrows on the scale in the upper portion of Fig. 1 specify the length, in inches, of the eight stimuli. The choice of numbers by Os makes it evident that lengths are being estimated in inches, although this was not specified by the instructions.

Discussion

The most remarkable aspect of these data is the similarity between visual and kinesthetic judgments. That it is remarkable may not be readily apparent, especially if one holds that experience gives ample opportunity, in looking at and touching objects of different lengths, to learn which "sights" go with which "feels," and further to learn the appropriate number of inches to assign to corresponding sensations. But there is evidence that for many continua, the relation between sensory and stimulus magnitudes remains non-linear despite extensive histories of experience with identified stimuli and the sensations they elicit. (For example, many adults have had considerable experience in hefting a range of labelled weights, yet their judgments of heaviness are markedly non-linear with physical weight [Stevens & Galanter, 1957].) The extent to which judgments of length, experienced through whatever modality, are constrained by experience is an empirical question.

Finally, it is of interest that Kelvin & Mulik (1958), exploring the relation between felt and seen length by means of a cross-modal method of constant stimulus differences, were led to pessimistic conclusions about the feasibility of intermodal comparisons. In the present study, the application of direct scaling methods leads to an unequivocal finding: for adult observers, a range of linear extents may be judged interchangeably by sight or touch.

Fig. 1. Kinesthetic vs. visual judgments of length. The abscissa shows magnitude estimations of length made by Os looking at metal rods; the ordinate shows magnitude estimations of length made by the same Os touching the ends of the rods. The arrows on the scale inset at the top of the figure show the lengths of the rods in inches; the scale values are aligned with those on the abscissa. Filled circles represent the means of two judgments of a rod by a single O; the product-moment correlation coefficient r between log kinesthetic and log visual judgments is +0.946. The open circles represent the geometric means of 30 judgments from 15 Os for each rod; the straight line is drawn to have a slope of one and a y-intercept of zero.

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Note

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