A comparison of the English and metric system in a length estimation task¹

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Size estimates by English and metric system users were compared on a length estimation task. The results indicated that some differences exist between estimates of the two measurement system users but not in a systematic direction. A discussion was made that the unit of measure that one memorially constructs to estimate length may be greater than the basic unit.

The system of measurement used by natives of English speaking countries differs from the metric system in terms of the definition of the standard unit. A problem of interest to the behavioral scientist is whether differences in the units may be reflected in different estimations being made of the same physical quantity as a function of the measuring unit used. For example, estimation using the centimeter (cm) as the standard rather than the inch, results in estimates in terms of a smaller unit of measure. The magnitude of the standard (as well as the magnitude of the dimension estimated) may be an influential variable of the magnitude of the estimate. A second related variable is the effect of a history of commerce with a particular unit of measure. For a given system of measurement, using the familiar unit of measure for estimation of a physical quantity should result in more accurate or less variable estimates than using an unfamiliar unit of measure. An attempt was made to put this argument to test in the present study; however, for the most part this study was exploratory. The general question asked was whether any differences exist in estimates of the same physical stimulus by users of different measuring systems.

Subjects and Apparatus

Seventeen college-age males from an American university and 17 Danish citizens ranging in age from

18 to 32 years were used to estimate the length of three stimuli in terms of four physical and one verbal unit of measure. The stimuli were straight line drawings 8.73, 24.61, and 49.88 cm, painted on different-size cards of poster board. The lines extended diagonally across the cards. The units of measure used were line drawings painted on cards 216 by 279 mm. The four physical units were segments of 1 cm, 2.54 cm (1 in.), 4 cm, and 7 cm.

Procedure

A fifth response condition was used in which each S was asked to estimate and verbally report the length of the three stimuli using the unit of measure familiar to him. For the English system users (EU), estimates were given in inches, for the metric system users (MU), estimates were given in centimeters. No information was given about the length of the physical units of measure.

All Ss were individually tested. They were instructed to estimate the length of the stimuli in terms of the line segments which were presented for each stimulus, i.e., "Estimate how many of the line segments are contained in the line." The Ss were told to use fractions of a line segment if they wished. The presentation of the stimuli and the four units of measure were randomized for each S. Presentation of the verbally requested familiar unit was always last. In all, each S made 15 estimations.

Results

Table 1 presents a summary of the pertinent data characteristics. It was not possible to examine the effect of single and joint variation of the independent variables on size estimates by the analysis of variance because of the considerable differences in the variances of the subgroups. However, some qualitative differences

Table 1. Means, Standard Deviations, and Per cent Error for All Stimuli by All Units of Measure for English (EU) and Metric System Users (MU)

	Units of Measure									
	1 cm		2.54 cm		4 cm		7 cm		Familiar Unit	
	EU	MU	EU	MU	EU	MU	EU	MU	EU (in.)	MU (cm)
8.73 cm Stimulus Means	8.27	8.27	9.22	9.30	8.15	8.61	9.18	9.45	9.49	9.12
Standard Deviations	1.93	1.72	1.34	1.36	1.08	1.63	0.78	1.30	1.97	1.96
% Error	20.12	17.91	11.63	15.63	14.53	14.30	10.81	11.98	20.23	18.60
24.61 cm Stimulus Means	20.23	23.02	25.25	27.57	25.63	29.00	32.57	29.26	26.97	25.94
Standard Deviations	6.38	6.75	4.06	7.57	3.78	6.18	6.50	6.38	2.96	3.78
% Error	27.39	22.33	13.88	20.33	12.41	22.65	33.67	24.49	11.63	12.57
49.88 cm Stimulus Means	36.35	43.23	49.00	58.61	53.02	62.58	67.12	60.79	55.11	51.23
Standard Deviations	11.10	18.20	12.20	22.35	16.60	17.20	21.60	11.37	15.75	12.98
% Error	30.01	28.81	17.03	32.12	20.22	30.46	37.39	25.47	20.02	17.52

based on the summary data can be made. Since estimation by the physical units represents a different task than estimation by the verbal unit, it will be discussed separately.

There is a trend for estimates made by the MU to be greater than those for the EU when estimating in terms of physical units. This occurred for EU-MU comparisons in 9 out of 12 cell means. The estimates of the larger two stimuli estimated by the largest unit of measure (7 cm) do not follow this trend. Another finding indicated by the data summary is that estimates for both the MU and EU for the larger stimuli were generally overestimated by the three larger units of measure, and underestimated by the cm unit.

The error scores in Table 1 represent the mean percentage deviations, computed without regard to sign, of estimates from measured size of the stimuli. An examination of error scores for the physical units presents results similar to the comparison of means; no consistent trend occurred between the two classes of Ss. Both the magnitude and error examination suggest that the role of familiarity with a particular unit of measure has little effect on estimations when the units are physically presented and not specified as familiar ones.

Estimates by verbal report using a familiar unit of measure (in. or cm) did not differ between the MU and EU. However, in all cases, estimates verbally reported, using a familiar unit were greater than estimates made of the same stimuli using the corresponding physical unit, e.g., EU estimates were greater when verbally reported in terms of inches than when using the physical inch unit. When error scores are compared with those for the physical units of measure some interesting differences are obtained. For the 8.73 cm

stimulus, the error value for the familiar verbal unit is greater than those for the physical units; on the other hand, the error scores for the larger two stimuli are among the lowest of all units of measure when estimation is in terms of a familiar verbal unit of measure.

Discussion

A hypothesis suggested by the preceding result is that the unit one draws from memory and compares with the stimulus for estimation is some multiple of the smallest basic unit rather than the unit itself, e.g., perhaps 6 in. for the EU or 10 cm for the MU. [It should be noted that the term "basic unit" refers to common usage rather than a physically defined standard unit. For example, the meter not the centimeter, is the unit of measure accepted by the International Bureau of Weights and Measures; see Huntoon (1965).] This coincides with the experience one has in quantifying his environment; generally, one estimates lengths greater than 1 in. Whether the lengths fall within a prescribed range cannot be here decided but the results do suggest that the memorially constructed unit for length estimation may be greater than the basic unit.

In general, the findings support a conclusion that the estimation of relatively small lengths by MU and EU are not systematically different in terms of estimated magnitude and deviations from measured size. However, there is a suggestion in the results that differences may exist for larger stimuli.

Reference

Huntoon, R. D. Status of the national standards for physical measurement. *Science*, 1965, 150, 169-178.

Note

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ERRATUM

Gillooly, W. B. The effect of familiarization instructions on associative latency and learning. *Psychon. Sci.*, 1966, 4 (8), 303-304.—Line 21 of the first column should read H₂: SRF>SIF. On page 304, Noble's m should be read as italicized wherever it occurs.