Stimulus uncertainty and the latency of category judgment[1]

LAWRENCE E. JONES AND ALLEN PARDUCCI
UNIVERSITY OF CALIFORNIA, LOS ANGELES

The latencies of category judgments of size varied inversely with the skewness of the frequency distribution of stimuli. Although the task did not permit one-to-one identification of the stimuli, the data suggest that one function of category judgment is to reduce the uncertainty about which stimulus has been presented.

Category judgments, like "large" and "small," describe the relationships between the presented stimuli and some frame of reference. Experimental studies typically use simple psychophysical stimuli for which the scale of judgment is determined by the range of stimuli in the series presented for judgment. However, the judgments are also affected by the relative frequencies with which stimuli are presented from different parts of the range. In particular, the alternative categories of judgment tend to be used with equal frequency (Parducci, 1965).

One interpretation of this frequency effect is that the categories function to *identify* the stimuli. If the number of stimuli exceeds the number of categories that can be used consistently, identification is in general more efficient when the categories are used with equal frequency. The efficiency is greater in the sense of the judgments leaving less uncertainty about which stimulus has been presented.

The identification process has been studied directly by having Ss tell which of the alternative stimuli has been presented. Thus, Hyman (1953) demonstrated that reaction time varies directly with the uncertainty of the stimulus distribution. If identification is an important, though implicit, part of the usual task for category judgment, the same relationship should be found in studies of category judgment.

The present experiment tests this implication using the skewness of the frequency distribution of the stimuli, and hence the stimulus uncertainty, as an independent variable. The dependent variable is judgment time (JT), the interval between stimulus onset and S's response in the absence of specific instructions for speed. A preliminary study demonstrated the implied relationship between skewness and JT for the loudness of noise. The present study uses squares which vary in size.

Method

Subjects. Two undergraduate females served as Ss. They were hired on the basis of superior discrimination in a psychophysical experiment with other materials.

Stimuli. An in-line visual readout displayed a sequence of squares, one at a time, about 6 ft. from S in an otherwise darkened room. The 12 squares were of constant luminance, but their widths varied from 1.0 to 2.8 cm in a geometric progression. Each presentation was .4 sec., and the interstimulus interval was 7.5 sec. Responses and JTs were IBM recorded, with JTs measured by a CMC Time Function Translator.

The stimulus distributions, each consisting of 120 successive presentations, are characterized at the bottom of Fig. 1. Each S judged all three distributions. A day's session consisted of 240 presentations from one of the distributions, 120 in a random order and then the same 120 in reverse order. A different random order was used on a later day for each distribution: for S1, the sequence of distributions over the six regular sessions was I, III, II, III, I, and II; for S2, it was III, I, II, II, III, and I.

Procedure. The first session was devoted to general orientation, instructions, and practice with the response apparatus. The instructions requested that each

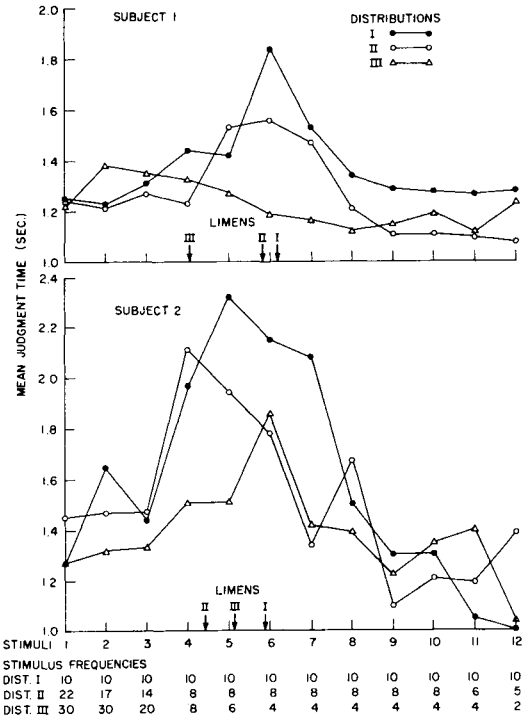

Fig. 1. JTs for each of the three distributions.

presentation be judged either "large" or "small" in comparison with the other squares in the same session, the judgment being made by pressing the appropriate button. The instructions did not reveal that the responses were being timed. Each session began with 40 unjudged presentations (the first 40 from the random order for that session) followed by a 30-sec. break and then the series of 240.

Data analyses. Preliminary tabulation indicated that the two Ss differed markedly with respect to their JTs. Thus, separate analyses were computed for each S. Since the differences in JT associated with order were small, data were combined for the two sessions for each distribution. Category limens, the traditional 50% values, were estimated graphically using probit paper. Approximately 1% of the JTs exceeded 3.5 sec. These JTs were reduced to 3.5.

Results

Figure 1 shows that JT varies inversely with the skewness of the distribution and thus directly with stimulus uncertainty for both Ss. These differences in JT are greatest near the category limen where the difficulty of decision is greatest. The peaking of each curve at the limen indicates that an earlier conclusion (Cartwright, 1941) that JT is greatest at the PSE or limen for comparative judgments also holds for absolute category judgments. It was to simplify the problem of overlapping gradients from different limens that the judgments had been restricted to just two categories. These single limens shift toward the more frequently presented stimuli, thus tending to equalize the frequency of category use. Day-to-day shifts in limens for the same distribution were rather large, however, so that the inversion of the limens for the two skewed distributions for S2 is probably not important.

Analyses of variance were performed upon the JTs for the two stimuli nearest each of the category limens. The differences associated with distribution were highly significant, $F = 8.51$ for S1, 12.43 for S2, $df = 2/197$. The means of the JTs for these pairs of stimuli are presented in Table 1 for comparison with the stimulus uncertainty of each distribution.

Table 1. Uncertainty, Judgment Time, and Limen for Three Distributions of Stimuli

Subject	U[a]	Mean JT[b] 1	Mean JT[b] 2	Limen 1	Limen 2
Dist.					
I	3.59	1672	2234	6.15	5.90
II	3.47	1546	2023	5.80	4.45
III	2.79	1324	1683	4.02	5.10

[a] *Stimulus uncertainty in bits, defined as* $-\Sigma\, p \log p$, *where p is the probability of each stimulus and the summation is over the 12 stimuli.*

[b] *For two stimuli bounding the limen (msec.).*

It is not intuitively obvious that JT for category judgments should vary directly with stimulus uncertainty. The frame of reference is more complicated, more irregular, for the skewed distributions. The empirical correspondence to the relationship found between reaction time and uncertainty for identification tasks adds support to the functional interpretation of the tendency to use categories with equal frequency. Identification, in the sense of reducing the uncertainty about which stimulus has been presented, appears to be one of the functions of category judgment.

References

Cartwright, D. Decision time in relation to the differentiation of the phenomenal field. *Psychol. Rev.*, 1941, 48, 425-442.

Hyman, R. Stimulus information as a determinant of reaction time. *J. exp. Psychol.*, 1953, 45, 188-196.

Parducci, A. Category judgment: a range-frequency model. *Psychol. Rev.*, 1965, 72, 407-418.

Note

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