Rating the speed of a simple reaction

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It is shown that in an auditory simple reaction task Ss can rate their RTs with regard to speed. Furthermore, reactions to quiet signals are generally rated as being slower than reactions to loud signals. This observation does not support the view that RT-intensity effects are totally mediated through peripheral or predetection lags.

In the recently published proceedings of the Donder's Centenary Conference on reaction time (Koster, 1969), there was some discussion on the significance of including in RT studies readings which the S thought resulted from "bad" trials. It is a common experience in reaction time experiments that, on occasion, the signal to respond is somehow "missed" and thus an excessively long RT results on that trial. Such excessive latencies are often attributed to momentary inattention on the part of the S and for this reason are treated as atypical in a qualitative, as well as quantitative, way and are sometimes excluded from the calculated average and standard deviation. Es variously recommend that calculation of averages with RTs which Ss feel to be "unsatisfactory" be included or excluded, or even, to be safe, that both be calculated (Koster, 1969, p. 382).

The following experiment is an attempt to search for patterns, if any, in the relationship between actual RT and the S's idea of how fast he responded on the basis of reports of Ss' having some knowledge of how fast they respond. A positive relationship between slowness of responding and slowness rating would be expected. An equally important aim was to see whether the distributions of speed ratings were the same for two different intensities of auditory signal.

This second aim is of some theoretical interest. If the effect of intensity on simple auditory reaction is mediated through a delay in the time it takes the S to *hear* the signal, then the S should not be aware of the delay and should rate RTs to loud and soft signals as being equal. If, on the other hand, the delay is postperceptual, then the S should be aware of the delay and thus should rate reactions to soft signals as being slower than reactions to loud signals. There is evidence from the *visual* modality that the delay may be preperceptual, or retinal, in origin (Bernhard, 1940; Roufs, 1963; Vaughan, Costa, & Gilden, 1966).

APPARATUS AND STIMULI

The stimuli consisted of increments of 1-sec duration in the level of an ongoing background noise presented binaurally through headphones. Random noise was used in all cases. The masking level was kept at 65 dB re .0002 dynes/cm^2. On switching in the *quiet* signal, the level rose to 68 dB, a clearly audible, though small, change. Switching in the loud signal caused the level to rise to 85 dB. Stimuli were switched in electronically and this, together with the fact that the stimuli consisted of white noise, prevented the presence of any audible switching transients, despite a very rapid rise time.

A constant intertrial interval of 10 sec was used with no warning signal. This interval was sufficiently long to prevent anticipatory responses because it is too long to estimate accurately.

RT responses were microswitch releases effected by using the index finger of the preferred hand. Readings were taken manually from a set of "decatron" counters giving RTs to the nearest centisecond. Ss were also provided with four Morse keys, labeled 1-4 from right to left and situated immediately before them on a table. The fastest end of the RT continuum was represented by "1" and the slowest by "4." The appropriate key was pressed with the nonpreferred hand after the reaction had been made.

PROCEDURE

Six Ss, all Royal Navy enlisted men, served in three sessions on consecutive days. No S had a hearing loss greater than 20 db to any frequency on either ear.

The main experimental sessions (two) consisted of strings of 150 stimuli, 75 to each intensity in quasirandom order. There was a practice session on the first day before these two main sessions which consisted of 40 stimuli of each intensity, in which Ss did not have to *rate* the stimuli until the very last few trials. This was designed simply to enable the S to get the feel of the task of making a simple reaction.

RESULTS

In calculating the results, the first 10 reactions from each test session were not recorded. There were no obvious or large effects of practice, so both sessions have been combined, giving a total of 140 "quiet" reactions (RT_Q) and 140 "loud" ones (RT_L). The results are given in Table 1.

Relation of RT to Rating Employed

For both RT_Q and RT_L, RT is related systematically to the category used to describe it, as is shown in Fig. 1. We use a very strict test for this and find that all six Ss show the relationship RT in Category 1 < RT in Category 2 < RT in Category 3 < RT in Category 4, using mean within-category values. This is better than chance with $p < .02$, by sign test, and is in the expected direction.

Relation of Rating to Intensity

Clearly from Table 1, "slower" categories are employed with much greater frequency in the case of RT_Q than in RT_L. The mean ratings were 1.19 for RT_L and 2.04 for RT_Q. All Ss showed this effect ($p < .02$).

The Size of the Intensity Effect Considered Within Categories

$RT_Q > RT_L$, when mean values are considered, for all Ss. The size of the difference is 76 msec. However, differences *within* categories are much smaller. (This is true only for Categories 1, 2, and 3. However, Category 4 contains so few cases that the comparison is hardly merited.) For Categories 1 and 2, the size of the intensity effect for within-category comparisons is less than the overall effect for all Ss ($p < .02$). Thus, the overall difference between RT_Q and RT_L was 76 msec, while

Table 1
Reaction Times in Milliseconds

Measure	Rating (1 = Fast) 1	2	3	4	Mean Category	Overall RT
RT_L	178	218	308	349	–	186
Percent RT in Category	84	14	1	1	1.19	–
RT_Q	207	247	316	678	–	262
Percent RT in Category	23	54	19	4	2.04	–

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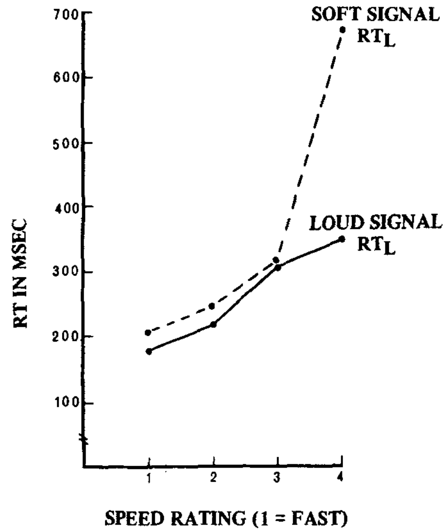

Fig. 1. Reaction time and speed rating for loud and soft stimuli.

the within-category differences were 29 msec for Categories 1 and 2.

DISCUSSION

First, we can say that Ss can rate their speed of reaction in a meaningful way. Such ratings may carry important implications for the practical measurement of RT and hence for theoretical notions. An obvious extension of the approach adopted here would be to examine the form of the reaction-time distribution when it is decomposed by extracting readings from the longer categories as rated.

Second, the difference in the distribution of speed ratings between the two intensities suggests that Ss are aware of at least some of the intensity-dependent delay in RT. This suggests that the *detection*-time model of intensity effects in RT is inadequate to account for the auditory data. Roufs (1966) felt that the phenomenological state of perceiving and the triggering of a simple reaction were one and the same process. He says, "... the visual latency is the difference in time between the onset of a stimulus and the moment the subject is aware of it .... As this delay is an integral part of the reaction time, the measurement of the latter provides a mean to find the variation in latency as a function of stimulus luminance." This does not appear to be true for audition. Other evidence, from the effects of auditory stimulus intensity on phenomenal simultaneity, seems also to point to the inadequacy of a simple phenomenological model to account for auditory intensity effects on simple RT (Sanford, unpublished data).

In conclusion, it seems possible to obtain reaction-time speed ratings, and these may be useful in separating sensory effects from motor effects in reaction time. Just as in psychophysics, confidence ratings are meaningfully related to obtained scores, so may speed ratings be of value in reaction-time work. Some current research is being aimed at the use of a more continuous rating system for speed in a variety of reaction-time situations.

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Memory and conservation

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Minimal support for the Genevan hypothesis that memory of stimuli is often dependent upon the operational schemes that underlie the cognition of those stimuli was found. Specifically, number conservation and not length or amount conservation was found to be significantly related to recall and recognition of the conservation stimuli. The relationship was due to nonconservers' retention failures and not to conservers' ability to remember correctly. Seriation and water-level performance was related to recall of the appropriate stimuli. Ninety-two first and second graders of average intelligence were studied.

A recent hypothesis from Geneva (Piaget, 1967; Piaget et al, 1968; Inhelder, 1969) stated that the mnemonic code for the retention of many simple stimuli is critically dependent upon the operational schemes of intelligence that are related to the cognition of those stimuli. In some cases the mnemonic code may be the operational scheme (e.g., seriation). Thus, as the various operational schemes develop and mature, it is possible that memories of stimuli encoded in those schemes would also develop and mature. There is evidence (Altemeyer, Fulton, & Berney, 1969) that memories of a serially ordered array of sticks actually improved somewhat over a 6-month period and that the degree of improvement was closely related to improvement in the child's ability to arrange sticks in serial order (Inhelder, 1969). It has also been demonstrated that not every kind of "memory encoding related to operativity will lead to progress with a sufficient interval of time [Inhelder, 1969, p. 362]." To date there is limited evidence for memory change in the direction of operational maturity for serial order, double serial order (M), water level in a tilted bottle, and some causal relationships.

Since a prerequisite for memory improvement is the relationship between operativity and immediate memory, the present investigation examined the relationship between conservation of amount, number, and length and the child's immediate recall and recognition memory of the transformed conservation stimuli.

SUBJECTS

There were 92 children in all, 48 first graders, with a mean age of 78.67 months (SD = 4.43) and a mean IQ of 102.3 (SD = 11.03), and 44 second graders, with a mean age of 93 months (SD = 7.58) and a mean IQ of 103.1 (SD = 11.07).

PROCEDURE

As a group in their classrooms, Ss were given a booklet in which were depicted by line drawings the following operational problems: (1) Conservation of amount in three scenes, one under the other on a page (two equal glasses of liquid, each glass being poured into either a tall narrow glass or a short wide glass, the tall narrow glass and the short wide glass with correct and different liquid levels); (2) conservation of length in two scenes, one under the other on the page (two equal sticks, one dark and one light, and one above the other, with the dark stick drawn so that one-third of it extended to the right of the other stick); and (3) conservation of number in two scenes on the page (a row of five circles above a row of equal length of five cups; the row of five cups was longer than the row of five circles). To the right of the top and bottom scenes for each problem were the words "yes" and "no," which the