Response scales and sequential effects in judgment

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There are persistent sequential effects in judgment tasks. For example, responses tend to be similar to the value of the just-prior stimulus. This is called assimilation. Also, if feedback is or is not provided after each trial, then responses contrast with or assimilate to, respectively, each of several earlier stimuli in the sequence. These context effects have been shown to be independent of stimulus modality and of the range of stimulus values within a modality. By providing different sets of feedback in order to affect the responses used, this article shows that these sequential effects in judgment data are also independent of the form and range of the scale of responses used to label stimuli.

When people are asked to identify uniquely stimuli that have been drawn from a larger set, as is the case in absolute judgment experiments, their responses depend in part on what occurred on earlier trials. For example, if no feedback is given, then responses correlate positively with the responses that occurred on each of several prior trials. This means that responses are more similar to previous stimuli and responses than would be the case if each response depended only on its immediate stimulus. This sequential effect is called assimilation.

If the procedure is altered by giving the subjects feedback after each response, then there is again assimilation of the response to the just-previous stimulus and response. But responses are now negatively correlated with the stimuli and responses of each of several trials earlier in the sequence than Trial $N - 1$. That is, there is now contrast of the response, rather than assimilation, to the stimuli and responses that occurred on each of several earlier trials.

These context effects are ubiquitous, and they appear to be independent of the stimulus modality tested. They occur whether the task is to judge loudness (Holland & Lockhead, 1968), lightness (Lockhead, Note 1), or line length (Ward & Lockhead, 1971, Study 2). They even occur when there are no physical stimuli at all to be judged and the subjects guess what number had been selected randomly (Ward & Lockhead, 1971, Study 3). These guessing data are a reason to assign at least one source of these sequential effects to the response system (Lockhead, 1973).

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It appears generally to be the case that responses are assimilated to each of the several just-previous stimuli or responses when feedback is not given, and responses are assimilated to the just-previous trial but are contrasted with trials further back when feedback is given (Staddon, King, & Lockhead, 1980). It should be noted that these assimilation and contrast effects are not the context effects discussed by Helson or his students (cf. Helson, 1959).

Assimilation and contrast have been most extensively examined in absolute identification tasks in which response categories increase arithmetically. In these tasks, successive stimuli are usually spaced in about equally discriminable intensity steps, and the smallest stimulus is assigned the response "1," the next largest stimulus is assigned the response "2," and so on, with the N th stimulus assigned the response " N ." But scales of such arithmetic progression are not essential to produce these sequential effects. In magnitude estimation data, the logarithm of the response scale is approximately linear with the logarithm of the stimulus scale. This means that successive responses increase geometrically with successive geometrically spaced stimuli, rather than arithmetically as in absolute identification data. There are sequential effects also in magnitude estimation data. The log responses are assimilated, apparently uniformly, to the just-prior several stimuli (Jesteadt, Luce, & Green, 1977; Ward, 1970).

The magnitudes, but not the forms, of these several sequential effects depend on the range of stimuli used. When the stimulus range is made smaller in an absolute identification procedure, while the number of stimuli and the number of responses is held constant, there is an increase in the magnitude of assimilation as measured in response units (Holland, 1968). The average category distance that responses shift toward the just-prior stimulus is greater when the

stimulus range is small than when it is large. Changes in sequential effects have not previously been examined when the stimulus range is held constant and the response range is varied. Neither have sequential effects been examined when responses are spaced geometrically and feedback is given. Since it is necessary to understand how the various scales are related in order to model context effects (Staddon et al., 1980), some response scale effects on sequential performance are examined in this article. Different response scales were defined for the same set of stimuli by varying the feedback numbers provided to the subjects after each response. The primary question asked is whether sequential effects follow changes in the response scale.

EXPERIMENT 1: GEOMETRICALLY SPACED RESPONSES WITH FEEDBACK

Method

Stimuli. The stimuli were 30 .5-sec sinusoids at 1,000 Hz, ranging from 51 to 80 dB SPL in 1-dB steps, presented diotically over headphones.

Subjects. There were four paid adult observers, each of whom was naive with respect to the experimental procedure.

Procedure. The individually tested observers sat in a sound-attenuating chamber and were instructed by means of a visual-display terminal to listen to the first tone, which was always 65 dB SPL, and to assign that tone the absolute value 100. They did this by keying "100" onto a numeric keyboard in front of them and then pressing the "Enter" key. There was a 1-sec interval between entry of the response and presentation of the next stimulus. That next stimulus was selected randomly, with replacement, and judged in terms of how many times louder or quieter it appeared to be than the just-previous tone (the 65-dB tone, in this example). If the tone appeared 2.5 times louder, it was to be called 250; if it was judged half as loud, it was to be labeled 50. The subject's response and the subsequent feedback were written on the screen and then erased before the next trial. Feedback was based on Stevens's law: $FB = kI^\beta$, where I is intensity of the stimulus in dB SPL, β is the exponent appropriate to loudness (.67), k is a scaling constant, and FB is the numeric feedback, truncated to the nearest whole number, assigned to each tone. Each observer provided 400 responses in each of five sessions.

Results and Discussion

The geometric mean response given to each of the 30 stimuli is shown in Figure 1. The heavy line in this figure connects the points that indicate the feedback given. Mean performance was generally excellent, although the 16 lowest intensity stimuli were overestimated and the 14 highest intensity stimuli were underestimated. The error bars around each mean in Figure 1 indicate ± 1 SD of the mean log responses. Variability tends to decrease with intensity; the loud tones were more discriminable than the quieter tones.

The variability of the responses about each stimulus is not simply random error but shows assimilation and contrast effects. These are seen in Figure 2. With the data averaged over groups of adjacent stimuli to aid legibility, Figure 2 shows the mean response to the current stimulus as a function of the stimulus

Figure 1. Mean response (log scale) to each stimulus in Experiment 1. Error bars indicate ± 1 standard deviation. The heavy line indicates the feedback assigned to each stimulus.

(the parameter in the figure) that occurred from one to seven trials earlier in the sequence. When the stimulus on the just-prior trial (lag = 1) was of low intensity, the average response was less than when the just-prior stimulus was of high intensity. This assimilation effect appears identical to that found in absolute identification experiments, whether or not feedback is given, and to that found in magnitude estimation experiments in which feedback is not provided. This

Figure 2. Geometric mean response to the stimulus on Trial 1 as a function of the stimulus occurring K trials earlier in Experiment 1. The stimuli have been averaged over groups of five adjacent intensities.

experiment could be called a magnitude-estimation-with-feedback study.

Figure 2 appears to show no relation between responses and stimuli that occurred two trials back, but there is a clear effect for three and more trials back in the sequence. Responses tend to be low if high-intensity stimuli occurred from three to any of perhaps six trials back; responses tend to be high if low-intensity stimuli occurred on any of these several earlier trials. This is contrast. Just as when feedback is given in an absolute identification task in which responses are separated in equal arithmetic intervals, there is assimilation followed by contrast in estimation data when feedback is given and responses are geometrically spaced.

EXPERIMENT 2: VARYING THE RESPONSE RANGE

Experiment 1 shows assimilation and contrast effects in the identification task when the feedback is determined by Stevens's law with an exponent of .67. To learn whether it is important to provide as feedback the response normally expected in a magnitude estimation procedure or whether any exponent might serve in the same manner, Experiment 1 was repeated but with the arbitrarily chosen exponents of .33 and 1.0 used to determine the feedback. If subjects give direct estimates of stimulus magnitudes (Stevens, 1975), and if a modulus is provided as it was in Experiment 1 and in this study, then not more than one set of feedback numbers can match the numbers the subjects should assign. In this case, they might ignore these new feedback numbers, since these are different from the numbers commonly assigned in a magnitude estimation task. It is known, however, that people adjust their responses to conform with the range of responses they are instructed to use (Baird, Kreindler, & Jones, 1971; Robinson, 1976; there was no trial-by-trial feedback in these studies, and sequential effects were not examined). People might also adjust their responses to conform to the trial-by-trial feedback. Accordingly, this experiment was designed to determine what psychophysical functions occur, and what sequential effects occur, when the feedback in this identification task provides a relatively large (exponent = 1.0) and small (exponent = .33) range of numbers for the subjects to use.

Method

Stimuli. The same 30 stimuli used in Experiment 1 were used here.

Subjects and Feedback. The observers were three people naive with respect to psychophysical studies. The feedback assigned to each stimulus was based on an exponent of .33 for one person and 1.00 for the other two observers.

Procedure. The procedure identical to that used in Experiment 1 was repeated with the exception of the particular numbers provided as feedback.

Results and Discussion

The mean response given to each stimulus is shown in Figure 3 for both feedback conditions. Average performance was quite good and clearly followed the

Figure 3. Mean response (log scale) to each stimulus in the two conditions of Experiment 2. The triangles indicate when feedback was assigned according to an exponent of 1.0; squares indicate a feedback exponent of .33. The lines indicate the feedback assigned each stimulus in the two conditions.

Figure 4. Geometric mean response as a function of the stimulus occurring K trials earlier in Experiment 2. Feedback exponent = .33. The stimuli have been averaged over groups of 10 adjacent intensities; the filled triangles represent prior intensities from 71 to 80 dB, the open squares represent prior intensities from 61 to 70 dB, and the open triangles represent prior intensities from 51 to 60 dB.

Figure 5. Geometric mean response as a function of the stimulus occurring K trials earlier in Experiment 2. The feedback exponent = 1.0, and the parameters are the same as in Figure 4.

feedback. The small but regular over- and under-estimations seen in Figure 1 from Experiment 1 are again apparent here. Again, too, responses to low-intensity stimuli were more variable than those to high-intensity stimuli for both conditions. The particular exponent seems to make little difference to the quality of performance. The subjects adjusted their responses in terms of the feedback provided, and they performed about equally well no matter which exponent controlled the feedback.

The sequential effects in the .33 and 1.00 exponent conditions are shown in Figures 4 and 5, respectively. The data have been collapsed into three groups of 10 stimuli—low, middle, and high intensity—for convenience of presentation. As in Experiment 1, the variation in the responses is structured. In all three feedback conditions, responses assimilated to the previous stimuli and contrasted with earlier events. Thus, the importance of prior events to judgments does not depend on arithmetic spacing of the response numbers.

GENERAL DISCUSSION

Sequential effects in judgment data have the same form independent of the response scale, at least when arithmetic spacing is compared with geometric spacing. In the studies reported here, as in all situations that have been examined in the literature, how large or how small a stimulus is reported to be varies in part as a function of what went before it in the judgment series. This is the case for studies of how

objects are categorized, as in absolute identification experiments, and for studies of the judged intensity of some attribute of an object, as in magnitude estimation experiments. This also holds whether or not people are given feedback after each response. How an object or an attribute of an object is identified depends on past events, which change the state of the person so that current events have different effects. More simply put, performance in these tasks depends on memory.

These sequential effects are independent of the spacing of responses used, and they appear to endure for several trials back in the data. It must be cautioned, though, that it is difficult to know which of these effects are independent of which others. This is because some contingencies that occur between responses and remote events might be due to response propagation from trial to trial (Jesteadt et al., 1977; Ward & Lockhead, 1971, p. 77). For example, continuing assimilation could result from assimilation between a response and the just-prior response in a process by which one response affects the response on the next trial, which affects the response on the next trial, and so on throughout the data.

Whether or not response propagation is the source of the continuing assimilation that occurs when there is no feedback is not known. But some effect other than response propagation is involved when feedback is given. In these cases, there are two effects, assimilation and contrast, and both cannot be due to response propagation (Staddon et al., 1980). No-feedback data often also show contrast as well as assimilation; this occurs later in the sequence than in feedback data (Ward & Lockhead, 1971; Figures 2 and 3). Additionally, there are often contingencies between responses and the variability of events on earlier trials (King, 1980). Also, when several successive stimuli have been similar in intensity, the discriminability between the last two stimuli is greater than when prior stimuli were different from them in intensity (Fry, 1981). Such factors provide the suggestion that more than the just-prior trial is involved in judgment data.

The sources of the variety of sequential effects that occur in judgment data are not known. Nonetheless, these effects are real. They are also in need of explanation if the judgment process is to be satisfactorily modeled. It is known that responses depend on two things, the stimulus being judged and other events in the situation (see, for examples, Baird et al., 1971; Cannon, 1939; Cross, 1973; Guilford, 1954; Helson, 1948, 1959; Holland, 1968; Lockhead, 1973; Parducci, 1965). This means that psychophysical equations of the form $R_i = f(I_i)$, such as Stevens's law, are incomplete descriptions of the data. Rather, it may be stated that $R_i = H[f(I_i), g(M)]$, where M is the memory or the effect of prior events, I is the intensity to be judged, R is the response, and H , f , and

g are functions that may vary with the stimuli and the task. This recognizes the fact that people classify stimuli or attributes of stimuli in regard to the environment in which those events occur and in regard to previous events. This also allows the suggestion that variables influencing responses can be measured by examining sequential effects. If this is the case, then sequential effects in psychophysical tasks could serve as a tool to measure memory processes.

REFERENCE NOTE

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