Reaction time as a function of arousal and anxiety¹

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In a visual discrimination task the S's momentary arousal, reflected by spontaneous changes in skin potential (GSR), contributed significantly to the intra-individual fluctuation of reaction time; chronic anxiety level, measured by an inventory scale, contributed significantly to inter-individual fluctuation. Both high anxiety and arousal were associated with longer reaction time. The present negative relation between response speed and GSR arousal and the previously reported positive relation between response speed and EEG desynchronization may result from different phases of arousal.

When performance on a task is measured as a function of physiological activation or arousal, and arousal is varied by manipulating some experimental stimulus, any observed changes in performance may be the outcome not of the variation in arousal per se but of some other influence of the experimental stimulus. Thus, Lansing, Schwartz, & Lindsley (1959) have demonstrated that a warning signal used to elicit the desynchronization of the alpha brain wave has a stronger effect upon human reaction time than the desynchronization itself. One way of avoiding such confounding of the influence of the stimulus itself with that of the arousal it generates is to relate performance to spontaneous changes in the arousal level. In the present experiment, phases of spontaneous fluctuation of the GSR were sampled by the experimenter, and the relation of the momentary arousal level, as well as the chronic anxiety level, to performance in a reaction time task was studied.

Method

The GSR was recorded from the palm and the wrist of the passive hand by the potential method. The S sat in a shielded room, but the GSR recorder was set in another room, where the experimenter could observe the continuous GSR record. Keeping the interstimulus interval within the range of 10-20 sec., the experimenter initiated a trial either when the GSR record was steady (nonarousal) or when it showed a marked deflection (arousal) (see Fig. 1).

A trial consisted of the tachistoscopic presentation for 250 msec. of a pair of vertical lines. The S had two response keys in front of him, and his task was to press the key corresponding to the longer line as fast as possible. The ratios of the lengths of the vertical lines were 19/20 for the first pair, 17/20 for the second, and 15/20 for the third. The absolute length of lines varied between 1.5 to 3.0 cm. The order of presentation of the three types of stimulus pairs was randomized. In all, 96 trials were given.

The Ss were 18 college students selected out of 80 students on the basis of their anxiety scores on a paper-and-pencil questionnaire scale. This scale was

Fig. 1. Examples of the GSR arousal and nonarousal. The arrows indicate the onset of the task stimuli.

a slight modification of one described by Nishisato (1960). Six of the 18 Ss comprised the low-anxiety group (LA), with the score range of 123.5-133.5, six the medium-anxiety group (MA), with the range of 156.0-186.5, and the remaining six the high-anxiety group (HA), with the range of 200.0-240.0.

Results and Discussion

After the experiment, response pairs were selected such that the two responses of each pair had been made by the same S to the stimulus line of the same ratio but at different phases of the GSR, that is, one during the arousal phase and the other during the nonarousal phase. The numbers of response pairs analyzed for three anxiety groups and three stimulus ratios were 14 (HA-19/20), 26 (MA-19/20), 24 (LA-19/20), 18 (HA-

Fig. 2. Medians of reaction time as a function of the GSR arousal-nonarousal and the ratio between task stimuli.

Fig. 3. Medians of reaction time as a function of anxiety and the ratio between task stimuli.

17/20), 18 (MA-17/20), 36 (LA-17/20), 24 (HA-15/20), 16 (MA-15/20), and 26 (LA-15/20).

The effect of the arousal versus nonarousal conditions (see Fig. 2) was tested by the matched-pair nonparametric T test. Reaction time at the moment of arousal was significantly longer than reaction time during nonarousal ($CR = -3.665$, $p < .01$). In addition, as seen in Fig. 3, under the nonarousal condition, the high-anxiety group showed the longest reaction time, and the medium-anxiety group the shortest. In this nonarousal condition, the degree of anxiety proved to have significant effect upon reaction time (nonparametric H test with $H = 12.071$, $p < .01$). Under the arousal condition, however, there was no marked difference in reaction time among the three anxiety groups. These results show that momentary arousal contributes significantly to the intra-

individual fluctuation of reaction time, and that anxiety contributes significantly to the inter-individual fluctuation.

The findings that the EEG desynchronization is accompanied by shortened reaction time (Lansing et al, 1959) and that the GSR arousal is followed by lengthened reaction time (present study) show that these two indices of arousal are associated with the speed of reaction in opposite ways. This discrepancy may be interpreted in the following way. The EEG desynchronization is a central phenomenon, and the GSR is a peripheral one. And the latencies of these two are quite different; the response latency of the EEG desynchronization (the time between stimulus presentation and the disappearance of the alpha rhythm) is about 1 sec. shorter than that of the GSR. Callaway & Yeager (1960) report the existence of a phase of EEG alpha cycle, immediately preceding desynchronization, which is associated with slow response speed. Thus, there are probably three phases of arousal, one associated with pre-desynchronization alpha, one with desynchronization, and one with GSR. Fraisse (1957) has identified three phases of the psychological refractory phenomenon, a refractory phase, a facilitatory phase, and a subnormal phase, which are associated with, respectively, slow, fast, and slow reaction speed. It may be that these three phases of the psychological refractory phenomenon reflect the three phases of arousal.

References

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Note

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