

An EEG correlate of autonomic discrimination¹

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In a forced choice procedure, Ss can identify the presence or absence of their own spontaneous GSRs. Correctly and incorrectly discriminated GSRs are preceded by opposing patterns of 5 cps EEG activity. It is suggested that discriminable GSRs are produced by the same central events which serve as cues for the discrimination.

Mandler & Kahn (1960) have unsuccessfully attempted to demonstrate discrimination of changes in heart rate within an operant paradigm. The present attack on the problem of autonomic discrimination employed the GSR, a discrete and easily defined response, instead of the more subtle heart rate changes investigated by Mandler & Kahn. In addition, the Ss were given training in controlling their GSR in anticipation that the acquired means of control would provide cues for the discrimination. This training consisted of an operant conditioning procedure coupled with the suggestion that the reinforced response can be produced by emotional thinking, the procedure having been shown to be effective by Crider, Shapiro, & Tursky (in press). EEGs were recorded concurrently because it was felt that central alerting responses would most likely be used as a means of controlling and thus discriminating the GSR.

Method

Electrodermal activity was recorded as the potential difference between two nonpolarizing silver-silver chloride sponge electrodes placed on the thenar eminence of the right palm and the dorsal aspect of the right forearm. A GSR was defined as a palm-negative change in potential of at least .5 mV as recorded via an R-C coupled amplifier having an input time constant of 1 sec. The EEG was measured between standard occipital and temporal leads and recorded on FM tape. It was analyzed at 5 (theta), 10 (alpha), and 20 (beta) cps by playing the tape back through a filter (Becker et al, 1958) and integrating the filter output over 1-sec. intervals (Tursky, 1964). Respiration, measured from a strain gauge respirometer fixed around the waist, and gross skeletal activity, recorded from a vibration transducer fixed to the springs of the S chair, were also recorded to eliminate from consideration GSRs elicited by movement or irregular breathing.

The Ss, 8 males and 2 females between the ages of 19 and 23, were seated in a sound-attenuated, temperature controlled room. They were told that in the first 10 min. of the experiment they would be taught to produce a certain kind of emotional response by thinking,

and that in the next 10 min. their ability to recognize this response would be tested. It was explained that in the first part they would receive a 1000 cps, 1 sec., auditory tone for each emotional response (i.e., GSR) on a 10-sec. DRL schedule, and thereby earn 5 cents. All other GSRs (those following a GSR by less than 10 sec.) would be indicated by a 200 msec. blip. In the second part, the DRL schedule and the blips would continue, but half of the tones would not be contingent upon GSRs. Non-contingent tones were given in a random order at intervals sufficiently greater than 10 sec. from a preceding GSR to eliminate temporal cues. The S was to indicate whether he thought each tone was contingent upon a GSR or not by pressing a "yes" key or a "no" key. Correct guesses earned 5 cents and were indicated by a light. Incorrect guesses lost 5 cents. The 10-min. training and discrimination periods were then repeated. Ss were asked to sit still and not to breathe irregularly.

Results

Although none of the Ss made fewer than 50% correct guesses, only four discriminated significantly above chance ($p < .05$), with 69%, 69%, 78%, and 81% correct guesses.

EEG correlates of GSRs were found by measuring the integrated filter output in each of the 10 1-sec. intervals preceding each GSR. For each S, the amplitude values for each 1-sec. interval of a given frequency were averaged over the correctly identified GSRs and the incorrectly identified GSRs. EEG amplitude per interval was converted to percentage deviations from the mean amplitude of all 10 intervals.

Although there were consistent within Ss correlates of GSR activity at all frequencies, the only results relevant to the discrimination that were consistent across Ss occurred in the 5 cps analysis. Figure 1 shows the averages of each S's EEG correlate for correctly and for incorrectly identified GSRs. It appears that the two correlates tend to vary in opposite directions from second to second.² The stability of the difference between the two curves across Ss was tested by finding for each S the difference in 5 cps activity between correct and incorrect identifications for each 1-sec. interval, ranking these 10 differences, and testing for concordance across Ss by computing Kendall's W. The statistic was significant at the .02 level. Furthermore, a significant across-Ss rank order correlation was obtained between the percent of correct guesses and the variance of the 10 differences in EEG activity between correctly and incorrectly identified

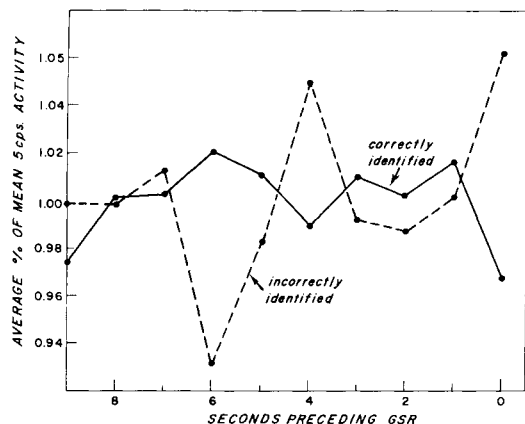


Fig. 1. EEG patterns preceding correctly and incorrectly identified GSRs. Averages of individual patterns for 10 Ss.

GSRs ($\rho = .59, p < .05$). Thus differential 5 cps EEG activity preceding a GSR is related to its discriminability, with better discriminators showing a greater EEG differential.

Discussion

The EEG pattern preceding a GSR indicates whether or not it will be discriminated. Since the EEG activity precedes the GSR, the activity cannot be due to afferent feedback from the autonomic change. Thus it is clear that such feedback is not the sole determinant of GSR discriminability.

There are, however, two possible interpretations of the EEG patterns. One is that the pattern preceding discriminated GSRs represents a central event which produces the GSR and in turn serves as a cue for its discrimination. This event would then be discriminable whether or not a GSR were present. This interpretation is in accord with the introspections of the Ss. Good

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call is totally irrelevant. Presumably, any response conditioned by operant methods had some significance to the animal prior to its selective reinforcement. If it is used somehow in obtaining food it is an operant already and we have simply submitted it to further operant conditioning. If it is ordinarily elicited simply in response to food, then we have shown that this response can be operantly controlled.

We are happy to see that our critics support our only conclusion, viz. operant conditioning of the VR of nonhuman primates can be achieved. It is a point on which there has not been unanimous agreement among authorities prior to our experiment (Lilly, 1960; Andrew, 1962).

With our statement on acquisition of VRs back in the context from which it was removed, it is clear that we were not suggesting that all VRs of all animals

discriminators reported using cues such as "When a new thought popped into my mind after I had been concentrating on one thing for a few seconds," or "When I thought of emotional experiences."

The other interpretation is that the event indicated by the EEG patterns only modifies the ability to discriminate autonomic feedback from the periphery. In this case, GSR discrimination would require the simultaneous occurrence of central and peripheral events. The preceding central events would not necessarily be discriminable by themselves. A decisive experiment would entail testing for GSR discrimination after deafferentation.

Although a consistent relationship between alpha rhythm alerting responses and GSR discrimination was not found, the importance of the 5 cps activity is consistent with Walter's (1953) view regarding theta rhythm as an indicator of emotion.

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Notes

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2. The form of the two curves may result from the tendency of correctly and incorrectly identified GSRs to fall at different phases of periodic fluctuations of 5 cps activity.

are acquired in this way. The point is that there are now a number of experiments demonstrating operant control of VRs in nonhumans. What remains to be demonstrated is whether or not this operant conditioning is different in any fundamental way from the operant conditioning that is postulated as being important in the acquisition of human verbal behavior.

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For comment by Wechkin and Sackett see page 246.