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CONTINUOUSLY VARYING SKIN POTENTIALS ELICITED BY  
SINUSOIDALLY VARYING ELECTRIC SHOCK POTENTIALS

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Although the electrodermal responses, GSP and GSR, have been extensively studied, and have been used as indices of autonomic functioning and of emotion over a period of many years, their basic nature is still not well understood. The stated aim of the investigation carried out under this grant was to determine whether a form of quasi-linear systems analysis can be applied to these response measures to yield new insights into the nature of the underlying response mechanisms and their interrelationships. It was originally proposed that the principal response to be investigated should be the electrodermal response (galvanic skin potential, GSP) as elicited by an electric shock stimulus applied to the skin. The experimental procedure involves a change from the usual method of applying electric shock stimulation, which has been to apply brief pulses of electric current of approximately one second duration and with a modulation envelope essentially square. The response subsequent to this stimulation has been examined and its characteristics measured in terms of latency, magnitude, rate of rise, and its characteristic of being unipolar or bipolar. Following one such elicitation, an interval of time, typically averaging 30 sec., was allowed to elapse before the next stimulus was applied. In the investigation reported here, the stimulus was to have been a continuously varying shock current in which the modulation envelope was either 1) that of a sinusoid of some fixed frequency, or 2) that of a random or quasi-random time function. The response, then, would not be a discrete response to a discrete stimulus application, but rather a continuous, driven response which would be correlated with the modulation envelope applied to the stimulus.

Most of the desired experimental goals were reached. Limitations of time and funding did not permit the investigation of

random or quasi-random modulation envelopes. However, a series of experimental runs on three Ss (two runs on one S, one on each of the other two) was accomplished, using sinusoidal modulation envelopes of frequencies of .05, .10, .15, .20, .30, .40, and .80 Hz. In all cases results showed that it was possible to drive the GSP and to achieve relatively high coherence between the driving frequency and the response itself. The analysis was laborious, and because of practical considerations was limited to Fourier analysis of the response in order to determine the relative energies at the driving frequency and at successive harmonics of that driving frequency, and correlational analysis in order to determine the degree of linear relationship between the driving frequency and the driven response.

Results:

The most significant findings and conclusions of the preliminary study were as follows:

1. The skin potential response is capable of continuous driving, without habituation, between frequencies of .1 to .4 Hz.
2. The GSP has an insignificant to vanishingly small response to frequencies of 0.05 Hz. and 0.80 Hz.
3. The response is relatively flat over the range from .10 Hz. to .40 Hz.
4. There is a suggestion that a natural resonance phenomenon can be triggered by driving in the range from .10 to .20 Hz.
5. The linearity of relationship between the driving frequency and the driven response can go as high as .9 or as low as .1 for different Ss or for the same S at different times and for different frequencies.
6. The shape of the response function, while periodic, nonetheless exhibits significant and reliable harmonic content.
7. The reliability of the response, in the case of two Ss, suggests that the original goal of the research, that of demonstrating that quasilinear analysis could be applied successfully to these measures has been achieved. Applications of the technique to improve our understanding of the bases of such response systems are feasible and desirable.

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8. The electrodermal response system of one S was sufficiently strongly entrained by the driving frequency that a nearly pure sinusoidal response was generated with a peak-to-peak magnitude of 80 mv. This response was sustained at the rate of .1 hz. for a period of more than 2 minutes without apparant dimunition.

9. There is a suggestion in some of the records that very low frequency variations, or possibly beats, do occur, which could be analysed by more elaborate recording and computer-analysis techniques.

10. Breathing, heart-rate, and blood-volume all demonstrated driving by the sinusoidally-modulated shock-stimulus, but in varying degrees for the different Ss. In all Ss there was a clear relationship between blood-volume and electrodermal response such that the electrodermal response appeared in its driven form only when blood-volume was markedly reduced. There was, however, no report of apparant intensity difference or change in discomfort produced by the stimulus.