Detection of one's own spontaneous GSRs*

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Detection of spontaneous GSRs was studied as a function of prior feedback training and size of GSR. The study was designed and analyzed within the framework of the theory of signal detectability. Approximately half of the 57 Ss received GSR feedback training. During the detection period, all Ss heard a low buzz approximately every 30 sec, and they indicated whether or not they thought that they had just made a GSR. They had in approximately half the trials. The results indicated that the particular feedback training used had a small positive effect on detection and that trained Ss could more easily detect their large GSRs.

The purpose of this experiment was to determine the ability of Ss to detect their own spontaneous galvanic skin responses (GSRs) as a function of feedback training and the size of the GSR.

Considering the major role that feedback of one's autonomic nervous system (ANS) activity has played both in theories of emotion (James, 1884; Cannon, 1929) and more recently in studies of voluntary control (e.g., Stern & Kaplan, 1967) and operant conditioning (e.g., Miller, 1969) of ANS responses, it is somewhat surprising that so few studies have been devoted to a direct investigation of Ss' ability to detect their own ANS responses. Examples of the latter type of experiment include studies by Stunkard and his associates (Stunkard & Koch, 1964; Griggs & Stunkard, 1964), who investigated the ability of obese and normal Ss to detect stomach contractions, and Mandler & Kahn (1960), who tested Ss' ability to detect heart rate changes.

Experiments in which the ability to detect spontaneous GSRs were investigated include studies by Baron (1966) and Donelson (1968). Baron's 10 Ss were given a 10-min training period, during which they received a signal every time they succeeded in producing a GSR by thinking emotional thoughts. This was followed by a 10-min forced-choice test period. Ss heard a low tone and had to indicate whether or not they had just made a GSR. Ss received 5c when they were correct and lost 5c when they were incorrect. According to the author, only four Ss discriminated significantly above chance. Donelson's seven female Ss received four alternating training and test periods of

3 min each. During the test period, S pushed a button whenever she thought she had made a GSR. There was no mention of knowledge of results or reinforcement for the Ss in this article. Donelson reported that none of her Ss detected their GSRs at a level better than chance.

In an attempt to surmount some of the problems inherent in traditional detection experiments, such as the effect of S's criterion level and other non-sensory factors, the present investigator modeled this GSR detection study after the auditory detection experiments done within the framework of the theory of signal detectability (Swets, Tanner, & Birdsall, 1961).

It was hypothesized that feedback training would facilitate detection, particularly of the large GSRs. It was assumed that prior exposure to GSR feedback (the training period) would aid detection because of the many recent reports of voluntary control of ANS responses which have stressed the importance of feedback (Brenner & Hotherhall, 1966; Stern & Kaplan, 1967; Brenner, Kleinman, & Goessling, 1969). A second hypothesis of this experiment was that large GSRs would be more easily detected than small GSRs.

SUBJECTS

Fifty-seven undergraduates at The Pennsylvania State University served as Ss in this experiment. None had previous experience with the GSR.

APPARATUS

The GSR was recorded with the aid of a Fels Dermohmmeter and an Esterline-Angus milliammeter recorder; S current was 70 microA. The electrodes were two zinc plates: one, 1 in. in diam, was attached to the palm of S's left hand and the second, 2 x 3 in., was attached to the ventral surface of the left forearm. Both electrodes were covered with zinc sulfate before being applied.

An ohmmeter, which was wired in parallel with the resistance meter of the Dermohmmeter, was used to provide feedback to half of the Ss

during the training period. Also in the S room was a 28-V buzzer, the low noise of which was used to "ask" S if he thought that he had just made a GSR. S indicated his decision by pressing one of four numbered buttons mounted near his right hand: 1 indicated that S was positive that he had made a GSR, 2 that he thought he had made a GSR, 3 that he thought that he had not made a GSR, and 4 that he was positive that he had not made a GSR. A counter was placed in front of S and provided knowledge of results by increasing when S was correct.

PROCEDURE

All Ss were told that this was an experiment designed to test their ability to detect GSRs. They were also told a little about the GSR and that it could be produced by thinking about sexual events, a feared object, or any other personally arousing experience. Half of the Ss, randomly selected, were then given a 15-min training period. During this time, they were encouraged to try to make GSRs and to note carefully their bodily sensations when GSRs occurred. They were able to observe their GSRs on the ohmmeter mentioned above. During this 15-min preliminary period, a second group of Ss was given the same instructions but no feedback.

Following this phase of the session, both groups were treated identically. They were given instructions concerning the buzzer, which was the signal for them to indicate by pushing the appropriate button whether or not they thought that they had just made a GSR, and the counter. Ss were cautioned not to breathe irregularly or make unnecessary bodily movements.

The buzzer was sounded manually by E. An attempt was made to have approximately 15 signal trials, i.e., S had made a GSR, and 15 no-signal trials for each S. Criterion of a GSR was a decrease in resistance of 100 ohms or greater. E tried to sound the buzzer approximately every 30 sec, keeping in mind that he did not want to create any pattern, e.g., signal, no signal, signal, no signal, etc., and that he wanted to obtain approximately an equal number of signal and no-signal trials. For a signal trial, the buzzer was not sounded until the GSR peaked. (This delay was used because of an interest in the relationship of the size of the GSR and its detectability.) For no-signal trials, the buzzer was sounded after a minimum of 20 sec of constant skin resistance increase.

QUANTIFICATION OF DATA

GSR Data

Those GSRs that were the basis for signal trials were measured and converted to micromhos. A median

*The author thanks T. Bush, P. Jubinski, and F. Conte for help with various phases of this study. The constructive comments of A. Crider and D. McFadden on an earlier version of this paper are also acknowledged. This research was supported by a grant from the Central Fund for Research, College of Liberal Arts, The Pennsylvania State University.

Table 1
Mean Magnitude of Large and Small GSRs
for Trained (N = 30) and Untrained (N = 27)
Ss (in Micromhos)

Relative GSR Magnitude	Large Small	Training	No Training
		1.2 .4	1.8 .6

split was used to separate each S's large and small GSRs. Table 1 shows the mean magnitude of large and small GSRs for both the trained and untrained Ss.

Detection Data

Each S's no-signal trials were designated as corresponding to large or small signal trials by their proximity in time to a large or small GSR (signal trial). Receiver operating characteristics (ROCs) were constructed for the rating method data obtained in this study according to the procedure described by Egan & Clarke (1966). Basically, the lowest points represent the Ss' responses under the strictest criterion with subsequent points being based on cumulative probabilities. The ROCs and d' scores, to be described next, are based on combined data across Ss and not means of individually derived values. In order to determine d', a "hit" was defined as a trial on which S made a GSR, a signal trial, and pushed either Button 1 or Button 2: he was sure or he thought that he had made a GSR. A "false alarm" was defined as a trial on which S had not made a GSR, a no-signal trial, but he pushed either Button 1 or Button 2. The d' scores were determined separately for trained and untrained Ss and for their large and small GSRs according to the following formula: $d' = Z_N - Z_{SN}$, where proportions greater than .5 were taken as negative. Z_N signifies the z score based on the proportion of false alarms and Z_{SN} indicates the z score based on the proportion of hits.

RESULTS AND DISCUSSION

The first hypothesis, that training would facilitate detection, received weak support from the results of the present study. Figure 1a shows the ROC curves for the trained Ss, and Fig. 1b for the untrained Ss. The performance of the untrained Ss falls almost exactly on the chance line, whereas the detectability level of the trained Ss is consistently above chance. Table 2 summarizes the findings in terms of d' scores. All values are low, as could be assumed from the ROC curves, with the scores for untrained Ss approaching zero (chance) and the scores for trained Ss being positive but low (.35 for their large GSRs and .20 for their small GSRs).

Further examination of the ROC curves reveals that the difference in detectability of the trained and untrained Ss was largely a function of the lower false alarm rate of the former group. This finding points out the importance of using TSD or related methodologies in subsequent studies of detection of one's own ANS responses. A procedure which would have examined only the hit rate would have led to the erroneous conclusion that training had no effect.

It was thought that prior exposure to GSR feedback (the training period) would aid detection, because Ss would learn which types of sensations or thoughts accompanied GSRs. The two previous studies (Baron, 1966; Donelson, 1968) which dealt directly with the question of detection of spontaneous GSRs both included training sessions, but both lacked the necessary control groups which would have enabled their authors to comment on the contribution of prior training to detection.

Several possibilities exist to account for the lack of greater training effects in the present study. The training period may have been too brief, it did not have built into it a means of motivating the Ss to actually make use of the period, and it may have been too different from the actual detection situation. That is, during the training session, S produced GSRs by thinking about arousing thoughts. But during the detection period, he was asked to detect GSRs, some of which may have been accompanied by his arousing thoughts and some of which undoubtedly were not. One of the more important factors in the lack of a greater difference between the groups' detection as a function of training is thought to be the fact that both groups received feedback on every trial once the detection period began. This trial-by-trial knowledge of results, or feedback, may have overridden any advantages the trained Ss might have had.

The second hypothesis of this study was that large GSRs would be more easily detected than small GSRs. Figure 1b shows that those Ss who did not receive training could not detect their large GSRs any better than they could their small ones. Figure 1a shows that the trained Ss, on the other hand, did detect their large GSRs better than their small GSRs. Table 2 indicates, however, that these results are weak: d's are in the predicted direction but are relatively small.

Two articles from the TSD literature appear to be relevant to the results of this study. Egan, Schulman, & Greenberg (1961) conducted an auditory detection experiment that was similar in design to the present

Fig. 1. Receiver operating characteristics for trained (N = 30) and untrained (N = 27) Ss and for their large and small GSRs (intra-S).

study in that the observation interval was not defined for S until after it had passed. In other words, rather than Ss receiving a warning that the observation period was beginning, as in the present study, he was "asked" after the observation interval if a signal had or had not occurred. Their basic finding was that detection decreased considerably as a function of memory time, the time between the onset of the observation interval and the "asking" light. Their longest memory time was 2 sec. In terms of the present study, this would indicate that detection scores would have been higher if the memory time had been shortened. In actuality, it is difficult to manipulate memory time in a spontaneous GSR detection study,

Table 2
d's for Trained (N = 30) and Untrained
(N = 27) Ss Examined Separately for
Their Large and Small GSRs

Relative GSR Magnitude	Large Small	Training	No Training
		.35 .20	.07 -.05

since we can't specify the relevant stimulus, much less its onset.

The second relevant TSD study was conducted by Gundy (1961) and dealt with the detection of unspecified signals. In the present experiment, the group that did not receive training was faced with a similar task—detecting an unknown stimulus. Gundy found that when no demonstrations of the signal to be detected were given, initial performance was poor. The results of Gundy's study, as well as those of Egan, Schulman, & Greenberg, are mentioned here not only because of their relevance to this study, but because they call attention to two variables: (1) memory time, and (2) an unspecified signal, both of which should be considered in future studies of ANS detection.

In conclusion, this brief study has demonstrated that, using the d' measure of detectability, a pretraining period had a small effect on detection and trained Ss displayed slightly better detection of their large, as opposed to

small, GSRs. The nature of the specific stimulus to which S responded, e.g., some bodily sensation, arousing thoughts, etc., must await further investigation.

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