Two-flash threshold, skin conductance and skin potential[1]

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The subjective threshold of fusion of paired light flashes (two-flash threshold) and tonic levels of skin conductance and skin potential were simultaneously measured in samples of drug free and medicated psychiatric patients. Significant intercorrelations were found between the two-flash threshold and a range corrected index of skin conductance and potential in both patient samples.

Neurophysiological studies of the facilitation of sensory processes by stimulation of the ascending reticular system have suggested to several investigators (e.g., Venables, 1963) that the subjective threshold of fusion for paired flashes of light may serve as an indicant of physiological arousal level. Several recent experiments have provided evidence supporting this hypothesis: Two-flash thresholds (TFTs) have been found to correlate with skin conductance and with a measure of sedative susceptibility —the sedation threshold (Rose, 1964; Luther, 1965). In studies of TFT variation within a single S, barbiturate intake has been found to raise the TFT whereas stimulants have been found to lower the threshold (Luther, 1965; Kopell, Nobel, & Silverman, 1965). Rose (1966) reports significant correlations between the TFT and psychometric and clinical ratings of anxiety.

In studies of the relationship between tonic levels of skin conductance and other indicants of arousal, it has been found that a considerable increase in the correlation between the variables may be obtained when levels of electrodermal activity are "corrected" by removing the effects of individual differences in range of response (Lykken, Rose, Luther, & Maley, 1966). A crude estimate of an individual's limits of conductance is obtained by recording tonic levels during rest and during a task designed to elicit a maximum level of activity, e.g., blowing up a balloon to bursting. Mean conductance levels during the TFT (or other tasks) are then expressed as a function of that individual's range:

$$\phi_{SC} = \frac{\text{(mean during TFT)} - \text{(estimated minimim)}}{\text{(estimated maximum)} - \text{(estimated minimum)}}$$

This correction reduces the contribution of those variables which affect absolute skin conductance values but are unrelated to arousal.

This report presents data on the applicability of this correction technique to two electrodermal indicants of arousal—skin conductance and skin potential —and investigates the relationship between these variables and the TFT.

Subjects

All Ss were males, ages 26-61. The Drug group (N = 20) consisted of resident psychiatric patients who were either currently receiving tranquilizing medication or had been receiving chemotherapy within five days prior to testing. Ss in the Nondrug group (N = 20) were applicants for admission to the hospital psychiatric wards and were not taking tranquilizing medications of any kind. Any S reporting visual disturbances or having a history of organic dysfunction was excluded.

Apparatus

Skin potential was measured directly following a procedure outlined by Venables and Sayer (1963). Potential differences between an active and an inactive site were fed to a Sanborn recording unit having calibrated zero suppression at its input. A null meter at the preamplifier output indicated when the tissue voltage and the suppressor voltage were equal. The middle phalanx of the second finger of the right hand was the active site. The inactive reference site was located on the ventral right forearm and was prepared by lightly sandpapering the skin until the *stratum lucidum* was ruptured. A third ground electrode was placed on the left forearm. To control effective electrode area, pieces of surgical tape, each punched with a 1/4 in. hole, were placed over the active and reference sites. Corn pads were placed over the holes and half filled with an electrolyte of .07 molar concentration of $ZnSO_4$ in a neutral base. Matched zinc electrodes of 1/4 in. diameter with less than one mV standing potential were taped over the holes. Skin conductance values were obtained by calculation from measurements of skin potential recorded under two conditions: (1) the "normal" condition of no current flowing through the recording electrodes, and (2) a second reading taken immediately afterward while a small transient current was passing through the circuit. Conductance values were calculated as a function of the two voltage readings and the known precision resistor added to the circuit during the current reading. (Maley (1967) provides a more detailed explanation of this procedure.) Two-flash thresholds were measured using a specially constructed apparatus that produced paired flashes of light of 10 μsec duration and variable interflash delay times of 8-180 msec. S was seated in a lighted (40 W bulb) audiometric room about 4 ft from

Table 1. Intercorrelations of the TFT, skin potential and skin conductance during the threshold task. (* = $p < .05$)

	NON-DRUG				DRUG			
	TFT	SP	CSP	SC	TFT	SP	CSP	SC
SP	-.01				-.15			
CSP	-.64*	.32			-.59*	.46*		
SC	-.14	.10	.35		-.49*	.04	.56*	
CSC	-.54*	.26	.86*	.52*	-.60*	.05	.65*	.70*

an eye level black box containing a 3/4 in. flash tube and a small, yellow, dim fixation light. The flash tube was viewed with both eyes.

Procedure

S was initially given detailed instructions and an outline of the procedures to follow. After attachment of the electrodes, a 5 min rest period was used to provide an estimate of minimum basal conductance and potential levels. TFTs were obtained by a modified method of constant stimuli. S was presented 50 trials of paired flashes centered about his estimated threshold as determined by preliminary testing: 10 trials were at the interstimulus interval (ISI) of his estimated threshold, and the remaining 40 trials were systematically balanced within ±10 msec of it. In addition, 15 trials of paired flashes at an ISI all Ss would see as one flash were systematically included in the presentation schedule to provide a reference point. At the end of the TFT measurement, S inflated a small rubber balloon until it burst.

Analysis

Skin potential measurements under the no current and current conditions were taken at 1 min intervals during rest, at the beginning, middle, and end of the TFT task, and during the balloon task. Skin conductance values were later calculated from the skin potential readings. Conductance and potential levels during the TFT task were obtained by averaging the pre-, mid-, and post-TFT recorded values. The level of electrodermal activity for each S during the TFT was expressed in absolute conductance and potential units (micromhos and mV) and in range corrected units (% of total range). Pearson product-moment correlation coefficients were used throughout.

Results and Discussion

Table 1 presents the intercorrelations across Ss, between the TFT, absolute and corrected skin conductance (SC, CSC), and absolute and corrected skin potential (SP, CSP) during the performance of the threshold task. In both samples, large increases in the TFT-electrodermal correlations are obtained when corrected values of SC and SP are used in place of the absolute values. In all cases, the direction of covariation is such that high absolute and corrected tonic levels are associated with low values of the TFT (short ISI). Similar patterns of correlations occurred in both samples.

Additional evidence for the utility of the range correction technique is observed in the correlations between the two electrodermal variables. The correlations between SC and SP are small and positive. Correcting only one of the basals results in a slight increase in the relationship, while correcting both measures considerably raises the degree of correspondence. Individuals showing high levels of CSC, then, also show high levels of CSP. This finding supports the data showing a high within S correspondence between the two measures (Maley, 1967).

Average levels of SC (CSC) during the TFT task were 5.49 micromhos (50%) for the Nondrug group and 4.60 micromhos (25%) for the medicated sample. Only the CSC difference was significant ($p < .05$). Average levels of SP (CSP) during the task were -31.24 mV (49%) for the Nondrug group and -26.78 mV (21%) for the Drug sample. Both of these differences were significant ($p < .05$). Mean TFT values were 53.9 msec and 56.5 msec for the Nondrug and Drug groups, respectively. The higher TFT values and the lower conductance and potential levels found in the Drug sample are consistent with the arousal decreasing properties of the tranquilizing medications.

References

KOPELL, B., NOBLE, E., & SILVERMAN, J. The effect of thiamylal and methamphetamine on the two-flash fusion threshold. *Life Sci.*, 1965, 4, 2211-2214.

LUTHER, B. Unpublished Ph. D. thesis, University of Minnesota, 1965.

LYKKEN, D. T., ROSE, R., LUTHER, B., & MALEY, M. Correcting psychophysical measures for individual differences in range. *Psychol. Bull.*, 1966, 66, 481-484.

MALEY, M. Unpublished Ph. D. thesis, University of Minnesota, 1967.

ROSE, R. Unpublished Ph. D. thesis, University of Minnesota, 1964.

ROSE, R. Anxiety and arousal: A study of two-flash fusion and skin conductance. *Psychon. Sci.*, 1966, 6, 81-82.

VENABLES, P. H. The relationship between level of skin potential and fusion of paired light flashes in schizophrenic and normal subjects. *J. Psychiat. Res.*, 1963, 1, 279-287.

VENABLES, P. H., & SAYER, E. On the measurement of the level of skin potential. *Brit. J. Psychol.*, 1963, 54, 251-260.

Notes

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