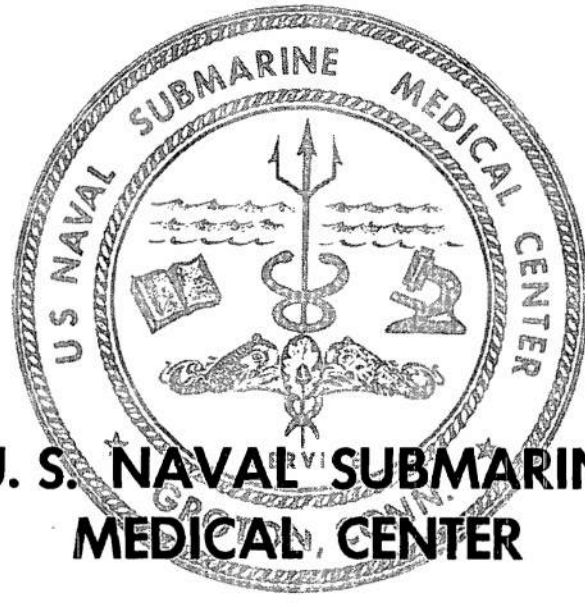

U. S. NAVAL SUBMARINE MEDICAL CENTER

Submarine Base, Groton, Conn.

REPORT NUMBER 571

THE RELATIONSHIP OF GALVANIC SKIN RESPONSE TO THE EMOTION-EVOKING PROPERTIES OF WORDS

by

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and

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Bureau of Medicine and Surgery, Navy Department

Research Work Unit MF12.524.002-9004.01

Released by:

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Naval Submarine Medical Center

12 March 1969

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SUBMARINE MEDICAL RESEARCH LABORATORY
NAVAL SUBMARINE MEDICAL CENTER REPORT NO. 571

Bureau of Medicine and Surgery, Navy Department
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SUMMARY PAGE

THE PROBLEM

To investigate the efficiency of the galvanic skin response (GSR) as a measure of cognitive response to a series of submarine-relevant words as a technique for assessing differences in the emotionality of submariners.

FINDINGS

GSR reactivity to highly emotionally-toned (non-submarine) words was greater than for neutral words, though the difference did not meet the 5% confidence level. However, significant differences (5%) in GSR reactivity were found between words rated highly-emotional as compared to those rated less emotionally-evoking.

APPLICATION

Individual differences in GSR-reactivity to cognitive stimuli appear to be related in a complex manner to general emotionality and may be useful as a predictive index of ability to tolerate the stresses of long submergence.

ADMINISTRATIVE INFORMATION

This investigation was conducted as a part of Bureau of Medicine and Surgery Research Work Unit MF12.524.002-9004—Selection and Retention of Submarine and Diving Personnel. The present report is Report No. 1 on this Work Unit. It was approved for publication on 12 March 1969 and designated as SubMedResLab Report No. 571. Related reports under Work Unit MF022.01.02-9004 were published as SubMedResLab Reports No. 511, 532, and Memorandum Report 68-15.

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ABSTRACT

The two brief studies were designed to investigate the relationship between the autonomic nervous system component of emotions evoked in a laboratory situation by briefly exposed words of varying degrees of emotional-evoking "power." Moreover, in the event that reliable relationships were found between these two classes of variables, it was further hypothesized that a practical approach to evaluation of individual differences in motivation might be disclosed.

The results of two pilot studies showed a tendency for GSR-reactivity to words with a high emotional-evoking property (as indicated by Q-sort of words) to be greater than for neutral words. However, this difference did not meet the confidence criterion set for this study at the 5% level.

Using 40 words, 10 neutral and 30 "submarine-relevant" in varying degrees as adjudged by Q-sorts performed by 6 Laboratory staff members, it was demonstrated that the mean GSR-reactivity for 16 enlisted subjects to the most emotional words determined by Q-sort was significantly greater as compared to the same statistics computed for the least emotional-evoking words (5% confidence level, t-test). However, the smallness of the subject sample, together with the relatively "weak" relationship of GSR reactivity to word content indicate the relative tenuousness of the findings from these pilot studies as a whole.

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THE RELATIONSHIP OF GALVANIC SKIN RESPONSE TO THE EMOTION-EVOKING PROPERTIES OF WORDS

INTRODUCTION

The interaction between psychological and physiological factors has long been recognized. In general, there have been two types of relationships described in the literature: (1) non-specific relationships in which stimuli evoke physiological responses and, (2) the association of specific psychological factors with specific physiological and biochemical changes. Skin resistance has been used as an accurate indicator of reactivity beginning with the work of Fere in the late Nineteenth Century. Rapid changes in skin resistance called Galvanic Skin Response (GSR) occur in response to external and internal stimuli.

The physiological basis for changes in galvanic skin response seems to rest in changes in the electrical properties of sweat glands and surrounding tissue when the sweat glands are stimulated to secrete, although the accompanying constriction of peripheral arterioles with the resulting decrease in blood flow may also be involved (McCleary, 1950). In either case, measurement of GSR provides an indirect indicator of the overall reactivity of the sympathetic nervous system (SNS).

The measurement of sweat gland activity as an indicant of SNS reactivity was used in these studies instead of heart rate or other SNS indices for several reasons: the sweat glands show no appreciable autonomous rhythmic activity, are not doubly innervated, i.e., by both SNS and parasympathetic nerves and are not subject to hormonal control (Wang, 1964).

Sweating does not occur equally on all parts of the body. Two fundamentally different stimuli trigger sweating (Kuno, 1956), namely, thermal and emotional stimuli. "Thermal" sweating results from ambient heat and occurs over the entire body, except for the palm and sole. There is a marked time lag after exposure to the stimulus (heat) before sweating begins. "Psychological," or emotional sweating, on the other hand, occurs mainly on the palm and sole, but the forehead and axilla may also become involved if the stress is of sufficient intensity. For the purpose of the present study, emotional sweating was wholly inferred from palmar conductance indices obtained from subjects in an air-conditioned laboratory in which thermal sweating was minimized.

In 1949, McCleary and Lazarus published data arguing that autonomic nervous system (ANS) "discrimination" without awareness did occur. Their experimental procedure involved the presentation of stimulus material at exposure speeds too short to permit conscious discrimination, yet there was evidence of autonomic discrimination as inferred from the GSR's of the subjects. Too, McGinnies (1949) conducted studies involving recognition thresholds and perceptual defense mechanisms. One major finding from this study was that the so-called taboo words elicited greater GSR's as compared to neutral words suggesting a relationship between cognitive responses and skin resistance changes.

This research is presented in two parts: (1) a pilot study involving, for the most part, the word list of McGinnies (op. cit.) with certain modifications, and (2) a second study using a list of submarine-relevant words and terms which had been ranked as to their emotional-evoking properties by six staff psychologists of the Submarine Medical Center, Groton, Connecticut. The major hypothesis underlying the second and more important study was that individual differences in GSR-reactivity to affectively-loaded submarine words, since it is for the most part involuntary in nature, may be systematically related to the general emotionality of the submariner and ultimately, of course, to the quality of his adjustment to the submarine environment. Prior to the implementation of the validation studies with respect to underway submariner adjustment however,

it was first necessary to demonstrate that these differences in GSR responsivity (within the submariner population) were usefully large and predictable. This, in short, was the final objective of this pilot research.

METHODS AND PROCEDURES

Pilot Studies

Two preliminary studies, which will hereafter be referred to as Pilot Study with Memory Drum and Pilot Study with Projector, were conducted for the purpose of familiarization with the equipment and the techniques.

Subjects. The Pilot Study with Drum was conducted with 19 enlisted volunteers for the Submarine Service awaiting admission to the Submarine School, Groton, Connecticut. Similarly, for the second study, 16 enlisted submariner candidates were used.

The Pilot Study employed a memory drum to present a series of 40 words. For the most part, the words were those used by McGinnies (1949) in the experiment focused upon certain aspects of the perceptual defense question. Because of inadequacies with the rotating drum, a Kodak 35mm slide projector was used for the second part of the preliminary study. For the Pilot Study with projector, the same word list previously employed was used. The words were projected in random order at 15-second intervals with an exposure time of two seconds. The words[1] used were as follows:

Baseline:	Experimental Words:			
words	*enemy	child	broom	clear
berry	*shock	*raped	*blood	stove
shoes	apple	glass	*horny	river
table	fresh	sleep	trace	*panic
grass	*death	*filth	*screw	trial
chair	*beers	teeth	*belly	*whore
light	*sperm	games	*drown	music
white	*bitch	dance		
whole				
pause				

1. Words with an asterisk affixed were rated as emotionally-toned.

Instrumentation. All of the instrumentation was located in the recording room adjoining the measurement laboratory visible by means of a one-way screen. The projector was controlled from the polygraph recording room.

An Offner Type R Dynograph and a Fels Dermohmeter were used for recording basal skin resistance level, and GSR*. A polygraph event marker served to record the onset of stimuli and other events throughout the experiment. Each subject was measured individually while seated comfortably in a chair in the air-conditioned room. The experimenter read the instructions aloud to the subject, after which silver chloride electrodes were placed on the subject's left palm, forearm and chest. Fifteen minutes were usually sufficient enough for the skin to hydrate. During this time a basal skin resistance level was established.

Scoring Technique for GSR's. A basal skin resistance level was established for each subject using the resting period before, and after the test, and during the first 10 baseline words. A baseline skin resistance score was determined from the mean GSR's to the 10 baseline words. From this baseline, it was possible to calculate the percentage decrease in resistance of each response to a given word stimulus. No consistent habituation effect in GSR magnitude was noticed from one to another word stimuli though there appeared to be a slight increase in resistance level of which the GSR's occurred as the series of word-stimuli progressed.

A rating system was devised whereby each subject could be assigned a score or index indicating individual differences in GSR-reactivity to each word stimuli. For a subject, a rank of 3 was assigned to the maximum response to any test word. A 2 was assigned to a response less than the maximum but greater than one-half the maximum response. A response greater than zero but less than or equal to one-half the maximum

*Heart and breathing rates were also recorded but were not considered to be a significant aspect of the present study. Therefore, these data are not included in this report.

was given a rank of 1. No response to the stimulus was given a rank of zero. These rankings were recorded on the data sheet for each subject for each work stimulus. In computing the overall reactivity of all the subjects to the word stimulus, a score called "sum" was determined as the sum of the products of the rankings. For example, the word "enemy" had 12 zero rankings, 3 one rankings, 4 two rankings, and 0 three rankings. Its "sum" would be: $12 \times 0 + 3 \times 1 + 4 \times 2 + 0 \times 3 = 11$. This "sum" provided an index of the magnitude of the responses to each word stimulus and as such, was used to rank order the GSR reactivity of the array of words, rank 1 being assigned to the highest sum-score.

Submarine-Relevant Words Study

Having completed the pilot studies, another list of 30 experimental words and 10 baseline or neutral words was prepared. The subjects were 35 enlisted men awaiting admission to Basic Enlisted Submarine School at Groton.

Method and Procedure. The list of 30 experimental and 10 baseline words was made into 35mm slides, which were again presented at 15-second intervals with an exposure time of two seconds. The test consisted of the 10 baseline words followed by the random presentation of the 30 experimental words. The entire test procedure took about ten minutes.

The same procedure used in the Pilot Study with Projector was employed in recording physiological responses for each subject. A basal skin resistance level was established for each subject using the resting period before and after the test and during the first 10 baseline words. The percentage decrease in resistance of each response to a word stimulus was determined. The same rating system was employed in determining a subject's response to a word.

Emotional Content of Words. The emotional content of the experimental words was assigned by a group of five psychologists and one psychiatrist (all members of the Submarine Medical Center staff) by means of a Q-sort (Weybrew, 1953) of the 40 words used in the experiment. The experts' evaluations were equated by assigning values of 2 for high emotionally-toned words, and a 0 for neutral words. These ratings were then summed and rank ordered, the highest possible sum for a given word being 12, resulting from 6 judges assigning a rank of 2 to the word in question.

The list of the words employed was as follows:

Baseline:	Experimental Words:			
words	water	death	drown	horny
think	tense	empty	escape	alone
berry	qualify	depth	burst	school
shoes	torpedo	nervous	worry	angry
table	secure	skipper	boredom	panic
glass	friend	destroy	learn	explode
chair	liberty	crowded	silent	trapped
clear	failure	afraid		
whole				
pause				

RESULTS

Pilot Studies

The subjects in both pilot studies reacted more to the emotionally toned words than to the neutral words, although the differences failed to reach the 5% confidence level (Wilcoxin Test). However, some "neutral" words evoked significant GSR's, for example, the word "apple." One might hazard a guess that some subjects were reacting to the academic jargon "apple" meaning to clutch or fail on an examination. Too, the baseline word "grass" which was included in McGinnies' studies as a neutral word similarly evoked GSR's in some, possibly the result of the modern jargonized usage of "grass" to refer to marijuana. One realization resulting from the pilot studies was that modern connotations had to be considered in making up the list of emotionally-toned and neutral words.

Submarine-Relevant Words Study

Each of the words were rank ordered according to the sum of the ratings of the 6 "expert" judges. Three words, "death," "panic," and "trapped," received the maxi-

mum emotionality ratings, namely a summed-score="12." Only slightly less emotionally-toned words as judged by the experts were the words "drown," "tense," "horny," "nervous," and "explode."

A Spearman-Rho Coefficient was calculated for the array of 30 words between the expert ratings and the calculated GSR reactivity score to give Rho = 0.18 not significantly greater than zero at the 5% level.

On the notion that the GSR-reactivity and "expert" judgments of the array of 30 words was curvilinear, the sample was fractionated and Rho coefficients recalculated. Accordingly, for the 9 words assigned the highest emotionality ratings by the experts, the Rho coefficient was found to be — 0.43 and for the lowest 17 words 0.13, neither reaching the confidence criterion of 5%.

The interrelationships of the tests making up the Submariner Selection battery with the distributions of GSR-reactivity scores was also examined. Spearman-Rho Coefficients were computed for the two distributions (N = 16) with the following results:

Coefficient between GSR reactivity and a Verbal Aptitude Test (NGCT) was 0.324,

Coefficient between GSR reactivity and an Arithmetical Aptitude Test (ARI) — 0.140,

Coefficient between GSR reactivity and a Mechanical Aptitude Test (MECH) 0.187, and,

Coefficient between a Psychiatric Screening Questionnaire (PIB, Weybrew & Youniss, 1957) — 0.281. While none of these coefficients met the 5% confidence criterion, the non-linearity of the regression line between PIB and the GSR Reactivity scores is indicated by the Rho coefficient of — 0.71 ($p = < .05$) computed for the 9 subjects having the highest GSR reactivity scores. This finding suggests the possibility that men in this age group with the fewest manifest neurotic symptoms show greater autonomic responsivity to cognitive stimuli, at least as indicated by GSR reactivity.

SUMMARY AND DISCUSSION

The two brief studies were designed to investigate the relationship between the autonomic nervous system component of emotions evoked in a laboratory situation by briefly exposed words of varying degrees of emotional-evoking "power." Moreover, in the event that reliable relationships were found between these two classes of variables it was further hypothesized that a practical approach to evaluation of individual differences in motivation might be disclosed.

The result of two pilot studies showed a tendency for GSR-reactivity to words with a high emotional-evoking property (as indicated by Q-sort of words) to be greater than for neutral words. However, this difference did not meet the confidence criterion set for this study at the 5% level.

Using 40 words, 10 neutral and 30 "submarine-relevant" in varying degrees as adjudged by Q-sorts performed by 6 Laboratory staff members, it was demonstrated that the mean GSR-reactivity for 16 enlisted subjects to the most emotional words determined by Q-sort was significantly greater as compared to the same statistics computed for the least emotional-evoking words (5% confidence level, t-test). However, the smallness of the subject sample, together with the relatively "weak" relationship of GSR reactivity to word content indicate the relative tenuousness of the findings from these pilot studies as a whole.

Future studies along similar lines might explore the feasibility evoking individual differences in autonomic reactivity by use of more intensely emotional words, or by use of pictures, or both. Another limitation of the study may have centered around the use of the Q-sort technique as a means of estimating the differential emotional-evoking properties of the various word lists used in the studies. One possibility might be to get weightings for the stimuli by use of some techniques like the Semantic Differential (Osgood, 19). One final limitation of the study might have been related to the techniques used in recording GSR and/or the method of scoring the records after they

were obtained. Previous work at the Laboratory along these lines (Weybrew & Alves, 1959) suggested the possibility that a more useful GSR-reactivity score might be differences in rate of recovery-to-basal level following the initial GSR to the stimulus rather than the amplitude of response itself.

In short, the results of this study, while somewhat tenuous, nevertheless suggest at least the plausibility of using measures of autonomic responsivity evoked by cognitive stimuli as useful valid indices of general emotionality within the population about which selection decisions are to be made.

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13. ABSTRACT

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14 KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Measurement of emotionality						
Perceptual defense						
Submariner selection						