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ABSTRACT

The relative predictive abilities of two indices of test anxiety were investigated. The galvanic skin response (GSR) and the Test Anxiety Scale for Children (TASC) were used as predictor variables for IQ and achievement test performance. The results of multiple linear regression analysis indicated that neither the TASC nor the GSR, combined over four achievement content area subtests, (administered in random order), were highly consistent predictors of the test performance. That the TASC failed to correlate, in a systematic way, with either GSR levels or with test scores casts some doubt on its validity as a measure of test anxiety. It is suggested that the effects of such variables as social desirability response, acquiescence, and defensiveness of response patterns, and two unexpected findings, the effects of test order on GSR arousal, and increased arousal across tests from the beginning to the end of testing be investigated. (PP)

A STUDY OF THE RELATIONSHIPS BETWEEN TEST ORDER, PHYSIOLOGICAL AROUSAL, AND INTELLIGENCE AND ACHIEVEMENT TEST PERFORMANCE

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Anxiety has been a topic of great interest to researchers for many years. Since 1950 more than 1500 studies have been indexed under the heading of anxiety (Spielberger, 1966), and at least 120 different procedures have been used to infer its presence (Sarbin, 1968). Several books and a great many research articles have focused primarily on anxiety among school children. Sarason, Davidson, Lighthall, Waite, and Ruebush's (1960) book Anxiety Among Elementary School Children, and a more recent publication by Phillips, Martin and Meyers (1969) are reviews of the theory, research and implications of anxiety among school children.

Although much of the anxiety research with children has been concerned with the existence and consequences of anxiety in general, a relatively large body of knowledge has been developed in the area of so-called "test anxiety", a unique form of anxiety specific to evaluative situations.

The profound interest shown in test anxiety appears to be justifiable in view of the importance of testing in our society. Entrance into college, job placement, promotions, ability grouping and clinical diagnoses are all, in part, determined by how well one performs on tests. Those variables which can adversely affect test performance should, therefore, be identified and thoroughly investigated for purposes of prediction and control, and anxiety appears to be a very important influencing variable. Test anxiety, for example, has reportedly

been related not only to IQ and achievement, but also to self-concept, social class, motivation, need for approval, and dogmatism. Unfortunately, the myriad of research studies discovering these various relationships have been inconsistent in their findings and inconclusive as to the antecedents, nature and consequences of test anxiety. Some investigators have attributed these inconsistencies to the measuring instruments used in anxiety research (Krause, 1961; Lazarus, 1966). The most common method of measuring anxiety is the self-report scale on which the individual reports his own unique, phenomenological experience of anxiety. According to Cattell & Schier (1958) more than a hundred such tests have been developed which claim to measure anxiety. Several of the measuring instruments designed specifically for use with children are the Children's Manifest Anxiety Scale (Castenada, McCandless & Palermo, 1956), the Test Anxiety Scale for Children (Sarason, Davidson, Lighthall and Waite, 1958) and the School Anxiety Scale (Phillips, 1966). The Test Anxiety Scale for Children (TASC) is probably the most widely known and extensively researched instrument used in test anxiety investigations with elementary school populations.

The validity of self-report scales, like the TASC, is dependent upon the individual's accurate introspective report of his affective experiences, a dependency which presents some unique problems to the anxiety researcher. A common criticism of introspective self-reports is that such indicators may not have entirely consistent referents concerning the phenomenological experience of affect. When one person reports that he experiences anxiety he may be referring to a different state than another person.

Krause (1961) and Lazarus (1966) have considered the implications of defensive responding in producing invalid results on self-report anxiety instruments.

Other possible sources of error with self-report scales are social desirability responding, which means the individual being tested answers the way he thinks the tester expects him to respond, and acquiescence or yea-saying responding. Phillips, et al (1969) contend that because of the errors inherent in self-report instruments, it is likely that from 30 to 60 per cent of the variance of introspective measures of anxiety can be attributed to something other than what is generally called anxiety.

The realization that there are serious problems in obtaining relatively error free measures of anxiety with self-report scales, has led some researchers to seek other means of inferring the existence and extent of anxiety. Behavorial indices have been considered a possible improvement over self-report measures, (Tolman, 1958), but a more popular approach seems to be attempts at the measurement of physiological arousal. Although physiological research in the social sciences is not a recent development, it has become increasingly widespread due to improved instrumentation and processes to reduce and analyze psychophysiological recordings rapidly and effectively.

A physiological index commonly used is the galvanic skin response (GSR). The sensitivity of the GSR to emotional arousal and the relative ease with which it is obtained are factors which have led to its extensive application in physiological research (Edelberg & Burch, 1962; Levi, 1967). The GSR was selected for this study because it appears to be less subject to the problems associated with self-report scales, such as defensiveness, acquiescence, and social desirability responding. These sources of error are not as likely to affect the GSR since it is difficult to manifest conscious cognitive control over the functioning

of the autonomic nervous system. An additional attribute of the GSR is that it makes possible the collection data over a relatively long time period during which several discrete events could occur. The value of numerous measures of anxiety is obvious when one considers the many situations in which anxiety may vary.

The purpose of the present study was to investigate test anxiety as experienced in an achievement testing situation among elementary school students. Two indices of test anxiety, the GSR and the Test Anxiety Scale for Children, were compared to determine the ability of each type of measure to predict achievement and intelligence test performance. The physiological data were collected in the normal classroom during the administration of a standardized achievement battery.

The present study was not the first to investigate test anxiety with a physiological index. Greer (1966), Chambers(1967), Kissel & Littig (1962), Oetting (1966), and Raphelson (1957) have all used the GSR in the study of test anxiety. The differences between these studies and the present one were the populations under investigation and the settings in which data were collected. In all other GSR investigations of test anxiety, the research was conducted in laboratory like settings in which one subject at a time was tested. In all but Greer's (1966) study (he used first grade students) the population samples consisted of late adolescent or adult subjects.

Method

Sample

The subject sample consisted of 61 male and 58 female fifth and sixth grade students from three school districts in Illinois. One school each from

northern, central, and southern Illinois were used in the investigation thus giving the sample a representative geographical, racial and socioeconomic balance within the state. Twelve subjects from each of 12 classrooms were selected for participation in the study on the basis of several criteria; (a) it was necessary to have recent IQ and achievement test scores available and (b) equal numbers of Ss from each of the three IQ ranges, 89 and below, 90-110, and 111 and above. Random selection of Ss was made from those who met these criteria.

Instrumentation

The three participating schools were selected because each administered the SRA Achievement Battery in fifth and sixth grades. Since analyses consisted of comparisons with previous achievement scores it was desirable that they all come from the same battery.

A short achievement test consisting of ten-minute subtests was constructed from items contained within the SRA Achievement Battery. The arithmetic and language arts subtests were used in one school where SRA Achievement scores were available for these two content areas only. For the other schools, the four areas of arithmetic, language arts, social studies and science were tested. The abbreviated achievement battery was developed specifically for use in the present study, and for the sole purpose of creating arousal levels that might be expected during a normal achievement testing situation. The instrument was neither intended nor used for the purpose of measuring achievement level.

The TASC, a widely used self-report scale of test anxiety developed by [illegible]rason, et al (1958), was used in comparisons with the GSR measures.

Apparatus

An E & M Instrument Co. "Physiograph Six" polygraph recorder was the apparatus used to collect GSR data. Through various modifications of the original equipment it was possible to obtain GSR measures on twelve subjects from each participating classroom. A silver/silver chloride (Ag/AgCl) active electrode and a large silver plated reference electrode were attached to one hand and wrist of each subject according to the procedure used by Nighswander (1970). Wires thirty feet in length made it possible to extend the electrodes from the Physiograph to every position in the classroom. A sodium chloride (Sanborn-Redux) electrode paste was used as a conductive medium between the metallic electrode surfaces and the skin.

Experimental Procedure

The day before the experiment was conducted the experimenters (E_1 & E_2) introduced themselves to the students and briefly described the nature of the study. Although all details were not revealed, Ss were informed that an achievement test would be administered. On the following day, prior to the commencement of classes, and before the students entered their rooms, the Physiograph was moved in and positioned at the rear of the classroom behind a large folding screen. Electrodes were extended to the desks of the Ss and the wires were taped to the floor. When the students entered the room the 12 experimental Ss were instructed to proceed to the restrooms and wash their hands carefully. Upon return, each S's non-dominant hand and wrist was given an additional cleaning with alcohol whereupon the electrodes were attached. The experiment began immediately after all electrodes were attached.

The first 15 minutes of the experiment was an adaption period to allow the Ss to adjust to the feel and novelty of the electrodes. During this time E_2 showed a nonarousing film slide while E_1 calibrated the GSR instrumentation. When adaptation was achieved the ten-minute subtests were administered consecutively in an order which had been randomly determined prior to the collection of data. Continuous GSR data were obtained during each of the subtest administrations and for a 15 minute period of time following completion of the last subtest. During this posttest phase of the study another set of film slides were shown.

The entire experiment was conducted in either 1-$\frac{1}{2}$ or 1 3/4 hours depending upon whether two or all four subtests were administered.

Analysis of Data

The GSR recordings obtained during the experiment consisted of sustained changes in basal skin resistance from a pre-established baseline. Resistance values were converted to conductance units as recommended by Lacy & Siegel (1948). The GSR conductance and TASC self-report measures were compared to determine their differential abilities in predicting IQ and achievement test performance. A multiple linear regression analysis was used in the analysis of the data (Kelly, Beggs & McNeil, 1969).

Results

Approximately one-half of the subject sample was administered a two subtest battery consisting of arithmetic and language arts tests while the other half of the sample took a four subtest battery with additional tests covering the content areas of social studies and science. Because the

treatments were different it was necessary to perform separate analyses on each group. Those who were administered only two tests will be referred to as School A Ss, and those who were administered four subtests as Schools B & C Ss. School A consisted of a total of 57 experimental Ss and Schools B & C combined had 62 Ss.

The intercorrelation matrix found in Table 1 indicates the relationships among IQ and achievement test scores, TASC scores, and GSR scores obtained during various phases of the experiment for School A.

Insert Table 1 about here

As expected the test scores correlated well with other tests scores and GSR scores correlated well with other GSR measures. The meaningful correlations, however, are those between the TASC and test performance and between GSR's and test performance. In this matrix all coefficients over .22 are significantly different than zero at the .05 level of significance. Significant negative correlations were found to exist between the TASC and composite achievement and language arts achievement scores. The arithmetic GSR measures failed to correlate significantly with any test scores, however, the language arts GSR level was significantly related to language arts, arithmetic, IQ, and overall achievement performance.

Table 2 contains the intercorrelation matrix showing relationships between test performance, TASC, and GSR variables, for School B & C Ss. The two additional test performance and corresponding GSR variables for social studies and science content areas are shown in this table.

The intercorrelations between the important variables in Table 2 are markedly lower than those in Table 1.

Insert Table 2 about here

The TASC was found to be significantly related only to science test performance and of all the GSR scores only two revealed significant correlations with test scores. Social studies GSR was positively related to arithmetic achievement and posttest GSR negatively related to science test performance. In all three instances of significant correlations, the coefficients were quite low.

Tables 1 and 2 revealed the low correlations that existed between the TASC scores and the various GSR levels. In those few cases in which the correlations were significant, or approached significance, the relationship between the variables was negative. These results suggest that the two measures, TASC and GSR, were not measuring the same thing.

In the initial stages of analysis it was quite discouraging to discover that for at least half the sample, GSR levels were apparently unrelated to IQ and achievement test performance. For School A Ss, GSRs during language arts tests correlated with all measures of test performance and yet in Schools B & C only two coefficients reached significance and those were quite low, thus accounting for little variance. A closer inspection of the data revealed why such results may have been obtained. The order in which the tests were administered was randomly determined for each classroom because randomization was believed to be good experimental procedure. In the analysis it was discovered that a phenomenon had occurred during the experiment which could render the analysis based on the original design of random ordering of

treatments, meaningless. The results indicated that GSR arousal tended to increase from the first to last test rather than fluctuate from test to test, as expected. Although the order in which the tests were administered did influence the initial arousal levels and overall GSR responding for all tests combined, there was an unmistakable enhancement of arousal across tests from beginning to end. In the analyses this effect became particularly significant because the GSR scores corresponding to the tests over each specific subject content area were combined. For example, GSR levels from a test administered first in order for Ss in one classroom, were combined with GSR levels for the same test given second, third, or fourth in order for Ss in other classrooms. Since test time one cannot be equated with test times, two, three, and four due to the enhancement of arousal over test administrations, such a procedure would render the results invalid, because in reality, except for the first test, the various orders of testing constituted different treatment conditions. Through the administration of the first subtest, however, all variables except the independent variable, were held constant, thus allowing for meaningful comparisons of GSR arousal created by each of the different subtests as they were administered first in sequential order. In view of the inappropriateness of making analyses of all test orders, only those results pertaining to the subtests administered first are presented here.

Table 3 is a correlation matrix of the GSR levels for the classrooms in School A in which arithmetic and language arts tests were administered first. Below the broken lines are the means associated with each of the various groups.

Insert Table 3 about here

Although none of the correlation coeeficients were significantly different from zero it is apparent that the highest correlations were associated with the GSR levels obtained during the arithmetic tests. Quite revealing were the differences noted between both the specific test GSR means and the overall GSR means. The first figure in order is the GSR value associated with its own particular test. Immediately below is the overall GSR mean for all tests given. In Table 3 the arithmetic test generated a significantly ($p < .05$) higher specific test GSR mean, and also a greater overall GSR level, when it was administered first in order.

Table 4 illustrates the results of tests given first in sequential order for Schools B & C.

Insert Table 4 about here

The correlation matrix at the top of the table reveals nine coefficients of correlation significantly ($p < .05$) different than zero. Interestingly all correlations with arithmetic GSR are negative in value while relationships between the language arts GSR level and test performance are positive. The specific and overall GSR means, like those of Table 3 show the differential effects of the various tests on initial arousal. As in School A, Ss in Schools B & C were also most highly aroused by the arithmetic test and the arousal for the overall testing situation was significantly greater when the arithmetic test was given first than when other tests were administered first.

DISCUSSION

The results of the study were somewhat disappointing and yet the discovery of the phenomenon which apparently produced these results was surprising

and profound in its possible implications for educational testing.

The major purpose of this study was to investigate the relationships between GSR and TASC values in an effort to determine whether there was a significant level of concurrent validity between these physiological and self-report measures of test anxiety. The expected high correlations between the two test anxiety measures were not found. Nor did the two indices of test anxiety (TASC & GSR) show consistently significant relationships with the achievement and intelligence test variables. One could surmize, on the basis of these results, that neither the TASC nor the GSR are accurate measures of the construct - test anxiety. Such a hasty generalization may be false, however, for a closer look at data revealed that, at least for the GSR, a confounding variable apparently invalidated those results which were a function of combined GSR levels.

The low and usually nonsignificant correlations between the TASC and test scores were somewhat surprising in view of the fact that the TASC is the most commonly used test anxiety measure in studies with children. Although the present study did not investigate the sources of invalidity impinging upon this self-report instrument, there is a considerable body of evidence which suggests that social desirability responding, defensiveness, and acquiescence can influence the way individuals respond in ways that are unrelated to the construct being measured. (Grandall, Crandall & Katkovsky, 1965; Phillips, 1969). Certainly the results of this study would lead one to question the validity of the TASC as a predictive instrument especially if, as some researchers have contended, anxiety is a state of organismic arousal and the GSR is an accurate measure of arousal.

Initially the GSR results appeared to be equally as disappointing as the self-report findings. The results of the analyses based on combined GSR levels

across all test orders, were of little value from the standpoint of predicting IQ and academic achievement. Only a few scattered correlations were statistically significant and these were generally low or did not replicate across samples. These results were, however, somewhat explainable due to the aforementioned phenomenon of enhancement of GSR arousal across tests regardless of test order. Randomization of test order, which was an effort to manifest some measure of control over differential ordering effects, actually resulted in the invalidation of combined GSR data obtained at different times during the experimental period. Recognizing the futility of making meaningful interpretations of the combined GSR data, analyses of subtests administered first in order only, were performed. The results of these analyses were quite revealing. Arithmetic given first in order appeared to be the single most highly arousing subtest of the four administered, and it was associated the greatest GSR arousal across all four subtests. The arithmetic GSR was also highly correlated with all subtests measures except arithmetic. Since the arithmetic subtest does appear first in the SRA Achievement Battery the implications of these results can be significant. Care must be taken, however, not to overgeneralize from these findings until more detailed investigations into the effects of test order on GSR arousal and test performance are conducted.

Another possibly valuable finding resulting from this study pertains to the phenomenon of increased arousal from the beginning to the end of testing. Although potentiation of GSR over time can occur if improper equipment is used, great care was taken in the selection of electrodes and the electrode medium to avoid this effect. Therefore, the tentative conclusion drawn at this point is that increased GSR levels across tests, as observed in this investigation, was a genuine

function of heightened physiological arousal and not an artifact. Further research is needed to substantiate this conclusion.

SUMMARY

The present study was an investigation into the relative predictive abilities of two indices of test anxiety. A physiological measure of autonomic arousal, the galvanic skin response, and a self-report measure, the Test Anxiety Scale for Children, were used as predictor variables for the IQ and achievement test performances of a sample of fifth and sixth grade students.

The results for the investigation revealed that neither the TASC nor the GSR (combined over four achievement content area subtests) were highly consistent predictors of test performance. The TASC failed to correlate, in a systematic way, with either the GSR levels or with the test scores, findings which cast some doubt on the validity of the TASC as a measure of test anxiety. Further studies into the effects of such variables as social desirability responding, acquiecence and defensiveness on response patterns to the TASC would appear desirable.

The results for the combined GSR data across all tests, were disappointing. A careful analysis of the data, however, revealed that contrary to the predicted fluctuation of GSRs from test to test, there was an increase in arousal across tests. This discovery led to the conclusion that the procedure of combining GSR levels for subtests administered in different orders was an inappropriate one. The random ordering of subtest presentation introduced a confounding variable which invalidated the combined results.

Due to this unexpected phenomenon, analyses of each of the specific test orders were performed. The results showed that the arithmetic subtest

administered first in sequential order was negatively correlated, to a significant degree, with IQ and most of the achievement measures and that arithmetic was the single most arousing subtest of all those administered.

The results of the present investigation appear to have possible implications for educational testing but until other studies into the validity of the TASC, the enhancement of arousal across tests, and the influence of test order on anxiety and test performance are conducted, the findings reported herein must be regarded as tentative.

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Table 1

Intercorrelations of Test Performance, TASC, and GSR Levels for School

Variables	1	2	3	4	5	6	7	8	9
1. IQ		.80	.75	.73	-.21	.07	-.31*	.07	-.10
2. Comp. Ach.			.89	.95	-.31*	.09	-.30*	.10	-.08
3. Ari. Ach.				.80	-.19	.07	-.36*	.00	-.12
4. LA Ach.					-.38*	.11	-.24*	.12	.04
5. TASC						.01	.11	-.19	.06
6. Ari. GSR							.69	.38	.94
7. LA GSR								.57	.89
8. Post-test GSR									.50
9. Mean GSR									

*p< .05

Table 2

Intercorrelations of Test Performance, TASC and GSR Levels for Schools B & C

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13
1. IQ		.70	.50	.68	.49	.50	-.18	.16	.17	-.00	.13	.14	.16
2. Comp. Ach.			.82	.86	.66	.60	-.17	.01	.12	.08	.06	.01	.08
3. Ari. Ach.				.57	.47	.38	-.17	.09	.17	.20*	.11	.08	.18
4. IA Ach.					.48	.45	-.01	.10	.17	.02	.10	.07	.13
5. SS Ach.						.51	-.16	-.04	.05	.09	-.04	-.16	.00
6. Sci. Ach.							-.23*	-.12	.01	-.01	-.17	-.22*	-.10
7. TASC								-.25*	-.34*	-.10	-.08	-.17	-.25*
8. Ari. GSR									.58	.40	.40	.67	.79
9. IA GSR										.39	.44	.57	.78
10. SS GSR											.52	.53	.72
11. Sci GSR												.73	.78
12. Post-test GSR													.82
13. Mean GSR													

* $< .05$

Table 3

GSR Means and Correlations Between GSR Levels and Test Performance for Subtests Administered First in Order Among School A Subjects

	Ari.-GSR	LA-GSR
IQ	.29	-.00
Comp. Ach.	.24	.03
Ari. Ach.	.17	-.04
LA Ach.	.33	.07
Specific Test Mean GSR	2.12	.90*
Overall Mean GSR	2.98	1.81*

* $p. < .05$

Table 4

GSR Means and Correlations Between GSR Levels and Test Performance For Subtests Administered First In Order Among Schools B & C Subjects

	Ari.-GSR	LA-GSR	SS-GSR	Sci-GSR
IQ	-.58*	.46*	-.17	.00
Comp. Ach.	-.59*	.42*	-.27	.28
Ari. Ach.	.04	.46*	-.24	-.19
IA Ach.	-.52*	.41*	-.15	-.34
SS Ach.	-.49*	.45*	-.26	-.06
Sci. Ach.	-.16	-.03	-.34	-.21
Specific Test Mean GSR	1.36	.71	.79	.82*
ll Mean GSR	2.77	1.83	1.90	1.30*

*p. < .05