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THE RELATIONSHIPS AMONG PHYSIOLOGICAL MEASURES
OF ANXIETY AND PSYCHOLOGICAL MEASURES OF ANXIETY:
A MULTIVARIATE, NATURALISTIC APPROACH

BY

GARY ROBERT MORROW

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE
REQUIREMENTS FOR THE DEGREE OF
MASTER OF ARTS
IN
PSYCHOLOGY

UNIVERSITY OF RHODE ISLAND

1973

THESIS ABSTRACT

An examination of the hypothesis that a significant relationship would be found between a set of four commonly employed psychological instruments for assessing anxiety and a set of seven commonly employed physiological measures of anxiety was carried out. The research was done in a naturalistic setting to improve on the typical laboratory anxiety research that has, of late, been highly criticized and analyzed with a multivariate approach as advocated by many critics of traditional bi-variate research. The methodological approach of naturalistic research was operationalized by employing 54 patients suffering a first myocardial infarction admitted to a large metropolitan hospital.

Statistically significant intercorrelations were found among the four psychological instruments employed: Bendig short form of the Taylor Manifest Anxiety Scale (TMAS), and abbreviated versions of the State-Trait Anxiety Inventory (STAI), Multiple Affect Adjective Check List (MAACL), and Mood Adjective Check List (MACL). Two out of the twenty-eight pair-wise correlations between these four instruments and the seven physiological measures averaged over a 24 hour period (heart rate, systolic and diastolic blood pressure, epinephrine, norepinephrine, vanillylmandelic acid, and urine output) were significant; but, in general, a low, negative pattern of

pair-wise correlations was found between the two sets with the physiological set also demonstrating insignificant pair-wise intercorrelations among the seven physiological measures of anxiety.

The multivariate technique of canonical correlation (external factor analysis) revealed no significant linear overlap between the psychological and physiological measures of anxiety. A principal components analysis (internal factor analysis) revealed three factors accounting for 68 percent of the total variance. All four psychological instruments showed high factor loadings, $-.94$ to $-.80$, with communalities from $.93$ to $.66$, on the first group factor which was clearly separated from the other two. The seven physiological measures formed the other two factors which demonstrated some degree of overlap between them.

These results were interpreted as indicating that, for the sample employed, there was clearly a difference between what is being assessed by the psychological instruments purporting to measure anxiety and physiological measures commonly employed for assessing the same emotion.

This interpretation was discussed in terms of Schacter's theory of emotion; and implications for further research were discussed.

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Finally, but certainly not least, my sincere appreciation to my wife Joan, who spent long hours aiding me in this work along with still longer hours typing and attempting to understand why I can't write legibly or learn to spell, while still taking care of me and our two boys.

"... it seems safe to estimate that over 5000 articles or books on anxiety have been published during the past two decades."

Charles D. Spielberger. Anxiety: Current trends in theory and research. New York: Academic Press, 1972, p.6.

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INTRODUCTION

Anxiety has long been regarded as a fundamental human emotion. Cohen (1969) stated that it is clearly reflected in ancient Egyptian hieroglyphics. The eleventh century Arab philosopher Ibn Hazm unequivocally asserted the universality of anxiety as the cornerstone of all human existence when he states that: "No one is moved to act or moved to speak a single word who does not hope by means of this action or word to release anxiety from his spirit." (Kritzeck, 1956, p.573).

In the seventeenth century, most of the intellectual leaders of the day came to share the views of the philosopher Spinoza who believed that anxiety was essentially a state of mind or perhaps an attitude. They also felt that this emotion was a sign of "weakness of the mind" and that the effects of the emotion could be overcome by a "courageous dedication to reason", (May, 1950, p. 24). By the nineteenth century, existential philosophers such as Nietzsche, Schopenhauer, and perhaps most forcefully Kierkegaard, had challenged the earlier belief in the rational control over emotions and stated what they believed to be the obvious insufficiency of reason in overcoming emotion.

Also during the nineteenth century emerged the first serious concern by scientific disciplines in the subject of anxiety. This was primarily expressed by Darwin who believed that the potential for anxiety was an inherent characteristic not only of men but also of animals- that it had evolved as a type of adaptive mechanism over countless generations. His work The Expression of Emotion in Man and Animals published in 1872, marked the first true scientific interest in anxiety.

However, as Spielberger (1972) pointed out:

Prior to 1950...there were relatively few experimental investigations of anxiety in humans. The complexity of anxiety phenomena, the lack of appropriate instruments for assessing anxiety, and ethical problems associated with inducing anxiety in the laboratory have all contributed to the paucity of research. (p.5).

More recently, the publication, in 1950, of three important books can be considered as one of the two major stimulating forces that began what today has become a very prolific and intensely interesting area for research. The books were May's The Meaning of Anxiety, Mower's Learning Theory and Personality Dynamics, and Dollard and Miller's Personality and Psychotherapy. In addition to presenting viewpoints from different theoretical schools, they greatly stimulated both theorizing and research about anxiety.

The second of the two major stimulating forces, at about the same time, came in the form of psychometric

instruments designed to assess anxiety such as Taylor's (1951,1953) Manifest Anxiety Scale and Mandler and Sarason's (1952) Test Anxiety Questionnaire. With the development of many 'paper and pencil' measuring devices, research on anxiety has flourished since about 1950.

In the past 20 years anxiety has become both an overriding concern of society in general (as witnessed by the amount of anti-anxiety medication consumed), and a burgeoning field of investigation by researchers from various disciplines. May (1950) found evidence of society's central concern over anxiety in a survey of contemporary literature, music, art, religion, political and philosophical thought, as well as in the fields of psychiatry, psychoanalysis, and psychology. In the field of music, Leonard Bernstein even went so far as to title his Second Symphony The Age of Anxiety.

Since 1950, over 2500 articles and books dealing with anxiety have been indexed in "Psychological Abstracts". In this same period, the percentage of anxiety studies in the field of psychology alone, (as presented in Psychology Abstracts) has risen from about 0.2 percent of the published literature to almost 1.6 percent. These statistics gathered by Spielberger (1972) led him to conclude that: "it seems safe to estimate that over 5000 articles or books on anxiety have been published during the past two decades." (p.6).

Within this ever increasing field of research on

anxiety there is a great diversity of theoretical viewpoints as well as methodologies. In terms of the various measurement techniques applied to the assessment of anxiety, however, there appear to be two approaches most commonly employed. The first of these common measurements approaches employs physiological measures thought to be representative of anxiety, while the second common major measurement approach is based on psychological psychometric instruments. This second category is comprised of the various 'paper and pencil' instruments such as those mentioned above- the term 'paper and pencil' referring to the fact that these instruments are usually printed items to which a subject responds by checking off some self-referent phrase or adjective as being descriptive of his feelings or mood.

Physiological Approaches to the Assessment of Anxiety

The relationship between the emotion psychologists have come to call anxiety and the various physiological effects engendered by it has long been recognized. As far back as half a century B.C., the Roman poet Lucretius observed that: "...when the mind is excited by some more vehement apprehension, we see the whole soul feel in unison through all the limbs, sweats and paleness spread over the whole body, the tongue falter, the voice die away,...the ears ring..." (Lucretius, 50 B.C.). In his rebuttal to Damascene's division of sorrow into four species, Saint Thomas Aquinas gave an explanation of

an emotion so close to presently defined anxiety that the translators of his Summa Theologica (Fathers of the English Dominican Province, 1941) call it anxiety.

Darwin (1965) provided a vivid description of the physiological manifestations of anxiety remarkably similar to those given 2,000 years before: "...trembling, increased perspiration, dryness of the mouth, change in voice quality..." (p.306).

Investigators have employed a great number of physiological approaches for the measurement of anxiety. Cattell (1972) mentioned over 50 different indices used in various studies. Many of the commonly employed physiological approaches appear, however, to center around two basic areas:

1. Endocrinological correlates of anxiety
2. Cardiovascular signs of anxiety

Endocrinological Correlates of Anxiety

Apparently the first ordered scientific observations on endocrinological correlates of anxiety were carried out by Cannon in the 1920's and summarized years later, (Cannon, 1953). He found increases in a substance called adrenin with anxiety responses in laboratory animals. Von Euler (1959) demonstrated shortly thereafter that the substance adrenin was composed of the two constituents adrenaline (or epinephrine) and noradrenaline (or norepinephrine). These two constituents along with their metabolized end product vanillylmandelic acid, VMA,

are commonly referred to as catecholamines.

Funkenstein (1955) postulated specifically that increases in adrenaline were associated with the emotion anxiety, whereas noradrenaline increases were linked to anger. Since that time, there have been a large number of investigators who have presented experimental evidence both for and against Funkenstein's view. (Elmadjian, Hope & Lansen, 1957; Manger, et. al., 1957; Silverman, et. al., 1961; Nelson, et. al. 1966).

The measurement of urinary catecholamines was first reported by Euler and Lundberg (1954) in their study comparing epinephrine levels in pilots on days when they flew as compared to non-flying days. Further indication that increased catecholamine excretion is associated with anxiety has been reported by Levi (1963) and Jones, Bridges & Leak (1968).

Although these investigators have reported a clear relationship between catecholamine excretion and anxiety, only one study was found in which any robust attempt at quantifying the relationship was given. ^{by} Gusova (1969) reported that catecholamine excretion is a function of emotional state and that, specifically, adrenaline excretion was "proportional" to affective expression.

Cardiovascular Signs of Anxiety

As Deane and Zeaman (1958) pointed out, the use of heart rate as a physiological assessment of anxiety has

been firmly established in a large number of studies under a variety of experimental situations. Among the more interesting and pertinent studies involve: novice parachutists before their first jump (Epstein, 1967); space flight and centrifuge rides (NASA, 1961); auto race drivers (Frost, et. al., 1951); and scholastic examinations (Bogdonoff, et. al., 1961).

As with heart rate, both systolic and diastolic arterial blood pressures have consistently been employed in studies as indices of anxiety (Lorimer, et. al., 1971; Gottschalk and Gleser, 1969). Jones, et. al. (1968) clearly demonstrated that the anxiety of a 15 minute oral exam could result in significantly increased blood pressure.

Increased systolic pressure has been reported as a reliable physiological sign of anxiety by several investigators in a variety of experimental settings: Williams, 1950, 1954; Cattell & Scheier, 1958; Van Egeren, 1963. Mefferd and Wieland (1966) included both measures (along with heart rate, norepinephrine and epinephrine) in their battery of physiological measures of anxiety administered to volunteer Caucasian Air Force enlisted personnel during a period of basic training.

Psychological Approaches to the Assessment of Anxiety

As mentioned above, the ever-increasing number of

psychological psychometric instruments for the assessment of anxiety have predominantly had their birth in the past two decades. Most of the experimental literature on anxiety research in the field of psychology has employed one or another of these instruments. In terms of format, these instruments largely can be placed into two broad categories:

1. Psychological Instruments Employing Self-Referent Descriptive Phrases

These instruments employ phrases that the subject checks as descriptive of his own opinion of himself. The Taylor Manifest Anxiety Scale (Taylor, 1951, 1953) is an example of this type of psychometric instrument. As shown in Appendix A, the subject is provided a number of phrases (such as, "At times I lose sleep over worry." and "I am happy most of the time.") which he can check as descriptive of his own opinion of himself.

2. Psychological Instruments Employing Self-Referent Adjectives

An example of this type of psychometric instrument would be The Multiple Affect Adjective Check List, MAACL (Zuckerman, 1960). As shown in Appendix B, this type of measure provides the subject a list of descriptive adjectives such as "afraid", "confused" and "relaxed", which he can check off as descriptive of his feelings or moods.

THE PROBLEMS

It might be expected, in view of the large number of investigations in the field of anxiety research, that a consensus on the validity of the various measurement instruments and techniques reviewed above would exist. That is to say that experimenter A who employed cardiovascular signs of anxiety (such as heart rate) would be certain that he was, in fact, measuring the same thing as experimenter B who was employing a psychological instrument such as the Taylor Manifest Anxiety Scale. Regrettably, as Spielberger (1972) has pointed out, there has been, in fact, little overlap in the two major measurement approaches. Physiological researchers employ physiological approaches and psychological researchers have stayed with psychometric psychological approaches to the assessment of anxiety.

Most past attempts to investigate intercorrelations between the approaches have provided conflicting results, as reported by Cattell (1972), Izard (1972), Hamburg (1971), Gottschalk and Gleser (1969), Levitt (1967), and Sarason (1960). Although these investigators have pointed out a number of problems with past attempts to ascertain the relationship between commonly employed physiological and psychological assessments of anxiety,

criticism has centered largely in the areas of experimental manipulation and analytic techniques.

Experimental Manipulation:

Sarason (1960) was an early critic who attributed conflicting results to variations in a subject's individual response to an experimental situation. This same approach was taken by Levitt (1967), who also pointed out that in the typical laboratory setting there is very little validation of whether or not an experimenter is, in fact, eliciting the result he desires. Research by Allport (1924), Tomkins (1962), and Izard et. al. (1962) has strongly suggested that few, if any, contrived laboratory situations would do a credible job of eliciting anxiety in all subjects.

The present study was designed specifically to control the potential source of extraneous systematic variance due to the fact that a given experimental condition designed to be anxiety provoking may well have the desired effect on subject X, but not on subject Y in the typically short time the subject is placed in the experimental situation designed to be anxiety producing. Although great imagination and ingenuity has been shown by investigators in setting the anxiety provoking experimental condition, (Levitt, Persky and Brady (1964) employed hypnotically induced anxiety, Lamb (1969) used a public speaking experience), the point remains that

since each subject may react to a given brief situation in a different manner, such contrived laboratory situations can serve to cloud the results of such investigations.

An interesting and sound alternative approach to the contrived, laboratory-manipulated, experimental setting so often criticized, was found in the naturalistic approach to experimentation. Briefly, this approach as advocated by Barker (1969), Willems (1969) and applied to the clinical area by Raush (1969) is an alternative to the experimental method as commonly applied. Instead of setting up a situation in the laboratory and manipulating the subject to elicit a desired response, i.e. anxiety, the naturalistic approach calls for the observation of the subject in an environment free of the manipulation usually associated with laboratories. The aim is to find an environmental setting that evokes the desired response and then carry out the measurement process in that environment.

While this approach was certainly not viewed for the purpose of this study as being the total answer to the criticisms raised over past research, it was viewed realistically as a viable alternative to past methods and as a valid approach towards partially answering past methodological and research design objections.

Operationalized in terms of this study, the naturalistic method took the form of employing a hospital for

the environmental setting. Unlike the vast majority of past investigations, no experimentally designed situation was employed to induce anxiety. Rather, the naturally occurring anxiety resulting from a subject's recent heart attack was employed (Miller, 1965). By having the subjects in a controlled environment for a much longer period of time than in past studies, it was felt that possible effects due to transient situational events were controlled to a high degree, leaving only the naturally occurring reaction to the myocardial infarction as an effect of long duration.

A second aspect, in terms of the present study, of the environmental setting was that approximately half of the subjects employed in the study were participants in an experimental, systematic anxiety-reduction technique being concurrently investigated by the hospital's Psychological Research Section. Although the results of this technique are not yet known, the practical effect that the anticipated success of this technique would have on the present study is to increase the variance of the measures and hence, potentially add greater power to the multivariate analyses employed.

Analytic Techniques:

A second major area of past criticism is of the various statistical treatments employed in past studies. Much of the past literature on the relationship between

physiological and psychological approaches to the assessment of anxiety has centered on simple correlations among various measures (Sarason, 1960; Levitt, 1967). This bivariate approach is criticized Izard (1972) and Cattell (1972) largely on the basis that it is ineffective, not economical, and simply unable to give the information desired in assessing whether the two approaches are in fact measuring a unitary emotion or rather a pattern of coincident emotions called mistakenly by a common name.

These critiques call for a multivariate approach, and a number of researchers, such as the two mentioned, along with Barratt (1972), Mefferd and Wieland (1966), and Nowlis (1965) have been applying such an approach.

The problem of assessing degree of relationship between the two sets of anxiety measures (psychological measures of anxiety and physiological assessments) is handled best by a multivariate technique that, as far as can be determined, has not previously been employed. Canonical Correlation is that technique of choice, for it is designed to obtain the relationship between two sets of measures where each set is comprised of two or more items or measures.

Operationalized in terms of the present study, the various physiological measures are considered as a set while the psychological instruments form the other set. Canonical Correlation indicates the degree of relationship found between elements common to both sets extracted

orthogonally in n-space on the basis of decreasing magnitude of relationship.

Quite complete explanations of both the advantages and applications of this multivariate technique are presented by Tatsuoka (1971), and Cooley and Lohnes (1971).

The second technique employed in the multivariate approach taken in the analysis of the present study was Factor Analysis. As Cattell (1972) pointed out, such a multivariate approach has a number of distinct advantages; among which are the fact that in order to cover the 11 variables investigated in this study, $(11 \times 10/2 =) 55$ separate paired experiments would be required by the bivariate method. A final important point is that neither analysis of variance nor successive pair-wise correlations are able to answer the question of whether a unitary concept or cluster of concepts is being viewed.

So both a naturalistic approach, coupled with a multivariate schema of analysis, was brought to bear on the problem of assessing the degree of relationship between commonly employed physiological measures of anxiety and psychological instruments purporting to be measuring the same thing. This purpose was operationalized in the following specific predictions:

1. There is a significant relationship between a battery of physiological tests of anxiety and a battery

of physiological measures of anxiety.

(2.) Patterns of anxiety measures can be predicted from patterns of physiological concomitants and vice-versa.

METHOD

Subjects:

Fifty-four patients admitted to Rhode Island Hospital suffering from their first myocardial infarction served as subjects for this study. There were 42 males, ranging in age from 43 to 69 with a median age of 56 years old, and 12 females ranging in age from 56 to 69 with a median age of 62 years old. All were Caucasian with the exception of one American Indian. Ethnic backgrounds appeared commensurate with what would be expected of the medium size metropolitan area of Providence, Rhode Island from which the sample was drawn between December, 1971 and January, 1973.

Prior to the start of the study, permission was granted by 23 collaborating cardiologists to obtain data from their patients.

Instruments:

Table 1 shows the physiological measures and psychological instruments selected for this study.

Physiological Measures

The seven physiological measures employed represent a sample of those commonly employed in past studies and were selected on the basis of the following criteria:

TABLE 1

Physiological and Psychological Measures of Anxiety

Physiological

1. Cardiovascular Signs
  - a. Heart rate
  - b. Systolic arterial blood pressure
  - c. Diastolic arterial blood pressure
2. Endocrinological Correlates
  - a. Epinephrine
  - b. Norepinephrine
  - c. Vanillylmandelic acid
3. Heuristic Measure
  - a. Urine output

Psychological

1. Descriptive Phrase Instruments
    - a. Taylor Manifest Anxiety Scale, TMAS (Taylor, 1951)
    - b. State Trait Anxiety Inventory, STAI (Spielberger, 1966)
  2. Adjective Instruments
    - a. Mood Adjective Checklist, MACL (Knowliss and Green, 1965)
    - b. Multiple Affect Adjective Checklist, MAACL, (Zuckerman, 1962)
-

1. Widespread use by past researchers in the field.

The cardiovascular signs employed here were reviewed above in the introduction along with the first two of the endocrinological correlates-- epinephrine and norepinephrine. Vanillylmandelic acid is the end product of both epinephrine and norepinephrine metabolism, as discussed by Petressek, et. al. (1966) and Engleman and Sjoerdsma (1971), and should serve as a viable endocrinological correlate.

It was anticipated at the beginning of the study that measures of intermediary metabolites of both epinephrine and norepinephrine (metanephrine and normetanephrine, respectively) would be available for the analysis. A case for their employment has been made by Petressek et. al. (1966) and Engleman and Sjoerdsma (1971) although their use in anxiety research does not appear to be widespread. Unfortunately, unforeseen problems developed in the laboratory analysis and values were not available for use in this study. Appendix C contains a brief description of the laboratory difficulties encountered.

The final physiological measure, urine output, is not commonly found as one of the measures in widespread use, but rather is this investigator's most reliable personal indicator of anxiety and so was included for heuristic reasons.

2. Reliability of measurements.

Table 2 shows the reliabilities found in the

TABLE 2

Reliabilities of Physiological Measures and References

<u>Physiological Measures</u>	<u>Reliability</u>
<u>Cardiovascular Signs</u>	
1. Heart rate	1.00*
2. Systolic blood pressure	1.00*
3. Diastolic blood pressure	1.00*
<u>Endocrinological Correlates</u>	
1. Epinephrine	.83 (Crout, 1961)
2. Norepinephrine	.91 (Crout, 1961)
3. Vanillylmandelic acid	.94 (Saundersman, 1970)
<u>Heuristic Measure</u>	
1. Urine Output	1.00*

Note: * No published data were discovered on the reliabilities of these measures, so it was realistically assumed that since the measuring devices are mechanical in nature any error would be introduced by humans and, as such, would be normally distributed about a mean error of zero.

literature for the physiological measures. As can be seen, there is adequate reliability in all the measures employed.

3. Availability of measures.

As mentioned earlier, one of the aims of this study was to interfere as little as possible with the environment of the subject. A valuable viewpoint of the naturalistic method employed here is that measurements are obtained as nonreactively as feasible, (Willems, 1969; and Sechrest, 1969). A major advantage of the hospital setting was that all the physiological signs were obtainable as part of the normal routine that formed the subjects' environment. For example, the cardiovascular signs of heart rate, and blood pressures were taken as normal hospital procedure every four hours.

Psychological Instruments

As with the physiological measures selected, the psychological instruments employed for this study represent a sample of those commonly employed by a majority of the investigators in past studies. In addition to their widespread use, they were selected on the basis of the following two specific criteria:

1. Ease of administration

Because of the sample to be used, it was necessary to select instruments that could be administered in a relatively short time. For this reason the short form of the Taylor Manifest Anxiety Scale developed by Bendig

(1956) was selected as well as the short form of the Multiple Affect Adjective Check List of Zuckerman (1960). Spielberger's (1966) State Trait Anxiety Inventory (STAI) was transformed from a descriptive phrase format to an adjective check list as validated by Izard (1972). Thus, an item such as "I feel jittery." became "jittery". These modifications of the psychological instruments were justified because they enabled the administration period of the psychological assessment to be kept under 20 minutes.

Since even the condition of knowing that a psychological test is being taken can affect a subject's anxiety level, as demonstrated by Levitt (1967), the instruments were presented as part of a normal hospital practice designed to improve service by asking patients' reactions to their stay. As shown in Appendix A, the Bendig form of the Taylor Manifest Anxiety Scale had filler items along this line.

2. Validity for the intended purpose

Table 3 presents a summary of the reliability and validity studies concerning the Taylor Manifest Anxiety Scale.

There has been apparently little published information concerning the Mood Adjective Checklist employed here. Knowlis and Green (1965) report the validity in terms of the factor loading and separation of the particular factor in question, but little information on

TABLE 3
Validity and Reliability Studies on TMAS

Study	Population	N	Result
Taylor (1953)	University	59	Test-retest =.88 (3 weeks)
	University	179	Test-retest =.88 (4 weeks)
Hoyt and Magoon (1954)	Clinic	174	Taylor Scores tricotomized into 'high', 'medium' and 'low' compared to counselor rating =.47
Buss (1955)	Psychiatric patient	64	Correlations between rated clinical anxiety and TMAS =.60
Zuckerman (1962)	University	246	=.57 between TMAS and MAACL
Spielberger (1966)	University females	126	=.80 between TMAS and STAI
	University males	80	=.79 between TMAS and STAI

studies employing just one of the factors of the MACL has been presented. The results of a pilot study carried out by this author indicated high intercorrelations with the other psychological instruments employed ($r=.73$ with the TMAS; $r=.93$ with the STAI; $r=.88$ with the MAACL) and so this instrument was retained, (Morrow, 1972).

Validity and reliability studies concerning the State Trait Anxiety Inventory (STAI) are summarized in Table 4.

Information on the Multiple Affect Adjective Check List (MAACL) is presented in Table 5. The correlation between the full scale and the shortened version used here is reported by Zuckerman (1962) to be .82.

Procedure:

Measures were made on each subject on the tenth to twelfth day following admission into the hospital, depending on the laboratory schedule. Selected originally as a target period by the hospital project mentioned above, this time since admission was viewed as viable and realistic for the present study based on two primary considerations. The first of these was that the subject would have been removed from intensive care and had sufficient time to acclimate to the routine and environment of his room. The second was that even the minor interruption and inconvenience caused by the administration of the psychological instruments would pose minimal

TABLE 4

Validity and Reliability Studies on STAI

Study	Population	N	Result
Spielberger (1970)	University	109	test-retest $r = .79$ 1 week
O'Neil, Spielberger and Hansen (1969)	University	50	STAI scores and systolic blood pressure both in- creased on diff- erent tasks
Spielberger (1970)	University male female	334 648	reliability = .83 reliability = .86
Spielberger (1970)	University male female	80 126	$r = .79$ with TMAS $r = .80$ with TMAS
Spielberger (1970)	University male female	80 126	$r = .58$ with MAACL $r = .52$ with MAACL

TABLE 5

Validity and Reliability Studies on MAACL

Study	Population	N	Result
Zuckerman (1960)	University	32	scores rose "significantly" on exam class days
Atkinson (1965)	actors	40	significant ($p < .01$) difference between normal days and days on stage
Hankoff, Rudorfer, and Paley (1962)	psychiatric	50	$p < .01$ relationship between MAACL scores and tricotomized anxiety ratings
Zuckerman (1965)	University	35	test-retest $r = .68$ ($p < .01$) 1 week
Zuckerman (1965)	various 17 studies	19 to 246	$r = .18$ to $.69$ with TMAS; 14 out of 17 studies $p < .05$

potential for adversely affecting the medical condition of the subject.

The subject was placed on a special diet prior to the collection of urine during a 24-hour period in order to control many dietary factors found previously to influence the catecholamine analysis. (A complete listing is given in Appendix D.)

The 24-hour collection period was employed to control the normally occurring diurnal variation in the release of epinephrine, norepinephrine and vanillylmandelic acid in the urine. The total urine output over the 24-hour period was recorded by the ward nursing staff and cross checked against the values reported by the hospital laboratory.

Heart rate, systolic and diastolic blood pressures, the cardiovascular signs, were obtained by taking a simple arithmetic average from the nurses' chart of the subject over the same 24-hour period as that employed for the urine collection.

Weil-Malherbe (1968) described in detail the chemical analytic techniques for measuring the endocrinological correlates from the subjects' urine. For epinephrine and norepinephrine, the Crout Fluorometric Method was used, while the Pisano Spectrophotometric Method was employed for vanillylmandelic acid. (Refer back to Table 2 for the reliabilities of these methods.)

Since correlations between psychological measures

of anxiety and the subject variables of intelligence, age, education and sex have been shown to be non-significant, (Zuckerman, Lubin and Robins, 1965; Zuckerman, 1960; Tolor and Mabi, 1965; Zuckerman and Biase, 1962), no selection criterion was employed for the sample based on these variables.

Special instruction sheets were prepared for the attending physician, alerting him to certain drugs that could possible affect the chemical analyses and requesting that he refrain, if possible, from administering them. Unfortunately, it soon became evident that in selected cases it apparently was not possible for medical reasons to refrain from administering certain medications. A thorough record was made of each drug administered to each patient as taken from the ward record of medication administered.

A separate search of the literature on possible drug effects was made and then the results compared with the medication given each patient. Those patients given medication that would have possibly interfered with the chemical analyses were excluded from the sample. Appendix D reports the results of that literature search and the interfering medications discovered.

Corrections were made to the laboratory values of the catecholamines by employing a method of correcting by body weight developed at Rhode Island Hospital based on over 1000 observations. This correction was made when

it became apparent that some of the urine values recorded did not, in fact, represent a true 24 hour collection period.

RESULTS AND DISCUSSION

The statistical significance of the canonical variates generated from canonical correlational analysis was tested according to the Wilks' Lambda Criterion (Wilks, 1932). The Wilks' likelihood ratio, may, in the canonical correlational problem, be modified and used to yield a Bartlett's Chi-Square approximation (Bartlett, 1947).

The first canonical variate generated in the present analysis of the data proved to be non-significant ($\lambda = .45, \chi^2 = 37.77, d.f. = 28, p < .10$). As the .05 level of significance is commonly accepted as the standard in research methodology, these results must be viewed as representing little more than chance occurrences.

For this reason, it is clear that there were no linear combinations of the physiological measures of anxiety that correlated significantly with a linear combination of the psychological measures. The results of the canonical correlational analysis portion of the multivariate approach showed, then, that it was not possible to infer that any relationship existed between the set of physiological measures and the set of psychological instruments all purporting to be measures of the same thing--anxiety.

Before examining the results of the second stage of the multivariate approach--that of factor analysis--it is worthwhile to examine briefly the R or intercorrelation matrix generated for the data. As there were eleven different variables or measures involved in this study (seven physiological and four psychological, shown in Table 1) the intercorrelational matrix is eleven by eleven and contains the various pair-wise correlations among all the variables considered. Tables 6, 7, and 8 show this matrix as broken down into three constituent portions for ease in interpretation.

Table 6 presents the pair-wise intercorrelations among the seven physiological measures of anxiety, or how they correlate among themselves. As with the other two tables, the correlation coefficients reported are Pearson product-moment correlation coefficients. Table 7 presents the pair-wise intercorrelations among the four psychological instruments for assessing anxiety; while Table 8 shows the pair-wise correlations between the seven physiological and four psychological measures taken two at a time.

These results aid in further understanding the results of the canonical correlational analysis. Inspection of Table 6 reveals that there were only five significant ($p \leq .05$ or greater) correlations out of the $(7 \times 6 / 2 =) 21$ possible pair-wise correlations among the physiological measures. This points out why there were

TABLE 6

Intercorrelations Among Physiological Measures of Anxiety

Variables	1	2	3	4	5	6	7
1. Heart rate	1.00						
2. Systolic blood pressure	.01	1.00					
3. Diastolic blood pressure	-.02	.77**	1.00				
4. Epinephrine	.25	.15	-.01	1.00			
5. Norepinephrine	.30*	-.15	-.10	.25	1.00		
6. Vanillylmandelic acid	.43**	.00	.00	.21	.55**	1.00	
7. Urine output	.20	.22	.19	.06	.47**	.26	1.00

Note: * $p < .05$
 ** $p < .01$

TABLE 7

Intercorrelations Among Psychological Anxiety Instruments

Variables	8	9	10	11
8. TMAS	1.00			
9. MACL	.67**	1.00		
10. STAI	.65**	.90**	1.00	
11. MAACL	.67**	.75**	.89**	1.00

Note: ** $p < .01$

TABLE 8
Correlations Between Physiological Measures of
Anxiety and Psychological Anxiety Instruments

Variables	1. Heart rate	2. Systolic blood pressure	3. Diastolic blood pressure
8. TMAS	.04	-.17	-.21
9. MACL	.03	-.18	-.32*
10. STAI	-.06	-.20	-.35**
11. MAACL	-.04	.05	-.14

Note: * $p < .05$
 ** $p < .01$

TABLE 8--Continued

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4. Epinephrine	5. Norepinephrine	6. Vanilly- mandelic acid	7. Urine output
.02	.00	.02	.06
-.16	-.08	-.10	-.06
-.13	-.02	-.08	-.11
-.06	-.08	-.06	-.05

---

no significant linear combinations of these measures revealed through the canonical correlation, since with very low intercorrelations among the various measures of this set it is unclear whether, in fact, all the measures are measuring the same thing.

Table 8, which shows the correlations between the set of seven physiological and four psychological measures, reveals that only two out of the $(7 \times 4 =) 28$ possible pair-wise correlations between a given psychological instrument and a physiological measure were significant ($p < .05$ or greater). The pattern of correlations between the psychological instruments and physiological measures is seen to be generally negative and non-significant.

The interpretation of the various bi-variate correlations, then, makes clearer the results of the multivariate canonical correlation. The canonical correlation analysis reports linear combinations from each of two separate sets of measures that are related. Close inspection of the measures employed in each of these two sets revealed that not only were the two sets not interrelated in any significant manner, (Table 8) but also that one of the sets (the physiological measures) demonstrated insignificant interrelationship among the measures of the set, (Table 6).

The second stage in the multivariate approach was that of Factor Analysis. Bartlett (1948) has pointed out that canonical correlation can be considered

external factor analysis since individual variables are combined into sets for analysis, (as was done here with the physiological set and the psychological set) whereas the technique of factor analysis can be viewed as internal factor analysis since the variables are each examined separately. By employing both multivariate techniques, a powerful analytic strategy for assessing any possible relationship(s) was used.

The results of the Hotelling (1933) principal components analysis with a Kaiser (1958) varimax orthogonal rotation are shown in Table 9. Three factors accounting for 68 percent of the total variance were retained not only because of the amount of total variance they represented but also because all eleven measures were represented in the factors as well as presenting a factor structure that was interpretable.

The factor structure as reported in Table 9 clearly mirrors the results presented above in that a clear separation is seen between factor I, a general factor on which all the psychological instruments had high loadings as well as communalities, and the other two factors on which the physiological measures loaded. The fact that not one of the physiological measures had a factor loading on the first factor that even approached significance is further evidence consistent with the results of both the canonical correlation and examination of the bivariate correlations.

TABLE 9

Factor Loadings, Physiological and Psychological Measures

(N=54)

Factor	I	II	III	h^2
<u>Physiological Measure</u>				
1. Heart rate	-.03	<u>.65</u>	-.02	.42
2. Systolic blood pressure	.05	.03	<u>.94</u>	.89
3. Diastolic blood pressure	.21	-.01	<u>.90</u>	.85
4. Epinephrine	.08	<u>.45</u>	.07	.22
5. Norepinephrine	.03	<u>.81</u>	-.17	.68
6. Vanillylmandelic acid	.03	<u>.78</u>	-.05	.61
7. Urine	-.03	<u>.60</u>	<u>.32</u>	.46
<u>Psychological Instrument</u>				
8. TMAS	<u>-.80</u>	.08	-.09	.66
9. MACL	<u>-.91</u>	-.08	-.16	.86
10. STAI	<u>-.94</u>	-.09	-.18	.93
11. MAACL	<u>-.92</u>	-.07	-.08	.85

Factor I

This general factor, accounting for 32 percent of the total variance, is clearly a psychological one since all the four psychological instruments showed heavy factor loadings on it. Its clear separation from the other two factors is seen in that the seven physiological measures have low, insignificant, factor loadings on this factor. The four psychological instruments, then, are quite consistent in what they are assessing. And the separation of this factor from the physiological measures points out that what is being assessed is quite different from that being measured by the physiological indices.

Factor II

This group factor, accounting for 20 percent of the total variance, is seen as one of the two factors that comprised the physiological measures. As can be seen from Table 9, the endocrinological correlates discussed above comprise the major part of this factor, and thus it can be labelled as an endocrinological factor emerging from the analysis.

As vanillylmandelic acid is a metabolic end product of both epinephrine and norepinephrine, it is to be expected that the three endocrinological correlates would load on the same factor. The relatively low communality (h^2) for epinephrine on this factor can be viewed from two perspectives. The first of these

is in terms of the various studies reviewed before on the Funkenstein hypothesis (1955) that states that epinephrine is more specific to anxiety than norepinephrine. Seen in that context, it may be that these two measures are assessing different aspects but have enough overlap so that they both assess common elements of anxiety to a certain extent. The second perspective is a statistical one. As seen in Table 10, which presents the distributional statistics for the sample, the distribution of the epinephrine measures was positively skewed. Close inspection of the raw data reveals this to be due to a few reported laboratory values of zero.

The loading of heart rate on this factor was also somewhat unexpected, although the same general pattern was observed in a pilot study. As Deane and Zeaman (1958) pointed out, there have been many studies that have concluded that heart rate is not only a good measure of anxiety but is also highly correlated with both systolic and diastolic blood pressures. It is conceivable that what is shown here is, in fact, a peculiarity of the subject population used in this study. It must be remembered that these subjects have experienced medical damage to their hearts due to the myocardial infarction. While this was fully realized prior to the start of this study, it was felt that the many advantages to be gained from both the naturalistic research approach and the multivariate analysis would outweigh the limited

TABLE 10
Distributional Statistics for Variables (N=54)

Variables	Mean ($\bar{X}$)	Standard Deviation (σ)
heart rate (beats/ minute)	76.98	11.09
systolic blood pressure (mmHg)	107.81	12.42
diastolic blood pressure (mmHg)	69.19	10.01
epinephrine (μ g/24 hrs.)	18.37	28.73
norepinephrine (μ g/24 hrs.)	114.00	62.14
Vanillylmandelic Acid (μ g/24 hrs.)	5.88	2.38
urine output (cc/24 hrs.)	1836.57	632.10
TMAS	5.87	4.99
MACL	14.46	5.43
STAI	33.63	9.64
MAACL	-7.80	7.91

generalizability resulting from employing this select population. And so, the divergent finding here may be attributable simply to an anomaly of the sample employed.

Factor III

This group factor accounting for 16 percent of the total variance is seen as a blood pressure one, as both systolic and diastolic arterial blood pressure showed both high factor loadings and high communalities on this factor.

The sometimes very complex biochemical mechanisms aside, the loading of urine output with both heart rate and blood pressures can perhaps be understood by a simple hydraulic analogy. If the urine output is considered as the product of a simple filtering mechanism, the kidneys, then its output would be dependent on both the rate of flow of the fluid filtered (the blood) as well as the pressure this fluid was exerting on the side of the semipermeable membrane in the kidneys doing the filtration. As the rate of blood flow is governed by the heart rate and the blood pressures determine the fluid pressure, it makes sense that urine output would relate to both measures.

The high, statistically significant intercorrelations among the four psychological instruments (Table 7) were anticipated on the basis of previous work. Past studies employing various populations have yielded significant intercorrelations, although not always as high

as reported here. Izard (1972) pointed out that previous literature has shown the correlation between the STAI and TMAS to be from .79 to .83. Spielberger (1966) reported $r = .52$ to $.58$ between the STAI and MAACL, while Zuckerman (1962) reported correlation coefficients of .57 to .69 between the TMAS and MAACL.

The results of Table 7 show that these high intercorrelations were also found for the sample used here.

The same high intercorrelations found with the MACL add evidence to the contention of Nowlis and Greens (1965) that the factor employed here (Factor B) is a viable measure of anxiety. As the STAI employed the TMAS as one of the three component tests from which it was evolved, high intercorrelations are to be expected, of course.

The fact that abbreviated versions of the TMAS, STAI, and MAACL were employed and still demonstrated the same degree of interrelationship as previously reported for the full versions lends further credence to their reliability, as a portion of the literature reported in support of the validity of each of the psychological instruments used is concerned with correlating the given instrument with others in the field.

While, as mentioned previously, generalizations beyond this sample must be carefully qualified (as with any research), it is quite clear that the specific predictions made prior to the experimental phase of this

study were entirely unsupported for the sample used. The results of the multivariate techniques employed demonstrated consistently that there was, in fact, no relationship between the set of physiological measures employed and the set of psychological instruments utilized in this study. Some individual bi-variate correlations showed significant relationships between certain physiological and certain psychological measures, (Table 8 gives significant correlations between diastolic blood pressure and both the MACL and STAI; however they are negative correlations), but the results of both the canonical correlational analysis and the factor analysis demonstrated clearly that there was no relationship between the physiological measures taken as a set and the psychological instruments taken as a set and applied to this sample.

IMPLICATIONS

The results of the factor analysis indicate that not only is there a difference between what is being assessed by the psychological instruments and the physiological measures applied to this sample, but also that there is not a commonality being assessed by the various physiological measures. This latter result, the non-unitary nature of the physiological results can be compared with results of an experimental laboratory setting, as long as differences in sample composition are taken into account.

Mefferd and Wieland (1966) examined 71 physiological variables taken from a sample of 95 Air Force volunteer recruits. The 64 variables retained for analysis were subjected to a factor analysis which revealed a resulting 22 factor structure accounting for 80 percent of the total variance. They found heart rate, norepinephrine, epinephrine, systolic and then diastolic blood pressures to load (in the order given- with factor loadings of .76 to .17 respectively) on the sixth factor generated which accounted for 3.7 percent of the common variance. Unfortunately, they do not report more information on the total factor structure, although it may be surmised from both the large number of factors reported

and the low variance accounted for by the factor reported, that the physiological variables investigated demonstrated far from a consistency in what they were assessing.

The results of the present study do not, of course, rule out the possibility that the various measures and instruments employed for this sample were assessing different facets of anxiety. Much of the bi-variate research has been criticized by Aronson and Carlsmith (1968) and Cattell (1972) due to the fact that saying that two measures are correlated does not say anything about possible other measures that might be responsible for the relationship. Saying that the rate of melting of an ice cream cone is highly related to the incidence of sunburn on a beach is meaningless until it is realized that they are both the consequence of a sunny day.

Barratt (1972), Cattell (1972), and Izard (1972) all call for a multivariate approach such as that employed in order to partially alleviate such an objection. By the use of sets of measures and techniques such as canonical correlation that reveals relationships between the sets and factor analysis, which reveals relationships across as well as within sets, the level of analysis increases in both power and scope. For by employing such a stratagem, clusters or groups of measures can be identified that form the elements of a larger concept rather than being lead astray by trying to

theorize on the basis of isolated individual measures. Taken in terms of the results presented, this line of analysis would lead to the possibility, that for the sample employed there is a distinct difference between the facet of the emotion called anxiety that is assessed by psychological instruments and the facet assessed by physiological measures. And that, in fact, there also appears to be some separation within the physiological measures themselves.

Taken a step further, the results found for this sample can be viewed in terms of a theory of emotion that Berkowitz (1965) has called: "... an important and provocative conception of emotions that gives special attention to the individual's environment, or at least to his understanding of it." (p. 321). This theory, first proposed by Schacter (1964) postulates two major components as constituents of an emotion such as anxiety. The first of these is a general pattern of sympathetic nervous system discharge or physiological arousal, while the second component is comprised of socially determined cognitions or simply the individual's understanding of the events that produced the excitation.

In the classic series of experiments which form the major body of investigation for his theory, Schacter (1967) injected epinephrine into subjects and then exposed them to the actions of a confederate who appeared

either angered, euphoric, amused, anxious, fearful or simply exhibited no emotion at all. Schacter's expectations that the subjects would interpret their physiological reactions in terms of their cognitive evaluation of how the confederate was acting were fulfilled in that the subjects reported on psychological instruments that they felt angry, anxious or whatever other emotion they had been taught through the modelling of the confederate went with the physiological arousal they were experiencing.

As the psychological instruments examined in this study clearly were assessing a cognitive interpretation of how the subjects were evaluating an emotion, while the physiological measures were assessing what can be viewed as physiological arousal, the results that the two sets of measures were not related can be understood in terms of Schacter's theory.

SUMMARY

The findings of the present study may be summarized as follows:

1. No overlapping patterns of the psychological instruments and physiological measures were revealed by the multivariate methods of canonical correlation and factor analysis. Bivariate analyses revealed the relationship between the two sets of measures to be generally negative and not statistically significant.

2. The factor structure revealed that the four psychological instruments were not assessing the same thing as the physiological measures, and that there was, in fact, some overlap in what the physiological measures themselves were assessing.

3. The psychological instruments were highly inter-correlated, even in the shortened versions applied.

4. The high correlations with other psychological instruments demonstrated by the MACL lends support to the contention that the portion (Factor B) employed here is a viable anxiety measure.

5. Principles of naturalistic research can be applied to the area of anxiety research with minimal interruption of ongoing activity in a hospital.

IMPLICATIONS FOR FUTURE RESEARCH

A number of new avenues for investigation are suggested by this study. It must be realized that the present study does not provide support for these ideas, but rather that they flow from speculations over future extensions of the methods and techniques employed.

1. The present study should have conceptual replications carried out with different populations so that the tentative conclusions may be further tested and modified if necessary.

2. Sets of different physiological measures and psychological instruments should be employed in studies utilizing a multivariate approach so that the findings of this study may be extended.

3. Projective psychological instruments such as the Rorschach and TAT should be employed to ascertain if they are measuring the same dimensions of anxiety as the instruments and measures employed in this study.

4. It is important to employ clinical evaluations and perhaps selected behavioral correlates as part of future work so that further validity information may be gained on the measures along with a closer link to actual clinical applicability.

5. As results from the types of studies suggested

above begin to identify patterns of measures and instruments that appear to be assessing the same or differing facets of anxiety, it should become easier to develop theories of anxiety and anxiety-related phenomenon that conform more to 'real world' findings than many of those presently formulated.

APPENDIX A

Bendig Short Form of the TMAS Employed

The following 38 self-referent statements were presented to each subject under the title of "Patient Evaluation of Hospitalization Period". Instructions required the subject "to give your own opinion of yourself" and to "decide for each statement whether it is true as applied to you or false as applied to you".

- ___ 1. I do not tire quickly.
- ___ 2. I am about as nervous as other people.
- ___ 3. I spend my days under a great deal of strain.
- ___ 4. I cannot keep my mind on one thing.
- ___ 5. I feel that the nurses have been trying to put me at ease.
- ___ 6. I frequently notice my hand shakes when I try to do something.
- ___ 7. I worry quite a bit over possible troubles.
- ___ 8. Often my bowels don't move for several days at a time.
- ___ 9. At times I lose sleep over worry.
- ___ 10. I have received good service when I needed something here.
- ___ 11. My feelings are hurt easier than most people.
- ___ 12. I often find myself worrying about something.
- ___ 13. The staff on the floor have been considerate of me.

- ___14. I wish I could be as happy as others.
- ___15. I am usually calm and not easily upset.
- ___16. I feel anxious about something or someone almost all of the time.
- ___17. I am happy most of the time.
- ___18. It makes me nervous to have to wait.
- ___19. I am treated like a person and not like a case.
- ___20. At times I am so restless that I cannot sit in a chair for very long.
- ___21. I have often felt that I faced so many difficulties I could not overcome them.
- ___22. The service here seems to be reasonably efficient.
- ___23. I have been afraid of things or people that I know could not hurt me.
- ___24. I certainly feel useless at times.
- ___25. I find it hard to keep my mind on a task or job.
- ___26. I have adjusted more quickly to being ill than I thought I would.
- ___27. I am more self-conscious than most people.
- ___28. I am the kind of person who takes things hard.
- ___29. I am a very nervous person.
- ___30. I have been able to feel friendly to my visiting family and friends.
- ___31. Life is often a strain for me.
- ___32. At times I think I am no good at all.
- ___33. I can think as well as before I came here.
- ___34. I am not at all confident of myself.

- ___35. I remember pleasant things more often than I used to.
- ___36. At times I feel that I am going to crack up.
- ___37. I don't like to face a difficulty or make an
important decision.
- ___38. I am very confident of myself.

APPENDIX B

Self-Referent Adjective Checklists (NACL, MAACL, STAI)

This list of 66 adjectives (presented as part of the larger hospital study described earlier) contained the three self-referent adjective instruments employed. The instructions stated that "each of the words in the following list has been used at some time or other to describe feelings or mood". Subjects replied to each adjective in one of the following ways:

- "definitely describes your mood and feelings"
- "slightly descriptive of your mood and feelings"
- "cannot decide if the word applies to your mood or feelings"
- "definitely does not apply to your mood and feelings"

The final instructions were that: "YOUR FIRST REACTION IS IMPORTANT HERE, SO THAT IT IS IMPORTANT TO WORK RAPIDLY".

-
___ 1. active	___ 11. careless
___ 2. afraid	___ 12. cheerful
___ 3. affectionate	___ 13. clutched-up
___ 4. alert	___ 14. cocky
___ 5. annoyed	___ 15. confident
___ 6. apprehensive	___ 16. confused
___ 7. blue	___ 17. content
___ 8. calm	___ 18. downhearted
___ 9. can't concentrate	___ 19. drowsy
___ 10. carefree	___ 20. elated

___21. energetic
___22. fearful
___23. fed-up
___24. frightened
___25. frustrated
___26. helpless
___27. impatient
___28. jittery
___29. joyful
___30. keyed-up
___31. kindly
___32. lighthearted
___33. lonely
___34. nervous
___35. optimistic
___36. panicky
___37. patient
___38. peaceful
___39. playful
___40. pleasant
___41. pleased
___42. quiet

___44. regretful
___45. relaxed
___46. restless
___47. sad
___48. secure
___49. shaky
___50. sluggish
___51. sociable
___52. sorry
___53. strong
___54. subdued
___55. tense
___56. tired
___57. trustful
___58. uncertain
___59. upset
___60. vigorous
___61. warmhearted
___62. washed out
___63. weak
___64. weary
___65. Witty
___66. worried

APPENDIX C

Brief Description of Laboratory Difficulties Encountered in Measurement of Metanephrine and Normetanephrine by the Pisano Spectrofluorometric Method

As discussed in the Method Section, it was anticipated that measurements of the intermediary metabolites of epinephrine and norepinephrine (metanephrine and normetanephrine, respectively) would be available for analysis as physiological endocrinological correlates. Unforeseen difficulties were encountered, however, in the analysis employing the Pisano Spectrofluorometric method.

According to Dr. James Driscoll of Rhode Island Hospital, the problem encountered centered in the fact that some interfering substance was being absorbed in the same spectrographic band as the metanephrines and was hence causing invalid results to be obtained. It is not clear whether or not some medication given the subjects was to blame or that perhaps some reagent employed in the analysis was a cause. The Pisano method employs over five distinct steps, during each of which some interference or unforeseen reaction could have potentially caused the undesirable results obtained.

APPENDIX D

The Effects of Medications on Catecholamine Analyses

Medication	Reference Number From Appendix D References Showing Effects On:		
	Catecholamines		VMA
	Definite	Possible	None
Aminophylline	5		
B-Vitamins	8 (large dose)		
Chloral Hydrate	5		
Chlorpromazine (Thorazine)	1,10,6		
Clofibrate	12		
Ethyl Alcohol	11,5		
Erythromycin	11,14,8	5	
Guanethidine (Ismelin)	11,5	6	15
Guanoxan (Evacar)	11		
Hydralazine	8		2
Imipramine (Tofranil)			6
Isoproterenol	5 (large dose)		
Levodopa	9,6,5,(a)		
MAO Inhibitors (Hydrazine derivatives)	8,9,6		
Methenamine (Uritone)	11,9	5,6	
Methocarbamol (Robaxin)			11,6(b)

APPENDIX D--Continued

Medication	Reference Number From Appendix D References Showing Effects On:		
	Catecholamines		VMA
	Definite	Possible	None
Methyldopa (Aldomet)	11,14,8,9		
Morphine Sulfate			10,6(c)
Nicotinic Acid	11,9		
Nitroglycerin	5,6		9
Quinidine	11,14,8		
Quinine	11,14,5,8		
Reserpine	5,6		11,8,15
Riboflavin	11		
Salicylates			11,8,6
Tetracyclines	11,14,8,9		
Chlorothiazide			2
Digitoxin			5,14
Disulfiram (Antabuse)			6
Diuril			5
Insulin			6
Lithium Carbonate			6
Mecamylamine			2
Meprobanate (Equanil)			10,6
Pentobarital			10,6
Phentolamine			2

Note: (a) Effect on norepinephrine, not epinephrine
 (b) Effects Gitlow test only
 (c) No effect on VMA analysis

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