A REVIEW OF RESEARCH ON PSYCHOLOGICAL CORRELATES OF BLOOD PRESSURE

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The use of measures of blood pressure as dependent and intervening variables in psychological research has a long and exciting history, dating back before the turn of the century. But, psychologists do not seem to have used the measure of an individual's blood pressure to represent "emotional" changes as much as they have used other measures, for example, the GSR. One aim of this review is to encourage a fresh look at the meaning, measures, and results of studies of blood pressure.

The design of this review can be summarized in the following way. The first studies to be considered are pertinent to this question: Are there replicable changes in blood pressure when Ss are presented with certain classes of external stimuli? Secondly, are there characteristic ways of responding to a given external stimulus as a function of certain kinds of cognitive states or processes? The review concludes by reviewing studies which attempt to explore the major question: Do various psychological states have possible causative relationships with levels of sustained high blood pressure?

Perhaps the first review of the literature relating psychological and physiological variables was that by Angell and Thompson (1899) which together with that of Robbins (1919) discussed various psychological variables as they related to Ss' reactions on a plethysmograph. The most comprehensive review was done in 1929 by Darrow. Recent reviews, which consider limited portions of the literature relating psychological and physiological variables, are those by Moses, Daniels, and Nickerson (1956) and Shapiro (1960). Also available is an annotated bibliography
of blood pressure research from 1920 to 1950 (Koller & Katz, 1952). Because hypertension is more frequently found in Negroes than in Caucasians, there is a separate literature which has been reviewed by Schulze and Schwab (1936) and Lennard and Glock (1956). The present attempt is to provide a comprehensive review of that literature which is specifically relevant to persons interested in relationships between psychological and blood pressure variables.

Emotion-Producing Stimuli and Blood Pressure Responses

Techniques for nonsurgical measurement of human arterial blood pressure were first described in 1896 by Riva Rocci (according to Bard, 1956). Given an instrument for easy and painless measurement, a variety of pressors were ingeniously conceived to produce changes in blood pressure. By "pressor" is meant any externally or internally applied stimulus expected to induce a blood pressure response. By way of introduction to the vast amount of literature in this general area, it would be useful to illustrate the sensitivity of blood pressure to various stimuli.

The first published research on blood pressure in American psychology is that by Marston (1917), a Massachusetts lawyer who wanted to demonstrate the validity of measures of blood pressure change for detecting when a person was lying. His Ss were asked to tell either the "truth" or a "lie," embellished around one or two facts supplied by the experimenter. Subjects' introspections were used to show that blood
pressure increased when the Ss began to attempt to deceive, and decreased when they told the "truth." Actually, it did not matter what the objective facts were; so long as the Ss thought they were deceiving or telling the truth their blood pressures were affected. Langfeld repeated the experiment in 1920 and obtained the same results.

Even dreams and music have been associated with changes in blood pressure. MacWilliams (1923) found that blood pressure might rise even while Ss slept, and that this elevation was associated with Ss reporting (on being awakened) that they had been dreaming. Lovell (1941) showed that blood pressure went up following a loud, unexpected sound. Steinman, Jaggi and Widmer (1955) played Ss recordings of Mozart and Beethoven, and produced a decline in blood pressure. When the Ss listened to jazz and Japanese music, blood pressure went up. The literature abounds with results which indicate that blood pressure changes may be associated with many forms of psychological stimuli or stresses.

Psychological Stress and Temporary Elevation of Blood Pressure

A number of researches have shown fluctuation of blood pressure during various kinds of interviews. One of the earliest studies of this kind in American research is that by O'Hare (1920) in which he reported that his patients reacted to the discussion of relevant life problems with an elevation in blood pressure. Alexander (1939b) noticed that when his patients had particularly disturbing sessions in analysis, their blood pressures were markedly elevated. Wolf, Pfeiffer, Ripley, Winter and Wolff (1948) assert that, for their patients, blood pressure
went up when unpleasant life experiences were discussed, and went down with "nice" conversation. Pfeiffer and Wolff (1950) demonstrated rises in blood pressure when Ss discussed personally important topics with "threatening" significance.

Perhaps the most thorough study employing the psychiatric interview as a stimulus is that by Innes, Millar and Valentine (1959). The experimenters used simultaneous recording of the interview and physiological measurements to permit a matching of blood pressure changes with specific content areas in the interview. Contrary to the findings of other studies to be reviewed later, the investigators found no correlations between specific kinds of interview content and blood pressure changes. Blood pressure did fluctuate according to interview content, but the authors were not able to establish a coding category which would fit with the blood pressure changes. There was, however, a significant relationship between the use of self-referent pronouns (I, my, etc.) and increases in blood pressure, regardless of the content of the sentence in which the pronoun appeared or the context of the discussion. Innes, Millar and Valentine's Ss were both normals and neurotics, and it is possible that such a mixture obscured differences between the two groups. Their failure to create a code which would work may be viewed as a criticism of much of the work using the interview technique.

There are some more recent studies which take advantage of objective events posing threats to the physical or psychological life of people who experience them. For example, Graham (1945) measured the blood pressure of soldiers who had seen long combat in the African desert campaign in World War II and found 27 per cent showed high
diastolic blood pressure (100 mm) for several months afterward. Ruskin, Beard and Schaffer (1948) found that the diastolic blood pressure of 56 per cent of Texas City survivors was markedly elevated (95 mm) for about one to two weeks after the tremendous explosion there. A rather unusual experimental environment was created as a stimulus for parachutists by Grimsk (1959). He hypnotized these men and had them "relive" a jump experience. Continuous blood pressure readings were taken. Blood pressures went up when "the plane took off," stayed high during the flight, went down when the Ss "jumped" and felt their chute open. Readings after Ss "hit the ground" were still higher than those taken before "takeoff."

In 1932 Cannon suggested that emotion was a generic term to apply to an emergency pattern of physiological changes regardless of the psychological components, e.g., anger or fear. A study by Ax in 1953 attempted to explore physiological differences accompanying stimuli specifically designed to arouse anger and fear separately. The anger stimulus consisted of insulting behavior to the subject by a lab technician who alternately jostled, verbally insulted, and was generally nasty.

The fear stimulus consisted of a gradual intermittent shock stimulus to the little finger which never reached an intensity sufficient to cause pain. When the subject reported the sensation, the experimenter expressed surprise, checked the equipment, pressed a key which caused sparks to jump near the subjects, then exclaimed with alarm that this was dangerous high voltage short circuit (Ax, 1953, p. 35).

The same subjects were used in both the anger and fear situations. Fourteen physiological measures were taken, and frequency of changes, rather than amplitude, was used to measure response. The number
of diastolic blood pressure, heart rate, GSR, and muscle tension increases was greater for anger than for the fear condition. A similar study is that by Schachter (1957). He exposed Ss to situations intended to produce emotions of pain, fear, and anger in that order. For the pain experience, Ss kept their hands in a bucket of ice water (3 degrees centigrade for one minute). The anger and fear situations were similar to those used by Ax. Subjects responded to these stimulus conditions with a significant increase in diastolic blood pressure to the Pain and Anger conditions and a significant systolic increase to the Fear condition. Another experiment by Funkenstein, King and Drolette (1957) used frustrating tasks to induce anger. Results were similar to Schachter's.

In a recent book, Buss (1961) compares the results of the above three studies in terms of blood pressure changes. He asserts that, in general, these experiments support the notion that physiological emotion, apparently, is not as Cannon hypothesized, i.e., all the same emergency pattern. The results also indicate, that for fear (or anxiety) stimuli, at least, there may be a consistent blood pressure pattern of response: a rise in systolic pressure (and also heart rate) and a smaller increase in diastolic pressure. The results describing the blood pressure patterns accompanying anger are less consistent in these three studies.

Psychological Factors as Intervening Variables

In this section studies shall be reviewed in which psychological variables are used as intervening variables in the research. A frequently
used clinical technique for assessing the dependent variable, blood pressure reactivity, is the cold pressor test. The S immerses his hand (or foot) to the wrist in crushed ice and water at a temperature of four to six degrees centigrade for at least one minute. Subjects experience various degrees of pain, but with no ill effects. All Ss show some increase in blood pressure. While reaction time and rate of recovery may be thought by many psychologists to be important variables with this physical pressor, most research with the cold pressor test has used amount of change from resting level as the significant variable. This is called reactivity as contrasted to the absolute blood pressure level reached.

There are several studies which seem to show that reactivity to the cold pressor test varies according to the psychological characteristics of Ss. For example, White and Gildes (1937) observed that patients with somatic symptoms of anxiety (e.g., finger twitching) showed a greater reaction to the cold pressor test than did patients without these symptoms. Malmo and Shagass (1952) compared the reactivity of various types of psychiatric patients. Subjects diagnosed as neurotic showed greater increases of blood pressure on the cold pressor than did psychotics or a control group of normals, and took longer to recover. More recently Harburg (1962) observed a significant association between college males who reported higher hostility in minor interpersonal conflicts and higher diastolic rise on the cold pressor test.

Cranston, Chalmers, Taylor, Henschel and Keys (1949) combined the cold pressor test and a stressful interview. Subjects were given six to eight cold pressor tests on different occasions to establish their
usual degree of reactivity. Subjects then experienced an interview in which they talked about topics which the investigators judged to be emotionally relevant for them. The interview is reported to have evoked hostility and resentment in most Ss. Immediately after the interview, Ss again took the cold pressor test. Blood pressure levels were significantly higher. The process by which an emotion such as hostility or resentment heightens the effects of pain is not clearly understood. Also, it might be that the cold pressor was merely the final stress necessary to produce an elevation of blood pressure.

Other kinds of physical "stress" conditions are employed to produce blood pressure reactions. For example, Stevenson, Duncan, Flynn and Wolf (1949) had Ss perform a standardized exercise, taking blood pressures before and after. Subjects who were rated by psychiatrists as "relaxed" showed less increase in blood pressure than those rated as "preoccupied" or already in therapy for anxiety symptoms. Thurrell, Greenfield and Roessler (1961) rated psychiatric patients (none of whom were on drug therapy) on degree of "psychological responsivity" based on a fifteen minute interview. Subjects rated as "hyperresponsive" showed a greater variation of blood pressure from a base line following an injection of mecholyl than did those rated "hyperresponsive."

Are There Psychological Determinants of High Blood Pressure?

Much of the research linking psychological variables and blood pressure has been done in an effort to discover the "cause" of permanent
high blood pressure or hypertension. Such studies were begun on the hunch, and some evidence, that there were behavioral differences between persons with high blood pressure and those with low. For example, Alexander (1902) was among the earliest to note differences between the blood pressures of persons committed to mental hospitals and blood pressures of the general population, with the patients tending to have higher blood pressures. In 1919 Moschowitz drew up a personality description of hypertensives based on observations made on his patients. The hypertensive was described as: overweight, sluggish, slow and ungraceful; tense and irritable; with narrow intellectual horizons and no hobbies; sleeping badly; having lost the ability to enjoy life, even though financially successful. Moschowitz carefully avoided asserting this syndrome as the cause of high blood pressure. Other examples of this sort of research are studies by Malmo and Shagass (1950) and Benedict (1956).

Specific Personality Differences of High and Low Blood Pressure Groups

Using a combination of self-ratings and ratings by two peers, Hamilton (1942) found that young high blood pressure Ss are more frequently described as submissive, introverted, less self-assertive, less self-confident, slow, lethargic, and getting less enjoyment from the opposite sex. These results seem similar to those found in a population of college males by Harburg, Julius, McGinn, McLeod and Hoobler (1962) who report positive correlations of Cattell's 16 PF measures of "sensitivity" and "submissiveness" with consistently high systolic blood pressure levels measured in different situations, e.g., on a college
registration line, in the physician's office, and at home taken by the student. Higher blood pressure among this population was also associated with yielding in an argument between peers.

Brower (1947a) correlated blood pressure of college students with scores on the Rorschach and MMPI. He found a significant negative correlation between diastolic blood pressure and FC scores on the Rorschach. FC is considered by Brower to be a measure of adjustment. In another study, Brower (1947b) found significant positive correlations between diastolic blood pressure (he did not measure systolic) and the "?," Depression, Hypochondriasis and Psychopathic Deviate scales of the MMPI. Cattell and Scheier (1959) report correlations between "systolic blood pressure," and some of the Cattell 16 PF factors. No further description is provided of the procedure or the Ss. They claim a positive correlation between high systolic pressure and Extraversion, A+, Q2-, N+, M-, E+, having bigger bones, exuberance, long range goals, low confidence of skill in untried performance, and more tremor in right hand.

There are a few studies which report no differences in scores on personality tests between high and low blood pressure samples. For example, Innes, Millar, and Valentine (1959) found no significant differences between hypertensive pregnant females (average age 26), normotensive females after delivery (age 26), psychoneurotic females (age 32) and hypertensive females (age 53) in scores on the MMPI. Robinson (1959) found no significant relationship between blood pressure and performance on the Maudsley Personality Inventory, and the Porteus Mazes. Storment (1951) compared five groups of male hospital patients using the
Guilford-Martín STDCR, GAMIN and OAgCo. The groups of patients were:
(1) hypertensives; (2) rheumatic heart disease; (3) coronary occlusion;
(4) arteriosclerosis; and (5) noncardiac infectious disease patients.
There were no differences among the five groups on test scores.

Hostility and High Blood Pressure

One of the most energetic "schools" of research on hypertension
is that which promotes the repressed hostility hypothesis. Beginning
with Alexander's (1939a) theoretical discussion, this hypothesis asserts
that hypertension develops because the prehypertensive person continu­
ally represses feelings of hostility instead of expressing them. This
repressed hostility or tension is somatically expressed in increased
blood pressure which, over time, leads to the permanent vascular changes
associated with hypertension. Saul (1939) treated hypertensives in
analysis and concluded that the salient similarities among hypertensives
are "the prominence in every case of a dominating mother . . . marked
inhibition of heterosexuality, repressed hostility and being neither
weak and dependent nor aggressively hostile" (p. 160).

A number of clinical observers have worked along the line of
Alexander's repressed hostility hypothesis. They usually interpret the
material obtained in psychotherapy sessions. It will remain an open
question as to how representative of the general population of hyperten­sives
are those in psychotherapy; it is quite likely that they are a
small and selected part of the population. Sample studies in this area,
yielding results much like Saul's, are those by Wolf, Pfeiffer, Ripley,

There are other studies which raise problems for the idea that hypertensives repress their hostility. Neiberg (1957) gave a multiple-choice form of the Rosenzweig P-F Study before and after a criticism experience. There were no differences in poststress aggressivity between hypertensives and normal Ss. Schachter (1957) exposed Ss to pain, fear and anger situations in that order. Judges rated expression of anger and fear by Ss. High blood pressure Ss expressed more anger and fear; there was a positive correlation between expression of anger and blood pressure. A study by Kaplan, Gottschalk, Magliocco, Rohorst and Ross (1961) further suggests that hypertensives are more hostile than those with normal blood pressure, but that they express their hostility in measurable ways. Shapiro (1960) has reviewed research relevant for the repressed hostility hypothesis and concludes that available data are inconclusive.

The Prehypertensive Personality

In order to successfully argue that a particular personality syndrome precedes the development of hypertension (and might therefore be causative) it is necessary to demonstrate that persons of a given personality type are more likely to develop hypertension than are others. No such research has been done. Indirect evidence is provided in two studies (Ayman, 1933; Kalis, Harris, Sokolow & Carpenter, 1957) which show that young Ss with high blood pressure are more likely than normals to develop hypertension (see, for example, Levy, White, Stroud
and Hillman, 1945) and are similar in personality to older persons with hypertension.

Several other examples of research lend partial support to the idea that emotional responses, conditioned by early learning, may in turn mediate blood pressure reactivity. An experiment by Hokanson (1961b) provided Ss with a stressing social situation. Increase in systolic and diastolic blood pressures under social stress were correlated with scores on several tests of manifest hostility. Subjects high in Test Hostility showed greater rises in systolic and diastolic blood pressure. Hokanson argues that Ss with high Test Hostility scores must feel anxious or guilty about expressing hostility. He relates this to the findings in another study (1961a) in which Ss who released aggression showed a greater decline in blood pressure after the experiment than did Ss who did not aggress. Hokanson contends that "aggression anxiety" acts to inhibit aggression and is related to early emotional conditions of the child by his parents.

Some evidence is available seeming to support the argument that blood pressure reactivity may be genetically transmitted. For example, studies by Hines (1940), Doyle and Fraser (1961) and Shapiro (1961) demonstrate that children of hyperresponsive parents show greater increases of blood pressure to stress than do children of normoresponsive parents. However, a respectable alternative hypothesis, which fits the data equally well, is that hypertensive parents create conditions in the home which lead to development of high blood pressure or reactivity in their children. As far as is known, the only research relating S's reported behavior of his parents and S's own blood pressure reactivity
is that by McGinn (1962). He found that hyperresponsive college males described their mothers as aggressively rejecting them, and fathers passively rejecting, as compared with normoresponse Ss.

These data are consistent with the hypothesis that stressful experiences in childhood can lead to physiological overreactivity to stress in adulthood. Two descriptions of the process by which this might occur are those by Mowrer and Viek (1945) and Malmo (1957). However, there are no studies which have employed direct observation of parental behavior rather than children's or parents' recall.

Finally, if personality characteristics precede development of hypertension and are causally associated with it, then one might expect to find different personality traits among essential hypertension patients as compared with those whose hypertension can be ascribed to some structural malfunction, such as dysfunctional kidney. However, Ostfield and Lebovits (1958) found that essential hypertension patients and renal hypertension patients, matched on age, sex, race and socioeconomic status, showed no differences in group scores on the MMPI or Rorschach or in response to a stressful interview. It is always a possibility that personality characteristics are a noncausal correlate of hypertension in all stages of its development and that both can be attributed to some other causal agent.

Effects of Environmental Stress

One such possible agent is environmental stress. Inadequate behavior in social situations might have disturbing consequences for some people, hence the relationship of personality measures with blood
pressure. For other persons, occupational strains or other stressing events in the daily environment might occasion frequent elevation of blood pressure and lead to the development of the illness in the way suggested by Malmo (1957).

Steiglitz (1930) was perhaps the first to argue that repeated episodes of emotional tension could lead to permanent hypertension. In 1937 Palmer performed a study with the cold pressor test and concluded that hypertension is a chronic emergency response.

Those who have definite essential hypertension usually have experienced severe and prolonged mental or nervous strain and often have suffered from insomnia, functional gastric disorder, marked exhaustion and occasionally, more or less severe nervous breakdown (1937, p. 692).

Reiser and his colleagues (Reiser, Brust, Shapiro, Baker, Ranschoff, & Ferris, 1950; Reiser, Brust, & Ferris, 1951; Reiser, Rosenbaum, & Ferris, 1951) have attempted to link the occurrence of life-crisis and the development of hypertension by intensive clinical examination of the events which preceded the onset of the illness. No specific stress seemed a necessary condition, but the authors feel these stresses usually represent threats to the patient's self-concept, such as threatened divorce, or failure on the job.

Another way to test the environmental stress hypothesis is to examine blood pressures across cultures, predicting that cultures characterized by highly stressful conditions of life will have more hypertensives than those cultures in which life is easier and less stressful. For example, Shreenivas (1951) found lower blood pressures
among natives of East India than are found in the United States. Maddocks (1961a, b) found lower blood pressures in South Sea Islanders than in residents of London, England. However, why should it be expected that the overcrowded conditions of life in the Orient are less stressful than those in more advanced economies? Further, Marcussen (1950) discusses several cases in which symptoms of high blood pressure disappeared when the S was under an extreme environmental stress (e.g., being a prisoner-of-war of the Japanese) but reappeared upon re-establishment of a "normal" pattern of life.

The most effective test of the stress-produces-hypertension hypothesis would be to expose an organism to stress and see whether it develops hypertension. Selye (1943), Farris, Yeakel, and Medoff (1945) and Yeakel, Shenkin, Rothboller and McCann (1943) claim that rats exposed to loud noises (sounds produced by an air blast) at frequent intervals for a long period of time develop hypertension. Russian researchers have also been able to experimentally produce hypertension in animals using Pavlovian conditioning techniques, according to a review of their work by Simonson and Brozek (1959).

However, some researchers have not been able to duplicate these results. Shapiro and Horn (1955) used conditioning techniques in an attempt to produce experimental neuroses in cats. Full-blown neurotic behavior never developed, according to the authors. Neither was the blood pressure of the conditioned animals markedly above that of controls. Shapiro and Meibado (1956) exposed rats to various conditioning procedures designed to evoke "chronic anxiety." No hypertension was produced, but there was evidence that existing vascular disease could be
seriously exacerbated by the stress procedures. The Shapiro studies used a conditioning technique rather than the noxious stimuli procedures of Selye and Farris because, as Shapiro (1960) has pointed out, the latter involve long periods of extreme fatigue for the animal in addition to "psychic" effects, thus clouding the interpretation of results. On the other hand, there is reason to suspect that Shapiro's animals never experienced the degree of stress that did the Selye and Farris animals and that this amount of stress is necessary to produce permanent high blood pressure.

Discussion

In conclusion, it should be noted that most of the extant research is the product of members of the medical profession. For some unclear reason psychologists lost interest in blood pressure as an important physiological variable to be related to personality factors shortly before 1930. Some valuable research has been produced by psychologists in very recent years, but in small quantity. One of the consequences of domination of the field by medical researchers is that much of the research does not meet those methodological criteria which psychologists would employ.

The following problems are seen as those which are most in need of solution at the present time.

1) Can permanent high blood pressure be induced in animals by techniques which are commonly accepted as producing experimental neuroses?
2) What, if any, is the relationship between childhood experiences and blood pressure characteristics?

3) Are certain young adult personality types more likely to develop high blood pressure than others?
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