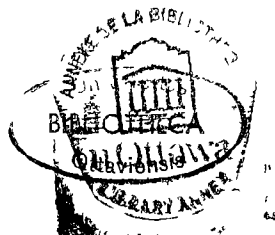


RELATIONSHIP OF PSYCHOLOGICAL  
STRESS-TYPE OF THE INDIVIDUAL  
TO IMPROVEMENT OF SPECIFIED  
FUNCTIONS FOLLOWING CEREBRAL  
VASCULAR DISEASE

By John W. Cullen.

Thesis presented to the School of  
Psychology and Education of the  
University of Ottawa as partial  
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Philosophy

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## CURRICULUM STUDIORUM

John F. Cullen was born January 24, 1934, in Janesville, Minnesota. He received the Bachelor of Arts degree in Philosophy from St. Mary's Seminary College, Baltimore, Maryland, in 1956. He received the Master of Arts degree in Clinical Psychology from the Catholic University of America, Washington, D.C., in 1960. The title of his thesis was Selective Sensitization: Its Effect on the Word Choice of Experimentally Facilitated and Experimentally Frustrated Subjects.

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## INTRODUCTION.

Stroke is one of the most common causes of disability and death among older people in this country. Yet it is still a little-understood disorder. It is known that younger people, and people in better overall health, generally recover better than older and sicker people, but the rate of recovery that can be expected remains a baffling question.

It is the common observation of professional people working with acute stroke patients that spontaneous recovery of some functions, such as speech, or motor ability, may occur very rapidly after the onset of the stroke. This rapid return of a function that was interrupted by the stroke is interesting from a theoretical point of view. The function depended in some way on the area of the brain affected by the vascular lesion, and return of the function cannot be caused by regeneration of the injured tissue--brain tissue has almost no capacity for regeneration. Similarly, vicarious functioning of some other area of the brain could hardly have taken over the control of the disturbed function, since present knowledge indicates that considerable time is required to establish such connections in the brain. Therefore some other explanation is needed.

One theory advanced posits an edematous reaction in the brain tissue surrounding the area of a lesion. Widespread edema disturbs brain functions, which return only when the

pressure on the control centers is reduced. Some kinds of people seem prone to the development of edema.

This experiment is an attempt to identify physiological high-stress types of individuals after they have sustained a vascular lesion from a stroke. These high stress subjects should be susceptible to the formation of cerebral edema, which can disturb functions measured by well-chosen psychological tests. Since sooner or later the edema subsides, these subjects should show a higher degree of spontaneous recovery on the tests than do subjects who do not readily develop edema. The validity of this logic is tested by this experiment.

This is clinical research, and the problems faced in conducting this kind of clinical study with acute stroke patients cannot be overstated. The problems are discussed at length in this paper.

The report begins with a review of the literature supporting the thinking involved in the study. This is followed by a design for testing the hypotheses, and then the hypotheses themselves are stated. Following the presentation of results, implications for further research are discussed, and in an appendix, illustrations of the psychological tests are presented.

## CHAPTER I

### REVIEW OF THE LITERATURE

In this chapter, a selective presentation is made of the literature on recovery of function following brain lesion, and some background for Selye's stress theory is given. It is the purpose of this experiment to infer a functional relationship between certain findings in these two areas of knowledge, and then to test experimentally the inference which has been made. Since the subjects studied were hospitalized patients who had just experienced a stroke, some background on the nature of a stroke is required.

A cerebral vascular accident, or stroke, is due to the blockage or occlusion of a cerebral vessel. This occlusion can have varying effects depending on where the occlusion occurs and what brain tissue is affected. In the case of the most readily recognized stroke, hemiplegia and/or aphasia occur. In acute cases there is nearly always some permanent damage to brain tissue in the area irrigated by the diseased vessel. The psychological effects of the recent vascular lesion, if any can be discovered, are usually expressed as impairment or interruption of one or more specific functions. The impairment may be accompanied by personality changes, but it is not the purpose of this paper to discuss these. Dysfunction, such as aphasia, can be strikingly obvious, even

without any specialized measuring instrument. However, with specialized test batteries, such as the one employed by Reitan<sup>1</sup>, relatively subtle effects of the cerebral pathology may be demonstrated.

It would be inconsistent with the literature to be discussed to say that observed psychological deficits appearing in close temporal relationship to a cerebral vascular accident are a direct and primary consequence of actual brain lesions; however, it is entirely reasonable to say that newly acquired impairment is somehow attributable to the stroke.

As early as 1914, there were reports in the literature of reversible impairment following cortical insult, and this was linked to temporary pathology secondary to the primary lesion. Von Monakow<sup>2</sup> described this as a shock-like effect following cortical insult. Thus it is hardly a new idea that factors other than actual brain lesion can give rise to acquired psychological deficit. Von Monakow theorized that removal

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1 Ralph M. Reitan, Psychological Deficits resulting from Cerebral Lesions in Man, mimeographed paper presented to the Pennsylvania State University Symposium, August 7, 1963; also appears as a chapter in J.M. Warren and K. Akert, eds., The Frontal Granular Cortex and Behavior, New York, McGraw-Hill, 1964, (p. unknown).

2 G. von Monakow, Die Lokalisation im Grosshirn und der Abbau der Funktionen durch kortikale Herde, Wiesbaden, Bergmann, 1914, (p. unknown), cited by Donald G. Fergays, Cf. footnote number 4.

of one cortical area, even though it had been essential to one given function, could withdraw a source of neural facilitation to other quite different cortical or subcortical areas, thus temporarily hindering their activities. He gave this theory the name Diaschisis.

Alford<sup>3</sup> in 1948 argued that an edema-like reaction gradually spreads to tissue adjacent to the lesion, and even to more remote loci in the brain, temporarily inhibiting certain functions. With subsidence of the edema, spontaneous return of disrupted functions can occur. In 1952 Fergays<sup>4</sup> provided experimental support of Alford's idea in studies with both rats and humans, and in 1960 Herschberger<sup>5</sup> replicated Fergays' work with rats. The human subjects Fergays<sup>4</sup> worked with were neurosurgery patients at the Montreal Neurological Institute. His study of serial testing of fifty of these patients showed delayed aphasic, motor, sensory, and intellectual defects following brain operation. Although in the

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<sup>3</sup> L.B. Alford, "Cerebral Localisation, Outline of a Revision", in Nervous and Mental Disease Monographs, Vol. 77, 1948, p. 3-99.

<sup>4</sup> Donald G. Fergays, "Reversible Disturbances of Function in Man following cortical Insult", in Journal of Comparative and Physiological Psychology, Vol. 45, No. 3, Issue of June 1952, p. 209-215.

<sup>5</sup> Austin C. Herschberger, "Delayed Loss of Function due to Brain Lesion", in The Psychological Record, Vol. 10, No. 1, issue of January 1960, p. 1-7.

immediate postoperative period the level of functioning was actually a little better than that found preoperatively on the tests, disturbances on the psychometric tests began to show up about the third postoperative day. By the twentieth day, partial or complete recovery from deficits had occurred without any special training. Fergays concluded that the delayed impairment could be interpreted as a function of cerebral edema which had been precipitated by the surgical lesions, and which required some days to develop. The increasing intracranial pressure in the areas affected by the edema temporarily inhibited some functions, and these functions did not begin to return until the intracranial pressure began to decrease. The edematous response appears to be a usual consequence of surgical or other lesions of the brain.<sup>6</sup>

Reitan<sup>7</sup>, discussing his experience at Indiana University Medical Center, describes cerebral edema as inevitable following brain surgery. The questions which arise are (1) whether Fergays' finding of delayed impairment is solely a product of cerebral edema, and (2) to what extent the edema is quantitatively and qualitatively similar from one patient to another.

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<sup>6</sup> S.P. Hicks and S. Warren, Introduction to Neuro-pathology, New York, McGraw-Hill, 1950, p. 123+269.

<sup>7</sup> Ralph M. Reitan, presentation to the Ontario Psychological Association Institute on the Psychological Effects of Brain Lesions, Toronto, February 2-4, 1965.

On the first question, Herschberger<sup>8</sup> reports findings from his study with rats which he feels are consistent with a combination of both the shock-like reaction postulated by von Menakow<sup>9</sup> and the edema-like reaction of Alford.<sup>10</sup>

For the second question, which has considerable bearing on the present study, a brief excursion into Selye's theoretical formulations may prove illuminating. The edematous response of tissue surrounding an area of injury or lesion is described by Selye<sup>11</sup> as an adaptive (or protective) reaction of the organism. It is in effect a way of sealing off and defending the area. The extent of this reaction at any given time is determined primarily by the balance of pro- and anti-inflammatory hormones at that moment. Although this hormone balance fluctuates in response to the many factors operating on an organism at any particular time, each person has a more or less characteristic point of balance for the pro-inflammatory and the anti-inflammatory hormones. This point of balance is referred to in this paper as the "physiological stress-type" of the individual. The term "stress" is used because

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8 Herschberger, Op.Cit.

9 von Menakow, Op.Cit.

10 Alford, Op.Cit.

11 Hans Selye, The Stress of Life, New York, McGraw-Hill, 1956, p. 103.

Selye sees stress as the most important factor influencing the state of an organism. The stress-response mirrors the action of the hormone secretions on an individual's system, and is thus said by Selye<sup>12</sup> to be "the common denominator of all adaptive reactions in the body."

To clarify the semantics involved, stress is a reaction or a response to a stimulus called a stressor. The stressor can be either physical or psychological. Selye infers the presence of the stress response by observing and measuring its manifestations--adrenal enlargement, increased corticoid concentration in the blood, loss of weight, and so forth. He defines stress<sup>13</sup> as "the rate of wear and tear in the body," and more operationally<sup>14</sup> as "the state manifested by a specific syndrome which consists of all the nonspecifically induced changes within a biologic system." The stress reaction goes through three stages<sup>15</sup> which are called the alarm reaction, the stage of resistance, and in some cases, a stage of exhaustion. Collectively, these reactions are termed by Selye the General Adaptation Syndrome or G.A.S.

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12 Selye, Op. Cit., p. 54.

13 Ibid., p. 274.

14 Ibid., p. 54.

15 Ibid., p. 64.

Although at first glance, the alarm reaction or first stage of the General Adaptation Syndrome might be accepted on the basis of intuition or face validity as a correlate of anxiety, the literature does not support this view. In fact, Cattell<sup>16</sup> reports that the alarm reaction (or effort-stress as he prefers to call it) may have some inverse relation to anxiety. In his words:

When a person grapples with a difficulty, he shows the stress response; when he retreats and attempts escapist solutions, he shows anxiety. The so-called psychosomatic neurotic, who develops a physical symptom from his encounter with a problem, is in this sense the opposite of a neurotic.<sup>17</sup>

In speaking of the physical symptoms that people develop, Selye makes the point that the General Adaptation Syndrome, or its less involved counterpart, the Local Adaptation Syndrome (L.A.S.) can sometimes be set off inappropriately by a relatively insignificant stressor.<sup>18</sup> At such times, the system is really overprotected and the adaptive reaction becomes more of a problem than the precipitating stressor. Selye<sup>19</sup> refers to this as a derailment of the adaptation syndrome, and the ensuing

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<sup>16</sup> Raymond B. Cattell, "The Nature and Measurement of Anxiety", in the Scientific American, Vol. 208, No. 3, issue of March 1963, p. 102.

<sup>17</sup> Ibid., P. 102

<sup>18</sup> Selye, Op. Cit., p. 103.

<sup>19</sup> Ibid., p. 66.

diseases he calls diseases of adaptation. Examples of such diseases are hay fever, rheumatoid arthritis, and allergies. Some individuals have a lower threshold than others for these diseases of adaptation, and in the present study these people were classified as (physiological) high-stress types. These people over-respond in their resistance to stress<sup>20</sup>.

High-stress people, in addition to having a relatively low threshold for diseases of adaptation, are characterized by alterations in the white cell balance in the blood, and notably by changes in the number of white cells circulating in the blood which will stain with the dye eosin<sup>21</sup>. These latter cells, known as eosinophils, increase greatly in number when a person suffers from asthma, hayfever, or allied conditions. Their number shows a sharp decrease in the immediate presence of physical or psychological trauma; that is, during the alarm reaction. This decrease in eosinophils (eosinopenia) is used by Selye<sup>22</sup> as a physiological measure of stress. The stressor or stimulus precipitating the eosinopenia can be a psychological one or even a conditioned stimulus. For example,

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20 Selye, Op. Cit., p. 103.

21 Ibid., p. 21.

22 Hans Selye, "The General Adaptation Syndrome and the diseases of Adaptation", in Journal of Clinical Endocrinology Vol. 6, p. 117-230.

Gallender et al.<sup>23</sup> have conditioned rats to respond with eosinopenia to stimuli previously associated with traumatic experiences (electric shock). Other investigators have found that eosinopenia can be precipitated by adrenalin injection<sup>24</sup>, and that eosinophilia (increase in eosinophils) can be related to cigarette smoking<sup>25</sup>. The eosinophil level does not appear to be affected significantly by lack of sleep<sup>26</sup>. This writer was unable to find any reference in the literature to the relationship between eosinophil level and the chronological age of the person.

The literature on the psychological effects of brain damage in humans is quite extensive and sometimes contradictory.

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<sup>23</sup> H. Gallender, O.T. Law, R.L. Isaasson, "Changes in the Circulating Eosinophil Level associated with Learned fear; Conditioned Eosinopenia", in the Journal of Comparative and Physiological Psychology, Vol. 53, Issue of December 1960, p. 520-523.

<sup>24</sup> K. Inasumi, H. Shimizu, "Elaboration of the Conditioned Reflex Eosinophil Count Reduction through Adrenaline Injection in Humans", in Journal of Experimental Medicine, Vol. 9, issue of May 1962, p. 32-36.

<sup>25</sup> I. Schoen, "Eosinophilia apparently related to Cigarette Smoking", in the New England Journal of Medicine, Vol. 270, issue of June 18, 1964, p. 1344-1347.

<sup>26</sup> G.E. Thomas, "Psychobiological Studies II: Sleep Habits of Healthy Young Adults with Observations of Level of Cholesterol and Circulating Eosinophils", in the Journal of Chronic Diseases, Vol. 16, issue of October 1963, p. 1099-1114.

In fact, Meyer<sup>27</sup> prefaces his review in Eysenck's Handbook with the note that he is attempting "to salvage from this mass of data and contradictory generalizations some unifying principles" with respect to the effects of brain lesions in man. One of the places where unity is conspicuously lacking among investigators is in the varieties of tests they have applied in this area. Of course, there is merit in the use of many approaches to the study of a problem, but these varying approaches mean that findings often cannot be directly compared with each other.

While there is no general agreement among the experts as to an ideal test battery, some investigators have at least settled on regularly administered batteries. Reitan<sup>28</sup>, for example, has used a standard test battery for a period of some thirteen years, and has accumulated great masses of data which can be compared from one patient to another. By 1959 his battery had already been administered to "about 2,000"<sup>28</sup> patients, and since then a steady stream of patients at Indiana University has received the same battery. Surveying the accumulated data,

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27 V. Meyer, "Psychological Effects of Brain Damage", in the Handbook of Abnormal Psychology by H.J. Eysenck, Ed., New York, 1961, Basic Books, p. 529-565.

28 Ralph M. Reitan, Principles Used in Evaluating Brain Functions with Psychological Tests at the Neuropsychology Center, Indiana University Medical Center, mimeographed paper dated January, 1959, p. 1-18.

Reitan has suggested<sup>29,30</sup> that the Trail Making Test (TMT) is one of the most sensitive tests in his battery for reflecting dysfunction related to brain damage. He has further suggested<sup>31</sup> that the TMT is relatively impervious to practice effect, and thus offers some advantages as a periodically administered test used to gauge improvement or deterioration in a patient's mental ability. Fortunately, the TMT is not formidable in appearance, and is brief enough that it can be attempted by patients who are recovering from a severe cerebral accident.

A somewhat novel test has been described by Rosvold et al.<sup>32</sup> It was specifically designed as a potential technique for classifying patients as brain-damaged or non-brain damaged, and the reports by both Rosvold's group and by Schein<sup>33</sup>

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29 Ralph M. Reitan, "Validity of the Trail Making Test as an Indicator of Organic Brain Damage", in Perceptual and Motor Skills, Vol. 8, 1958, p. 271-276.

30 Ralph M. Reitan, "The Relation of the Trail Making Test to Organic Brain Damage", in the Journal of Consulting Psychology, Vol. 19, 1955, p. 393-394.

31 Ralph M. Reitan, Personal Communication with the Author, letter dated June 5, 1963.

32 H.E. Rosvold, A.F. Mirsky, I. Sarason, E.D. Bronsoms, Jr., and L.H. Beck, "A Continuous Performance Test of Brain Damage", in the Journal of Consulting Psychology, Vol. 20, 1956, p. 343-350.

33 J.D. Schein, "Cross Validation of the Continuous Performance Test for Brain Damage", in the Journal of Consulting Psychology, Vol. 26, 1962, p. 115-118.

indicate that it is very successful in this respect. This test, the Continuous Performance Test (CPT), can be repeatedly readministered with negligible effects from practice.<sup>34</sup> For this reason, and because of its sensitivity in detecting even very brief lapses in attention span, it was recommended by Schein<sup>34</sup> for inclusion in the present project; sensitive measures were needed to detect temporary cerebral dysfunction. The Continuous Performance Test itself is described in a subsequent section of this paper, and is illustrated in the appendix. Its ability for detecting brief lapses in attention span assumes some importance because such lapses seem to occur with greater frequency in brain damaged groups than they do in groups of normal controls. Psychological tests such as the Memory Span for Digits, as for example on the Wechsler scales, can often detect relatively gross lapses in attention, but very brief lapses ordinarily would escape detection with such a test. The Continuous Performance Test was tailor made to provide a very sensitive measure of gaps in a patient's sustained attention.

The tests described above have the virtue that they can be repeated, and so they provide a means of studying improvement following a stroke.

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<sup>34</sup> J.D. Schein, Personal Communication with the Author, letter dated July 7, 1962.

Selye's theory of stress, as already discussed, provides a basis for evaluating the relative severity of adaptive tissue responses in the brains of people affected with a stroke. If it is known that a given individual probably is experiencing a marked adaptive reaction, then it can be assumed that at least some of his impairment on initial tests of psychological functions may be due to his adaptive reaction rather than to the actual brain lesion caused by the stroke. If such subjects can be identified, then it seems quite logical to predict rapid test improvement for them as their adaptive response subsides. This experiment is designed to pick out just such subjects. The test is in seeing if they do improve more rapidly, as predicted.

The next chapter outlines the design of the experiment for testing this hypothesis.

## CHAPTER II

### EXPERIMENTAL DESIGN

This chapter presents a discussion of the tools, population, and methods which were used to test the specific hypotheses stated at the end of the chapter.

The chapter begins with a description of the physiological measures which were used in classifying subjects as high or low stress-types. This description is followed by a description of the psychological tests selected for the experiment, as well as a rationale for the choice of tests. Following this, some comments are made on the sample population. Criteria which subjects had to meet to be included in the study are mentioned, and the referral procedures are described. Reference is made to the difficulty encountered in collecting an adequately sized sample of acute stroke patients. Finally, the method of the experiment is outlined, and the specific hypotheses are presented.

#### 1. The Physiological Tools

The dichotomous classification of subjects as high or low physiological stress types required investigation of the subjects for the presence of certain physiological correlates of stress. As mentioned in the preceding chapter, Selye and others have used the circulating eosinophil level as an index

of stress, and Selye<sup>1</sup> himself suggested for this study that eosinophil counts could be used as the basis for the decision about the stress group to which a subject should be assigned. Since all the patients seen for this study were hospitalized, it was possible to collect additional information from the medical records and from direct interview of the patient himself, regarding the number of diseases of adaptation he had had. This information was used in conjunction with the eosinophil counts in assigning patients to high or low stress groups.

Eosinophils are a class of polymorphonuclear leucocytes or white blood cells which are distinguished by the fact that they stain clearly with the dye eosin. In order to make the analysis for these cells, blood samples were drawn at weekly intervals from subjects included in the study, with the first sample taken the morning following the receipt of authorization from the attending physician for the study of his patient. Both the collection of the blood samples and the actual count were performed by registered medical laboratory technologists, following standard procedures. Blood samples sufficient to fill two pipettes were taken in the mornings, from a lancet puncture of one of the fingers.

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<sup>1</sup> Hans Selye, Personal Communication with the Author, University of Montreal, February, 1963.

It is known<sup>2</sup> that circulating eosinophil levels can fluctuate considerably, even in normal subjects, depending on the involvement of the autonomic nervous system, the glandular part of the pituitary gland, and the suprarenals. Of particular importance is the fact that the circulating eosinophils follow a 24-hour periodicity cycle which is species specific. In man, the lowest count occurs in the early hours of the morning, prior to the initiation of vital activities. Godlowski refers to this physiologically occurring low point as "endogenous eosinopenia".<sup>3</sup> Because of the diurnal cycle, it is important that blood samples to be examined for circulating eosinophils should be drawn at approximately the same hour in each case. When this precaution is observed, fluctuations can be attributed to factors other than diurnal variation. Thus technicians were instructed to draw the blood samples at approximately the same hour each morning.

In making the count of eosinophils, standard counting techniques<sup>4</sup> were followed using certified Prepper Trophy Thoma

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2 The information given here about eosinophil fluctuations is taken from Z.Z. Godlowski, Enzymatic Concept of Anaphylaxis and Allergy and the Role of Eosinophils in Anaphylactic Reactions Related to Hormonal Alterations, Edinburgh, Livingstone, 1953, p. 94-95.

3 Ibid., p. 94-95.

4 Notes compiled by G.M. Rutherford of Ottawa Civic Hospital, as presented by Randolph of Northwestern Medical School, Chicago, at the Clinical CWH Conference, Chicago, October, 1949.

white blood cell diluting pipettes and AO Bright-Line hemacytometers. The eosinophil stain used colors all the white cells with a reddish color, but the eosinophil cells become a deep red and are clearly distinguishable. For each blood sample, the medical technologist made two separate counts of cells appearing in the nine squares of the hemacytometer grid, each of these counts being done on a different portion of the blood sample. The average of these two counts was then entered into the formula<sup>5</sup> for calculating the absolute number of circulating eosinophils per cubic millimeter of blood.

The reliability or consistency of the eosinophil counts obtained on each sample of blood can be regarded as high, since the method of making two counts is self-correcting. If these two counts are not consistent with each other, additional counts are made. Standard laboratory techniques are designed to keep the error within a maximum limit of ten per cent. Since the circulating eosinophil level varied from week to week, sometimes considerably, it was inappropriate to attempt to compute the test-retest reliability of the counts done one week with those done the following week. It was possible to compute the reliability of the two counts done on the same sample of blood,

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<sup>5</sup> Rutherford, Op. Cit., p. 16. The formula takes into account the dilution of the blood by the staining solution, the depth of the hemacytometer, and the number of squares counted. the formula is: Total n counted  $\times 10 \frac{1}{2} \times 18 \times 20 = n/\text{cu. mm.}$

and such a reliability coefficient is reported for eight cases in the next chapter. This reliability was not computed for all cases for two reasons: 1) the procedures employed in laboratory analysis are self-correcting so that differences in counts are not accepted if they are large. It is automatically presumed that an error was made; the samples are discarded and new counts are done on new blood samples, thus keeping the consistency of these two counts very high. 2) Raw count data were not available on all cases. When the blood work is done by the hospital laboratories (as it was on all cases at the Ottawa Civic Hospital and the St. Louis de Montfort Hospital), results are reported only in terms of cubic millimeters of blood. For practical reasons, the hospital laboratories had to be used for some of this work, even though it might have been desirable to have the eosinophil counts done only by specially trained research personnel.

The interpretation of eosinophil levels is directly related to the stage of adaptation which the individual has reached. As discussed previously, there are three stages of adaptation: the alarm reaction, the stage of resistance, and the stage of exhaustion. During the alarm stage, there is a drop in eosinophils (eosinopenia), followed by a sharp rise in eosinophils during the stage of resistance, and finally

a drop in eosinophils if the stage of exhaustion is reached.<sup>6</sup> In studying CVA patients, obviously it is impossible in most cases to establish an individual's premorbid base rate for eosinophils. The best that can be done is to chart the course of the eosinophils once the CVA has occurred. Ideally, initial measurements should be made immediately upon the patient's admission to the hospital to ensure that he is still in the first (alarm) stage of adaptation, at which time one would expect to find some degree of eosinopenia. Unfortunately, one of the practical realities to be faced in attempting to do clinical research in a general medical hospital is that tests cannot always be done at the time most advantageous for the research. Thus it happened that time was lost between the onset of a patient's stroke and the time the authorization of his physician was received to include him in the study.

Initially high eosinophil levels were found in many patients. Selye maintains that patients who have experienced physical trauma are seen to exhibit a decrease in eosinophils during their alarm stage, and a rise in eosinophils during their stage of resistance.<sup>7</sup> Thus the interpretation was made that patients whose eosinophil level was high within the first

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<sup>6</sup> Hans Selye, The Stress of Life, New York, McGraw-Hill, 1956, p. 121.

<sup>7</sup> Ibid., p. 121.

week after the onset of their stroke had entered the stage of resistance. These patients were called "high-stress" types. The high eosinophil count was interpreted as evidence that the individual was showing resistance to the stroke in the form of inflammation and edema of the cerebral tissue near the site of the vascular lesion. As Selye points out, the edematous<sup>8</sup> response can be largely maladaptive.<sup>9</sup> When the brain is affected, one aspect of the maladaptation can be interference with cerebral functions not directly affected by the lesion itself.<sup>10</sup> It was observed that the patients with initially high eosinophil counts tended to have counts which levelled off in subsequent weeks, and their lower eosinophil counts were interpreted as coinciding with lessening of the cerebral edema.

The patients who were found to have an initially low eosinophil level several days after their stroke, followed by increase in the level only in the second or third week after the stroke were taken to be low stress people whose systems had little capacity for rallying in an adaptive or maladaptive way to defend the organism against a foreign intruder. The

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8 Selye, Op.Cit., p. 101.

9 Ibid., p. 103-104.

10 L.B. Alford, "Cerebral Localization, Outline of a Revision", in Nervous and Mental Disease Monographs, Vol. 77, 1948, p. 3-99.

deficits observed in the functions tapped by the tests done on these patients were interpreted as a direct consequence of the brain lesion itself.

In addition to counting the level of circulating eosinophils in the patients at weekly intervals, information was collected on the patient's past medical history, and particularly on the so-called diseases of adaptation he might have had. These diseases of adaptation were referred to in the preceding chapter, where it was noted that the term is taken from Selye.<sup>11</sup> Such diseases occur as a byproduct of defensive and adaptive mechanisms of the physical organism in dealing with stress. Selye<sup>12</sup> discusses fifteen groups of diseases which he designates as diseases of adaptation: high blood pressure, diseases of the heart and of the blood vessels, diseases of the kidney, eclampsia, rheumatic and rheumatoid arthritis, inflammatory diseases of the skin and eyes, infections, allergic and hypersensitivity diseases, nervous and mental diseases, cancer, and diseases of resistance in general.<sup>13</sup> From Selye's discussion, a list of diseases was extracted, and if it could be determined that a research subject had

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11 Selye, Op.Cit., p. 66.

12 Ibid., p. 125-209.

13 Ibid., p. 127.

ever had any of these diseases, this fact was combined with the eosinophil information in classifying the subject with the high or the low stress group. Presence of one or more of the diseases was interpreted as a positive indicator of stress.

Inquiry was made about the following diseases:

1. Hypertensive kidney disease
  - a. nephrosclerotic hypertension
  - b. Brights disease
2. Eclampsia
3. Rheumatic fever
4. Rheumatoid arthritis
5. Inflammatory diseases of the skin and eyes
6. Allergic and hypersensitivity diseases
7. Gastric and duodenal ulcers
8. Ulcerative colitis
9. Diabetes
10. Hyperthyroidism
11. Gout
12. Addison's disease
13. Weight gain or weight loss (pathological)

In the early stages of the experiment, it was expected that adequate information about the patient's medical history could be taken from his hospital chart, but it soon became apparent that supplementary interview of the patient was desirable. Notes in the hospital chart are sometimes made in a nearly illegible scrawl, and some residents are less compulsive than others in obtaining thorough intake information. Thus the patient was interviewed whenever this was possible, in addition to his chart being reviewed. Even with the double check, there was no assurance that information was complete

and accurate, but the procedures described were the best and most practical ones available. No attempt was made to corroborate the historical information further, as for example by interviewing relatives, although some gain might have resulted from such an additional step. It was felt that the possible gain was insufficient to justify the practical problems involved in attempting to contact relatives.

## 2. The Psychological Tools.

After much consideration and debate, the tests chosen for measuring the dependent variable in this study were the Wechsler Memory Scale (Form I), the Trail Making Test, Parts A and B, and the Continuous Performance Test. These were selected as tests which could be repeated with minimal practice effects and tests which would be sensitive to the presence or absence of cerebral dysfunction. It was felt that a larger battery than this would be unwieldy for bedside administration to patients who were seriously ill and who might tire easily.

The Wechsler Memory Scale turned out in practice to have been a poor choice for two reasons: the distractions on the hospital wards--people talking, radios, etc.--are particularly bothersome for patients attempting some of the memory items; and a fair proportion of patients, particularly at the Ottawa General Hospital turned out to be primarily French speaking, who, even when they could speak English, expressed

some difficulty in handling the items of the memory scale. When it became evident that many patients would not be able to do the memory scale, it was dropped from the battery, and only the memory for digits test was retained from the scale, since this could be administered easily in either French or English. Eventually, even the memory for digits test was dropped, largely on the basis of Reitan's<sup>14</sup> report that digit span scores have little or no consistent relationship with cerebral dysfunction.

Both the Trail Making Test and the Continuous Performance Test were retained in the battery and were administered on at least two different occasions to all subjects who were capable of taking them. Some few subjects were not capable of taking the tests because they were aphasic or semi-comatose, and appeared not to understand what was expected of them. These patients sometimes smiled and obligingly held parts of the test apparatus which were handed to them, but they did not respond appropriately to the directions, even though the directions were repeated several times in both English and French. Some aphasic subjects were less obliging than others, and the most unobliging subject encountered, although he appeared fully conscious, would not even acknowledge the presence of the examiner by looking at him. Despite such incidents, both

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<sup>14</sup> Ralph M. Reitan, presentation to the Ontario Psychological Association Institute on the Psychological Effects of Brain Lesions, Toronto, February 2-5, 1965.

the Continuous Performance Test and the Trail Making Test were administered to most subjects otherwise suitable for the study.

The Trail Making Test, as adapted by Reitan from the Army Individual Test,<sup>15</sup> has been described in a number of Reitan's publications appearing since 1955.<sup>16</sup> It consists of two parts, A and B, each on a separate sheet, as shown in the appendix. On one side of each sheet, there is a short sample test for practice, and on the back of the sheet, the test proper appears. Part A has twenty-five circles distributed over a white sheet of paper and numbered from 1 to 25. The subject is required to connect the circles with a pencil line as quickly as possible, beginning with the number 1 and proceeding in numerical sequence. Part B has twenty-five circles numbered 1 to 13 and lettered from A to L. The subject is required to connect the circles, alternating between numbers and letters as he proceeds in ascending sequence. The score is obtained as the number of seconds needed to finish each part. Errors by the subject are pointed out immediately by

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<sup>15</sup> The Trail Making Test is one of the performance subtests of the Army Individual Test published by the War Department, U.S. Adjutant General's Office, Washington, D.C., 1944.

<sup>16</sup> Ralph M. Reitan, "The Relation of the Trail Making Test to Organic Brain Damage", in the Journal of Consulting Psychology, Vol. 19, 1955, p. 393-394. This article was the first of several that Reitan published on the Trail Making Test. By 1963 he had five additional publications on the TMT.

the examiner and contribute to the score only insofar as additional time is needed for corrections. Raw scores (in seconds) can be converted to a ten point scale with ten as the best possible score. The scale for converting the score, in terms of number of seconds required for completion, to the ten point scale is given in the Trail Making Test Manual<sup>17</sup> prepared by Reitan.

Directions for the Trail Making Test were given to the subject as each part was introduced, and if he appeared not to understand, the directions were freely elaborated on until he appeared to understand and was able to complete the sample. French speaking patients were given the directions in French, through the courtesy of a nurse who acted as interpreter. If a subject could complete the sample for Part A, he was given Part B of the test. If he was unable to complete Part A, the test was discontinued and Part B was not given. However, if he did complete Part A, he was given the sample for Part B, and if he successfully completed that, Part B of the test was administered.

The time required to complete each part was recorded in seconds, and these two time scores were used in all calculations involving Trail Making Test scores. On the retest,

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17 Ralph M. Reitan, Trail Making Test, Manual for Administration, Scoring, and Interpretation, Indianapolis, Indiana University Medical Center, (no date given), p. 5.

any increase in speed, no matter how slight, was considered "improvement", and was so entered in the Chi Square contingency tables. If the retest time was the same as, or longer than, the initial test time, it was interpreted as "not improved".

Through experience with the Trail Making Test, it was learned that a poor score on Part B, particularly if it contrasted with a good score on Part A, could reflect something quite different from cerebral dysfunction. It sometimes indicated a lack of familiarity with the alphabet. This was encountered in some patients with less than grade five education, and in each case, the patients were very reluctant to admit their uncertainty about the order of the letters of the alphabet, preferring to try and stumble through Part B of the test by trial and error. After this pattern came to light, subjects for whom there was a question about educational level were given a "test" to recite the alphabet as quickly as possible prior to administration of the Trail Making Test.

In addition to the Trail Making Test, the Continuous Performance Test (CPT) was a routine part of the test battery administered to all subjects. The CPT has been described and

and used by previous investigators.<sup>18,19</sup> However, the actual piece of apparatus employed in this experiment was a modification and improvement of the relatively crude apparatus used previously. The equipment of Rosvold and of Schein was mechanical<sup>20</sup> and was capable of recording only a cumulative total of subject responses. By contrast, the present CPT is electronic rather than mechanical, and it automatically records considerably more data than simply cumulative totals. The electronic CPT was designed and built by Rousseau Associates,<sup>21</sup> incorporating suggestions provided by Schein<sup>22</sup> and the author.

The purpose of the CPT is to provide a sensitive means of detecting brief lapses in attention which would be missed

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18 H.E. Rosvold, A.P. Mirsky, I. Sarason, E.D. Bransome, Jr., and L.H. Beck, "A Continuous Performance Test of Brain Damage", in the Journal of Consulting Psychology, Vol. 20, 1956, p. 343-350.

19 J.D. Schein, "Cross Validation of the Continuous Performance Test for Brain Damage", in the Journal of Consulting Psychology, Vol. 26, 1962, p. 115-118.

20 In appearance it was something like a memory drum. A mimeographed description of the apparatus and illustrative sketches have been prepared by Schein (J. Schein, Gallaudet College, Washington, D.C., 1962)

21 The mailing address for Rousseau Associates is 257 Daly Avenue, Ottawa, Ontario, Canada.

22 J. Schein, Personal Communication, July 7, 1962, and September 3, 1963.

on more gross measures of attention span such as the Memory for Digits test from the Wechsler scales. This detection is accomplished by requiring the subject to watch a small screen on which illuminated letters are flashed by remote control, and to press a response button each time he sees the letter or combination of letters concerning which he has been instructed. The CPT control console, in addition to controlling presentation of the sequence of alphabetical characters for which it has been programmed, automatically records on a moving paper strip chart the frequency and duration of the subject's responses, and their temporal relationship to the cue symbol or symbols.

An illustration of the CPT apparatus is presented in the appendix. Circuit schematics were considered to be of such limited interest to the average reader that they were not included in this paper. However, photocopies of both the circuit schematics (12 sheets) and the operating manual can be made available by the author.

The controls for the CPT are housed in a metal cabinet measuring  $9 \frac{3}{4} \times 21 \times 18$  inches. For purposes of portability, the control console has been mounted at waist height on a wheeled cart so that it can be moved easily around the hospital. To the main cabinet are attached by means of flexible electric cables, the two components which directly involve the subject. These are a hand-grip push-button for the subject's response,

and the symbol display unit, measuring 5 x 3 x 7 inches, and carrying a screen 1 15/16 x 1 9/16 inches. The symbol display unit is capable of presenting, in any order, twelve letters of the alphabet, through use of a rear-projection principle. The letters are L, B, G, D, F, L, M, N, P, Q, T, X. Size of the projected symbols is 15/16 of an inch, and 6.3 volt lamps project them with an average brightness of 27 foot lamberts as measured with a spot-light meter, according to the manufacturer's specifications.<sup>23</sup> The illuminated letters appear on the screen in whatever sequence and for whatever exposure time the control unit has been programmed. Programming is done by means of two vector patch boards and six timing and "number of cycle" switches contained in the main cabinet. The main cabinet also contains transistorized computer circuitry and a four-channel Rustrak event recorder. In the event recorder four tracing pens register on pressure sensitive paper tape, moving at a speed of six inches per minute, the frequency and duration of every symbol presentation, every cue-symbol presentation, and every response by the subject. Despite the flexibility of the electronic CPT in terms of programs and timing, standard programs and timing had to be set up for the

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<sup>23</sup> The Schein apparatus had letters 5/16 x 3/16 inches across in black India ink on white paper. The revolving drum of the Schein apparatus required approximately 0.96 seconds to carry a letter completely past the viewing aperture, with full exposure in the aperture afforded it for 0.48 seconds.

experiment.

The two program boards were set up with the following sequence of letters:

A program: P, L, X, E, N, S, E, N; cue symbol: X  
 B program: X, E, P, S, X, P, L, N; cue symbol: X

The "number of cycles" switches and the program selector switch were set so that testing always started with the A program, which ran for three cycles (three full repetitions) and then automatically switched to the B program which ran for three cycles. Then it was necessary for the experimenter to press the reset button to start the machine again at the beginning of the A program.

Alphabetical letters were projected on the symbol display screen at the rate of 34.3 per minute, or approximately 343 during a full ten minute trial. The characters were exposed on the screen for 0.5 seconds<sup>21</sup> and then the screen was dark for 1.50 seconds before the next symbol presentation. From the beginning of one symbol presentation to the beginning of the next presentation, the time elapsed was 1.75 seconds.

The procedure with the subject was as follows: the subject was given the push-button in his non-paralyzed hand,

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<sup>21</sup> This exposure time is approximately half that allowed by the Schein-CPT (0.88 seconds), which could be speeded only mechanically. Schein recommended shortening the exposure time and lengthening the total trial with the electronic apparatus.

and the symbol display unit was positioned so that it was within his line of vision, and as close to him as it could be placed comfortably. He was told only that he was to watch the little box where he could see different letters flashing. He was to watch for the letter X, and each time he saw it, he was to press the response button down and release it. He was then encouraged to try not to miss any Xs, and the machine was turned on. If the subject responded appropriately, he was given a full trial of ten minutes. However, if his first responses were incorrect, the machine was stopped and directions were given again, following which the machine was once again started. When it appeared that the subject was giving his best performance, if he was making any correct responses at all, the test was continued for the full ten minutes. Subjects were never told in advance how long the trial would be, and following the trial, if subjects could speak, they were asked to guess how long the trial had been. There was a consistent tendency for subjects to underestimate the total time of the test.

Scoring of the CPT records was done by visual inspection of the strip chart recording. A full ten minute trial produced five feet of chart paper, and on this paper it was readily apparent if responses corresponded to cue-letter (X) presentations. A subject was credited with success for a given response, provided it was made before the next following

cue-letter (X) presentation occurred. Frequency scores were tallied for the number of correct responses given to the 21st to the 80th cue-letter presentations, inclusive. Thus a perfect score was 60.

### 3. The Sample Population.

As originally designed, the subjects for this study were to be the same ones referred for a simultaneous rehabilitation study of hemiplegic patients, and the same restrictions for age, sex, and medical condition were to apply for both studies. The final sample, as it turned out, was not identical in all respects for both studies, although there was considerable overlap. However, the samples were drawn from the same sources. Before giving a detailed description of the actual sample studied, some comments on the origin or referral of patients for the study are given. An arrangement had been made with some eighty Ottawa physicians that they would permit study of their hospitalized CVA patients for purposes of the rehabilitation project. Whenever one of these physicians had a CVA patient admitted to the Ottawa Civic Hospital, Ottawa General Hospital or St. Louis de Montfort Hospital, the research team received this information from the hospital admitting office. Then more detailed information about the patient was taken from his hospital chart and if he appeared to be a candidate for the research, his attending physician was asked to

sign a note on the hospital chart signifying his awareness of and authorization for the research procedures. Such initial steps resulted in time lost between hospitalization of a patient and the commencement of testing. In some cases, this unfortunate delay may have been a critical factor in deciding success versus failure of the study. However, the best advice available was that absolutely no testing of hospitalized patients should be attempted without the explicit, signed consent of the patient's attending physician, and so there was no way of obtaining the desired subjects except by complying with these conditions.

Despite the cooperation obtained from the hospitals and from most physicians, the sample accumulated at a disappointingly slow rate. New patients were referred for the study at the rate of three or four a week, but only one in eight or ten proved ultimately acceptable. Acute CVA patients within the proper age range, who were sick enough to be hospitalized, but well enough to be tested and then retested two weeks later, simply were not in very good supply.

Initial referrals were lost in several ways, ranging from revised diagnoses (to something other than CVA) to death of the patient. In general, the mildly severe CVA patients were the ones who were available in hospital for testing. Patients with little or no symptomatic involvement often are not hospitalized, due to lack of hospital space, and thus

were missed by the sampling procedure employed in this experiment. At the other end of the continuum, the very sick patients are often untestable because of a comatose or semi-comatose condition, or they may die before they have been in the hospital long enough for testing. As a result, it took over ten months to collect the sample described in this paper.

Any OVA patient who was under seventy-six years of age and who was judged by the neurologists to have an occlusion of the middle cerebral artery or the basilar-vertebral arteries, was accepted for study. All prospective rehabilitation study cases were seen by a neurologist,<sup>25</sup> whose opinion as to the diagnosis was accepted. In the case of patients who did not form a part of the rehabilitation study sample, but who were acceptable for this study, the medical opinion expressed in the patient's chart was accepted.

The age ceiling of seventy-five years was set on the advice of neurologists and also on the basis of acquired experience that beyond the mid-seventies, many of these patients are increasingly difficult to test. In the original experimental design for this experiment, it had been planned to accept patients only if their ages fell between forty-three

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<sup>25</sup> Dr. E.A. Atack, or Dr. Garth Embree examined each of the rehabilitation study cases. Both men are consulting neurologists, and both are on the staff of the Ottawa General and the Ottawa Civic Hospitals.

and seventy-two years. This corresponded to the range from minus one to plus one standard deviation from the mean age of all <sup>CVA</sup> patients treated at the Rehabilitation Institute of Ottawa over a three year period. It was found, however, that the sample did not accumulate so rapidly that one could afford to be too restrictive. Also, the experimental sample ran a little older than the Rehabilitation Institute cases. Accordingly, the maximum acceptable age was increased to seventy-six, and late in the experiment, one patient of seventy-seven was included.

Among the patients tested, symptoms showed varying degrees of severity, but every patient seen exhibited at least a slight degree of hemiplegia and/or aphasia. Conditions of patients ranged from alert to semi-comatose. Comatose patients obviously were not testable, and so had to be excluded from the sample. Characteristics of the sample population are given in Table I. It is of note that the patients described in the table are those from the final sample.

There may be individual differences determining the kind of person who has a CVA to begin with, and further, to be included in the present sample, a subject had to be sick enough to be hospitalized, but well enough to be tested. Thus despite all attempts to ensure randomization of the sample, various selective factors were operating. On the positive side, was the fact that every available subject who was within the desired age range, and testable, was accepted.

Table I.

Mean Ages of the Men and Women CVA Patients utilized in this Study.

	N	M	S.D.
Male	19	64.16	7.51
Female	19	68.42	6.25
Total	38	66.29	7.23

All patients were tested in the hospital at bedside, and in most cases there were other patients present in the room. In some cases there were nurses present as well.

#### 4. The Method of the Experiment.

In this section, an overview of the various steps of the experiment is given:

1. Selection of the sample- The sample was composed of thirty-eight hospitalized patients with recent cerebral vascular occlusion involving either hemisphere. Both men and women were seen. The age range was fifty-four to seventy-seven years. All CVA admissions reported during the period the study was being conducted at the the Ottawa General Hospital (over a period of ten months) and at the Ottawa Civic Hospital (over a period of eight months) were considered as candidates for the study if they were under seventy-six years<sup>26</sup> and if the CVA was of recent onset. The best available medical diagnosis was accepted as the criterion that a patient actually had a CVA. Authorization of the attending physician in each case was required preliminary to any testing. Non-CVA control subjects were not used.

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<sup>26</sup> One patient referred from St. Louis de Montfort Hospital was described by the referring physician as "about seventy". It was learned later that the patient was seventy-seven. In all other cases, patients were seventy-six years or younger.

Patients accepted for the study were tested individually at bedside in the hospital. The order of procedures given below is the logical one, although it was not necessarily the actual order followed in all cases.

2. Measures for determining physiological stress types- Eosinophil counts were done at weekly intervals, with the initial one being done as soon as possible after the patient was referred for the study. Blood was drawn and the laboratory work done by registered medical laboratory technicians, following standard procedures.

Information about the patient's medical history was collected from his hospital chart and from direct interview with particular reference to thirteen diseases of adaptation.

3. Psychological testing- Parts A and B of the Trail Making Test, and a ten minute trial with the Continuous Performance Test were administered to all subjects capable of taking them on at least two occasions: a) as soon as possible after referral of the subject for the study; and b) approximately two weeks after the first testing was done. A third testing at an additional interval of two weeks was done on some subjects, but it was not possible to obtain this third set of test results on all subjects.

4. Classification into stress groups- The physiological measures, eosinophils and diseases of adaptation, were utilized to assign each subject to either the high or the low stress

group. Three separate classifications were made, one on the basis of eosinophils alone, one on the basis of adaptation diseases alone, and one on the basis of eosinophils and adaptation diseases.

5. Comparisons made- Separate analyses were made using the high and low stress groups derived from each of the three classification methods. Within each method, the high and the low stress groups were compared for the frequencies with which retest improvement appeared. Frequencies of improvement were tallied for each of the three tests used, i.e., for the Continuous Performance Test, for the Trail Making Test, Part A, and for the Trail Making Test, Part B.

6. Statistical tests of stress types- Two by two contingency tables were made using the frequency data on each test according to each of the three classification methods. For each contingency table, the chi square was computed to test for significant differences between the frequencies shown in the cells. Yates's correction for continuity was applied whenever it was required because of small cell frequencies in the contingency tables.

7. Statistical test of age groups- Contingency tables were drawn up and chi squares computed to test for differences in frequencies of improvement on each of the retests for younger and older subjects.

8. Correlation of age and stress- The biserial coefficient of correlation was computed for age and stress group membership.

### 5. The Specific Hypotheses.

Stated in the null form, the major hypothesis is: On repeated tests sensitive to cerebral functioning, no significant difference in frequency of retest improvement occurs between high stress and low stress groups during the first three weeks following a cerebral vascular accident.

Secondary hypotheses are as follows:

1. No significant difference in frequency of retest improvement occurs between younger and older CVA patients during the first three weeks of the acute phase of illness.

2. There is no significant correlation between age and stress type.

The next chapter discusses the actual findings and the various significance tests which were applied to the data. Various aspects of the data are discussed.

## CHAPTER III

### RESULTS AND DISCUSSION

In this chapter, the frequency with which improved retest scores appeared in groups of subjects classified according to stress type, age, sex, etc., is statistically tested for the significance of inter-group differences. Where differences between the groups are found to exist, they are interpreted in the light of the theory presented earlier.

The chapter begins with a discussion of the classification of the subjects according to physiological stress types. Following this, the findings with regard to frequencies of retest improvement are presented for each classification method and on each test. Differences for age and for sex group membership are presented next, followed by the correlation between age and sex. Then the reliabilities of the tests are discussed. Finally, there is some discussion of ways in which a study such as this could be improved, and there are some observations on the physiological and psychological tests used in the study.

#### 1. Results.

The classification of subjects into high and low physiological stress groups was made on the basis of two different kinds of information, eosinophils, and diseases of adaptation.

For various reasons, discussed elsewhere, it was not possible to obtain both measures on all subjects. Both measures were obtained on a total of twenty subjects, and it was found that the two measures agreed in their classification 75% of the time. In other words, fifteen of the twenty subjects were given identical classifications by both the eosinophils and the diseases of adaptation. The phi coefficient of correlation for the relationship between the classifications by the two methods is 0.403. The maximum possible phi coefficient which could have been obtained is 0.9045, as calculated from the marginal proportions in the contingency table for this situation. For comparison purposes, the high and low stress groups are compared below as they are composed by the eosinophil classification method, by the diseases of adaptation classification method, and by mutual agreement in the two preceding classification methods.

The eosinophil method for comparing the high and low stress groups provided an N of 28, with 14 in the high stress group and 14 in the low stress group. The frequencies with which improved scores occurred on retesting were tabulated for the Continuous Performance Test, for the Trail Making Test, Part A, and for the Trail Making Test, Part B. Chi square tests for the significance of the differential frequencies with which retest improvement was observed in the high stress versus the low stress group are reported below.

Details of the scoring system used for the tests are given in the preceding chapter. At this point it can be noted that the Trail Making Tests were scored for the number of seconds required for completion of each part, and the Continuous Performance Test was scored for the "number of hits" on sixty stimulus presentations presented during approximately the second to the fifth minutes of the test (twenty-first to eightieth presentations, inclusive).

The results show that the frequency of retest improvement on the Continuous Performance Test was not significant. The obtained chi square of 0.164 (without Yates' correction) falls far short of the minimum value required for significance. The obtained frequencies and the chi square are shown in Table II, below.

On the Trail Making Test, Part A, the high stress subjects showed a significantly higher frequency of improvement than did the low stress subjects. This finding supports the working hypothesis of the study. The chi square of 3.889 (Yates correction applied) was just beyond the .05 level of significance, showing a definite trend in the data, but it cannot be interpreted as a highly significant finding. The subjects classified on the basis of eosinophils as high stress types showed a greater tendency to achieve improved retest scores on the Trail Making Test, Part A, than did the subjects classified as low stress. Table III illustrates these data.

Table II.-

Contingency Table and Chi Square for Frequencies of Improved and Non-improved Retest Scores on the CPT, by Stress Type, as derived from the Eosinophil Method of classifying CVA Patients for Stress.

Retest	Stress Type		Totals	X <sup>2</sup>	Prob.
	High	Low			
Improved	5	4	9		
Not Improved	9	10	19		
Totals	14	14	28	0.164 <sup>a</sup>	N.S.

<sup>a</sup> Yates's correction for continuity was not applied.

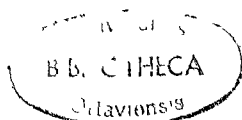


TABLE III.-

Contingency Table and Chi Square for Frequencies of Improved and Non-improved Retest Scores on the TMT-A, by Stress Type, as derived from the Eosinophil Method of classifying CVA Patients for Stress.

Retest	Stress Type		Totals	$\chi^2$	Prob.
	High	Low			
Improved	8	2	10		
Not Improved	6	12	18		
Totals	14	14	28	3.889 <sup>a</sup>	< .05 <u>sig.</u>

<sup>a</sup> Yates's correction for continuity was applied.

On Part B of the Trail Making Test, the eosinophil-high stress subjects improved with significantly greater frequency than did the low stress subjects. The obtained  $\chi^2$  (Yates's correction applied) for the differential frequencies was 6.857, and the probability of a value this large being obtained by chance alone is less than .01. Therefore, for this situation, it is possible to reject the null hypothesis at the .01 confidence level. This provides good reason for thinking there is a relationship between high stress group membership and likelihood of improvement on the Trail Making Test, Part B. Table IV presents these findings.

Considering the second method of classifying stress types, it can be seen by reference to Tables V, VI, and VII that no significant differences were obtained for any of the tests. The sample classified here by the Diseases of Adaptation Method is not identical with the sample on which eosinophil information was obtained, but there is considerable overlap. It is therefore interesting that Parts A and B of the Trail Making Test, which successfully differentiated the eosinophil high and low stress groups, do not come anywhere close to differentiating the high and low stress groups classified by diseases of adaptation. It is not clear why there should be this disparity. One possible explanation is that the eosinophil counts gave a picture of an on-going stress response in the individual, whereas the diseases of adaptation classification

Table IV.-

Contingency Table and Chi Square for Frequencies of Improved and Non-improved Retest Scores on the TMT-B, by Stress Type, as derived from the Eosinophil Method of classifying CVA Patients for Stress.

Retest	Stress Type		Totals	$\chi^2$	Prob.
	High	Low			
Improved	7	0	7		
Not Improved	7	14	21		
Totals	14	14	28	6.859 <sup>a</sup>	.01 Sig.

a Yates's correction for continuity was applied.

Table V.-

Contingency Table and Chi Square for Frequencies of Improved and Non-improved Retest Scores on the OPT, by Stress Type, as derived from the Diseases of Adaptation Method of classifying OVA Patients for Stress.

Retest	Stress Type		Totals	$\chi^2$	Prob.
	High	Low			
Improved	8	7	15		
Not Improved	7	10	17		
Totals	15	17	32	0.4729	N.S.

Table VI.-

Contingency Table and Chi Square for Frequencies of Improved and Non-improved Retest Scores for the TMT-A, by Stress Type, as derived from the Diseases of Adaptation Method of classifying CVA Patients for Stress.

Retest	Stress Type		Totals	$\chi^2$	Prob.
	High	Low			
Improved	7	7	14		
Not Improved	8	10	18		
Totals	15	17	32	0.0976	N.S.

Table VII.-

Contingency Table and Chi Square for Frequencies of Improved and Non-Improved Retest Scores for the TMT-B, by Stress Type, as derived from the Diseases of Adaptation Method of classifying CVA Patients for Stress.

Retest	<u>Stress Type</u>		Totals	$\chi^2$	Prob.
	High	Low			
Improved	5	6	11		
Not Improved	10	11	21		
<b>Totals</b>	<b>15</b>	<b>17</b>	<b>32</b>	<b>0.0136</b>	<b>N.S.</b>

simply earmarked the individual as a potential stress-responder in a situation which could have stimulated the stress response. Thus in the diseases of adaptation classification, the tests may have been run on people who were correctly classified as, for example, high stress, but were not necessarily displaying their full potential high stress response.

It is possible, of course, that the problems encountered with the adaptation diseases classification were simply the result of unreliability in the collected data about disease. In most cases, the information about the medical history was taken from the patient himself, either by a medical resident or by the psychologist conducting this experiment. Thus the patient was called on to recall and evaluate sicknesses and complaints he had had in the past. It is common experience that some people tend to minimize even serious complaints, whereas others magnify the slightest pain into a major disease.

Yet a third possible explanation for the failure of the adaptation disease-high stress subjects to exhibit a greater frequency of improvement on the tests than did the adaptation disease low stress subjects is the following. If the local topical responses of inflammation and edema of cortical tissue did not appear because they were actually suppressed by the general systemic condition of the individual, then there would be no reason for expecting rapid test improvement. It happens that it has been demonstrated that exposure of an individual

to a systemic stressor increases his resistance to an inflammatory agent. This phenomenon of "crossed resistance" is described by Turner,<sup>1</sup> who says ". . . physiologic alterations characteristic of the G.A.S. decrease the inflammatory potential of all tissues throughout the body, and thus prevent the normal degree of inflammatory response to such irritants as. . . trauma . . ." It follows from this that the adaptation disease-high stress subjects who had chronic systemic conditions such as diabetes mellitus or rheumatoid arthritis may thereby have been provided with resistance to the formation of cerebral edema in response to vascular lesions.

The third method for classifying patients into high and low stress groups was actually a combination of the two preceding methods. To be classified high by this method, the subject had to be classified high by both eosinophils and adaptation diseases. To be classified low, he had to have two low classifications by the preceding methods. This double check method reduced the total N to only fifteen. It can be seen by reference to tables VIII, IX, and X that no significant differences between high and low stress groups appeared on any of the tests. The Trail Making Test, Part B, showed the largest differences, but the chi square, without Yates's

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<sup>1</sup> C. Donnell Turner, General Endocrinology, Philadelphia, Saunders, 1955, p. 195.

Table VIII.-

Contingency Table and Chi Square for Frequencies of Improved and Non-improved Retest Scores for the CPT, by Stress Type, as derived from the combined Eosinophil-Adaptation Disease Method of classifying OVA Patients for Stress.

Retest	Stress Type		Totals	X <sup>2</sup>	Prob.
	High	Low			
Improved	3	3	6		
Not Improved	4	5	9		
Totals	7	8	15	0.0446 <sup>a</sup>	N.S.

<sup>a</sup> Yates's correction applied.

Table IX.-

Contingency Table and Chi Square for Frequencies of Improved and Non-improved Retest Scores for the THT-A, by Stress Type, as derived from the combined Eosinophil-Adaptation Disease Method of classifying CVA Patients for Stress.

Retest	Stress Type		Totals	X <sup>2</sup>	Prob.
	High	Low			
Improved	4	2	6		
Not Improved	3	6	9		
Totals	7	8	15	0.547 <sup>a</sup>	N.S.

a Yates's correction applied.

Table X.-

Contingency Table and Chi Square for Frequencies of Improved and Non-improved Retest Scores for the TMT-B, by Stress Type, as derived from the combined Eosinophil-Adaptation Disease Method of classifying CVA Patients for Stress.

Retest	Stress Type		Totals	X <sup>2</sup>	Prob.
	High	Low			
Improved	3	0	3		
Not improved	4	8	12		
Totals	7	8	15	2.026 <sup>a</sup>	N.S.

a Yates's correction applied.

correction applied, was not significant. If Yates's correction had not been required to adjust for the small cell frequencies, a significant chi square of 4.286 would have been obtained. While this observation by itself is of little importance, it does provide a clue of sorts that larger numbers of frequencies might have provided significant results.

Since there were various additional ways of grouping the subjects, as for example, by age and by sex, some information about these comparisons can be given. With reference to sex group membership, this was not found to have any bearing on improvement on any of the tests used in this experiment. The chi square calculations for each of the three tests yielded very small results which were not indicative even of trends in the data.

Age grouping, unlike sex grouping, produced some differences on the tests which were not unexpected. Young subjects tended to show improvement more frequently than did older subjects. Subjects were assigned to the young or the old age group according to their standing above or below the median age in the frequency distribution of ages for the total sample of thirty-eight subjects described in Table I, page 37. Grouped on this basis, the younger subjects showed more frequent improvement on two of the three tests. On the third test, the differences between the frequencies of improvement for younger and older subjects were not significant. These results are presented in Tables XI, XII, and XIII.

Table XI.-

Contingency Table and Chi Square for Frequencies of Improved and Non-improved Retest Scores on the CPT, by Age Group.

Retest	Age Group		Totals	$\chi^2$	Prob.
	Young	Old			
Improved	12	4	16		
Not Improved	7	14	21		
	Totals 19	18	37	4.753 <sup>a</sup>	.05 <u>Sig.</u>

a Yates's correction applied.

Table XII.-

Contingency Table and Chi Square for Frequencies of Improved and Non-improved Retest Scores on the TMT-A, by Age Group.

Retest	Age Group		Totals	$\chi^2$	Prob.
	Young	Old			
Improved	10	5	15		
Not Improved	8	13	21		
Totals	18	18	36	1.870 <sup>a</sup>	N.S.

a Yates's<sup>1</sup> correction applied.

Table XIII.-

Contingency Table and Chi Square for Frequencies of Improved and Non-improved Retest Scores on the TMT-B, by Age Group.

Retest	Age Group		Totals	X <sup>2</sup>	Prob.
	Young	Old			
Improved	9	2	11		
Not Improved	9	16	25		
	Totals	18	18	36	
				4.985 <sup>a</sup>	< .05 <u>sig.</u>

a Yates's correction applied.

The findings with reference to age raised some question that perhaps age might have been a contaminating factor in some of the preceding stress groupings. For example, if youthfulness were found to characterize the eosinophil-high stress subjects then the significant frequency of improvement discovered there could have been a function of young age rather than high stress. To rule out this possibility, the relationship of age and stress was explored by means of both a chi square for age versus stress (Table XIV) and a biserial correlation of age and stress, with a t test of the significance of the coefficient of correlation. Both procedures indicated that there was little or no relationship between age and stress, as classified by the eosinophil method.

For purposes of the chi square, subjects were assigned to the young or the old group on the basis of their rank position for age among the total sample of thirty-eight subjects studied in the experiment. This sample is described in Table I, page 37. Thus a subject who had an age ranking of 19 or lower (younger than sixty-seven years) was young; and a subject whose age ranking was above the median, ranking from 20 to 38 (older than sixty-seven years) was old. In this particular grouping, the young subjects had a mean age of 60.00 years (S.D.=4.455 years), and the old subjects had a mean age of 72.07 years (S.D.=5.172 years). Table XIV shows that there were no significant differences in the frequencies with which

Table XIV.-

Contingency Table and Chi Square for Age versus Eosinophil-Stress Classification.

Age Group	Stress Group		Totals	X <sup>2</sup>	Prob.
	High	Low			
Young	8	5	13		
Old	6	9	15		
Totals	14	14	28	0.574 <sup>a</sup>	N.S.

<sup>a</sup> Yates's correction applied.

young or old subjects were assigned to the high or low eosinophil-stress groups.

The biserial coefficient of correlation for age and eosinophil-stress group membership was  $-0.240$ , and the  $t$  test of the significance of this coefficient was only  $0.116$ , which is not significant. Therefore, the thought that stress group membership might in fact be a correlate of age was rejected.

Despite the fact that both younger age and high eosinophil-stress group membership appear to be characteristics of the subjects who showed the greatest frequency of retest improvement during this experiment, there is no reason for believing that they are not independent factors. The small negative biserial coefficient of correlation between the two variables suggests that there is no consistent relationship between them.

## 2. Reliabilities.

Reliability coefficients were computed for both the first and second administrations of the Continuous Performance Test (CPT). Two half-test scores were obtained for each administration of the CPT by tabulating the respective correct responses to odd and even stimulus presentations for each subject. Having obtained the half-test scores, it was possible

to apply the Rulon formula of reliability.<sup>2</sup> The obtained coefficients of reliability were extremely high, showing a very high degree of intra-test consistency in the performance of each subject on a given administration of the GPT. The coefficients are: first administration, 0.9929; and, second administration, 0.9938.

It would have been possible, with the data available, to compute a test-retest coefficient of reliability for the GPT, but this would have not been a meaningful figure, because the expectation was that many of the patients would improve during the time interval between the first and second administrations of the GPT, and that this would be reflected in their test scores.

Test-retest reliability was not computed for the Trail Making Test (TMT) for the same reasons given for the GPT. The test was administered with the expectation that many subjects would do better on the second administration than on the first. A figure on the stability of the TMT under these experimental conditions would not have been very helpful information. Split-half methods of reliability could

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2 The Rulon formula estimates the proportion of true variance in a test by calculating the error variance and subtracting this from unity, according to the formula:  

$$r_{tt} = 1 - \frac{\sigma_e^2}{\sigma_t^2}$$
 The formula is described by J.P. Guilford in Psychometric Methods, New York, McGraw-Hill, 1954, p.379.

not be applied in the case of the TMT because the test itself does not afford any way of being divided into equivalent halves.

In the case of the eosinophil counts, a split-half reliability coefficient was computed for eight subjects tested at the Ottawa General Hospital. As explained in the previous chapter, it was not possible to get the split-half scores in order to do a similar computation on all subjects. For these eight subjects, each half-score was the count from one of the two chambers of the hemacytometer used in counting blood cells. Applying the Rulon formula, a split-half reliability of 0.960 was obtained. This reflects a very high degree of stability in the frequency with which eosinophil cells appeared dispersed in a given sample of blood.

### 3. Discussion.

In retrospect, it is possible to see improvements which could have been made in the design of the study. The most obvious improvement would have been to have a larger sample of acute stroke patients, and to have had them available for testing immediately upon their admission to hospital. To some extent, these improvements could have been implemented in a research hospital in a city larger than Ottawa.

A further improvement which could have been made, but which would have been far too ambitious for a student to undertake for degree research would have been the use of an

extensive battery of tests sensitive to cerebral functioning. Reitan's battery,<sup>3</sup> for example, would have been an excellent choice. The virtue of a large and diversified battery of tests is that the investigator is much more likely to detect even highly specific psychological effects of the brain lesion. It goes without saying that a test designed to diagnose, say, dyscalculia, will not be very sensitive at picking up other kinds of impairment. Thus, if only such a test is used, many effects of the brain lesion may be overlooked. In the present experiment, the most sensitive test for registering changes in functioning following CVA proved to be Part B of the Trail Making Test. Surely there were other reversible changes which were not detected on the tests used in this experiment, but which might have been important changes to know about for verifying the hypothesis of the study. It can be noted in passing that even a single test sensitive to only a single factor might successfully differentiate an experimental population if a large enough sample were used. However, in order to facilitate research studying the course of psychological impairment following brain lesion, the best approach would be to employ both a large sample and a large test battery. Even short of these ideals, it is possible to find interesting results, as shown in this study.

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3 References are given in Chapter I. Cf. Footnotes 1, 28, 29, 30.

The eosinophil method of classifying subjects as high or low physiological stress types proved to be the one method that successfully differentiated the sample into those who did or did not show improvement on the retest. The fact that the eosinophil classification was able to do this, whereas the adaptation disease classification was not, is itself a finding of some interest. As noted in Chapter II, it was Selye personally who originally suggested that the classification into high and low stress types could be made with eosinophil counts. At the time of the discussion with Selye, adaptation diseases were not mentioned. In the light of the experimental results, as well as of the comments of Turner<sup>4</sup> with reference to "crossed resistance", it appears that adaptation diseases were an unfortunate choice for a means of differentiating people in terms of their probable physiological response to a stressful situation. Even so, the contrast between the two classification methods has merit because it points up the fact that chronic stress responders, if they are already responding to one situation, may not have anything left to respond to a new stress situation. The mechanisms involved are reminiscent, but not perfectly analagous, to the "all or none" law and absolute refractory period used to describe neuronal excitability.

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<sup>4</sup> Turner, Op.Cit., p. 195.

Just as the expert's choice proved to be the best choice for making the stress classification, another expert's (Reitan's) choice suggested the most helpful psychological test for the investigation. Both parts of the Trail Making Test showed themselves to be sensitive instruments, but Part B, because of its greater complexity, provided an excellent means for assessing improvement in the test performance of the stroke patients.

The Continuous Performance Test, despite its excellent premise, did not turn out to have been a very helpful inclusion in the test battery. Undoubtedly the CPT has value as a diagnostic aid, and it probably could have been programmed to give a better measure of improvement of the acute stroke patients in this study. Considering the finding that the more complex Part B of the TMT did a better job in this study than the less complex Part A, it can be hypothesized that a more complex CPT task might also have been more sensitive in detecting loss and recovery of function of the stroke patients. It is quite easy to vary the complexity of the CPT. Schein, in his cross validation study with the CPT, described a so-called "A X" task which is more complex than the "X" task he used.<sup>5</sup>

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<sup>5</sup> J.D. Schein, "Cross Validation of the Continuous Performance Test for Brain Damage", in the Journal of Consulting Psychology, Vol. 26, 1962, p. 115-118.

The "X" task was the one used in this study. In the "X" task, the subject is instructed to press the response button each time he sees the letter X on the display screen, whereas in the "A X" task, he is instructed to press the button each time he sees the letter X only if it was preceded by the letter A. The ease with which the complexity of the task can be increased is obvious. Perhaps the usefulness of the CPT would have been enhanced if either a single complex task had been used, or if two tasks had been used, one relatively easy, like the X task, and the other, complex.

The CPT apparently has some intrinsic interest for subjects. It was noted that with very few exceptions subjects under-estimated the length of the ten minute trial. In some cases, the estimated times were as low as one minute, and the modal time estimate was six minutes. There could perhaps be an interesting study developed to investigate the personality correlates of subjects who give the most deviant time estimates after being administered a test such as the CPT.

There was a problem encountered by some subjects on the CPT, which occurred frequently enough that some modifications had to be made in scoring. Some subjects started the test with many errors, but once they got used to the test, started doing much better. In order that these subjects should not be penalized, the first twenty cue-letter presentations were not scored. Similarly, some cue-letter presentations were not scored at the end of the test because, due to

a failure in the cycling mechanism of the CPT apparatus, differing numbers of cue-letter presentations had been presented to some subjects during one period of the Experiment. In order to correct for this inequality, and to ensure that all subjects were compared on an identical task, the responses to cue-letter presentations from the twenty-first to the eightieth, inclusive were scored, and only these sixty possible responses contributed to the CPT score.

Although the analysis of CPT data made use of only the "number of hits" scores on the sixty stimulus presentations referred to above, several other kinds of scores could have been obtained. For example, a number of subjects gave many extra responses. In some cases, some of these were given at an entirely inappropriate time, and some of these very same subjects failed to respond at appropriate times. The reasons for such unusual kinds of performances are not known, and no attempt was made in this study to utilize such information. However, it should be possible, particularly, if more data were accumulated, to advance a theoretical rationale for such performances.

This chapter has presented the results obtained with the various techniques used to test the hypothesis. It has also presented comments on observations made during the experiment, and discussion of some of the virtues and shortcomings of the tests used. In the next section, the findings are summarized and conclusions are stated.

## SUMMARY AND CONCLUSIONS

In this experiment, retest scores obtained approximately two weeks after the initial testing of newly hospitalized, acute, cerebral vascular accident patients, were analyzed for frequency of improvement. It had been hypothesized that patients classified as high physiological stress types would show a higher frequency of improvement on the retest than patients classified as low physiological stress types. This hypothesis was partially supported.

When patients were dichotomously classified as high or low stress types on the basis of eosinophil counts, it was found that the high stress types showed a significantly higher frequency of improvement than the low stress types on both the Trail Making Test, Part A, and the Trail Making Test, Part B. The Continuous Performance Test failed to differentiate the two groups.

Subjects classified as high stress types on the basis of a medical history of one or more adaptation diseases did not show any greater frequency of retest improvement than did subjects who had never had adaptation diseases.

A combined stress classification method using information from both eosinophil counts and the medical history failed to select groups of subjects who differed significantly from each other in terms of retest improvement.

It was found that younger subjects had a higher frequency of retest improvement than older subjects, but there was no correlation found between age of the subjects and eosinophil stress classification. Thus age and eosinophil-stress type appeared to be independent factors. No differences were found as a function of sex group membership.

On the basis of the findings in this study, it appears that counts of circulating eosinophils can provide a usable means of identifying individuals who are showing the stress response. This has implications for the study of psychotherapy as well as of other situations where it may be desirable to have an index of the person's physiological response.

In future research where one might wish to classify subjects according to physiological stress-types, a method which could be investigated would be to test the ease with which conditioned eosinopenia can be elicited.

The Trail Making Test can be recommended as a research instrument in the study of cerebral conditions. However, it should always be part of a battery which taps many different functions. The varied expression of psychological deficit in brain damage requires a complex test battery.

Finally, the Continuous Performance Test, although it was not very helpful in this study, remains an interesting device for further research. One possible study would be the

investigation of the personality correlates of individuals who underestimate the administration time of the test.

A second piece of research which would be very interesting would be the exploratory study of differences on the Continuous Performance Test between normal subjects and subjects known to have seizures of the petit mal type. Possibly the exposure time of symbols displayed could be progressively shortened until the subject began making a high number of errors. With adequate standardization, this could even become a diagnostic technique.

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The first research with the CPT. Rationale for the test and some results are presented.

Schein, J.D., "Cross Validation of the Continuous Performance Test for Brain Damage", in Journal of Consulting Psychology, Vol. 26, 1962, p. 115-118.

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Prepared primarily for the intelligent layman, this book summarizes most of Selye's thinking about the stress concept. It is an important source for learning about stress, and is highly recommended.

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For discussion of endocrinology and stress by an author other than Selye, this text is recommended. It was not used in developing the present experiment, but was helpful in explaining some of the findings.

Table XV.-

Circulating Eosinophil Counts on Twenty-eight Acute CVA Patients for the First Three Weeks following Hospitalization.

High Stress Group <sup>a</sup>				Low Stress Group			
Patient	Week			Patient	Week		
	1	2	3		1	2	3
1	810	489		15	160	510	400
2	666	333	244	16	156	330	280
3	593	489	489	17	122	156	89
4	444	222		18	100	222	55
5	440	176	267	19	89	200	400
6	425	122	155	20	89	66	111
7	415	415	411	21	66	180	198
8	366	222	366	22	67	78	187
9	356	220		23	66	122	122
10	325	250		24	66	111	154
11	319	211	222	25	33	165	222
12	286	11		26	11	167	
13	244	444		27	11	66	177
14	180	66	111	28	11	55	0

<sup>a</sup> Classification based on initially high counts which tended to level off.

Table XVI on the following pages shows the initial and retest scores obtained by each of the subjects on each of the three tests used in this experiment. For reference purposes, the subjects classified as either high or low stress types by the eosinophil count method, are indicated as such.

On the Continuous Performance Test (CPT), subjects received one point for each correct response, with a maximum possible score of 60. If a retest score was higher than the initial score, this was interpreted as "improved" for the data analyses.

Trail Making scores are given in seconds required to complete the test. Thus a lower retest score reflects improvement.

Table IV.1.-

Initial and Retest Scores for Three Tests Administered to Thirty-eight Acute CVA Patients

Patient	Dessin. Stress Class.	OPT		TMT-A		TMT-B	
		1st	Retest	1st	Retest	1st	Retest
1	H <sup>a</sup>	16	36	109	222	IC <sup>e</sup>	IC
2	H	58	59	54	58	365	177
3	H	58	60	71	45	343	100
4	H	51	60	50	22	165	48
5	H	55	49	45	40	60	54
6	H	57	50	12	14	390	300
7	H	58	60	110	100	390	365
8	H	59	60	150	70	370	390
9	H	30	54	140	118	480	245
10	H	58	60	20	27	165	100
11	L <sup>b</sup>	7	59	170	165	IC	IC
12	L	43	60	60	84	330	IC
13	L	22	52	200	150	IC	IC
14	L	0	0	IC <sup>e</sup>	IC	IC	IC
15	H	55	60	230	63	IC	240
16	L	0	0	10	IC	IC	IC
17	L	8	16	IC	IC	IC	IC
18	L	0	0	IC	IC	IC	IC
19	L	0	0	IC	IC	IC	IC
20	L	0	0	200	IC	IC	IC
21	H	56	72	0	45	120	IC
22	H	60	60	65	35	IC	270
23	L	56	60	120	120	IC	IC
24	L	2	20	IC	IC	IC	IC
25	L	0	0	IC	IC	IC	IC
26	L	0	0	IC	IC	IC	IC
27	H	47	58	500	IC	IC	IC
28	H	33	24	200	180	305	310
29	L	0	0	IC	IC	IC	IC
30	L	57	51	170	185	IC	IC

<sup>a</sup> H = High

<sup>b</sup> L = low

<sup>e</sup> IC = incomplete

Table VII.-(continued)

Initial and Retest Scores for Tiled Tests Administered to  
Thirty-eight Acute CVA Patients

Patient's	Eosin. Stress Class.	CPT		TMT-A		TMT-B	
		1st	Retest	1st	Retest	1st	Retest
31	H	0	0	IC	IC	IC	IC
32	H	41	38	IC	IC	IC	IC
33	L	0	0	IC	IC	IC	IC
34		57	48	300	210	900	400
35	H	53	57	270	202	IC	IC
36	L	58	29	IC	130	IC	IC
37	H	5	2	10	IC	IC	IC
38		0	60	105		280	

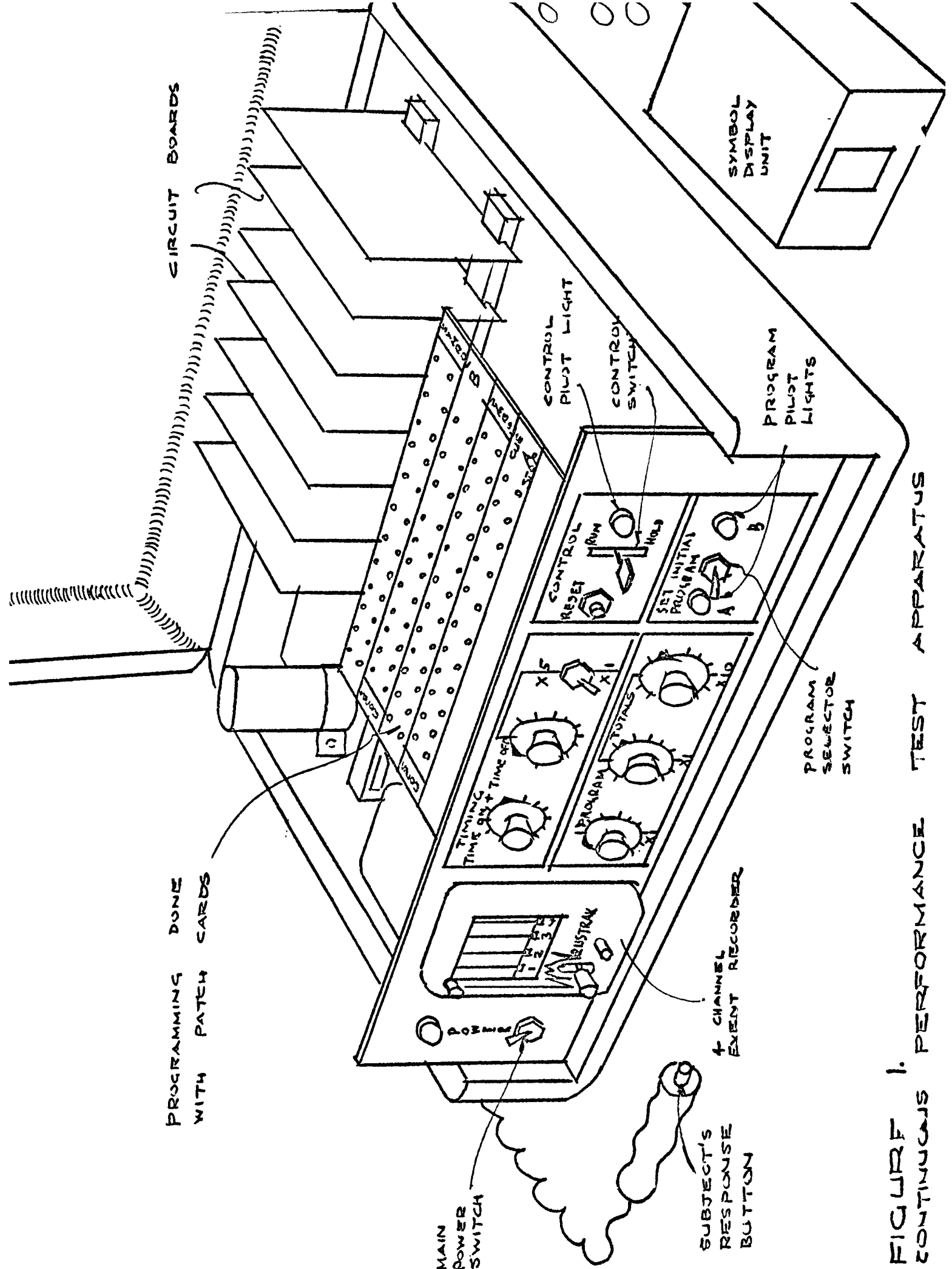
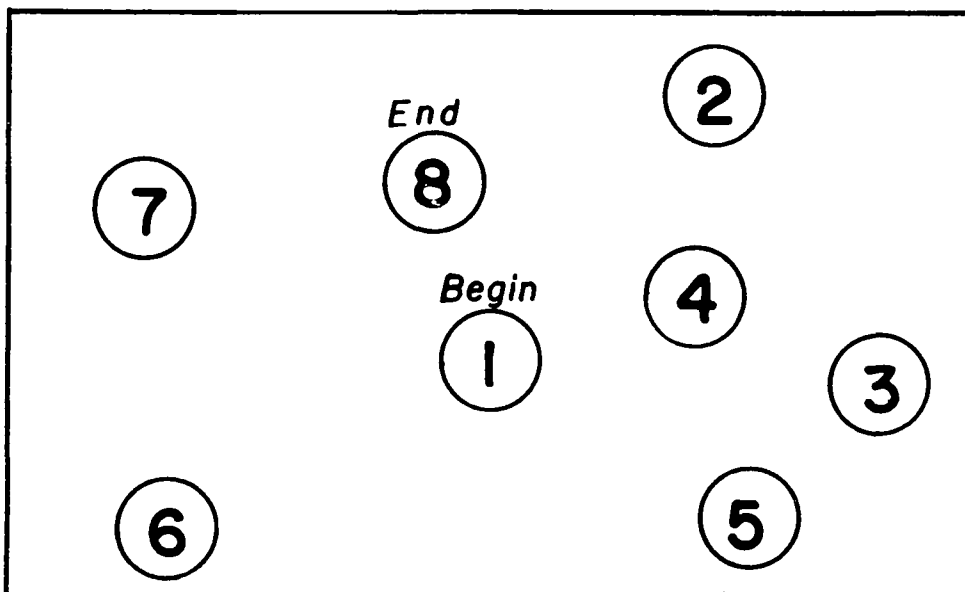


FIGURE 1. PERFORMANCE TEST APPARATUS

Part A

SAMPLE



15

17

21

20

19

16

18

5

4

22

13

6

*Begin*

1

24

14

7

2

8

10

3

9

*End*

25

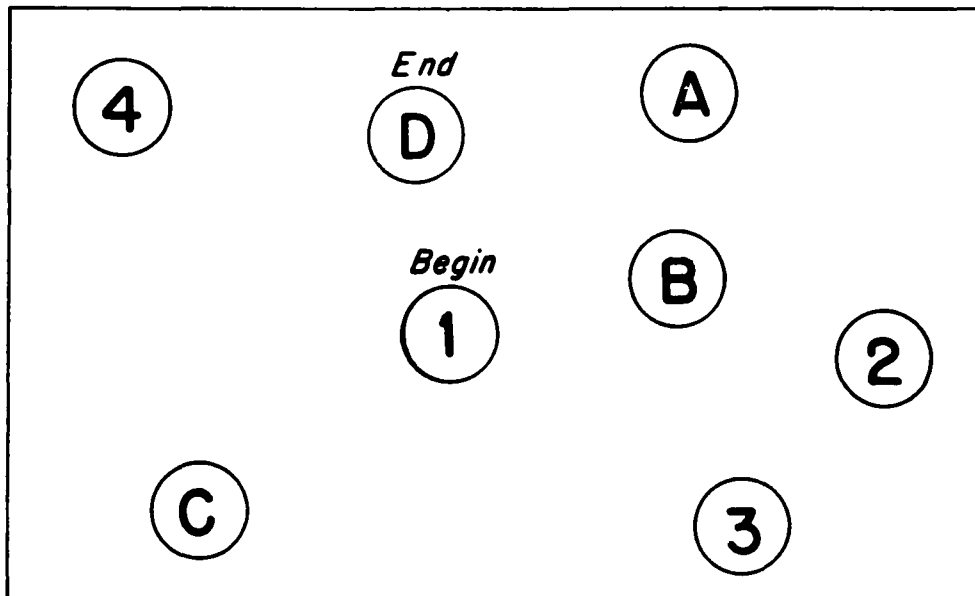
12

11

23

Part B

SAMPLE



*End*  
13

10

8

9

I

D

B

4

3

7

*Begin*

1

H

5

C

12

G

A

J

2

6

L

E

F

K

11

## APPENDIX 4

### ABSTRACT OF

#### Relationship of Physiological Stress-Type of the Individual to Improvement of Specified Functions Following Cerebral Vascular Accident<sup>1</sup>

Reversible disturbance of function in man following cerebral vascular accident is a recognized phenomenon. The spontaneous return of temporarily disrupted functions has been explained on the basis of an edematous reaction in the brain tissue. This edematous reaction puts pressure on control centers not directly associated with the primary lesion, thus inhibiting functions mediated by these centers. As the edematous reaction subsides, pressure is reduced, permitting some functions to return spontaneously.

This project was an attempt to utilize Selye's concept of stress, with its implications for the formation of inflammation and edema surrounding an injured area, in the study of spontaneous improvement following stroke.

Acute stroke patients were classed as high or low physiological stress types on the basis of three separate methods: 1) characteristics of weekly eosinophil counts; 2) history of adaptation diseases; and 3) a combination of the preceding two. It was predicted that patients classified

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<sup>1</sup> Jehn F. Cullen, doctoral thesis presented to the School of Psychology of the University of Ottawa, Ontario, July 1965, ix-85 p.

as high physiological stress types (who theoretically were more susceptible to formation of edema) would demonstrate a higher frequency of improvement on psychological tests than would low physiological stress types.

The results showed that when twenty-eight acute CVA patients were classified for stress on the basis of circulating eosinophils, the frequency of improvement on the Trail Making Test, Parts A and B, was significantly different between high and low stress types. The high stress types showed a significantly greater frequency of improvement.

The Continuous Performance Test did not significantly differentiate stress types. No significant differences were found, on any test, for methods of stress classification other than eosinophils.