CIVIL AERONAUTICS AUTHORITY
BUREAU OF FEDERAL AIRWAYS
TECHNICAL DEVELOPMENT DIVISION

Washington

NOTE NO. 18

STUDIES TO DEVELOP METHODS OF DETERMINING EMOTIONAL STABILITY

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for

AIR TRANSPORT SECTION

May
1939

The views expressed in this note are those of the writer and not necessarily of the Civil Aeronautics Authority.

FOREWORD

Safety in the air depends upon a number of factors, not the least of which is the human element. As aircraft performance and efficiency have progressed from year to year, additional complexities in their operation have arisen. Modern transport aircraft, which are built for high performance and powered with more than one engine, are equipped with flaps, variable pitch or constant speed propellers, adjustable tabs, retractable landing gears, de-icers, radio, and numerous engine and flight instruments which require close attention.

The selection of pilots to fly such equipment safely and the maintenance of their health are matters of prime importance to the Civil Aeronautics Authority, the air carriers, and the general public.

Recognizing the need for continuing research relating to better measurements of physiological and psychological standards in the selection of pilots and evaluation of their physical and psychological efficiency, the Civil Aeronautics Authority maintains a medical science station at Kansas City, Missouri. Numerous studies of pilot subjects are being conducted at this station. The studies relate not only to the development of better standards of examination of pilots, but also to the problems of anoxemia at various altitudes, the effects of pilot fatigue and other related subjects incident to flying.

In addition to this work, specific studies are conducted on contract by various institutions which specialize in certain phases of research. The Harvard Fatigue Laboratory is one of these organizations, and the report of Dr. John W. Thompson, which follows, should

prove of interest.

As a result of Dr. Thompson's study, it is planned to continue this phase of the work, as additional data along this line is desirable. Further research may serve to establish a new angle of approach, particularly in connection with the difficult subject of pilot selection.

INTRODUCTION

It has been found by experience that all individuals are not good pilot material even after the elimination of those possessing disqualifications such as marked errors in vision, unsuitable age, organic and other defects. Such qualities are readily recognizable on the basis of objective evidence and a priori known as essential determinatives. Further elimination results from the rejection of those who the selecting examiners "feel" would not meet the necessary demands. Finally, the remaining unsuitable ones who were not eliminated in the first two stages of selection are filtered out under actual flight conditions when, during their student period, they are found to be incompetent. As a result a group of pilot material is finally selected comprising specimen whose sine qua non is the supposed physical ability to fly or learn to fly commercial aircraft.

Throughout each stage the delineating criteria are in part of an objective nature and in part intuitive and subjective. The extent of the data gathered in both categories would seem to be inadequate. In addition, a classification based on subjective impressions is never wholly satisfactory, as a subjective evaluation does not yield itself to measurement and thereby evades standardization and accuracy.

The present work was undertaken to establish whatever correlations might exist between the state of "pilot acceptability" which is characteristic of the group of pilots and co-pilots studied and the results of objective methods applied to it. If in any instance a high positive correlation were to be found, then that particular property

being investigated would serve as a more or less useful characteristic in the recognition of either actual or potential members of the group.

In the course of previous experiments, it was found that the type of respiration characterizing man at rest showed some degree of correlation with different personality types. The individuals studied were extreme representatives of the cyclothymic and schizoid varieties, all being sufficiently extreme to require confinement in a mental hospital. In addition the schizophrenic individuals were further selected, so that only the relatively cooperative cases of long standing were observed. The breathing of the cyclothymic patients was characterized by a large tidal air, the standard deviation of which was large as compared with the small tidal air of more uniform magnitude in the schizophrenic individuals.

SUMMARY

Two groups of individuals, one consisting of rated pilots and the other of university students who are not pilots, have been subjected to a test which records the pattern of their breathing. There is evidence to show that this pattern is in some manner related to the "personality type" of the individual. The results of this work lend further support to this view since the pilot group is statistically differentiated from the non-pilot group on the basis of its pattern of breathing. Since the personality of a pilot is an integral part of his ability to fly, it is tentatively suggested that this method may be of value in selecting those individuals who

are temperamentally suited to the demands of airplane navigation.

DISCUSSION

I. Method

The subjects consisted of 42 rated pilots, with flying time varying from 6½ to 11,000 hours, 5 student pilots, 4 applicants for enlistment in the Navy and 50 male university students.

The university students volunteered for a number of tests and thus formed a selected group from the student body only insofar as they were ready to offer their services for experimental work. They reported in the morning without having had breakfast and were allowed to rest for at least one half hour in a recumbent position. Following the rest period they were connected to a recording spirometer of the Roth Benedict type and a record of their breathing for a period of at least 20 minutes was thus obtained. From this record a representative 3-minute sample was selected by inspection and the tidal air of each expiration and inspiration in the sample was measured.

The first 4-minute period was not included in the process of sampling since it has been found almost invariably to differ from the remaining portion of the graph; this peculiarity of the initial period has been attributed to the adjustment of the patient to the incommodity of the apparatus. In the large majority of cases the representative sample will be found in consecutive minutes near the middle portion of the record; if, as happened in a few cases, it was felt that more accurate sampling could be obtained by the choice of scattered minute

periods, then such a choice was made.

It is highly important at the outset to explain to the subject in detail what is to be done and gain his confidence before the record is attempted. This applies even more strongly in the examination of mental patients. Furthermore, if patients laugh, attempt to speak, or in any other manner become uncooperative during the test, that portion of the record in which these artifacts appear should be appropriately marked and subsequently eliminated. It has been my experience that such instances are rare if the patient is handled with appropriate consideration and adequate explanation. A useful step in the procedure is to ask the subject not to think of his breathing but rather to direct his thoughts into some other channel. Once the first three or four minutes have been recorded it is generally possible, by close inspection of the subject's accessory muscles of respiration and observation of his costal and abdominal movements, to detect whether or not his respiration is being forced. Should this be suspected, he can again be requested to "allow his breathing to take care of itself". If the supposition has been correct, the request almost invariably will be followed by an alteration in the breathing pattern. It is surprising how difficult it is willfully to vary one's breathing over a half hour period. If such an attempt is made, the record shows the artificiality by a lack of consistency in its pattern.

In the case of the pilots it was found impracticable to obtain a psychiatric estimate, though this was accomplished in the case of the naval applicants. The examining physicians in the recruiting staff

sent in an applicant from whom a pneumograph was to be obtained with information as contained in the appended Letter #1. After the pneumograph had been studied, a report was sent to the Navy Medical Officer as in Letter #2 and his diagnosis was then reported as in Letter #3.

II. Results

The accompanying histograph depicts the results obtained from the study of the rated pilots and university students. The table of figures summarizes the data from which it was drawn. Students are characterized by a smaller tidal air whereas pilots are characterized by a larger tidal air. There is some overlapping at the upper extreme of the student group with the lower extreme of the pilot group. There are three pilots whose tidal air considerably exceeds the average of their group. The lowermost limits of the curve are represented by a vertical line, whereas in both groups the right extremity falls gradually, as a frequency distribution curve might be expected to do unless altered by some other factor. The figures for the student pilots and the naval applicants are contained in Table I, along with the figures of the other individuals participating.

Copies of letters which passed between the examining physician at the Naval Recruiting Station and the investigator are appended in full.

The selection of individuals for particular occupations entails a forecast of performances under known conditions. It is a valid prediction, for example, that an introverted, reticent, sensitive

individual will not make a good door-to-door salesman. In such a case the circumstances with which the prospective employee would have to cope are known to be relatively uniform in their nature and of a type not easily or satisfactorily met by such an individual. Therefore it is essential to know accurately both sets of data - that is, the personal and environmental, before one can reasonably hope always to select the appropriate man for a particular position. The accuracy of the selection would be a function of the validity of the data. The aviation industry can select the prospective pilot only insofar as it knows the conditions to be met and insofar as the tests applied to pilots validly forecast their behavior. The demands of the situation are not the concern of this paper but they involve such elements as climatic conditions, noise, multiplicity of instruments, duration of flights, sudden emergencies such as fire, mechanical breakdown, etc. It must be clearly realized, moreover, that aviation is an industry which is rapidly changing and whereas a decade ago the conditions demanded one type of individual, they may well have changed sufficiently to require a different one today. To study the characteristics of present-day pilots whose selection, position, and success result from their ability to meet situations as they existed in the past and to stipulate these as being essential factors in the personality structure of pilots today, therefore, may not be a valid method. The results of the present investigation separate the pilots who have been successful as a group, from those in the random university sample. It would be going beyond the limits of the data to state that

the same results would be found in a group of successful student pilots at the present time. However, there is a slight suggestion, as evidenced by the few figures obtained from the examination of five student pilots, that the same would still be the case.

The true meaning of these differences in the characteristics of resting breathing in the two groups is by no means clear. As has been indicated above, these differences seem related somehow to the individual "personalities", - introversion and schizoid tendencies on the one hand, and extroversion and cyclothymic tendencies on the other. The "neurotic type" of curve is unlike either of the above, and if recognizable, it depicts the panting type of respiration with frequent sighs and uncommonly frequent swallowing episodes. This correlation appears less strange when it is recalled that respiratory differences have been known for a very long time to be associated with moods and emotions; the panting of sexual excitation is common knowledge; the slow easy breathing of physical and mental relaxation likewise is well recognized. The sudden inspiration of fright is still another example. Laughing or crying may be looked upon as respiratory variants. Indeed the phenomenon is so well known that actors make use of it in conveying to their audiences the emotions which they are supposedly experiencing. It may be, then, that a sample of an individual's breathing would be some index to his general emotional tone.

Another point of view would result from the fact that individuals in thinking, partake of "unconscious" vocalization. This

trait would be particularly marked in those whose thinking forms a dominant element in their lives and is predominantly done in terms of words. Such vocalization would be less marked in the "feeling" type of individual, and particularly in one disposed to visual phantasy. Visual phantasy thinking is more frequently a characteristic of the introvert in contradistinction to the extrovert, whose interest lies predominantly in "things" rather than "abstractions" and who is less concerned about feelings toward these "things". Such vocalization would interrupt the regularity of respiratory rhythm and thus yield an irregularly designed pneumograph.

There is yet another possible explanation. It is known that the physiology of some people is more "flexible" than that of others; such a one will respond more easily to given stimuli. This characteristic is well seen in the aging process, in which an individual passes from a relatively flexible type of response to one of relative rigidity. This rigidity renders an individual less adaptable, particularly to a rapidly changing environment more easily handled by one whose physiological reactions were less prone to remain constant. In fact, the introverted schizoid more often seeks a "stable state" than the extroverted cyclothymic whose environment of choice is essentially one of constant flux.

Whatever the explanation may be, it is my considered opinion that the pilots as a group, are definitely more "extroverted" and "cyclothymic" in their dispositions than a similar number of university students. Such features in their daily lives as simultaneous interests in a number of business enterprises, frequent entertainment, lack of

interest in abstract thought, hearty dispositions and carefree attitudes, lend support to this contention. The schizoid, on the other hand, is typically quieter, more reticent, more limited in his activities, less skillful in his ability to mix with people and also, more abstract in his thinking processes - in short, more the "student type".

It is also the judgment of qualified and experienced observers with whom this issue was discussed that an introverted schizoid type of person has not in the past succeeded as a pilot. It may well be that the increasing demands for knowledge in navigation and more theoretical aspects of flight technique call now for a less marked degree of "practicality" in pilots being trained today than in those trained formerly. With this in mind it would be particularly valuable to carry out the same tests in a large group of student pilots, in order to determine whether by such a method one could identify those who were later to fail during their training period.

The characteristics of the histograph are of some interest. Respiration is limited at the two extremes, but by different factors; one can breathe as deeply as the anatomical structure will permit, and experience no untoward effects, provided the rate is diminished sufficiently. However, in the opposite direction a limit is reached where no degree of increment in rate will compensate for the superficiality of respiration. In other words, the lower limit is of a physiological nature, whereas the upper limit is determined more by anatomical structure. This may be the explanation for the vertical

line limiting the lower extremity and the obliquity of the limit at the upper extreme. "Depth in breathing is a matter of choice, superficiality a matter of life."

If large tidal air had some positive correlation with "flying ability", one might expect the upper extremity to contain those with greater ability in this respect. Among the three highest tidal airs are two pilots whose reputation for flight is international. At the other extremity one might expect to find the poorest pilots, but if they are there, it is difficult to label them as such. A request was made during the course of the investigation to have a number of poor pilots sent for examination. With some evidence of surprise the answer came "We have no poor pilots; they are all good or they wouldn't be flying." A perfectly true statement, no doubt, but perhaps charged with some "esprit de corps". An investigation of student pilots would throw more light on this point.

An entirely different explanation of these findings might be suggested along the following lines of thought. If an individual were to adapt himself to high altitude it may be expected that his tidal air would increase. That such an explanation is improbable is shown by the fact that the commercial experience of the pilots studied varies from 6½ to 11,000 hours in the air and those with the shorter time do not fall in the lower portion of the pilot group curve. Furthermore, Armstrong (1) has shown that an adaptation to altitude does not take place by intermittent exposures to rarefied atmosphere.

(1) The Journal of Aviation Medicine, 9:92, 1938

In addition it might be said that the altitude at which the pilots more commonly fly would certainly not call for the observed increment in tidal air.

In concluding this discussion it should be emphasized that folly alone would suggest the application of this test to the selection of pilots until much more data of a similar kind has been accumulated, and then only as an additional tool to those whose value has been established.

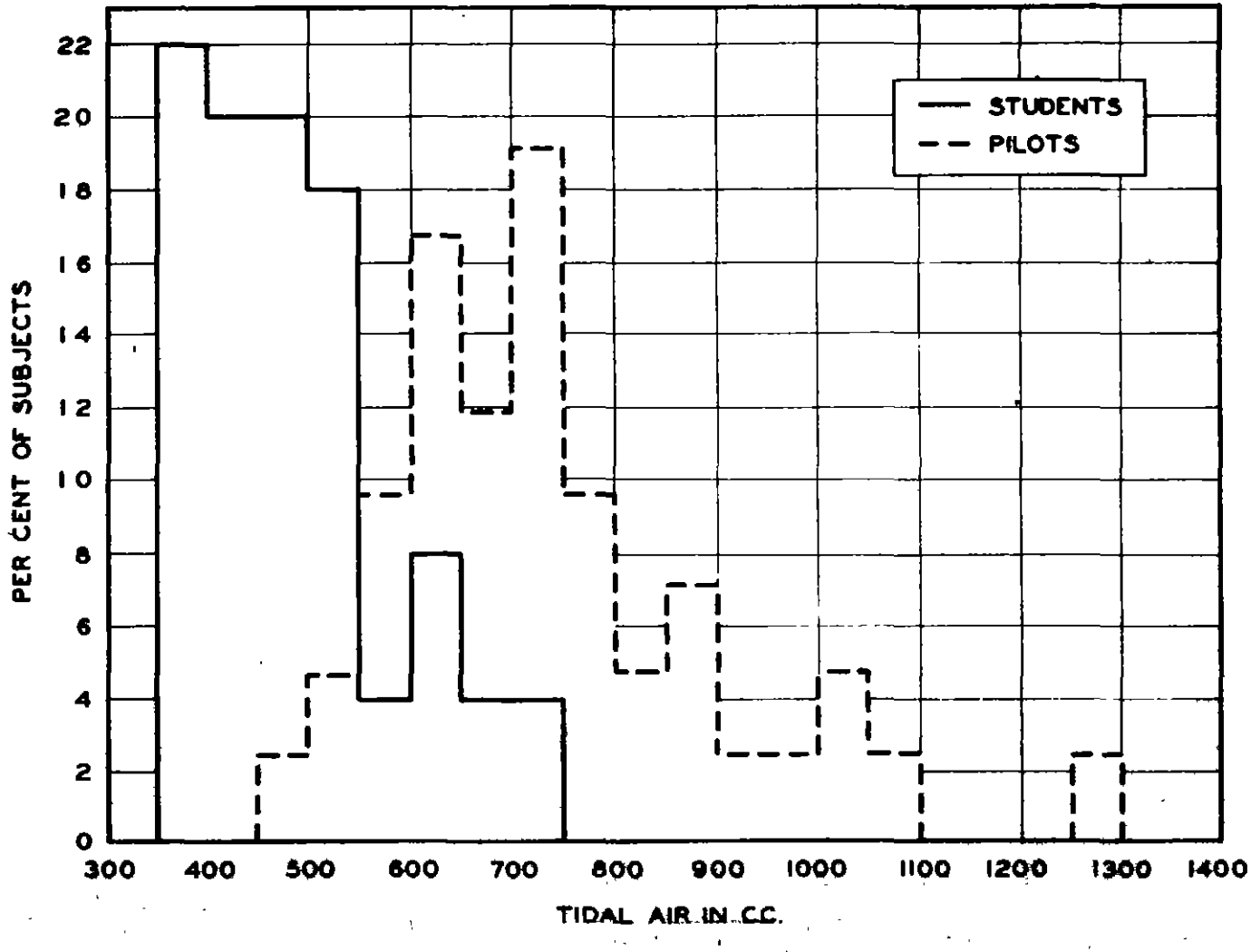
CONCLUSIONS

(1) Pneumographs have been obtained from 42 licensed pilots, 5 student pilots, 4 naval applicants and 50 students. These show statistically valid group differences in the tidal air of students as compared with those of pilots, and the possibility of this fact being correlated with traits in their personalities is suggested.

(2) Similar conclusions were reached in all cases in which a physician diagnosed the stability of personality in the individual by means of standard methods and stability as estimated from a study of the pneumograph. The number of such cases is too small to allow a valid statistical analysis of this particular data.

(3) The work is suggestive enough to invite further investigation along similar lines, particularly in the case of student pilots.

FREQUENCY DISTRIBUTIONS OF TIDAL AIR IN STUDENTS AND PILOTS



NAVAL FLIGHT CADETS

	Age	Height cm.	Weight kg.	Surface Area m.	Respiration	Tidal Air	Vent./min.
Subject 1	22	175.3	72.58	187	13	654	8490
Subject 2	20	188.0	86.64	213	14	702	9819
Subject 3	22	161.6	65.32	173	16	533	8528
Subject 4	25	180.3	82.55	202	10	872	9150
Subject 5	20	182.9	67.13	187	13	652	2810

NAVAL RECRUITS

Subject 1	16	170.2	58.89	168	20	393	7679
Subject 2	18	172.7	72.58	186	11	745	8181
Subject 3	19	170.2	68.95	180	13	664	8621
Subject 4	19	152.0	68.50	166	13	630	8402

C
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No. 1

U. S. NAVY RECRUITING STATION
Post Office Building
Kansas City, Mo.

18 August 1938.

John W. Thompson, M. D.,
1306 Bryant Building,
Kansas City, Mo.

Dear Sir:

This will introduce _____ who has been asked to appear at your office at 7:30 a.m. 19 August 1938 sans breakfast.

No. 2

C
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Kansas City, Missouri
August 16, 1938

Dr. _____
U. S. Navy Recruiting Station
Post Office Building
Kansas City, Missouri

Dear Dr. _____:

Re: Subject I.

I have a pneumograph on this subject and it is quite extreme in its type. I should say that if these records give us any index of the individual's personality then this person belongs to the "neurotic" group. An additional interesting point was the extensive salivation during the test period. I have no idea what this means except that it is conceivably related to his neurotic constitution.

So much for the test itself. Of course I couldn't help seeing the individual, although I did not speak to him, and purely from this very superficial impression I should judge that his mentality is below normal. I should be very much interested in knowing how this correlates with your findings and impression.

I am, sincerely,

John W. Thompson

JWT:MK

No. 3

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U. S. NAVY RECRUITING STATION
Post Office Building
Kansas City, Mo.

18 August 1938.

John W. Thompson, M. D.,
1306 Bryant Building,
Kansas City, Mo.

Dear Dr. Thompson:

Re: Subject I.

Physical data in the above mentioned case are:

Date of examination: 8-15-38.
Age: 16 years and 8 months
Physical Stigmata:
High narrow arched palate
Narrowing superior dental arch
Deviated nasal septum-extreme
Mental stigmata: (Functional)
Enuresis until 13 yrs. of age
Stammers when excited - mild
Flat personality reaction (clinical)
Eyes - marked tendency to stare with somewhat anxious expression.
Slow in school. Just finished 8th grade. All grades low.
No marked interest in any subject.
My diagnosis in this case was Constitutional psychopathic state, inadequate personality, altho under emotional stress this man might easily be classified as Emotional instability.

Sincerely,

Lt. (MC) U.S.N.

No. 4

C
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Y

1306 Bryant Building
Kansas City, Missouri
August 23, 1938

Dr. _____
U. S. Navy Recruiting Station
Post Office Building
Kansas City, Missouri

Re: Subject II.

Dear Dr. _____:

This boy shows a record which I must say I have never seen before. I am quite willing to say it is abnormal, but to what group he belongs is more than I can tell. All I can do is to say that he does not belong to the schizophrenic group nor to the manic-depressive group. I have not seen as many neurotic curves, but of those which I have seen this is not one. Perhaps there is some organic condition which may account for it. As I said before, I frankly don't know.

I shall be most interested to hear your opinion of the case, and thanking you for sending the boy, I remain

Yours sincerely,

John W. Thompson

JWT:MK

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U. S. NAVY RECRUITING STATION
Pickwick Bldg., 903 McGee Street
Kansas City, Mo.

30 August 1938.

John W. Thompson, M. D.
Bryant Building,
Kansas City, Mo.

Dear Sir:

Re: Subject II.

Receipt of your report is acknowledged.
The physical examination in this boy was as follows:
Eyes, ears, nose and throat normal. Mouth breather.
Height 69½", weight 133 lbs.
B.P. 100/78, P. 100.
Heart, lungs, abdomen, genitalia normal.
Glandular system apparently normal.
Functional psychopathic abnormalities:
Enuresis until 11 years of age. Flat personality curve with very little emotional change. (Facial or phonetic). Did not appear alert and was sluggish in answering questions. Flunked all courses in Freshman year in high school except Algebra for which he received only a passing grade. He admitted a great love for dogs and stopped going to school to take care of 15 dogs. His professed love for dogs was considered abnormal. He evinced very little interest in boys or girls of his own age and only occasionally indulged in athletics.

The mother and father were living and well. He had two sisters older than he and three other children younger than he.

It was my impression that this man has a Constitutional psychopathic state, inadequate personality, while my second impression was that of an early schizophrenia. There is very little basis for either of these diagnosis.

P. S. The G.C.T. test in this case was 64%.

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No. 6

1306 Bryant Building
Kansas City, Missouri
August 31, 1938

Dr. _____
U. S. Navy Recruiting Station
Post Office Building
Kansas City, Missouri

Dear Dr. _____:

Re: Subject IV.

This boy's record is definitely of a neurotic type, and I have no hesitation in saying that he deviates from the normal in his psychic makeup. I calculated his basal metabolic rate and found it to be Plus 19. I repeated the test a second time about twenty minutes after the first, and on the Second occasion found it to vary from Plus 13 to Plus 6. It seems to me that this would corroborate the previous diagnosis, as a purely metabolic disorder would not fluctuate as this one has done. Of course the measurements were made on a closed system and personally I don't think that such measurements are particularly accurate as regards the basal metabolic rate.

I should like very much to hear your view of this case.

Very truly yours,

John W. Thompson

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No. 7

U. S. NAVY RECRUITING STATION
Pickwick Bldg., 903 McGee Street
Kansas City, Missouri.

1 September 1938.

John W. Thompson, M. D.,
1306 Bryant Building,
Kansas City, Mo.

Dear Sir:

Re: Subject IV.

Receipt of your report is acknowledged.

The above named man was examined in this office on 7-27-38. The physical examination revealed no organic lesions or deviation from the normal. He admitted a history of hay fever, allergy to cow dander. No physical stigmata of degeneration were noted. During psychiatric examination he admitted a history of nervousness from 14 to 17 years of age and a probable history of inferiority complex. Observation revealed that he was nervous, and over active physically and orally (very loquacious). The reflexes were hyperactive.

Diagnosis:
Constitutional psychopathic state,
emotional instability.

Sincerely,

Lt. (MC) U.S.N.

No. 8

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U. S. NAVY RECRUITING STATION
Pickwick Bldg., 903 McGee Street
Kansas City, Mo.

2 September, 1938.

John W. Thompson, M. D.,
1306 Bryant Building
Kansas City, Mo.

Dear Sir:

Re: Subject III.

The subject named man was examined in this office on 8-13-38. He was considered normal in every respect except for a tachycardia, rate 120, which was considered due to increased nervous tension. He was reexamined on 8-18-38 and the pulse was found to be normal, rate 84, exercise 126, rest 86.

Diagnosis: None. Normal.

Sincerely,

Lieut., (MC), USN.

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No. 9

1306 Bryant Building
Kansas City, Missouri
September 2, 1938

Dr. _____
U. S. Navy Recruiting Station
Post Office Building
Kansas City, Missouri

Re: Subject III.

Dear Dr. _____:

I have looked up the pneumograph on this subject, and as far as I can tell there is nothing unusual about it. It has no outstanding characteristics, and therefore it either does not tell us of any marked psycho-physical deviation from the normal or else the individual has none to show. At the present stage of our knowledge I should not at all wish to be dogmatic, but I think one is reasonably safe in saying that the chances are that a person showing this type of record may be passed as "normal".

Would you be kind enough to let me have your estimate of this individual?

Thanking you, I am

Sincerely yours,

John W. Thompson