STUDIES IN MOTION SICKNESS

Series A

Reports on research administered by Wesleyan University by means of grants-in-aid from the National Research Council Committee on Selection and Training of Aircraft Pilots from funds provided by the Civil Aeronautics Administration.

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Committee on Selection and Training of Aircraft Pilots

Executive Subcommittee

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National Research Council

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LETTER OF TRANSMITTAL

NATIONAL RESEARCH COUNCIL

2101 Constitution Avenue, Washington, D.
Division of Anthropology and Psychology

Committee on Selection and Training of Aircraft Pilots

December 15, 1944

Dr. Dean R. Brimhall, Director
Division of Research
Civil Aeronautics Administration
Washington 25, D. C.

Dear Dr. Brimhall:

Attached is a report entitled Studies in Motion Sickness -- Series A, embodying two reports and a note on research conducted by G. R. Wendt, and administered by Wesleyan University. This report is submitted by the Committee on Selection and Training of Aircraft Pilots with the recommendation that it be included in the series of Technical Reports issued by the Division of Research, Civil Aeronautics Administration.

The studies in motion sickness included in this report, and in others to be discussed in subsequent reports, were among the earliest investigations undertaken in the research program of the Committee on Selection and Training of Aircraft Pilots. Since the earlier studies were largely exploratory in character, the experimental findings are somewhat limited, in part by the fact that a small number of cases was involved in such exploratory research. However, work in this area has led to a practical outcome in the form of the popular pamphlet "How to Prevent Air Sickness" which was distributed some years ago by the Civil Aeronautics Administration. Moreover, studies by Dr. G. R. Wendt under grants from the Committee on Selection and Training of Aircraft Pilots, from funds provided by the Civil Aeronautics Administration, laid the foundation for research which has been continued by him under the auspices of the Committee on Aviation Medicine.

Sincerely yours,

Morris S. Viteles, Chairman
Committee on Selection and
Training of Aircraft Pilots
National Research Council

MSV:rm

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FOREWORD

Included in this report are three studies from a series of investigations on motion sickness, administered by Wesleyan University under a grant-in-aid from the Committee on Selection and Training of Aircraft Pilots. These studies were designed for the preliminary and exploratory investigation of postulated hypotheses in the area of motion sickness.

Acknowledgments are made by the author to Dr. Chester J. Hill, Jr. (Wesleyan University), Dr. Stanley J. Alexander (Portland, Connecticut), Mr. John S. Helmick, Mr. C. F. Taylor, Jr., and Mr. George Everett, research assistants at the time these studies were carried out, and to Dr. D. B. Lindsley (Brown University), and his Staff at the Emma Pendleton Bradley Home, E. Providence, R. I., who all helped to make these researches possible. A portion of the work on the first study was supported by funds of the National Youth Administration.

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SUMMARY

In the following investigation the experimenters selected, by means of a motion-sickness history questionnaire and by interview, 19 college students who were susceptible to motion sickness and 20 who had never been motion sick to any degree, and who were free of illness or other physiological abnormality. Each subject served three days, taking a capsule with breakfast. On day 1 each received 2.5 mgm. benzedrine sulphate. On days 2 and 3 each received either a placebo or benzedrine (1 mgm. per 30 lbs. of body weight). The subjects were told that they were getting two different "drugs." Twice each day (before lunch and after dinner) each subject completed a 29-item questionnaire concerning subjective effects. Twenty of these items were of the kind, "Have you drunk (a) more water than usual_____, (b) less water than usual_____, (c) same amount of water as usual_____?" Questionnaires were scored both in terms of total number of abnormal items and in terms of preponderance of items in the direction expected after benzedrine.

Under the conditions of the experiment the questionnaire method was of almost no value for the detection of drug effects. There were as many abnormal items checked on the placebo day as on the drug day, and for the total group the nature of the abnormalities reported on the benzedrine day was only slightly more in the direction of the expected benzedrine effect than on the placebo day.

The group of subjects susceptible to motion sickness checked approximately three times as many symptoms as the group of non-susceptibles on each of the three experimental days. When asked to note their most prominent symptoms the susceptibles wrote in approximately twice as many as the non-susceptibles.

A comparison of the kinds of symptoms reported by susceptibles and non-susceptibles on benzedrine and placebo days showed: (1) that of the 19 susceptibles, 12 reported a greater excess of benzedrine symptoms on the benzedrine day, 3 on the placebo day, 1 reported no difference, and 3 reported no symptoms on either day; and (2) that of the 20 non-susceptibles, 2 reported a greater excess of benzedrine symptoms on the benzedrine day, 6 on the placebo day, 4 reported no difference, and 8 reported no symptoms on either day.

[illegible]

Section I

A STUDY OF THE [illegible]
SURFACE ON [illegible]
NON-[illegible]
OBSERVATIONS [illegible]

by

C. R. [illegible]

A STUDY OF THE SUBJECTIVE EFFECTS OF SMALL DOSES OF BENZEDRINE SULPHATE ON INDIVIDUALS SUSCEPTIBLE AND THOSE NON-SUSCEPTIBLE TO MOTION SICKNESS, INCLUDING OBSERVATIONS ON PSYCHOGENIC SYMPTOMS[1]

INTRODUCTION

The present investigation was an exploratory study designed to secure partial tests of two hypotheses relating to the nature of susceptibility to motion sickness.[2]

The one hypothesis was that susceptibility to motion sickness is associated with sensitivity to epinephrine and epinephrine-like substances.[3]

The discovery of a hyper-reactivity to benzedrine sulphate would be a partial verification of the hypothesis in that it would reveal a difference in the physiology of susceptibles and non-susceptibles.

The other hypothesis was that susceptibility to motion sickness is associated with a tendency to the development of psychogenic symptoms (i.e., those produced by suggestion). This hypothesis would be verified if the susceptibles, on placebo days, showed a larger number of symptoms than the non-susceptibles.

The experiment was designed to compare the reactions of extremes from the college student population, selected to represent those most susceptible and those least susceptible to motion sickness. Complete verification of the hypotheses would have been attained if no subject in the non-susceptible group showed as much reaction as any subject in the susceptible group. This outcome is, however, limited by the reliability and validity of the method of selection of susceptibles and non-susceptibles, by the reliability and validity of the method of determining symptoms, and by the validity of the drug schedule for the present purposes.

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[1]This is one of a series of investigations into the nature of susceptibility to the nauseating effects of motion done with the support of grants-in-aid from the National Research Council Committee on Selection and Training of Aircraft Pilots and administered by Wesleyan University. A major portion of the work of the study here reported was supported by funds of the National Youth Administration. Mr. George Everett assisted in the conduct of the investigation.

[2]For a semi-technical review of investigations on motion sickness in aviation, see: Wendt, G. R. Motion sickness in aviation. N.R.C. Division of Anthropology and Psychology, Committee on Selection and Training of Aircraft Pilots, May 1944.

[3]For an experimental test of the hypothesis that excesses of epinephrine in the blood stream facilitate motion sickness, see: Dorcus, Roy M. The influence of physiologically effective doses of epinephrine on vestibularly induced nausea. Washington, D. C.: Civil Aeronautics Administration Division of Research, Report No. 5, November 1942.

METHODS

The entire student body of Wesleyan University completed a questionnaire inventory of history of motion sickness. The extremes of the group were re-examined by means of the same questionnaire or interviewed, or both. Twenty-one "susceptibles" and 22 "non-susceptibles" with clean medical records were called together in a group and told the general objectives and specific procedures of the experiment. After signing a pledge to conform to the rules each received a sheet of instructions, three envelopes, each containing one capsule, and six "drug effect questionnaires." On three days of their own choice (the last two required to be consecutive) the capsule indicated for that day was taken with breakfast. Before lunch and after dinner on each day a copy of the drug effect questionnaire was completed. On day 1 all subjects received 2.5 mgm of benzedrine sulphate. On day 2 half of the susceptibles and half of the non-susceptibles received 1 mgm of benzedrine per 30 lbs. of body weight; the other half received placebo. On day 3 the drug and placebo groups were reversed. Nineteen susceptibles and 20 non-susceptibles completed the experiment and signed a pledge that they had adhered to all rules.

Selection of subjects. The criteria for selection of subjects were as follows: (1) Non-susceptibles were individuals who could not recall having ever been motion sick to any degree on any vehicle or device. (2) Susceptibles were individuals who had a history of motion sickness since childhood and who stated that they were still subject to motion sickness on one or more vehicles or devices at the time of the investigation. History of motion sickness was determined by a questionnaire inventory (see Appendix A) used first as a screening test and then repeated for the extremes of the population under conditions where a pledge of accuracy was required. (Wesleyan University students operate under a successful Honor System.) Six who were not so re-examined were interviewed instead. Most were both re-examined and interviewed, the interview taking place while they were in the laboratory to serve as subjects in other experiments in this series. Each subject was personally acquainted with one or both of the experimenters. The correct classification of our subjects, within the limits of our definition, does not seem open to question. If "susceptibility" and "non-susceptibility" were to be redefined as predictive concepts, some subjects might shift. It is our opinion that direct validation, by exposing each subject to various kinds of motion, would confirm the classification of almost all of the susceptibles (since there is no reason for doubting the accuracy of their report that they have been recently sick) but only of a majority of the non-susceptibles (since further experience might show that some could be made motion sick). (3) The college physician reviewed the medical records of each subject and only cases without illness or physiological abnormality were selected.

Procedures. Before getting the subjects together the body-weight of each was determined and drug dosages prepared. In large manila envelopes, one for each subject, were placed (1) a sheet of instructions, (2) three small, sealed envelopes, each containing a single capsule and labelled "Day 1, Day 2, and Day 3," (3) six copies of a drug effect questionnaire, with six addressed, stamped envelopes, and (4) two pledges to be signed, one at the beginning and one at the end of the experiment.

All prospective subjects were then called together and in 30 minutes were told the general objectives of the study and its specific requirements. The

requirements (see Appendix B) concerned certain general matters of conduct (eating, sleeping, use of other drugs, prohibition of discussion with others) and specific instructions about taking the capsule (at breakfast time) and returning two drug effect questionnaires each day (one before lunch, one after dinner). Each subject received his envelope of instructions and materials and signed an agreement to adhere to all rules. The remainder of the procedure was completed on their own initiative according to the instructions. A signed pledge that the capsules had been taken according to instructions and that all rules had been adhered to was returned with the last drug effect questionnaire.

Benzedrine dosage. On either day 2 or day 3 each subject received 1 mgm of benzedrine sulphate per 30 lbs. of body weight, i.e., a 150-lb. subject received 5 mgm. A milk sugar placebo was given on the alternate day. A 2.5 mgm dose of benzedrine was given on day 1 to detect any subjects with extreme sensitivity to the drug. (It should be noted that 5 mgm is a small dose for the average subject and possibly below the threshold for identifiable subjective effects.)

The subjects were told they were getting two different "drugs." The drug effect questionnaire required them to report what they thought they had taken. In the 120 questionnaires of the non-susceptibles all but 6 reported "no idea," "don't know," or "none." In the 114 questionnaires of the susceptibles all but 19 said the same. There were 16 reports of "sedative," "narcotic," etc. and 9 of "stimulant," etc.

Drug effect questionnaire. The questionnaire (see Appendix C) consisted of 20 items requiring a check of 20 activities which could be reported as increased, decreased, or unchanged, 5 items of report on conduct, and 4 items of free report on symptoms.

From items 1 to 20 (excluding item 16) two types of data were obtained for this investigation: (1) the total number of abnormal items, i.e., those indicating any change from the normal or usual state; and (2) a "benzedrine score," based on the direction of the changes, i.e., whether similar or opposite to the expected effects of benzedrine.

The methods used for scoring the questionnaires in order to obtain these data are described in detail in the appropriate section under "Results."

The validity of the questionnaire, for the purposes of the investigation, is discussed on page 11.

RESULTS

The results are presented in two sections. Section A deals with total numbers of abnormal items in relation to susceptibility, to dosage, to the experimental day, and to time of day. Section B deals with the kind of symptom reported, especially in relation to the drug schedule.

A. Total abnormal items. Table 1 shows the total number of abnormal items on questions 1-20 (excluding 16) for each subject on each day (sum of morning and

evening questionnaires), the totals for each subject, and the group averages. The designation, b, indicates the benzedrine day. Subjects are marked with a double asterisk to call attention to those who reported no symptoms on any of the three days. There were four non-susceptibles, but no susceptibles in this group. A single asterisk marks those who reported no symptoms on either the drug or the placebo day (days 2 and 3). There were 8 non-susceptibles and three susceptibles in this group.

Inspection of Table 1 shows that the susceptibles reported approximately three times as many abnormal items as the non-susceptibles on each of the three days, the average total items per questionnaire being 4.87 for the susceptibles and 1.65 for the non-susceptibles. Only one non-susceptible exceeded the average of the susceptibles, but there were five susceptibles

TABLE 1

NORMAL ABNORMAL ITEMS

Susceptibles					Non-Susceptibles			
Subject	Day 1	Day 2	Day 3	Total	Subject	Day 1	Day 2	Day 3	Total
1	17	23	22 b	59	1	4	6 b	8	18
2	3	2 b	[illegible]	[illegible]	2	0	1	0 b	1
3	16	23	9 b	[illegible]	3	11	1	1 b	13
4	13	15 b	18	[illegible]	4	7	9 b	2	18
5	18	16 b	7	[illegible]	5**	0	0	0 b	0
6	9	[illegible]	[illegible]	[illegible]	6**	0	0	0 b	0
7	10	[illegible]	[illegible]	[illegible]	7	6	2	3 b	11
8	12	18	20 b	[illegible]	8	4	0 b	0	4
9	9	[illegible]	[illegible]	[illegible]	9	0	3 b	0	3
10	1	3 b	2	[illegible]	10*	0	[illegible] b	0	0
11	1	0	[illegible] b	[illegible]	11	2	0	0 b	2
12	7	[illegible]	[illegible] b	[illegible]	12*	0	0 b	0	0
13*	1	[illegible] b	0	[illegible]	13*	2	0	0 b	2
14*	4	0	0 b	[illegible]	14*	1	0 b	0	1
15	9	[illegible]	[illegible]	23	15	12	0 b	1	13
16*	4	0 b	0	4	16	0	2	8 b	10
17	17	[illegible]	[illegible]	[illegible]	17	[illegible]	16	5 b	24
18	27	[illegible]	[illegible]	65	18	10	12 b	12	34
19	20	[illegible]	[illegible] b	[illegible]	19	9	9 b	4	22
					20	2	10	10 b	22
Av. per subject	10.4	[illegible]	[illegible]	[illegible]		[illegible]	3.3	2.7	9.9#
Av. per questionnaire	3.21	[illegible]	[illegible]	[illegible]		1.82	1.78	1.35	1.65

#The [illegible] represents a P-value below the 1% level [illegible] degrees of freedom.

below the average of the non-susceptibles. Although there is considerable overlap of the distributions (11 out of 19 susceptibles checked fewer abnormal items than the top non-susceptible), the difference between the means of the two groups is reliably greater than zero, as indicated in a P-value of less than .01, computed by means of the "t" test for unmatched groups.

Table 1 shows slightly more frequent report of symptoms on day 1 than on days 2 or 3, in the case of both susceptibles and non-susceptibles. Breakdown of results showing average symptoms per questionnaire returned in the morning and average in the evening shows slightly more symptoms in the later report: susceptibles, morning = 4.77, evening = 5.00, non-susceptibles, morning = 1.51, evening = 1.68 symptoms per questionnaire.

The average numbers of symptoms per questionnaire on the benzedrine days as compared to the placebo day are shown in Table 2. It may be noted that, in the case of both the susceptible and the non-susceptible groups, the benzedrine (full dose) day actually produced slightly fewer symptoms. This relationship holds up both when benzedrine was given on day 2 and when given on day 3.

TABLE 2

EFFECTS OF BENZEDRINE ON SUBJECTIVE SYMPTOMS
(Average Number of Symptoms per Questionnaire)

		Susceptibles	Non-susceptibles
Day 1	2.5 mgm benzedrine	5.21	1.76
Day 2 or 3	placebo	4.92	1.66
Day 2 or 3	benzedrine (full dose)	4.47	1.45

According to the over-all results the activities most often reported abnormal were those in items No. 5 (sleepy = 45 times, wide-awake = 24), No. 10 (relaxed = 23, excited = 37), No. 11 (fatigued = 39, fresh = 16) and 20 (less nervous = 11, more nervous = 43). Those least often reported abnormal were those in items No. 2 (more water = 12, less water = 11), No. 7 (urinated more = 16, urinated less = 5), No. 8 (less talkative = 10, more talkative = 12), No. 13 (less aware of heart = 7, more aware = 15), and No. 19 (throat drier = 15, less dry = 7). Other items worthy of note as showing one or the other symptoms low or high are No. 3 (palms damper = 39, less damp = 12), No. 9 (skin cool = 7, skin hot = 22), and especially No. 18 (headache = 40, less headache than usual = 1). All other items were intermediate in frequency, i.e., at least 10 and not more than 30 on any alternative, at least 29 and not more than 51 on any pair of alternatives. Those items which were more often checked in the "expected" direction on the benzedrine day are indicated in the following section.

B. Kind of symptom in relation to dosage. To investigate the direction of the symptoms a "Benzedrine Score" was obtained as follows: (1) by counting as +1 all abnormal items in the direction expected under benzedrine, as -1 all abnormal items in the opposite direction, and as 0 all items reporting no

change;[4] (2) by obtaining the algebraic sum of the scored items for each questionnaire;[5] and (3) by subtracting the algebraic sum for the placebo day questionnaire from that of the drug day questionnaire.

A positive benzedrine score thus indicates that on the benzedrine day there was a greater excess of benzedrine effect symptoms than there was on the placebo day. For example, in Table 3, Subject No. 4 of the susceptibles had an excess of +5 on his morning questionnaire and an excess of +6 on his evening questionnaire, obtaining a score of +11 for the benzedrine day. On his placebo day he obtained a +2 on the morning questionnaire and a +1 on the evening questionnaire, totaling +3. His Benzedrine Score is thus 11-3, or +8. Susceptible No. 10 had +2 and 0 on his benzedrine day; 0 and -2 on his placebo day, giving a Benzedrine Score of +4. It should be noted that this assumes that his minus score on the placebo day is his normal base-line from which benzedrine deviations are measured.

Table 3 presents the Benzedrine Scores for the subjects numbered as in Table 1. Double asterisks indicate those who reported no abnormal symptoms on any of the three days; single asterisks indicate those who reported no abnormal symptoms on days 2 and 3.

Comparison of the two groups of subjects indicates that 12 out of 19 susceptibles show a greater excess of benzedrine symptoms on the benzedrine day as compared to the placebo day, while only 2 out of 20 non-susceptibles show such a tendency. Three out of 19 susceptibles show a greater excess on the placebo day as compared to the benzedrine day (resulting in minus scores), and 6 of the 20 non-susceptibles show a greater excess of benzedrine effects on the placebo day as compared to the benzedrine day. Only one non-susceptible exceeds the average Benzedrine Score of the susceptible group. The average benzedrine day excess per questionnaire was +1.77 items for the susceptibles (out of an average number of 4.70 abnormal items per questionnaire, including questions 9 and 18, for day 2 plus day 3). For the non-susceptibles the average benzedrine day excess was -0.38 (out of an average number of 1.56 abnormal items per questionnaire). The average differences per subject between susceptibles and non-susceptibles are reliably significant, the t-value for unmatched groups falling below the baseline at the 1% level. Benzedrine affects a majority of the susceptibles in the expected direction; its effect on non-susceptibles is most often in the opposite direction, if any. It should be noted, however, that the absolute excess (averages of +1.77 and -0.38 symptoms per questionnaire) is so small as not to generate much confidence in the questionnaire as a measure of drug effect. It should, however, be pointed out that our classification of responses as being indicative of benzedrine may to some extent be in error. A correct classification might show the questionnaire method in a better light.

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[4] For this purpose questions 1-20 were used (excluding Nos. 9, 16, and 18), counting as +1 the following: 1a, 2a, 3a, 4b, 5b, 6a, 7a, 8b, 10b, 11b, 12b, 13b, 14a, 15a, 17a, 19a, and 20b. Their opposites were counted as -1 and the "c" responses as 0.

[5] It is realized that algebraic summing of the item values results in a benzedrine effect symptom (either) being "cancelled" by a symptom in the opposite direction (= item). The algebraic sum thus represents the excess rather than the total number of benzedrine effect symptoms. Table 4 presents the actual frequencies obtained for each item.

TABLE 3

EXCESS OF BENZEDRINE SYMPTOMS ON
BENZEDRINE DAY VS. PLACEBO DAY

Susceptibles		Non-Susceptibles	
Subject	Benzedrine Score	Subject	Benzedrine Score
1	+11	1	+5
2	+10	2	+1
3	+10	3	0
4	+ 8	4	0
5	+ 7	5**	0
6	+ 6	6**	0
7	+ 5	7	0
8	+ 4	8*	0
9	+ 4	9	0
10	+ 4	10**	0
11	+ 3	11*	0
12	+ 3	12**	0
13*	0	13*	0
14*	0	14*	0
15	0	15	-1
16*	0	16	-1
17	-1	17	-2
18	-2	18	-4
19	-5	19	-5
		20	-8
Av. per subject	+3.53#	Av. per subject	-0.75#
Av. per questionnaire	+1.77	Av. per questionnaire	-.038

#The t-value is 4.24 for this group difference, which represents a P-value below the 1% level of significance for 37 degrees of freedom.

On day 1 (2.5 mgm benzedrine) the susceptibles showed an excess of benzedrine effects over opposite-to-benzedrine effects of +0.13 items, per questionnaire, the non-susceptibles of -0.25 items. On placebo days the susceptibles showed a benzedrine-like excess of +0.29 items; the non-susceptibles of +0.28 items. On full-dose benzedrine days the susceptibles showed a benzedrine-symptom excess of +2.05 items, the non-susceptibles of -0.10 items.[6]

Table 4 shows in some detail the frequency of answers to each question. It shows the total number of checks for each symptom on the two questionnaires of the placebo day and of the full-dose benzedrine day for the susceptibles and

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[6] Editor's Note. These facts were obtained from a breakdown of the data used in computing the Benzedrine Scores. It may be noted that subtracting the placebo day excess from the benzedrine day excess will yield values similar to the "average per questionnaire" scores presented at the bottom of Table 3.

TABLE 4

FREQUENCY OF REPORTS OF SYMPTOMS

Questionnaire Item No.	Susceptibles: Placebo Day Alternatives a	b	Susceptibles: Benzedrine Day Alternatives a	b	Susceptibles: % Excess	Non-Susceptibles: Placebo Day Alternatives a	b	Non-Susceptibles: Benzedrine Day Alternatives a	b	Non-Susceptibles: % Excess
1	3	9	7	7	a15.8	1	1	1	4	b 7.5
2	3	3	6	1	a13.2	0	2	0	0	a 5.0
3	5	2	6	1	a 5.3	7	2	4	2	b 7.5
4	2	9	2	6	a 7.9	0	3	2	1	a10.0
5	10	4	4	13	b40.3	5	1	5	1	b 0.3
6	7	3	7	0	a 7.9	1	3	0	0	a 5.0
7	2	2	4	1	a 7.9	2	1	1	0	b 0.0
8	4	2	0	4	b16.1	0	0	0	1	b 2.5
9	2	4	2	3	b 2.7	0	4	0	1	b 7.5
10	7	10	3	6	0	0	5	1	4	a 5.0
11	11	2	4	9	b32.5	2	0	3	0	a 2.5
12	5	2	4	6	b13.3	0	0	4	0	a10.0
13	2	5	3	3	a 7.9	0	0	0	1	b 2.5
14	10	5	11	0	a15.7	0	0	3	0	a 7.5
15	2	2	5	0	a13.2	0	2	2	1	a 7.5
16	2	7	9	3	b28.9	0	4	2	2	b12.5
17	3	4	5	3	a 7.9	1	2	0	4	b 7.5
18	11	1	8	0	b 5.2	2	0	4	0	a 5.0
19	5	1	6	1	a 2.7	0	1	2	0	a 7.5
20	3	12	1	9	a 2.6	0	7	1	4	a10.0

and non-susceptibles. They are presented in this fashion to make it possible for the reader to recalculate the data in terms of his own classification of symptoms, if or when better information concerning the subjective effects of benzedrine is available. The columns headed, Per cent Excess, show which alternative (a or b) exceeds on the benzedrine day as compared to the placebo day, and the percentage amount by which the indicated alternative exceeds on the benzedrine day, compared to the placebo day. For instance, of the 38 questionnaires of susceptibles on the placebo day, 5 checked 3a, 2 checked 3b. The excess of 3a over 3b is 3, and that is 7.9% of the total, 38. On the benzedrine day 6 checked 3a, 1 checked 3b, an excess (again for 3a) of 5, and that is 13.2% of the total benzedrine day questionnaires. The Per cent Excess on the benzedrine day therefore favors alternative 3a by 5.3%

This method of analysis indicates that there was agreement between the two groups of subjects (excess on benzedrine days for the same alternative in the cases of both susceptibles and non-susceptibles) in the case of 10 out of 20 items, disagreement in the case of 7 items, and 3 items where one or the other group of subjects showed an excess of less than 1% for either alternative. Of the 10 items on which they agree, 6 are in the direction expected, 2 are in the

opposite direction from our expectation (items Nos. 4 and 20), and 2 are on [illegible] (Nos. 9 and 16) which were not "scored" by us. Alternatives No. 5b (wide awake) and No. 11b (less fatigued) were checked by a large percentage of susceptibles on the benzedrine day.

The two items on which the two groups agreed, but where they did not confirm our expectation of the benzedrine effect may have been incorrectly classified by us. Investigations with larger groups of subjects would show whether 4a (hands steadier than usual) and 20a (less nervous than usual) are more true to the subjective effects of this dosage of benzedrine than was our expectation.

In item 29 the subjects were given an opportunity to note their most prominent symptoms. The susceptibles wrote in symptoms on 64 out of 114 questionnaires; the non-susceptibles wrote them in on 33 out of 120 questionnaires. If we consider only the days on which benzedrine had been given (day 1 and the full-dose day), most of the symptoms selected were in the direction expected from benzedrine. The susceptibles wrote in 69 symptoms of the expected kind, 28 opposite to expectation and 11 which are unclassifiable. The non-susceptibles wrote in 22 of the expected kind, 20 in the opposite direction and 4 unclassifiable. The proportions between "expected" and "opposite" are similar to those obtained from the check-list portion of the questionnaire.

DISCUSSION

The validity of the drug effect questionnaire. This experiment had two purposes: to find the magnitude of the benzedrine effect in susceptibles and non-susceptibles, and to find the frequency of psychogenic symptoms (i.e., those produced by suggestion) in individuals who claimed they were susceptible to motion sickness and those who recalled no motion sickness. The following possible defects of our procedure should be pointed out:

(1) The initial selection of subjects was by questionnaire. This gave us groups already distinguished by the fact that one group replied "yes" when asked (by questionnaire) for a particular symptom, the other "no." Since our drug effect measurement was also by questionnaire, it is possible that, to some extent, we measured neither of the factors we were interested in, but only behavior specific to taking questionnaires.

(2) When a subject takes a questionnaire he endeavors to be cooperative and agreeable. In the present instance he may have felt a responsibility to report symptoms. This cooperativeness may vary in different subjects so that each one's standard of how evident a symptom should be, in order to justify a report, may also be expected to vary. One might expect that "susceptibles" would be more ready to cooperate in a research designed to find a cure for motion sickness, than would "non-susceptibles," for whom it is not a problem. Thus the "value" of a symptom for one group of subjects need not be the same as for the other group of subjects. To some extent, therefore, we may have measured cooperativeness rather than the two factors we were interested in.

(3) The dose of benzedrine given (5 mgm for the average weight subject) may have been improperly selected, best to reveal differences. Further studies

should explore a range of dosage

(4) Our classification of [illegible] as susceptible-symptoms, and opposite-to-benzedrine symptoms was based [illegible] available published information, some of it on subjective effects, others on objective effects. The complete propriety of taking observed behavior as an index of accompanying subjective report is open to doubt.

The final interpretation of the significance of our results should be deferred until supporting information is available. In the meantime, the obtained results are of interest as indicating the existence of a difference between susceptibles and non-susceptibles, even though the identification of the nature of the behavior in which they differ is not certain.

A Study of the Subjective Effects of Small Doses of Benzedrine Sulphate on Individuals Susceptible and Those Non-susceptible to Motion Sickness, Including Observations on Psychogenic Symptoms

I

APPENDIX

A. HISTORY OF MOTION-SICKNESS QUESTIONNAIRE
B. INSTRUCTIONS
C. DRUG EFFECT QUESTIONNAIRE

APPENDIX A

HISTORY OF MOTION-SICKNESS QUESTIONNAIRE

Please answer the questions below as accurately as possible.
THINK CAREFULLY ABOUT EACH QUESTION BEFORE ANSWERING IT.

I.

Place an "X" at the proper answers.

A. Under ordinary circumstances, if I were to make a sea voyage of four hours duration during a moderate wind, I predict that I would:

1. Become very seasick, to the point of nausea and vomiting
2. Become queasy, pale, and feel very uncomfortable
3. Be only slightly affected by the voyage
4. Be unaffected by the voyage
x. Could not predict because of lack of recent experience

B. I have taken sea voyages:
Often____, Occasionally____, Rarely____, Never____, Some years ago____, Recently____.

C. In the recent past I have become seasick:

1. Usually
2. Sometimes
3. Rarely
4. Not at all
x. Insufficient experience

D. I am or was susceptible to seasickness (Mark as many as are correct):

1. Now
2. During high school years
3. During grade school years
4. During pre-school years
5. Never, to my knowledge
x. Insufficient experience to make a judgment

II.

E. Under ordinary circumstances, if I were to make a train trip of four hours duration, I predict that I would:

1. Become very ill to the point of vomiting
2. Become queasy, pale, and feel very uncomfortable
3. Be slightly affected by the trip
4. Be completely unaffected by the trip
x. Could not predict because of lack of experience

F. I have taken train trips
Often____, Occasionally____, Rarely____, Never____; Some years ago____, Recently____.

G. In the recent past I have become train sick:

1. Usually
2. Sometimes
3. Rarely
4. Not at all
x. Insufficient experience

H. I am, or was, susceptible to train sickness:

1. Now
2. During high school years
3. During grade school years
4. During pre-school years
5. Never, to my knowledge
x. Insufficient experience to make a judgment

III.

I. Under ordinary circumstances, if I were to take a streetcar ride of one hour duration, I predict that I would:

1. Become very ill to the point of vomiting
2. Become queasy, pale, and feel very uncomfortable
3. Be slightly affected by the ride
4. Be completely unaffected by the ride
x. Could not predict because of lack of experience

J. I have taken streetcar rides:
Often____, Occasionally____, Rarely____, Never____; Some years ago____, Recently____.

K. In the recent past I have become streetcar sick:

1. Usually
2. Sometimes
3. Rarely
4. Not at all
x. Insufficient experience

L. I am, or was, susceptible to streetcar sickness:

1. Now
2. During high school years
3. During grade school years
4. During pre-school years
5. Never, to my knowledge
x. Insufficient experience to make a judgment

IV.

M. Under ordinary circumstances, if I were to make an automobile trip of four hours duration (as a passenger) I predict that I would:

1. Become very ill to the point of vomiting
2. Become queasy, pale, and feel very uncomfortable
3. Be slightly affected by the ride
4. Be completely unaffected by the ride
x. Could not predict because of lack of experience

N. I have taken automobile rides as a passenger:
Often____, Occasionally____, Rarely____, Never____, Some years ago____, Recently____.

O. In the recent past I have become car sick when riding as a passenger in an automobile:

1. Usually
2. Sometimes
3. Rarely
4. Not at all
x. Insufficient experience

P. I am, or was, susceptible to car sickness when riding as a passenger in an automobile;

1. Now
2. During high school years
3. During grade school years
4. During pre-school years
5. Never, to my knowledge
x. Insufficient experience to make a judgment

V.

Q. Under ordinary circumstances, if I were to make a plane trip of three hours duration in moderately rough air, I predict that I would:

1. Become very ill to the point of vomiting
2. Become queasy, pale, and feel very uncomfortable
3. Be slightly affected by the flight
4. Be completely unaffected by the flight
x. I have never flown in a plane
y. Insufficient experience for prediction

R. I have made plane trips:
Often____, Occasionally____, Rarely____, Never____, Recently____.
Some years ago____. As pilot____. As co-pilot____.

In the following list indicate any situations which have within about the last two years made you feel nauseated to some degree.

S. 1. Motion pictures: Yes___, No___, No experience___
2. Driving past trees through which the sun flickers
Yes___, No___, No experience___

T. 1. Merry-go-round: Yes___, No___, No experience___
2. Ferris wheel: Yes___, No___, No experience___
3. Airplane glider: Yes___, No___, No experience___
4. Elevator Yes___, No___, No experience___
5. Loop-O-Plane: Yes___, No___, No experience___
6. Lindy-loop: Yes___, No___, No experience___
7. Roller coaster: Yes___, No___, No experience___
8. The whip: Yes___, No___, No experience___

APPENDIX B

INSTRUCTIONS

Dear _____:

We are asking you again to serve as a subject in one of a series of experiments which we are doing for the national government. In this experiment we are asking you to take two drugs on two consecutive days. We are interested in their effects on you because you are one of a group of subjects on whom we already have (or will have) extensive data. We cannot tell you what the drugs are since this would interfere with getting valid results. We can assure you, however, that they are harmless in the dosage we are using, and are not likely to inconvenience you seriously.

Your reactions to the drugs will be indicated on questionnaire forms which we are enclosing. It is of crucial importance to the validity of this work that you assume responsibility for following instructions closely and filling out the questionnaires as accurately as possible.

General Instructions

1. Do not take the dose if you are ill with a cold or other disturbances.

2. Get a <u>normal</u> (for you) amount of sleep each night preceding the dose.

3. Do not take large amounts of alcohol the day before or any alcohol during the two days of the experiment.

4. Drink neither more nor less coffee than you usually do.

5. Smoke neither more nor less than usual.

6. Do not take any other drugs (aspirin, benzedrine, sleeping medicine, etc.) on the day before or during the experiment.

7. Do not take the dose on days when anything unusual, exciting, or depressing is happening (girl-friend on Campus, important hour-written, athletic contest, bad news, etc.).

8. After you have taken the drugs, see to it that your day remains normal. Do not suddenly decide to take a trip to New York.

9. <u>Do not discuss the experiment with anyone.</u> Talking about it at fraternity meals, comparing notes with other subjects, etc. can easily ruin our experiment.

Specific Instructions

1. Take the capsules with a glass of water at breakfast time.

2. Three hours later (but in any case before lunch) fill out a questionnaire, seal it in an envelope and mail it to me.

3. After dinner in the evening, fill out a second questionnaire, seal, and mail it.

4. Repeat the procedure on the following day.

Your cooperation will be greatly appreciated and the results thus achieved will be of considerable value to the general project.

Sincerely yours,

G. R. Wendt

P. S. Keep this letter for reference.

APPENDIX O

DRUG EFFECT QUESTIONNAIRE

Indicate in this questionnaire the effects of the drug we gave you. Note that we are interested, not in after-effects (i.e., hangover effects, etc., after the drug effects have worn off), but in the action of the drug itself. You may expect these to last 6 to 8 hours or more.

Choose one alternative in each question.
Be very sure to omit none.

1. Are you now, or were you at meals a) more hungry than usual_____, b) less hungry than usual_____, c) no different than usual_____?

2. Have you drunk a) more water than usual_____, b) less water than usual_____, c) same amount of water as usual_____?

3. Do (or did) the palms of your hands a) appear damper than usual_____, b) feel drier than usual_____, c) appear or feel no different than usual_____?

4. Are (or were) your hands a) steadier than usual_____, b) less steady than usual_____, c) no different than usual_____?

5. Do (or did) you feel a) more sleepy than usual_____, b) more wide awake than usual_____, c) no different than usual_____?

6. Do (or did) you feel a) more cheerful than usual_____, b) more depressed than usual_____, c) no different than usual_____?

7. Have you urinated a) more than usual_____, b) less than usual_____, c) same as usual_____?

8. Have you been a) less talkative than usual_____, b) more talkative than usual, c) same as usual_____

9. Has your skin felt a) cool and comfortable as compared with normal_____, b) hot and flushed as compared with normal_____, c) no different from normal_____?

10. Have you felt a) more relaxed than usual_____, b) more excited and tense than usual_____, c) no difference from usual_____?

11. Have you felt a) more fatigued than usual_____, b) less fatigued than usual_____, c) no different from usual_____?

12. Have you felt a) more hungry than usual_____, b) less hungry than usual_____, c) no different from usual_____?

13. Have you been a) less aware of your heart beat than usual_____, b) more aware of your heart beat than usual_____, c) normal_____?

14. Have you been a) more active than usual_____, b) less active than usual_____ c) normal_____?

15. Have you laughed and joked a) more than usual_____, b) less than usual_____, c) normal_____?

16. Last night did you sleep a) better than usual_____, b) worse than usual_____, c) normal_____?

17. Have you been able to concentrate a) better than usual_____, b) not so well as usual_____, c) same as usual_____?

18. Have you had headache today a) more than usual_____, b) less than usual_____, c) normal_____?

19. Has your throat been a) drier than usual_____, b) less dry than usual_____, c) normal_____?

20. Have you felt a) less nervous than usual_____, b) more nervous than usual_____ c) normal_____?

21. Enter below the number of cups of coffee and amount of smoking you did today, if any. If none, write in the word, none.

	Cups of coffee	No. of cigarettes	Other smoking
before breakfast			
at breakfast			
during the morning			
at lunch			
during the afternoon			
at dinner			
since dinner			

22. Did you take any other drugs yesterday or today? Yes___No___.
If so: when_____, what_____?

23. Did you drink any cocoa today? Yes__No__. If yes, how many cups_____?

24. At what hour did you take the dose of the drug we gave you_____?

25. What time is it now_____?

26. What kind of a drug do you think you took_____?

27. In summary, do you think you noticed drug effects today, a) none____, b) slight____, c) moderate____, d) considerable____, e) extreme____ ?

28. If you had noticed effects, did you notice any we have not listed? a) no___, b) yes___. If "yes", what were they?

29. What one or two symptoms of the drug effect were most prominent in your case?

STUDIES IN MOTION SICKNESS

Series A

II

AN INVESTIGATION INTO THE RELATIONSHIP OF THE ELECTROENCEPHALOGRAM TO MOTION-SICKNESS SUSCEPTIBILITY

by

D. R. Lindsley
and

In the following study an analysis was made of the occipital, pre-central and frontal EEG's of 10 motion-sickness susceptible male college students and 10 non-susceptibles selected by means of a motion-sickness history questionnaire. Susceptibles were those who were subject to one or more forms of motion sickness at the time of taking the questionnaire; all were in the most susceptible 5 per cent of the total group. Non-susceptibles were those who had experience on all vehicles and devices listed on the questionnaire and who had never been motion sick; 7 per cent of the total population of students fell in this category. The expectation was that if susceptibility is the result of a deviant condition of higher nervous activity, then these two groups, selected from the extremes of the population, might be clearly differentiated by their EEG's. The results, however, did not confirm this expectation. The EEG's of the two groups did not differ significantly with respect to normal characteristics of the EEG (alpha frequency, amplitude, and per cent time) or in abnormal tendencies (5-7 sec. activity from pre-central leads and abnormal response to hyperventilation). From the findings it may be concluded that susceptibility to sickness from motion is not accompanied characteristically by a deviant condition of high nervous activity as represented by the electro-encephalogram.

AN INVESTIGATION INTO THE RELATIONSHIP OF THE ELECTROENCEPHALOGRAM TO MOTION-SICKNESS SUSCEPTIBILITY[1]

INTRODUCTION

This investigation was undertaken to determine whether or not motion-sickness susceptibility is a result of a deviant condition of higher nervous activity. If subjects were selected from a group susceptible to motion sickness and compared in terms of their electroencephalographic records with subjects selected from a group who were not susceptible to motion sickness, it be possible to differentiate these two extremes of the population on the basis of their EEG's? This question was put to experimental test in this study and the electroencephalographic records of the two samples were carefully examined for any differentiating characteristics.

METHODS

A Motion-Sickness Inventory[2] was administered to 292 male college students in psychology classes at Brown University. The questionnaires were sorted at Wesleyan University by G. R. Wendt who then sent D. B. Lindsley the names of 13 men with experience on all devices listed who had never been motion sick and of the 13 men with the greatest amount of sickness. The names were arranged in the order NNSNSSNSNSS, etc. (N = non-susceptible, S = susceptible) without indication of susceptibility classification. D. B. Lindsley was to work down the list, getting, if possible, each subject. The EEG's were recorded at the Emma Pendleton Bradley Home, each subject going there by bus or auto. Occipital, pre-central, and frontal bipolar and monopolar lead records were taken under normal conditions and during two minutes hyperventilation. The EEG's were inspected for abnormality and representative samples were measured without knowledge of the susceptibility classification of the subjects, and a report was prepared on each subject. Thereafter the records of the susceptibles and non-susceptibles were sorted out and compared. It happened that 10 of each classification had been used.

Motion-Sickness Inventory. The Motion-Sickness Inventory requires the subject to report or estimate his susceptibility to sickness on each of 14 com-

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[1]This study was collateral to a series of investigations into the nature of susceptibility to the nauseating effects of motion done with the support of grants-in-aid from the National Research Council Committee on Selection and Training of Aircraft Pilots from funds provided by the Civil Aeronautics Administration and administered by Wesleyan University. The present investigation was conducted and supported by the Emma Pendleton Bradley Home, E. Providence, R. I., and Brown University. Wesleyan University collaborated in the planning of the study and the selection of the subjects. D. B. Lindsley and his staff donated the labor involved in taking and analyzing the electroencephalograms.

[2](See Appendix A.)

mon devices.

The 292 questionnaires were first ordered on the basis of scores obtained from an a priori scoring key (see Appendix B); then the extremes of the distribution were re-ordered to select as non-susceptibles only those with experience on all common devices, who had histories of complete freedom from motion sickness, and as susceptibles only those who had the greatest amount of recent motion sickness. The total group of 292 psychology students was more heavily weighted than usual toward the susceptible end of the distribution, so that we were able to obtain our 13 subjects without recourse to a larger parent population. Our recent experience with administration of this questionnaire to 1943-44 naval aviation cadet beginners shows 22 out of 1637 with susceptibility scores in the region of the distribution of the 10 subjects used in the present study.[3] Validation data showing a moderately high relationship of questionnaire scores to experimentally produced motion sickness are now available from the same recent studies of aviation cadets, using however, much less strict standards of selection of susceptibles (only one out of 110 susceptibles tested being as prone to sickness as our 'susceptibles') and somewhat less strict standards of selection of non-susceptibles.[4] If it is allowable to extrapolate from those data to the present subjects one would expect a high degree of validity for the questionnaire classification of the 20 subjects used in this experiment.

EEG recording and measurement method. The EEG's were recorded by means of a four-channel Grass inkwriter. Records were taken during a 15-to 20-minute period, while the subject was reclining on a cot with eyes closed in a semi-dark and sound proof room. An observer was present and signalled any movements which might cause artifacts. The observer also directed hyperventilation procedures which consisted of two minutes of over-breathing.

Analysis of EEG's was carried out according to a standardized method. Three meters of record were taken at random from the total period of the EEG for detailed analysis. The frequency, amplitude, and percent-time of alpha and other rhythms were measured from each sample and averaged.

RESULTS

The hypothesis which led to this investigation set up the expectation that "susceptibles" would show greater deviations of the EEG (especially presence of unusual amounts of 5-7/sec. activity in pre-central and frontal regions and a response to hyperventilation) than "non-susceptibles." This expectation was not confirmed, either by the results of inspection of the records for obvious abnormalities or by measurement of nine aspects of the records. We were thereby satisfied that the extreme hypothesis adopted was incorrect; abnormal EEG's are not the rule in susceptibles. The present methods have demonstrated no validity

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[3] Data of studies done under direction of G. R. Wendt for the Committee on Medical Research of the Office of Scientific Research and Development.

[4] Forthcoming report by Alexander, Cotzin, Hill, Ricciuti, and Wendt to Nat. Res. Council, Comm. on Aviat. Med.

[illegible] clinical [illegible] encephalitis [illegible] results do not preclude the possibility that other aspects of the EEG [illegible] measured by us, are associated with susceptibility, or that, mathematically significant differences between groups [illegible] be discovered.

Reading of records. The records of each subject were first inspected by [illegible] for abnormalities of frequency and amplitude both under resting conditions and accompanying the minutes of hyperventilation. On this inspectional basis, reading from consecutive entire record of each subject, fourteen subjects were judged to be [illegible] from the other six in showing 5-7/sec activity in pre-central and frontal regions or other deviations of the pattern of activity. None was pronounced enough to meet ordinary standards of "abnormality." In order of severity the subjects were marked as follows: Group I (most severe), non-susceptible subject number 9, 15, 19; Group II, non-susceptible subject number 2, susceptible Nos. 5, 6; Group III, non-susceptible No. 12, susceptible Nos. 3, 7; Group IV, non-susceptible No. 1, susceptible Nos. 10, 11, 17, and 20. The table shows 6 non-susceptibles and 8 susceptibles, thus to be most severe cases are susceptibles. In none of the 20 cases did hyperventilation produce signs of significant latent abnormality.

Results of measurement. Measurements were made only of occipital and pre-central bipolar records, according to methods described above. The results for each subject and for the groups are given in Table 1.

In none of the actual measurements of the EEG (frequency, amplitude, and percentage of alpha rhythm), in both occipital and pre-central regions, did the differences between groups reach established levels of significance. Contrary to expectation [illegible] alpha [illegible] evidence of 5-7/sec. activity in the pre-central region than the "non-susceptibles" but none of the differences is statistically significant.

[illegible]

In conclusion it may be said that [illegible] refined methods of inspection of EEG's may [illegible] consistent occurrence of important characteristics could [illegible] "susceptible" subjects be sufficiently [illegible] [illegible] degrees. Insofar as the EEG may be regarded as a measure of cerebral activity and as a manifestation of mental [illegible] it may be concluded that motion "susceptibility" is [illegible] deviant condition of the [illegible]

TABLE 1

ELECTROENCEPHALOGRAPHIC RESULTS VS. MOTION SUSCEPTIBILITY

Subject	MSI Score	Occipital Alpha Activity			Central Alpha Activity			Central 5-7/sec. Activity		
		Freq.	Ampl.	% time	Freq.	Ampl.	% time	Freq.	Ampl.	% time
Non-Susceptibles										
1	38	10.3	20.1	94.6	10.3	12.7	73.8			
4	38	9.2	41.1	98.8	9.2	15.4	66.1	6.0	22.8	1.3
9	38	10.9	8.6	39.4	11.2	6.6	28.4	6.6	8.4	11.2
12	38	10.2	14.5	87.9	10.6	6.8	33.0	6.2	8.7	9.4
14	38	9.5	26.1	93.9	9.9	12.9	66.2			
15	38	10.3	11.3	51.6	11.3	8.7	23.9	6.4	11.2	28.1
16	38	10.4	47.8	97.4	11.0	17.7	85.5			
19	38	9.6	16.2	91.9	10.4	9.6	54.6	6.2	25.0	4.7
20	38	11.0	11.6	77.2	11.8	6.7	21.0	6.5	9.3	1.4
26	38	10.3	25.2	99.2	10.7	7.3	61.5	6.2	9.4	2.7
Averages		10.17	22.25	83.19	10.64	10.44	51.40	6.30	15.11	7.08
Susceptibles										
3	10	10.5	19.6	83.0	10.9	13.1	64.2	5.7	14.8	2.4
5	21.5	10.6	21.7	91.6	10.9	7.0	65.9	6.3	10.7	1.6
6	21	10.1	21.6	96.4	10.2	11.0	92.0			
8	19.8	11.0	19.2	94.5	11.1	9.0	52.4	6.2	13.4	6.4
10	21.4	9.5	30.9	91.3	10.5	15.2	67.5			
11	21.1	10.3	40.7	92.6	10.1	17.9	81.8	6.2	17.3	2.4
13	22	9.9	48.0	98.9	10.3	22.2	95.2			
17	22.4	12.0	30.3	89.0	11.9	18.2	77.4	5.7	16.4	0.1
18	22.6	10.7	20.0	88.7	10.8	14.7	63.6	6.0	13.5	1.3
24	22.8	10.6	29.1	92.0	10.8	11.8	57.9	6.4	9.4	4.7
Averages		10.52	28.11	91.80	10.75	14.01	69.80	6.06	13.63	2.59
Degrees of freedom		18	18	18	18	18	18	12	12	12
t-value		1.25	1.14	1.28	.378	1.85	2.26	1.83	.673	2.24
P-value		.22	.24	.22	.70	.08	.04	.08	.52	.04

An Investigation into the Relationship of the Electroencephalogram to Motion-Sickness Susceptibility

II

APPENDIX

A. MOTION-SICKNESS INVENTORY

B. DIRECTIONS FOR SCORING MOTION-SICKNESS INVENTORY

APPENDIX A

MOTION-SICKNESS INVENTORY

Directions: Below are listed five moving vehicles and carriers whose motion can produce nausea (seasickness, car sickness, etc.). Think back over your own experience with each of these and answer according to this scale:

(x) Have not had enough experience to know whether I would be affected.
(1) Am now somewhat subject to sickness. Would probably vomit if the ride were long and rough.
(2) Used to be subject to sickness (a few years ago or as a child) but am not now subject to it.
(3) Have been somewhat subject to nausea, but not to the point of vomiting.
(4) Have never been affected by rides.

Check in the appropriate columns

	x	1	2	3	4
a. Rides in boats (seasickness)					
b. Rides as a passenger in autos (car sickness)					
c. Rides in trains					
d. Rides in streetcars or subway trains					
e. Rides in buses					

Directions for items [illegible]: Below are listed other moving carriers. Indicate in each case whether the device has made you feel nauseated during the last four years. Use the following scale:

(x) Have not had enough experience to know whether I would be affected.
(1) I have been [illegible] nauseated (to the extent of vomiting or almost so it).
(2) I have been [illegible] nauseated (but not severely).
(3) [illegible]

	2	3

APPENDIX D

DIRECTIONS FOR SCORING MOTION-SICKNESS INVENTORY

The M-S Inventory is divided into two groups:

(1) The more common motion carriers.
- a. boats
- b. autos
- c. trains
- d. streetcar or subway trains
- e. buses

(2) Devices.
- f. elevator
- g. hammock
- h. lawn swing
- i. merry-go-round
- j. ferris wheel
- k. roller coaster
- l. the whip
- m. airplane glider, loop-o-plane, etc.
- n. airplane rides as a passenger

More importance is attached to a history of sickness in the first group so the unit score values are different in the two groups.

		Items a-e		Items f-n
(x)	Little or no experience	Assign average value of all other checks (1-4) to each item checked in x.	(x)	Assign average value of all other checks (1-3) to each item checked in x.
(1)	Now subject to sickness--probably would vomit	Count 0	(1)	Count 0
(2)	Subject to sickness as a child--not now	" 1		
(3)	Somewhat affected	" 2	(2)	Count 1
(4)	Never affected	" 4	(3)	" 2

****

Note: If subject has checked more than three items in column x (a-n) a deduction is made according to this scale.

Number of "no experiences" (x)	Deduct
0	0
1	0
2	0
3	0
4	1
5	2
6	3
7	4
8	5
9	6 etc.

Compiled by G. R. Wendt, Dec. 1941

STUDIES IN MOTION SICKNESS

Series A

III

A NOTE ON AN UNSUCCESSFUL EFFORT TO INVESTIGATE THE EFFECTS OF TEMPERATURE ON VESTIBULARLY INDUCED NAUSEA

by

G. R. Wendt

SUMMARY

The Note on an Unsuccessful Effort to Investigate the Effects of Temperature on Vestibularly Induced Nausea summarizes two limited investigations in which the effects of environmental temperature on motion-sickness rates were studied. Subjects selected on the basis of motion-sickness history inventory scores were matched and divided into two groups of 16 subjects each. One group was subjected to a modified form of the Dorcus tilting procedure at a room temperature of 70°F. and the other group was subjected to the same procedure at a room temperature of 90°F. While the subject was lying supine and before being tilted upright, his ear canal was irrigated with ice water. However, only 2 cases of vomiting and 4 cases of subjective nausea were obtained. Since it was suspected that the low sickness rate might be a consequence of malfunction of the irrigator a check experiment at a room temperature of 80°F. was run, using 9 of the men who had shown no symptoms of illness, employing an irrigator of different design. This device insured massive irrigation of the far end of the canal. Two of the subjects vomited, 4 were nauseated, and 3 were without symptoms of sickness.

NOTES ON [illegible] OF TEMPERATURE
ON [illegible]

INTRODUCTION

The effects of environmental temperature on motion sickness rates have not been properly investigated. It is the general conviction of the victims of airsickness and car sickness that heat increases the tendency to illness and that temporary or complete relief is obtainable by getting in a cool breeze. Psychological explanations of the alleged bad effects of heat (attributing them to facilitation of the victim's preoccupation with his discomfort) and physiological explanations (attributing them to the consequences of pooling of blood in the lower parts of the body due to vasodilatation) have been proposed.[2]

This investigation was designed to test whether the alleged increase of vomiting under high temperatures is true. To produce sickness a modification of the method of R. M. Dorcus was employed,[3] since at the time this investigation was conducted this procedure appeared to be the most suitable one available. Because the irrigating procedure was not completely effective in producing sickness in this study, a check experiment was run in which a method of massive irrigation of the auditory canal was employed. A brief discussion of the check experiment follows this note.

METHODS OF THE ORIGINAL EXPERIMENT

Students in a class in introductory psychology served as subjects. Each had, at an earlier date, completed a motion sickness history inventory (see Report No. II, Appendix A), the scores of which were used to match the subjects in assigning them to the 90°F. and 70°F. Groups. Sixteen subjects served in each group. Nine of them would have been defined as non-susceptible (no history of motion sickness), one as susceptible (recent history of motion sickness), and the remainder as "intermediate."

Standardization of procedure was achieved by complete pre-planning of instructions, with the intent of inducing a matter-of-fact attitude of expectancy of sickness. The instructions given to each subject are listed in Appendix A.

Each subject spent 30 minutes in the laboratory, the first 18 minutes being devoted to preparation, instructions, and rest; 7 minutes to the nauseating procedure, and the remainder to rest. The subject, in trousers and undershirt,

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[1]This is one of a number of investigations into the conditions of motion sickness done with the support of grants-in-aid from the National Research Council Committee on Selection and Training of Aircraft Pilots. Mr. C. F. Taylor, Jr., was in charge of the laboratory work. Dr. C. J. Hill, Jr.; and Mr. J. S. Helmick helped with the conduct of the study. The otoscopic procedures were carried out by Dr. S. J. Alexander.

[2]Wendt, G. R. Motion sickness in aviation. N.R.C. Division of Anthropology and Psychology, Committee on Selection and Training of Aircraft Pilots, May 1944, p. 13.

[3]Dorcus, Roy M. The influence of physiologically effective doses of epinephrine on vestibularly induced nausea. Washington, D.C.: Civil Aeronautics Administration Division of Research, Report No. 5, November 1942.

lay supine on the tilt table with recording apparatus adjusted to chest, arm and leg. The constant-flow irrigating ear-plug of Dorcus[4] was inserted in the canal and held in place by the subject. The irrigation-tilt procedure was as follows: (1) with the eye-ear line vertical, nose up, the ice water was allowed to flow into the ear for 2 minutes, (2) the tilt-table was raised so that the eye-ear line was horizontal and irrigation continued for 30 seconds, (3) irrigation was stopped and the subject bent head and shoulders forward so that the eye-ear line was vertical, nose down; this position was held for 30 seconds, (4) the head and shoulders were returned so that the eye-ear line was again horizontal, (5) within 4 minutes the subject was removed from the tilt-table. Alternate days were devoted to work at 90° F. and 70° F.

Records were obtained for the purposes of detecting sickness and other physiological effects of the caloric stimulation. Observations were recorded on prepared sheets (see Appendix D). Five degrees of nausea, from none to the presence of vomiting, were noted during the experiment, and additional information on the duration of symptoms was checked on a special form (see Appendix C) by each subject and returned after 24 hours. Other data recorded were: (1) nystagmus, observed by the experimenter; (2) movement of a visual fixation cross, reported by the subject; (3) dizziness, after tilt, reported by the subject; (4) ataxia after removal from the tilt-table, observed by the experimenter; (5) skin temperature on forehead and back of hand, measured by a thermocouple; (6) records of pulse, of thoracic and abdominal breathing, photokymographically recorded; (7) serial determinations of systolic and diastolic blood pressures at 30 second intervals, recorded by graphic method.

RESULTS

In view of the ineffectiveness of the procedures for the production of sickness the following brief statements may be made relative to the findings: (1) nystagmus was observable in all of the 32 cases, indicating that the irrigator was to some extent effective on the vestibular apparatus; (2) one out of the 16 in the 90° F. group and 1 out of the 16 of the 70° F. group vomited; (3) one of the 90° F. group and 3 of the 70° F. reported slight or moderate nausea; (4) both of the men who vomited and the one who reported nausea indicated no continuance of symptoms after departure from the laboratory.

The presence of nystagmus suggested that the irrigator was to some extent effective, although the low incidence of sickness, on the other hand, raised the suspicion as to whether any considerable volume of cold water was reaching the inner end of the meatus, closest to the canals. For this reason the experiment was altered and a check experiment run to test the hypothesis that passive irrigation of the end of the auditory canal tended to produce greater sickness rates.

THE CHECK EXPERIMENT

Nine men who had served in the preceding experiment without showing nausea or vomiting were [illegible] and used as subjects. All aspects of the procedure

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[illegible]

and records were identical with the preceding experiment, except that: (1) the instructions were only reviewed, (2) the room temperature was kept at 80° F., (3) a modified form of aural irrigation was introduced in which a soft rubber tube was inserted into the meatus until it approached the tympanum, making possible massive irrigation of the inner end of the meatus; this tube was fastened to the head by means of adhesive tape.

It was observed that all of the subjects in the check experiment showed greater nystagmus or ataxia and reported greater visual movement and dizziness than they had in the preceding experiment. Two vomited, 4 reported moderate or severe nausea, and 3 reported no nausea.

It appeared that the method of irrigation used in the preceding experiment was a less effective means of stimulating the vestibular apparatus than the method of inserting the tube into the meatus, close to the canal. On the basis of the findings no leads were obtained as to the effects of enviromental temperature on sickness rates.

A Note on an Unsuccessful Effort to Investigate the Effects of Temperature on Vestibularly Induced Nausea

III

APPENDIX

A. INSTRUCTIONS
B. SICKNESS RECORD
C. FOLLOW-UP QUESTIONNAIRE

[illegible] [illegible]

Dear________________,

We would like to use you in our experiments on nausea [illegible] ________________________ at ________________ o'clock. The total time spent here will be about thirty minutes.

Will you read the list of conditions of the experiment given below and then reply on the enclosed postcard, indicating whether you can meet these conditions and whether the time we have set is suitable.

General Instructions

1. Do not come in if you are sick, even if it is only a slight cold.

2. Do not come in with a hangover or when very fatigued.

3. Eat a <u>normal</u> meal at your normal time.

4. Drink your normal amount of coffee, smoke your normal number of cigarettes, but not more than normal. Do not smoke during the 15 minutes preceding the experiment.

5. Do not drink (unless you normally do) [illegible] cola, tea or cocoa before the experiment. Do not take [illegible], nose drops or other drugs.

6. Do not come in after heavy exercise, [illegible] practice, sports practice, etc. We prefer you to have been [illegible] before you come in. <u>Do not</u> [illegible] <u>laboratory</u> [illegible].

7. We want you to be [illegible] necessary. If you [illegible] will have [illegible] warmed up [illegible] wear [illegible] coming over in light clothing.

8. If possible, [illegible] ordinary [illegible] which wear your [illegible] subjects [illegible] about equally [illegible].

9. <u>Do not</u> [illegible]

[illegible]

[illegible]

Observations:	None	Slight	Moderate	Gross
Nystagmus (horizontal)	_____	_____	_____	_____
Visual awr. (horizontal)	_____	_____	_____	_____
Dizziness (after tilt)	_____	_____	_____	_____
Ataxia (gait exam.)	_____	_____	_____	_____

Nausea: None_____Slight_____Moderate_____Severe_____Vomited_____(Time___)

Time:

Signature_____

APPENDIX C

FOLLOW-UP QUESTIONNAIRE

Please return 24 hours after experiment

Name_____ Time of experiment_____

Duration of symptoms:

1. Had no symptoms _____
2. Gone before leaving experimental room _____
3. Gone before 1 hour _____
4. Gone before 2 hours _____
5. Gone before 3 hours _____
6. Gone before 4 hours _____
7. Lasted remainder of day _____
8. Still persist on following day _____
9. Still persist at time of mailing this _____

Notes and Comments:

Describe fully any symptoms you had after leaving the experimental room.

In discussing this experiment with others, please be matter-of-fact in what you say. Nausea is very strongly affected by psychological factors. If our experiments are to be successful, it is necessary that each subject who co- in has approximately the same advance information. Say as little about the experiments as you can.