NAMRL-1234

NAUSEOGENIC VISUAL-VESTIBULAR INTERACTION IN A VISUAL SEARCH TASK

H. Jack Moore, J. Michael Lentz, and Fred E. Guedry, Jr.

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NAVAL AEROSPACE MEDICAL RESEARCH LABORATORY
PENSACOLA, FLORIDA

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Bureau of Medicine and Surgery
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30 March 1977

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SUMMARY PAGE

THE PROBLEM

This study describes the development of a Visual-Vestibular Interaction (VVI) test which may be useful in predicting motion sickness susceptibility in working situations aboard ship, aircraft, and other moving vehicles.

FINDINGS

The nauseogenic aspect of visual suppression of the vestibulo-ocular nystagmus reflex was evaluated in three experiments. In approximately 5 percent of the subjects tested, motion sickness symptoms, including vomiting, developed. The establishment of individual sensitivities to this form of motion sickness is noteworthy, not only because of the similarity of the visual task to applied performance, but it also provides a basis for investigating the types of displays and visual loads encountered in moving vehicles.

INTRODUCTION

Unexpected motion sickness has been reported in subjects performing a visual task during simultaneous vestibular stimulation (4,5). The subjects were required to add columns of digits on a rectangular matrix of numbers while being passively rotated in slow oscillations about an Earth-vertical axis. The occurrence of motion sickness in that situation was unusual in that previous experience with sundry visual tasks during the same type of vestibular stimulation had shown no such effect (2,3,6); nor was the motion stimulus per se felt to be provocative, since all but rare individuals could experience such motion in either darkness or light without complaint.

In general, previous experiments were focused on various aspects of visual suppression of the vestibulo-ocular nystagmus reflex. This reflex functions physiologically in the image stabilization of the external visual surrounds on the retina by providing an automatic compensatory eye movement when the head is in motion. The reflex can become inappropriate in aircraft or other moving platforms, however, since the head moves in inertial space while the visual task may center upon displays that are stationary relative to the observer. Reflexive movement of the eyes in such a situation results in visual blurring and a potentially disastrous degradation of visual performance.

The serendipitous production of motion sickness by a visual-vestibular interaction tends to bear out the wisdom of mothers who caution their children against reading in the car. It is particularly interesting because it provides a basis for the laboratory investigation of the types of displays and visual loads that might prove troublesome aboard ship, aircraft, or other moving vehicles. Moreover, it invites the appraisal of individual differences in vulnerability to bizarre visual-vestibular environments, and thus offers the possibility of improved predictors of motion sickness susceptibility.

This report describes three experiments in which similar visual-vestibular stimulation was used to elicit malaise. These experiments were performed for the purpose of finding an index of susceptibility to this type of sickness as well as for determining the distribution of individual differences in the population of interest (flight students). Secondarily, albeit always in the minds of the experimenters, was the elucidation of those aspects of the visual task that are specifically provocative in concert with the vestibular stimulation.

PROCEDURE

SUBJECTS

One hundred fifty-two naval aviation officer candidates (AOC's)* who had recently reported for active duty served as subjects. These men had received physical examinations in the preceding few days and were all physically and emotionally healthy.

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*The classification, AOC, as used herein does not distinguish among specific USN programs such as AOC, NFOC, AVROC, et cetera.

APPARATUS

Apparatus for each experiment consisted of a Stille-Werner RS-3 rotating chair with an integrally mounted 183-cm diameter cylindrical frame. The frame was completely covered with a heavy black fabric to occlude the view of the external room. The angular velocity of the chair was controlled by a signal function generator. Attached to the frame 86 cm in front of a seated subject was a 12 x 12 array of digits (Figure 1) that were spaced at 1.27 cm (1/2 in.) in rows and columns. Height of each symbol was 0.48 cm (3/16 in.), while the width averaged about 0.32 cm (1/8 in.).* In visual arc,subtended digit dimensions were 13' x 20'. Letters A-L at the top of the array and numbers 1-12 at the left margin provided coordinates for specifying any particular digit within the array. The visual display was printed on matte-finish photopaper and mounted on rigid white cardboard. The entire display subtended a square visual field of about 12 degrees of arc.

The display was illuminated by two clusters of small light bulbs located on standards in front of and bilaterally to the seated subject. The height of each was adjusted to the midline of the display, and the positions were equilateral so that illumination was very close to uniform. Voltage was adjusted so as to achieve an illumination of 0.1 ft-L on the white ground of the display, as measured by a MacBeth illuminometer. The eyes of the subject were shielded from the bulbs by interposed cardboard reflectors (Figure 2). A small cassette tape recorder with remotely controlled playback was also placed on board the capsule.

For the purposes of a static test situation, similar arrangements were made in a separate room, using an ordinary chair facing a stationary wall. In this case, however, the subject was not encapsulated.

METHOD

Volunteers were solicited from an available group of AOC's undergoing psychological testing. Subjects initially completed a Pensacola Motion Sickness Questionnaire (MSQ, Appendix A)**, and then read the written instructions for the first phase of the experiment (Appendix B). After an initial task familiarization under static conditions, subjects read a second set of instructions (Appendix C) and were then taken to the dynamic test. Each subject was given a further verbal briefing as necessary while being strapped into the rotary chair; this included reference to an emergency motion sickness bag, though mention was casual so as to minimize the expectation set of the subject. Subjects completing the experiment were isolated from those not yet tested.

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*The digit matrix was drawn with a Keuffel and Essex (K&E) 3240-200 CL Leroy lettering guide and a K&E No. 3 Leroy ink pen.

**This questionnaire is an adaptation of the MSQ described in Reason and Brand (Ref. 8).

	A	B	C	D	E	F	G	H	I	J	K	L
1	7	1	1	8	2	4	3	1	6	6	9	4
2	6	4	4	2	4	3	1	8	9	7	4	1
3	2	2	3	4	7	8	6	5	1	4	8	5
4	9	9	5	4	6	2	7	3	8	3	7	9
5	8	1	4	3	6	5	7	7	1	4	2	6
6	7	4	7	1	8	1	9	6	3	2	8	5
7	1	7	6	7	6	4	9	5	4	8	3	7
8	7	1	3	3	4	8	9	4	2	5	6	8
9	6	2	1	6	7	3	8	9	7	2	6	6
10	1	7	5	9	9	1	5	6	6	3	5	8
11	9	3	6	7	3	2	2	8	4	5	2	5
12	2	7	6	2	9	9	3	4	1	5	1	7

Figure 1

Visual Vestibular Interaction Test Matrix

Figure 2

Front View of Subject Prepared for VVI Task
(Device is completely enclosed during testing.)

In the dynamic test the subject was seated with his head centered above the Earth-vertical axis of rotation and supported by occipital pads to place the lateral semicircular canals approximately in the plane of rotation. Angular motion was sinusoidal at a frequency of 0.02 Hz, with peak angular velocities of ±155 deg/sec. The subject was initially rotated in darkness, and at the completion of the first half-cycle of oscillation, the capsule lights were turned on along with the cassette playback. These were under control of a 5-minute interval timer and thus remained on for six oscillatory cycles of the chair. After the 5-minute test period, the subject was rotated in darkness an additional half-cycle. The dynamic run was terminated prematurely only at the request of the subject or in cases of frank vomiting.

The cassette playback provided the subject with verbal commands of marginal coordinates on the visual display. Each command specified the locus of a visual problem within the digit matrix. Commands were issued every 7 seconds and were given in an established random order. A total of 43 marginal coordinate commands were issued over the course of the dynamic run.

During the dynamic test an observer recorded the subject's performance on each command. Immediately following the test, each subject completed a brief questionnaire concerning his reactions to the test. The questionnaire included seven specific areas of reaction: like/dislike, no stomach effects/strong stomach effects, no dizziness/strong dizziness, no sickness feelings/strong sickness feelings, steady/very unsteady, no temperature change/feel hot or cold, and dry/wet. A mark of 1 indicated favorable or no reactions, whereas a mark of 7 indicated extreme reaction. Each subject was also rated by an observer for pretest anxiety, disorientation, pallor, sweating, facial expression, unsteadiness, slow recovery, and over-all performance. These factors were rated on a 10-point scale, with 1 indicating little or no effect and 10 a very strong effect. The rating scheme used was that developed (1) for the Brief Vestibular Disorientation Test (BVDT).

This report describes three separate experiments that were conducted during development of the Visual Vestibular Interaction Test (VVI). The three experiments differ in only slight modification to the subject's task or to the self-rate and rater evaluation of susceptibility. Individual details for each experiment follow.

Experiment 1

The task of the subject (N = 51) was to extract the digit specified by the commanded matrix coordinates of each problem, together with the two consecutive digits below it in the column; the subject was to add these three digits mentally, and verbally report the sum.

At the completion of the dynamic phase, the subject completed a self-rate form, and the experimenter completed a rater evaluation of symptoms.

Experiment 2

The task of the subject (N = 50) was to extract the commanded matrix digit and the two consecutive digits below it in the column as before, but in this case, only a verbal report of the digits in consecutive order was required. During the static familiarization, the subject was required to report the sum of four consecutive column digits. The written instructions for both the static and dynamic portions of this experiment were modified to be consistent with this procedure. At the conclusion of the experiment, the subject completed the BVDT self-rate form, and the experimenter completed the BVDT rater form as previously described.

Experiment 3

The task of the subject (N = 51) was again to extract and report in order three consecutive column digits. In this case, the static familiarization was the same as the dynamic task, but lasted only 3 minutes. During the dynamic phase the subject's head was immobilized in the occipital rests by means of a soft fabric strap placed over the forehead. This strap could be manually removed by the subject in the event of sickness or emergency. The strap was employed to ensure that the subject was not leaning forward or moving his head during the testing. At the conclusion of the test, the subject completed a modified self-rate form wherein the continuum of steady to very-unsteady was replaced with a similar 7-point continuum ranging from no-headache to bad-headache.

RESULTS

In Experiment 1, two subjects were unable to complete the test sequence; both vomited. There were no aborts in Experiment 2. In Experiment 3, six subjects aborted prior to completion of the test. One of those six aborted immediately upon the start of rotation; this subject was not included in the data analysis (or total N) since testing had not started. Of the remaining five subjects who aborted during Experiment 3, four vomited. The average abort rate across all three experiments was approximately 5 percent.

Rater and self-rate scores for each subject were derived as the sum of category scores as previously described. Rater and self-rate score distributions are presented in Figure 3. The MSQ was scored by a procedure developed by Reason (cf. Ref. 8) (Appendix D). Spearman's rank-order correlation was calculated for all combinations of these measures within each experiment and is presented in Table I.

Visual performance in dynamic conditions was taken as the proportion of problems presented that was correctly accomplished. The first and last marginal coordinate commands of the subject's dynamic test were not counted. Subjects completing the dynamic test in Experiment 1 could thus turn in a maximum performance with 41 correctly reported sums, while subjects completing Experiments 2 and 3 would maximize with 123 correctly reported digits. Mean visual performance scores are presented in Table II for each of the three experiments. The addition task in the dynamic condition of the

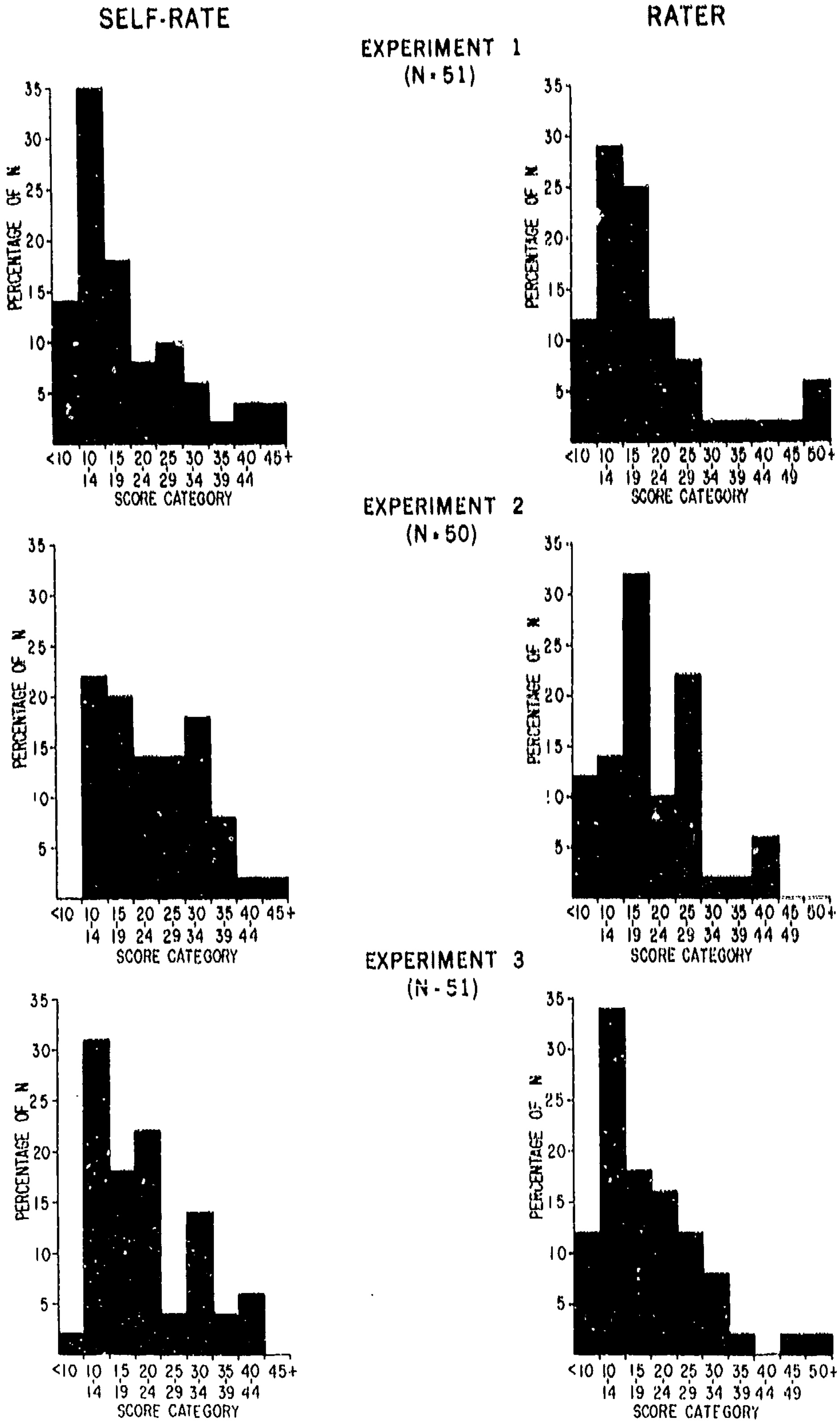

Figure 3

Distributions of Rater and Self-rate Scores for Experiments 1, 2, and 3

Table I

Spearman Rank-Order Correlations

		Experiment 1 A	Experiment 1 B	Experiment 1 C	Experiment 1 D	Experiment 2 A	Experiment 2 B	Experiment 2 C	Experiment 2 D	Experiment 3 A	Experiment 3 B	Experiment 3 C	Experiment 3 D
Percentage Correct	(A)	—				—				—			
Self-Rate	(B)	-.47***	—			-.23	—			-.21	—		
Rater	(C)	-.35*	.60***	—		-.35*	.64***	—		-.18	.80***	—	
MSQ	(D)	-.05	.34*	.11	—	-.25	.55***	.38**	—	-.25	.57***	.51***	—

* $p < .05$
** $p < .01$
*** $p < .001$

Table II

Summary of Visual Performance Scores

Experiment	Subject N	Maximum Possible Correct	Mean	Standard Deviation
1	51	41	24.27	8.85
2	50	123	76.94	28.67
3	51	123	69.55	27.77

first experiment, introduced because of suggestions that frustration in a similar task may have contributed to the motion sickness reported in an earlier study (5), did not produce a higher incidence of nauseogenic disturbance than was found in Experiments 2 and 3. Similarly, fixing the head in Experiment 3, to avoid unplanned nauseogenic Coriolis cross-coupled stimuli, did not significantly alter performance scores. However, the distributions of nauseogenic scores (Figure 3) do look somewhat different in Experiments 2 and 3, but the distribution in Experiment 3 is very similar to that in Experiment 1, and the number of aborts in Experiments 1 and 3 exceeded aborts in Experiment 2. In Experiment 2, it is possible that head movement may have contributed to the upward shift in the frequency distribution of self-rate scores; however, since no one aborted during this experiment, this possibility seems unlikely. Nevertheless, since head stabilization such as that used in Experiment 3 is simple, it should be used as a precaution against contamination of results by unplanned head movements.

DISCUSSION

Although the original purpose of the procedure from which the VVI Test evolved was to investigate improvements in visual performance during vestibular stimulation (4), the result was the discovery of a nauseogenic visual-vestibular interaction that is potentially useful in predicting motion sickness susceptibility (5). The over-all abort rate of approximately 5 percent was, if anything, atypically low. A recently tested group of subjects (N = 68) had a 14 percent abort rate.

The highly significant correlations between rater and self-rate scores indicate that an individual's subjective sensations are fairly closely parallel to observable responses. A small group of extremely susceptible individuals was particularly evident in the distribution of rater scores (Figure 3). The MSQ scores tended to correlate significantly with self-rate scores, but not necessarily with rater scores.

Visual performance measures were significantly related to signs and/or symptoms of nauseogenic disturbance in some of the comparisons but not in others, suggesting a relationship which is, at most, weak. However, in another study of fifty subjects (7) with a higher abort rate (12 percent) than was encountered in the present groups, much stronger empirical relationships were found between performance scores and ratings (performance versus rater $\underline{r} = -.70$; performance versus self-rate $\underline{r} = -.65$). Moreover, significant correlations were also found between performance scores and both rater and self-rate scores on another provocative test conducted by other raters on another day. For this reason, performance scores should not be discarded solely on the basis of the weak relationship in our present results, but further evaluation is clearly needed before their value as part of a predictive test could be adequately assessed or recommended. It is possible that some change in the task will prove to be efficacious because several methodological artifacts became apparent in the course of using the present procedure. During the sinusoidal angular velocity used as the vestibular stimulus in our studies, vestibular nystagmus waxes and wanes in a highly predictable manner with known response/stimulus gain and phase relations. It has been shown that systematic variations in vestibular nystagmus during each cycle of the motion stimulus are closely correlated with variations in visual acuity for head-fixed targets, and also that there are substantial individual differences in visual suppression of vestibular nystagmus (5).

While plots of mean performance errors with the current visual task revealed the expected cyclic performance variation for our group, attention to individual performance revealed problems. Some individuals managed to avoid error scores even though their visual acuity was reduced. Recall that verbal commands for new coordinates were presented every 7 seconds. If vision was blurred when the command was given, but cleared within the 7-second time frame, then a correct response could be given. Occasional responses occurred in the next time frame. A few subjects developed methods of finding coordinates without looking back and forth at margins; e.g., position H5 can be found by finding H and counting down five places. This kind of strategy permitted some subjects with relatively poor visual suppression to score as well as other subjects whose visual suppression was sufficient to completely override vestibular nystagmus and maintain clear vision throughout the cycle. It is also possible to avoid disturbance at the expense of poor performance simply by not attempting the task or even closing one's eyes at the part of the cycle where nystagmus is strong. If a number of subjects adopted this strategy, it would lower the correlation between performance scores and signs and symptoms of this form of motion sickness. Most of these problems can be overcome by using changing visual displays and subject-paced tasks. However, the relationship between performance scores and nauseogenic disturbance remains to be determined.

In the authors' opinion, the provocativeness of this particular test is dependent upon the conflict between voluntary saccadic fixations necessary to perform the task and the involuntary nystagmic eye movements generated by rotation. The provocativeness can be dramatically reduced by decreasing the complexity of the visual display or by reducing the severity of the vestibular stimulus. These and other variables need to be explored methodically to establish a good theoretical understanding of the principles involved.

The development of the VVI Test is particularly significant due to the similarity of the visual display load with that encountered in working situations aboard ship, aircraft, and other moving vehicles. In addition to early identification of individuals who are likely to evidence this type of motion sickness, it may be possible to develop an adaptation process that would effectively reduce or pre-empt this type of problem. Preliminary indications suggest that the rate of habituation to this provocative stimulus may be quite rapid (4,5).

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Appendix A

Pensacola Motion Sickness Questionnaire

PENSACOLA MOTION SICKNESS QUESTIONNAIRE

NAME____________________ AGE____ SEX____ OCCUPATION____________________

This questionnaire is designed to find out: (a) how susceptible to motion you are; and (b) what sorts of motion are most effective in causing that sickness.

Section A is concerned with your childhood experience of motion sickness, that is, prior to the age of 12. Section B is concerned with your experience of motion sickness since the age of 12.

The correct way to answer each question is explained in the body of the questionnaire. Please read these instructions carefully as you go along. It is important that you should answer every question.

Your replies to these questions will be treated in the strictest confidence. Thank you for your help.

SECTION A

All questions in this section refer ONLY to your childhood experiences of motion sickness (if any) where childhood is defined as the period prior to 12 years of age. It is quite possible that you will have difficulty recalling childhood motion sickness; nevertheless, please try to answer the questions to the best of your ability.

1. Indicate approximately how often you traveled on each type (before age 12) by using one of the following numbers:

   0 – no experience
   1 – less than 5 trips
   2 – between 5 and 10 trips
   3 – more than 10 trips

Cars	Buses or Coaches	Trains	Airplane	Small Boats	Ocean Liners	Swings	Merry Go Round	Roller Coasters

Considering ONLY those types of transportation that you have marked 1, 2, or 3 (i.e., those that you have traveled on), go on to answer the two questions below. Use the following letters to indicate the appropriate categories of responses: N – Never; R – Rarely; S – Sometimes; F – Frequently; A – Always.

	Cars	Buses or Coaches	Trains	Airplane	Small Boats	Ocean Liners	Swings	Merry Go Round	Roller Coasters
2. How often did you feel sick while traveling, i.e., queasy or nauseated?									
3. How often were you actually sick while traveling, i.e., vomiting?									

(Please turn over . . .)

NAMI 6500/24 (2-70)

SECTION B

This section is concerned solely with your experience of motion sickness (and travel) SINCE the age of 12. Please answer the questions in exactly the same way as in Section A.

1. Indicate approximately how often you traveled on each type (since age 12) by using one of the following numbers:

   0 – no experience
   1 – less than 5 trips
   2 – between 5 and 10 trips
   3 – more than 10 trips

Cars	Buses or Coaches	Trains	Airplane	Small Boats	Ocean Liners	Swings	Merry Go Round	Roller Coasters

Considering ONLY those types of transportation that you have marked 1, 2, or 3 (i.e., those that you have traveled on), go on to answer the two questions below. Use the following letters to indicate the appropriate categories of responses: N – Never; R – Rarely; S – Sometimes; F – Frequently; A – Always.

	Cars	Buses or Coaches	Trains	Airplane	Small Boats	Ocean Liners	Swings	Merry Go Round	Roller Coasters
2. How often did you feel sick while traveling, i.e., queasy or nauseated?									
3. How often were you actually sick while traveling, i.e., vomiting?									

NAMI 6500/24 (Back)

Appendix B

Instructions for Subjects

Part I

INSTRUCTIONS FOR SUBJECTS

This is a psychological experiment to find out facts about how humans function in certain tasks. It is voluntary, so you are not required to participate if you don't wish to.

Here is how the experiment works. You will be shown a matrix of digits similar to the one below:

	A	B	C	D	E	F	G	H	I	J	K	L
1	5	4	8	6	4	2	1	8	9	6	2	2
2	5	2	8	4	3	8	1	2	7	1	4	6
3	4	8	2	1	1	4	9	5	8	5	2	1
4	2	6	8	7	4	5	1	5	9	8	4	2
5	6	2	5	8	6	9	9	2	1	4	8	1
6	4	9	8	4	4	2	1	8	9	2	5	6
7	6	7	6	9	4	8	2	9	8	1	5	2
8	5	8	6	2	1	9	4	8	1	9	4	2
9	8	2	1	9	4	2	4	9	8	1	6	5
10	6	5	4	2	9	8	5	1	9	5	4	6
11	2	4	1	5	8	6	2	5	8	2	1	5
12	5	8	4	6	2	9	1	6	2	5	9	4

Notice that an ordered sequence of letters and numbers appears at the top and left, respectively, of the matrix. Notice also that any digit inside the matrix can be specified in terms of a column letter and row number. The digit "7", for example, can be pointed out by saying "D-4."

During the experiment you will hear a "letter-number" every 7 seconds. This "letter-number" will refer to a letter along the top margin of the matrix and a number along the left margin. Your job will be to find the digit inside the matrix which is beneath the letter and to the right of the number. Then you must add this digit to the next two digits directly underneath it in a column and report the sum.

Let's take an example. Suppose you heard "E-2." You would go down Column E and across Row "2" and find the digit "3" inside the matrix. Then you would add together in your head the three consecutive column digits beginning with "3" (3 + 1 + 4) and report their sum: "Eight."

The object will be to get as many correct sums as possible. However, if you run out of time doing a sum you must go on to the next problem since you will get credit only for the current answer. It is important that you try your hardest in this experiment.

If you have any questions, please save them until the experimenter is ready for you. You will have plenty of time to clear up anything you wish.

Appendix C

Instructions for Subjects

Part II

INSTRUCTIONS FOR SUBJECTS

Part II

In the second part of this experiment you will again do the same three-digit addition task, but this time you will be placed in a rotary chair that gently turns back and forth. The duration of the test will be the same. Again we want you to do your best.

It will be extremely important that you <u>keep your head still</u> and in the chair's head-rest while the chair is moving. Otherwise you may become motion sick.

If you have any questions, please save them until the experimenter is ready for you.

Appendix D

Scoring the MSQ

SCORING THE MSQ

Each section is scored separately and yields two subscores, which are summed for a section score. The two section scores are then summed to yield a total score, the MSQ.

Scoring is done with the aid of the following conversion table:

Experience Level	Frequency of Report R	S	F	A
1	2	4	6	8
2	3	5	7	9
3	4	6	8	10

Example: A subject has reported Section A as follows:

Question	Cars	Buses or Coaches	Trains	Airplanes	Small Boats	Ocean Liners	Swings	Merry Go Round	Roller Coasters
A1	3	2	2	3	3	0	3	3	3
A2	S	R	R	R	N	0	N	N	N
A3	R	R	N	R	N	0	N	N	N
Score									
A1&A2	6	3	3	4	0	0	0	0	0
A1&A3	4	3	0	4	0	0	0	0	0

Determine the cell score for "nausea in cars" by determining the experience level from A1. This is 3. The frequency is S. Enter the table and read the weight 6 at the intersection of Row 3 and Column S. Repeat for the remaining cells in Lines A1 and A2. Determine the cell score for "vomiting in cars." The experience level is 3. The frequency is R. Read the weighted score 4 at the intersection of Line 3 and Column R. Enter the weight on the "Vomiting" line under "Cars" as indicated. Note that 0 experience level and/or N frequency always lead to a zero cell score.

Sum the nausea weights to obtain the "corrected frequency score" for nausea: 6 + 3 + 3 + 4 = 16. Sum the vomiting weights to obtain the "corrected frequency score" for vomiting: 4 + 3 + 4 = 11. Determine the number of types of motion experienced: 9 - 1 = 8.

The total section score is obtained as follows:

$$\text{Section Score} = \frac{\text{Sum of the corrected frequency scores}}{\text{No. of types of experience}} \times 9$$

$$= \frac{16 + 1}{8} \times 9 = 30.4 \text{ (to the nearest tenth).}$$

The procedure is then repeated for Section B. Let us assume the section score for B is 12. The Motion Sickness Quotient is then obtained by summing the section scores:

$$\text{MSQ} = \text{Section A score} + \text{Section B score}$$
$$= 30.4 + 12 = 42.4$$

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REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: NAMRL-1234
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7. AUTHOR(s): H. Jack Moore, J. Michael Lentz [redacted] Fred E. Guedry, Jr.
8. CONTRACT OR GRANT NUMBER(s):
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This study describes the development of a Visual-Vestibular Interaction (VVI) test which may be useful in predicting motion sickness susceptibility in working situations aboard ship, aircraft, and other moving vehicles.

The nauseogenic aspect of visual suppression of the vestibulo-ocular nystagmus reflex was evaluated in three experiments. In approximately 5 percent of the subjects tested, motion sickness symptoms, including vomiting, developed. The establishment of individual sensitivities to this form of motion sickness is noteworthy, not only because of the similar

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lty of the visual task to applied performance, but it also provides a basis for investigating the types of displays and visual loads encountered in moving vehicles.

Moore, H. J. 1977
J. M. Lentz, F. E. Guedry, Jr.

NAUSEOGENIC VISUAL-VESTIBULAR INTERACTION IN A VISUAL SEARCH TASK. NAMRL-1234. Pensacola, FL: Naval Aerospace Medical Research Laboratory, 30 March.

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Motion sickness

Visual-vestibular interaction

Dynamic visual performance

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SUPPLEMENTARY

INFORMATION

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Errata:

H. J. Moore, J. M. Lentz, and F. E. Guedry, Jr., Nauseogenic visual-vestibular interaction in a visual search task. NAMRL-1234. Pensacola, FL: Naval Aerospace Medical Research Laboratory, March 1977.

Appendix D-1, fifth line from bottom of page should read:

$$= \frac{16 + 11}{8} \times 9 = 30.4 \text{ (to the nearest tenth).}$$