Sex Differences in the Incidence of Motion Sickness Induced by Linear Visual Oscillation

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BACKGROUND: In field studies, motion sickness is more common among women than among men. In laboratory research sex differences have been smaller, or absent. However, laboratory research on sex differences in motion sickness has employed exclusively rotational motion stimuli. We evaluated sex differences when motion sickness was induced using linear visual oscillation.

METHOD: Standing subjects were exposed to linear visual oscillation along the line of sight. We separately assessed the incidence of motion sickness and the severity of symptoms that are associated with motion sickness.

RESULTS: The incidence of motion sickness was 38% among women, but only 9% among men. Among subjects who stated that they were motion sick, the severity of symptoms did not differ between women and men.

CONCLUSIONS: Motion sickness induced using linear visual oscillatory stimuli exhibited sex differences greater than those that have been reported in field studies. Sex differences in motion sickness may vary as a function of the type of motion stimulation (linear versus angular).

KEYWORDS: motion sickness, sex differences, visual motion.

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Generally, motion sickness is more common among women than among men. For example, Lawther and Griffin[17] obtained reports of seasickness from more than 20,000 passengers on ocean-going ferries. Ratings of symptom severity were greater among women than among men by a ratio of 5 to 3. In addition, vomiting was more common among women (8.55%) than among men (4.33%). Similar sex differences have been reported for other types of vehicular travel, including rail, aircraft, and automobiles.[9,19]

In contrast to field studies, some laboratory studies have found small or nonexistent sex differences in motion sickness. Laboratory research on sex differences in motion sickness has suggested that men and women do not differ in motion sickness arising from inertial motion[4,13] or optical motion.[14,19] As one example, Cheung and Hofer[4] placed seated subjects at the center of a platform that rotated continuously around the vertical axis at 120°/s for a maximum of 15 min. Head movements were performed during platform rotation, yielding Coriolis cross-coupled stimulation. The dependent measures were ratings of symptom severity and the number of head movements that could be tolerated. No sex differences were found in either dependent variable. Klosterhalfen et al.[14] exposed male and female subjects to optokinetic motion. The results did not reveal any differences between men and women. There have been occasional exceptions,[8] but most laboratory studies have reported much smaller sex differences than occur in field settings. Our study was designed, in part, to address this discrepancy between effects observed in the laboratory and in vehicular travel.

One consistent feature of laboratory research on sex differences in motion sickness has been that stimuli have consisted of rotational motion, either rotation of inertial platforms,[4,13] or rotation of the visible surround.[8,14] Motion stimuli that rotate around the body's vertical axis have limited ecological validity:

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the average person spends little time spinning around. The issue of ecological validity is important because motion sickness is associated with motion stimuli that are intimately related to ordinary behavior. Motion sickness is associated with oscillatory motions whose frequency characteristics resemble those of ordinary standing body sway,[22] which (unlike spinning) is ubiquitous. This is true for inertial motion, but also for visual motion: motion sickness is reliably generated by linear visual oscillation that mimics the frequency and amplitude characteristics of standing body sway.[2,22,25] In addition, Lawther and Griffin[16] reported that the severity of seasickness was principally related to the magnitude of ship motion in heave, that is, to a linear component of the motion stimulus.

A second consistent feature of existing laboratory research on sex differences in motion sickness has been that subjects have been tested while seated. The incidence and severity of motion sickness differ between seated and standing subjects.[24] In the present study we did not use rotational motion stimuli and subjects were tested while standing.

While there is uncertainty about the extent of sex differences in motion sickness, there is also uncertainty about the causal factors that underlie such differences. Men and women differ in many ways, from anthropometrics to gender roles, and from hormones to cognitive abilities. In the motion sickness literature, scholars have suggested that sex differences may be related to a variety of hypothetical causes, including hormones,[9] spatial information processing,[21] or a hypothetical evolutionary adaptation that protects a fetus from toxins.[9] None of these hypothetical causes has proven entirely satisfactory. For example, sex differences in hormones can account for no more than one-third of the observed sex difference in motion sickness.[9]

One factor that has received little attention is the fact that, on average, men and women differ in size and shape. The sexes differ in height, in the length of limbs, and the size of hands and feet. The sexes differ also in weight and in mass distribution: The body's center of mass tends to be higher in men than in women. These anthropometric differences may lead to differences between the sexes in the dynamics of movement. For example, Hue et al.[10] reported that in men, bodyweight is a strong predictor of the spatial magnitude of postural sway. Given that men typically weigh more than women, the findings of Hue et al. suggest that body sway may differ between men and women. Several studies have shown this to be the case.[6,12] These sex differences may be relevant to motion sickness given that sickness can be induced using visual simulations of standing body sway.[22,25] In the present study, we asked whether visually induced motion sickness would be related to several anthropometric properties that are sexually dimorphic.

In studies that have examined sex differences in susceptibility to motion sickness, researchers typically have not reported anthropometric data, or have not included anthropometric parameters as factors in data analysis for inertial motion stimuli[4,13] or for visual motion stimuli.[8,14,19] Beard and Griffin[1] exposed subjects to horizontal inertial oscillation and found that height and weight were not significantly related to measures of motion sickness susceptibility. However, their study was limited to men and subjects were seated during exposure to stimulus motion.

In the present study, we had three aims. First, we sought to determine the extent of any sex difference in susceptibility to motion sickness that might occur when standing subjects were exposed to linear visual oscillation. Second, we asked whether motion sickness incidence might be correlated with anthropometric properties that are sexually dimorphic. Our third aim was to examine relationships between motion sickness incidence and symptom severity in the context of sex differences. In previous research examining sex differences, motion sickness has been operationally defined in terms of the severity of symptoms. For example, many studies have obtained ratings of symptom severity and have compared mean ratings between men and women.[1,13,14] This operational definition provides information about relationships between men and women in the severity of motion sickness, but does not address the possibility that there may be sex differences in the overall incidence of motion sickness. Motion sickness can be treated as a continuous phenomenon (i.e., more vs. less, as in the case of symptom severity ratings), but it can also be treated as a dichotomous phenomenon (i.e., none vs. any). Both perspectives occur in general parlance. In conversation (e.g., among sea passengers) it makes sense to ask, "how seasick did you get?", but it also makes sense to ask, "did you get seasick?" It can be argued that questions about the degree or severity of sickness imply an affirmative answer to the dichotomous question about incidence. In the present study, we separately assessed the incidence of motion sickness using a dichotomous classification and the severity of motion sickness using ratings of symptom severity.[2,3] The present study was part of a larger project in which we also investigated relationships between motion sickness, sex, and the kinematics of body sway: these data will be published separately.

METHODS

The subjects were 114 individuals who participated in exchange for course credit. There were 45 men (mean age 22.81 yr, SD 3.43 yr) and 69 women (mean age 21.78 yr, SD 2.23 yr). The experimental protocol was approved in advance by the University of Minnesota IRB. For each subject, we measured the following anthropometric parameters: total standing height, weight, foot length, body mass index (BMI), and the vertical height of the body's center of mass. We measured foot length from the midline of the heel to the tip of the great toe; where the feet differed we took the shorter of the two feet.

Each of these anthropometric variables is sexually dimorphic. BMI differs due to male/female differences in body composition.[5] Female foot length is smaller than male foot length, even after taking into account sex-based differences in height (i.e., foot length as a proportion of height[7]). In early adulthood, the body's center of mass tends to be higher in men and lower in women, independent of differences in overall height.[26] Anthropometric data are presented in **Table I**.

Table I. Anthropometric Data Indicating Statistically Significant Differences Between Men and Women.

	MEN ($N = 44$)	WOMEN ($N = 70$)	t	P
Weight	82.74 kg (14.45)	65.23 kg (12.37)	6.91	$P < 0.01$
Total height	1.82 m (0.07)	1.68 m (0.07)	10.23	$P < 0.01$
Center of mass height	1.07 m (0.05)	0.97 m (0.06)	10.02	$P < 0.01$
Center of mass height/height	0.594 (0.015)	0.580 (0.023)	3.41	$P < 0.01$
Shortest foot length	0.27 m (0.002)	0.24 m (0.001)	12.06	$P < 0.01$
BMI	25.05 kg · m^{-2} (3.74)	23.17 kg · m^{-2} (3.91)	2.55	$P = 0.01$

We measured the height of the center of mass using a purpose-built device known as a reaction board (**Fig. 1**). Two sheets of plywood, each 2 m × 0.75 m × 1.9 cm, were screwed together to form a stiff platform. The platform was placed horizontally, with each end supported by a circular rod. One rod rested on the sensitive plate of a digital scale.

Visual stimulus motion was created using a moving room which consisted of a cubical frame, 2.44 m on a side, mounted on wheels and moved along one axis on rails (**Fig. 2**). The interior surfaces of the walls and ceiling were covered with blue and white marble-patterned adhesive paper. At the center of the front wall was a map of the continental United States (53 cm × 80 cm; 19° × 28°). Illumination was provided by floodlights mounted inside the room and oriented so that shadows were minimized. Movement of the room (oscillation along an axis parallel to the line of sight) was powered by an electric motor under computer control.

Subjects stood on a force plate (AccuSway Plus; AMTI, Watertown, MA) with their heels on a line that was 1.37 m from the front wall of the room. The force plate rested on the concrete floor of the laboratory, such that motion stimuli were exclusively visual. Data collected using the force plate will be published separately.

Following the informed consent procedure, subjects removed their shoes and completed the Simulator Sickness Questionnaire, or SSQ,[11] which allowed us to assess the initial level of symptoms (SSQ-1). The SSQ comprises 16 symptoms, each of which is rated on a 4-point scale (not at all, mild, moderate, severe). We used the Total Severity Score (TSS), which we computed in the recommended manner. Subjects also responded to a forced-choice, yes/no question, "Are you motion sick?" Subjects were instructed (both verbally and on the consent form) to discontinue the experiment immediately if they experienced any motion sickness symptoms, however mild.

We next measured each of the anthropometric variables. To determine the location of the body's vertical center of mass the subject lay on their back on the reaction board (Fig. 1), with their heels on a line that was scribed on the board. The weight that was registered on the scale was related to the height of the body's center of mass using Eq. 1:

$$COM\,Height = \frac{R2 - R1}{Weight} * 2meters, \qquad \text{Eq. 1}$$

where R1 was the baseline scale reading (i.e., the registered weight of the board), R2 was the scale reading when the subject was lying on the board, weight was the subject's standing weight in kg, and 2 m was the distance between the reaction board support rods.

Following collection of anthropometric data, subjects entered the moving room and stood on the force plate. Subjects placed their feet on lines that maintained a constant stance width (17 cm between the midline of the heels) and a constant stance angle (10°) between the feet. Prior to room motion, we conducted postural and visual performance testing lasting 2 min, which will be reported elsewhere. Room motion was a sum of 10 sines in the range 0.02–0.4 Hz, with maximum displacement amplitude of 2.5 cm. Room motion was identical to that used by Bonnet et al.[2] and Stoffregen et al.,[25] as was the protocol used during moving room trials. A portion of the motion function is shown in **Fig. 3**. Each trial with room motion was 10 min in duration and subjects were exposed to a maximum of four trials.

Between trials the moving room was stationary and the subject was required to sit for 1 min. Before each trial subjects were reminded to discontinue participation immediately if they experienced any symptoms of motion sickness, however mild. Upon discontinuation or after the completion of the experimental protocol (whichever came first) subjects again answered the forced-choice, yes/no question, "Are you motion sick?" They then completed the SSQ a second time (SSQ-2). Subjects who stated that they were not sick after exposure to room motion were given a printed copy of the SSQ (SSQ-3) and asked to fill it out at the time of symptom onset or after 24 h if no symptoms developed. Several studies have reported that the onset of motion sickness can follow exposure by up to 12 h.[18]

Motion sickness incidence was based on a dichotomous classification that was derived solely from answers to the forced-choice, yes/no question, "Are you motion sick?" Subjects who answered this question in the affirmative immediately after

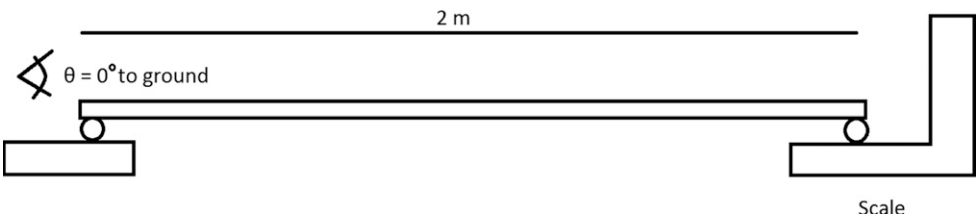

Fig. 1. The reaction board used to measure the height of the body's center of mass.

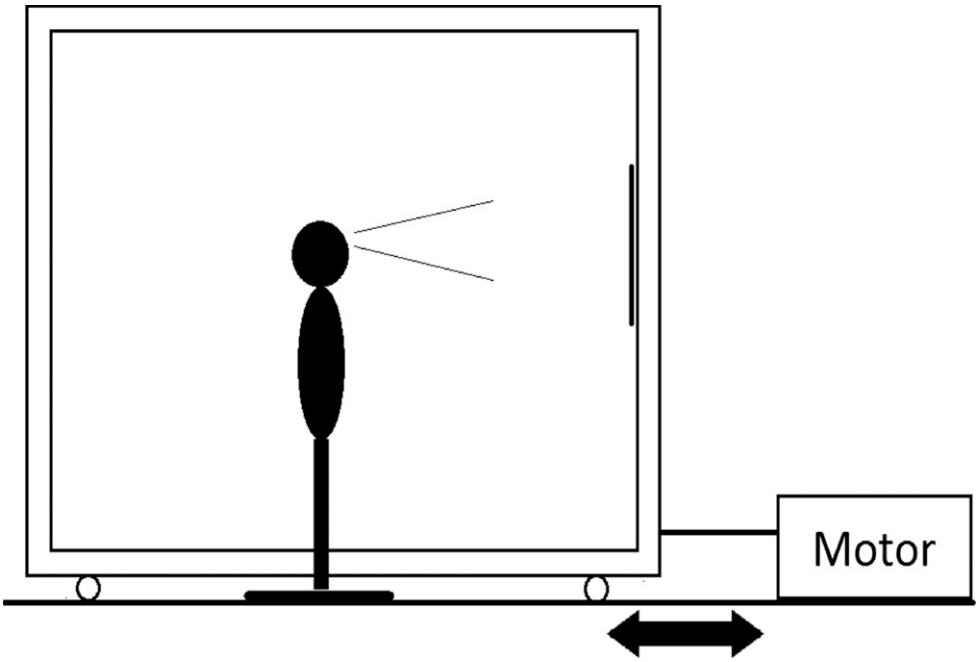

Fig. 2. The moving room.

exposure to room motion or within 24 h of their participation in the experiment were placed in the Sick group. All other subjects were placed in the Well group. Ratings of symptom severity (SSQ scores) were analyzed separately. Scores on the SSQ are not normally distributed and, for this reason, we analyzed SSQ data using nonparametric statistics, as recommended by Kennedy et al.[11] We also conducted a correlational analysis in which we examined relationships between anthropometric measurements and the classification of subjects into the Well and Sick groups.

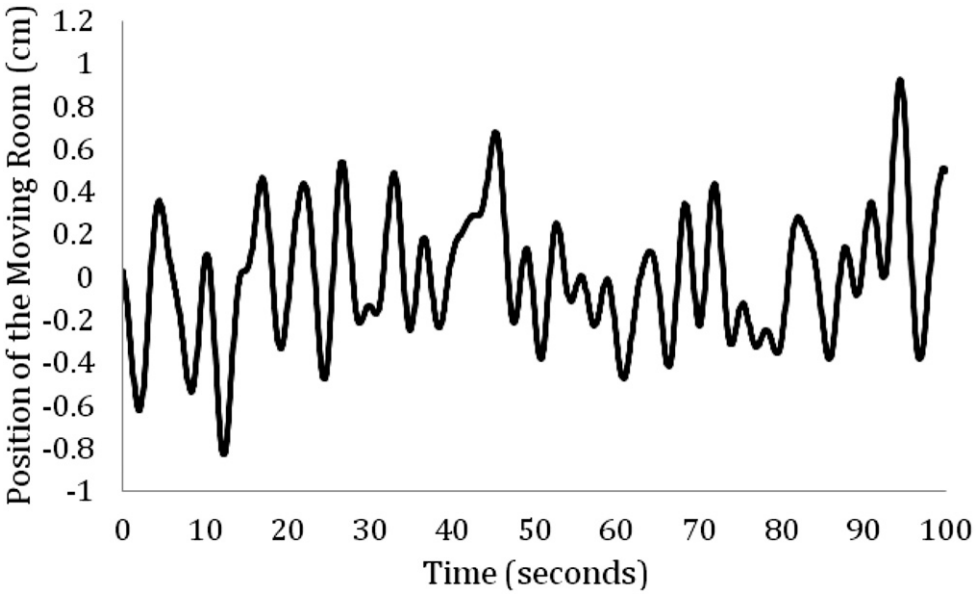

Fig. 3. A sample of room motion.

RESULTS

The anthropometric measurements are reported in Table I. Each of our anthropometric measurements differed significantly between the sexes. At pre-exposure each subject stated that they were not motion sick. Pre-exposure TSS scores did not differ between men (mean = 7.73, SD = 10.44) and women (mean = 11.87, SD = 15.22) (Mann-Whitney $U = 1275.50$, $P = 0.10$). By contrast, at pre-exposure TSS scores were higher for subjects in the Sick group (mean = 15.21, SD = 18.24) than for subjects in the Well group (mean = 8.46, SD = 11.17) (Mann-Whitney $U = 942.00$, $P = 0.04$).

Following exposure to visual motion in the moving room 30 subjects answered 'yes' to the forced-choice question, "Are you motion sick?" and were assigned to the Sick group. The remaining 84 subjects were assigned to the Well group. Thus, the overall incidence of motion sickness was 26.3% (30/114). Motion sickness incidence among women (38%, 26/69) was greater than among men (9%, 4/45) ($\chi^2 = 11.64$, $P < 0.001$).

There were 87 subjects who completed the full procedure. Of these, 80 answered 'no' to the forced-choice question on both SSQ-2 and SSQ-3 and, accordingly, were assigned to the Well group. The remaining seven subjects who completed the full procedure (3 men, 4 women) answered 'yes' to the forced-choice question on SSQ-2, and so were assigned to the Sick group.

There were 27 subjects who discontinued before the end of the moving room exposure (4 men, 23 women). The proportion of women who discontinued (0.33) was greater than the proportion of men who discontinued (0.09) ($\chi^2 = 9.00$, $P = 0.003$). For subjects who discontinued, the mean time of discontinuation was 22 min and 26 s, falling within the third 10-min moving room trial. Of the subjects who discontinued, 21 answered 'yes' to the forced-choice question, "Are you motion sick?" on SSQ-2 (i.e., at the time of discontinuation), while 2 answered 'yes' to the forced-choice

question on SSQ-3. These 23 subjects were assigned to the Sick group. The remaining four subjects who discontinued (3 men, 1 woman) stated that they were not motion sick on SSQ-2 and again on SSQ-3 and, accordingly, were assigned to the Well group. Of those four subjects, three gave fatigue as the reason for discontinuing, while the fourth cited time constraints.

The difference between postexposure TSS scores for the Well group (that is, all subjects who were classified as being well; mean TSS = 15.21, SD = 18.24) and the Sick group (that is, all subjects who were classified as being sick; mean TSS = 87.27, SD = 34.67) was significant (Mann-Whitney $U = 153.5$, $P < 0.001$). At postexposure, the difference between TSS scores for men (mean = 29.17, SD = 28.53) and women (mean = 48.30, SD = 41.68) was significant (Mann-Whitney $U = 1123.0$, $P = 0.013$). By contrast, as shown in **Fig. 4**, postexposure TSS scores did not differ between well men and well women (Mann-Whitney $U = 837.00$, $P = 0.69$) or between sick men and sick women (Mann-Whitney $U = 45.50$, $P = 0.69$). Postexposure TSS scores for the sick group (mean TSS = 87.27, SD = 34.67) were comparable to scores obtained in previous studies from subjects who stated that they were motion sick.[2,15,22]

The results for the SSQ subscale scores are summarized in **Table II**. For each of the three subscales (Nausea, Oculomotor, and Disorientation), postexposure scores were higher than pre-exposure scores. This was true for women and it was true for men. Separately, it was true for well women, for sick women, and for well men. Due to the fact that only four men reported motion sickness, we did not compute inferential tests on the subscales for this group.

We examined simple correlations between motion sickness incidence and each of the anthropometric measures. Only one of these simple correlations was significant: motion sickness incidence (well vs. sick) was negatively correlated with standing height ($r = -0.19$, $P = 0.048$). When controlling for sex, the correlation was not significant ($r = 0.05$, $P > 0.05$).

We examined several other partial correlations. When controlling for weight, motion sickness incidence was negatively correlated with overall height ($r = -0.21$, $P = 0.029$). When controlling for BMI, motion sickness incidence was negatively correlated with overall height ($r = -0.20$, $P = 0.034$), with the height of the center of mass ($r = -0.20$, $P = 0.033$), and with the shortest foot length ($r = -0.19$, $P = 0.045$).

DISCUSSION

In a moving room, standing subjects were exposed to linear optic flow that oscillated along the line of sight. We separately evaluated the incidence and severity of motion sickness. The incidence of motion sickness was greater among women than men, replicating many previous studies. However, the magnitude of the sex difference was larger than has been reported in earlier work. In addition, we identified anthropometric properties that were significantly correlated with motion sickness incidence. We discuss these results in turn.

At pre-exposure, incidence was 0, that is, each subject stated that they were not motion sick. Yet symptoms were greater among people who (later) became sick. Similar effects have been found in previous studies[3] and may reflect the fact that some SSQ symptoms can arise from things other than motion sickness (given that everyone stated they were not motion sick). It is important to note that at pre-exposure SSQ scores did not differ between women and men. In a related effect, several studies have reported elevated postexposure scores (relative to pre-exposure) among subjects who explicitly deny being motion sick.[3,23]

The moving room made people sick and the overall incidence of sickness (collapsed across the sexes) was similar to previous studies using the same device and similar experimental protocols. For example, in Bonnet et al.,[2] motion sickness was reported by 44% of subjects, while in Smart et al.[22] motion sickness was reported by 23% of subjects. Koslucher et al.,[15] using only female subjects, found an incidence of 36.1%. Our results demonstrate a sex difference in susceptibility to motion sickness induced by linear oscillation of the visible environment. The sex difference was in the expected direction: consistent with previous studies,[17] women were more likely than men to report motion sickness.

A novel feature of our results was the magnitude of the sex difference in incidence: women were four times more likely than men to state that they were motion sick. This result is not directly comparable to previous research, which has reported data only on symptom severity. However, our results suggest that there may be very large sex differences in the incidence of motion sickness in other settings

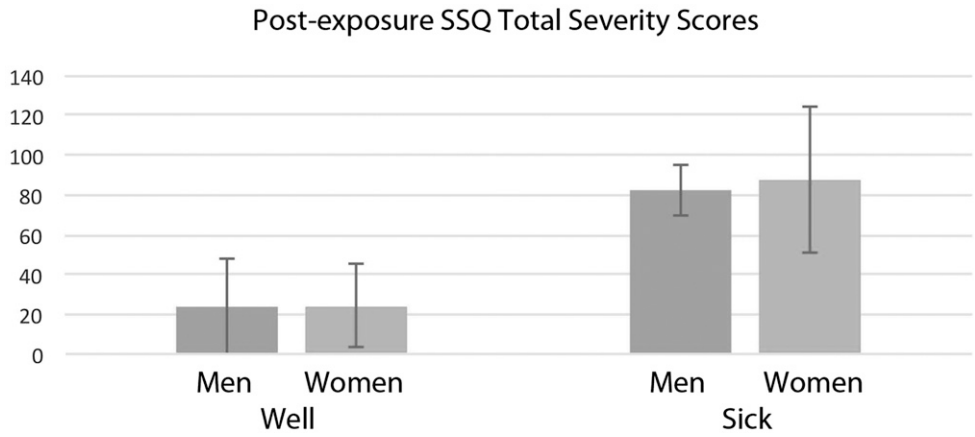

Fig. 4. Ratings of symptom severity (total severity scores on the Simulator Sickness Questionnaire) after exposure to room motion (SSQ-2 or SSQ-3) for well men ($N = 41$), well women ($N = 43$), sick men ($N = 4$), and sick women ($N = 26$). The error bars represent standard deviation of the mean.

Table II. Mean (SD) and Test Statistics (*z*-score, Wilcoxon Signed Ranks Test) for Each Subscale from the Simulator Sickness Questionnaire Comparing Pre-Exposure vs. Postexposure.

	NAUSEA			OCULOMOTOR			DIS*		
	PRE	POST	*z*	PRE	POST	*z*	PRE	POST	*z*
All women ($N = 69$)	8.16 (12.81)	38.99 (34.03)	6.34	12.96 (15.87)	38.23 (31.93)	6.49	7.87 (13.60)	52.25 (58.25)	5.72
All men ($N = 45$)	4.66 (7.51)	22.26 (24.15)	4.76	8.09 (11.70)	27.79 (24.40)	4.80	4.64 (11.10)	25.06 (37.84)	4.04
Well women ($N = 43$)	6.66 (10.31)	19.08 (18.50)	4.38	10.58 (13.25)	24.33 (20.50)	4.61	6.80 (12.29)	17.48 (22.13)	3.44
Sick women ($N = 26$)	10.64 (16.04)	71.92 (27.68)	4.47	16.91 (19.09)	61.22 (34.43)	4.47	9.64 (15.63)	109.75 (53.74)	4.46
Well men ($N = 41$)	4.65 (7.43)	16.75 (16.35)	4.39	7.76 (10.52)	24.77 (24.06)	4.56	3.73 (8.25)	17.32 (28.66)	3.62
Sick men ($N = 4$)	4.77 (9.54)	78.71 (18.06)	--	11.37 (22.74)	58.75 (15.63)	--	13.92 (27.84)	104.4 (28.98)	--

For each *z*-score, $P < 0.001$. Inferential tests were not conducted on sick men due to the small sample size.
* Dis: The disorientation subscale.

that are associated with visually induced motion sickness, such as interactive and virtual reality technologies. At postexposure, overall symptom severity was higher for women than for men. This finding is consistent with studies using inertial motion stimuli[13,17] and with some studies that have used purely rotational motion stimuli,[8] but differs from other rotation studies that have not found a sex difference in symptom severity.[3,14,19]

In the present study, the large sex differences found in terms of symptom severity (as well as in terms of motion sickness incidence) suggest that sex differences may be related to the nature of stimulus motion. It appears that men and women may be differentially susceptible to motion sickness arising from linear motion, but not to motion sickness arising from rotational motion. In this context it is important to recall that Lawther and Griffin[16] found that seasickness was preferentially related to ship motion in heave, that is, to the vertical linear component of ship motion, rather than to any of the angular components (roll, pitch, or yaw). One way to address this issue in future research would be to conduct a within-subjects comparison of responses to linear versus angular motion.

Among subjects who stated that they were motion sick, the severity of symptoms did not differ between men and women (Fig. 4). Our separate analyses of the incidence and severity of motion sickness revealed a novel finding: in the present study, there was a sex difference in the incidence of motion sickness, but not in the severity of motion sickness symptoms.

In our study, men and women differed significantly in overall height, weight, BMI, center of mass height, the ratio of center of mass height to overall height, and foot length (Table I). Each of these differences was consistent with previous anthropometric reports.[5,7,26] In this sense, our sample was representative.

Our correlational analysis revealed that the incidence of motion sickness was related to anthropometric factors. When controlling for sex, incidence was not related to overall height. However, incidence was negatively related to overall height when controlling for weight and when controlling for BMI. Separately, incidence was negatively related to the height of the center of mass when controlling for BMI. Finally, motion sickness incidence was negatively correlated with foot length (controlling for BMI): motion sickness was more likely among subjects with shorter feet. As noted above, women have lower center of mass and shorter feet even when controlling for sex differences in height.[7]

While these correlations were statistically significant, none was greater than 0.21, suggesting that motion sickness incidence is not strongly related to the anthropometric factors that we measured. Nevertheless, these statistically significant correlations suggest that anthropometric factors may play a role in susceptibility to motion sickness. It might be suggested that these results are trivial, because overall height, the height of the center of mass, and foot length are each strongly correlated with sex. However, we did not find significant correlations between motion sickness incidence and other anthropometric factors that are sexually dimorphic, such as weight, height of the center of mass as a proportion of overall height, and BMI. Taken together, the results of our correlational analysis suggest that susceptibility to motion sickness may be related to only some of the static anthropometric factors that are sexually dimorphic.

Our results do not imply a relationship between anthropometric parameters and incidence would obtain across the lifespan. In particular, our results are not relevant to the fact that children are much shorter than adults. On ships at sea children, as a group, appear to be more susceptible than adults,[17] but no difference has been found in the context of video games.[3] Our results could be used to motivate research examining relationships between height and susceptibility in children. For example, children typically exhibit a growth spurt relating to puberty that not only increases overall height, but also changes mass distribution within the body. It would be interesting to examine trends in susceptibility in the years surrounding puberty, focusing on changing anthropometrics while controlling for the hormonal and neurophysiological changes that accompany puberty. Separately, new research is needed to investigate possible relationships between motion sickness and anthropometric changes that characterize older adults.

In adults, anthropometric factors tend to be stable over many years. However, they can have effects that are dynamic over short time scales. Of particular relevance to motion sickness is the fact that anthropometric parameters influence the way that people move. For example, postural sway differs between men and women.[6,10,12] In principle, biomechanical and anthropometric variations that are related to sex might underlie observed sex differences in susceptibility to motion sickness. Note that sexually dimorphic parameters are not limited to stance. For example, sex differences exist for the head, the trunk, and the arms, any of which may be in motion when

sitting.[20] This fact may be important given that motion sickness is common during sitting.[8,18,19] However, some relationships between sex and movement may not be related to motion sickness. For example, postural sway is strongly affected by bodyweight,[10] yet in the present study we found no evidence that weight was related to motion sickness susceptibility.

In conclusion, in a moving room, standing subjects were exposed to optic flow that oscillated along the line of sight. We evaluated the incidence of motion sickness on the basis of subjects' forced choice, yes/no statements. Of the female subjects, 38% reported motion sickness, as compared to only 9% of male subjects. Our results suggest that sex differences in susceptibility may be greater in the context of linear oscillation than in the context of angular rotation.

Sex differences in visually induced motion sickness have special relevance to emerging technologies. There has been an explosion in imaging and display technologies, with increases in the overall quality of motion graphics and in the interactivity of display systems and technologies. Unfortunately, there has also been an increase in reports of motion sickness among people who interact with these imaging technologies. Visually induced motion sickness differs from transportation-related motion sickness in one qualitative respect: the presence versus absence of inertial displacement of the body. Thus, we cannot assume that the well-documented sex difference related to transportation will be the same in the context of noninertial visual technologies. This is an important topic for future research.

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