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SHORT AND SWEET

The sickening rug: A repeating static pattern that leads to motion-sickness-like symptoms

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Abstract. The nauseogenic properties of a patterned rug that reputedly caused motion-sickness-like symptoms in those who viewed it was the topic of this study. Naive observers viewed a 1:1 scale image of the black-and-white patterned rug and a homogeneous gray region of equivalent luminance in a counterbalanced within-subjects design. After 5 min of viewing, symptoms were assessed with the simulator sickness questionnaire (SSQ), yielding a total SSQ score and sub-scores for nausea, oculomotor symptoms, and disorientation. All four scores were significantly higher in the rug condition. Observers also reported significantly more self-motion perception in the rug condition, even though they were seated during the experiment. Results are consistent with findings that suggest that neurologically normal individuals who view a repeating static pattern can experience unpleasant symptoms, some of which are similar to motion sickness.

An individual who reported an unusual and unpleasant problem contacted us some time ago. He had recently purchased a rug (about 3 m $\times$ 1.6 m) that consisted of a repetitive pattern of black and white squares laid out in regular columns and rows (see figure 1). Once home, the rug was laid out, and he and his wife looked at their recent acquisition, only to experience disorientation, dizziness, headaches, and nausea that lasted about 2 h after the rug was viewed. Other independent viewers described similar symptoms. In addition to what were described to us as motion-sickness-like symptoms, a perception of self-motion was reported.

Motion sickness is unusual among 'sicknesses'. No bacteria, virus, poison, or physical 'problem' is responsible for its onset. Instead, sensory/perceptual processes regarding self-motion seem to be at work. The most widely cited possible 'cause' of motion sickness

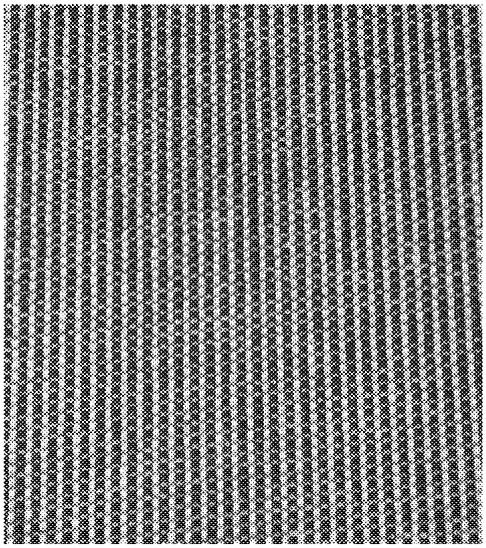

Figure 1. The sickening rug that was reported to cause motion-sickness-like symptoms and the perception of self-motion.

is sensory conflict (Reason and Brand 1975), a lack of agreement between sensory inputs (mostly visual and vestibular) compared to those that occurred in similar environments in the past.

Unpleasant motion-sickness symptoms, that can include dizziness, headache, vertigo, and nausea, are typically associated with passive self-motion or visually induced self-motion. Actual self-motion in a vehicle such as a boat, automobile, or aircraft can lead to sea sickness, car sickness, or air sickness. Visually induced self-motion, or vection (Fischer and Kornmüller 1930; Tschermak 1931), is often the result of a moving display, such as those that are often present in vehicle simulators (Hettinger et al 1990); they can lead to simulator sickness. Even watching a film or video shot from a first-person perspective (Bubka and Bonato 2010) can lead to simulated self-motion and, subsequently, motion-sickness-like symptoms. However, the case of the sickening rug is very different—no passive self-motion or visually induced self-motion seemed to be involved. The observers were stationary or actively moving and the display was totally static.

The notion that static patterns can lead to adverse symptoms is not new. It has been reported that about 4% of patients with epilepsy are susceptible to visually induced seizures (Wilkins 1995). In many of these patients only visual patterns invoke seizures (Jeavons and Harding 1975). Some of the patterns known to lead to seizures look suspiciously similar to the sickening rug that is addressed in this paper. However, important to note are two key differences: (i) the owners of the sickening rug did not suffer from any neurological disorders that we know of, and (ii) they did not have seizures but, instead, experienced symptoms that they thought were most similar to motion sickness. Furthermore, they were reportedly not the only ones who were affected by the rug.

The idea that neurologically 'normal' individuals can be affected by static repeating patterns such as grating is also not new. Previous research suggests that, when striped patterns are viewed, illusions of motion and unpleasant symptoms can result. When asked to participate in an experiment that required participants to rate the 'pleasantness' of square-wave gratings that varied in spatial frequency, Wilkins and colleagues (1984) were surprised when 11 of their 29 participants reported symptoms such as eyeache, tiredness, headache, and dizziness. The patterns used in their experiments were similar to the rug shown in figure 1 except that the design of the rug resulted in a repeated pattern on both the x and y axes. Wilkins (1995) has also devoted an entire chapter in his book *Visual Stress* to 'illusions and headaches', and also addressed motion-sickness-like symptoms such as nausea and general discomfort.

We decided to test the nauseogenic potential of the rug by conducting a simple experiment in our lab that was approved by the Saint Peter's College human-subjects ethics committee. We obtained from the rug's owner a high-resolution digital image of the allegedly sickening floor covering that we enlarged and printed, yielding a 1 m high $\times$ 1.3 m wide 'poster' (see figure 1). In a within-subjects design, twenty-two seated undergraduates viewed the image of the rug (experimental condition) and a homogenous gray poster (control condition). The gray poster had a luminance equal to the mean luminance of the rug's image. The stimulus surface was perpendicular to the observer's line of sight and viewing distance was 0.5 m. Each trial lasted 5 min and conditions were separated by 48 h. The order of conditions was counterbalanced.

To assess motion-sickness symptoms the simulator sickness questionnaire (SSQ) was used (Kennedy et al 1993). The SSQ is a well-accepted instrument for measuring motion-sickness symptoms in a variety of provocative environments. Participants rate symptoms before and after exposure according to published guidelines. Symptom ratings are based on research accrued from large databases. Four scores are obtained: a total SSQ score and three sub-scores—one for nausea, one for oculomotor symptoms, and one for disorientation. At the conclusion of each trial the participant was asked to rate his/her degree of self-motion perception on a 0 – 10 scale.

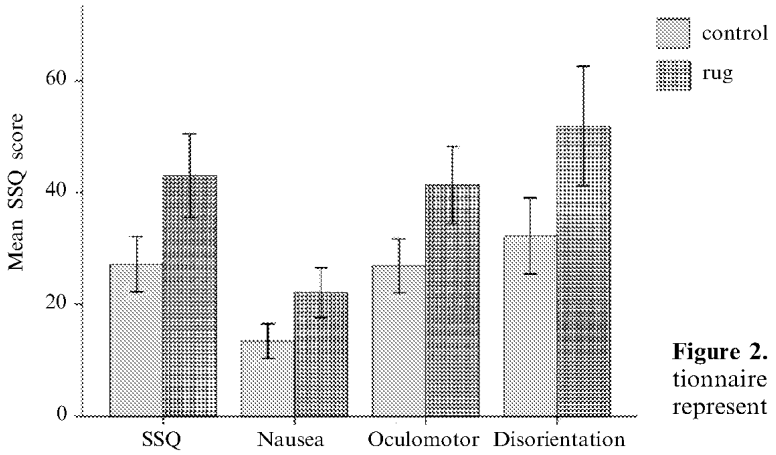

Figure 2. Simulator sickness questionnaire (SSQ) results. Error bars represent ±1 SE.

SSQ scores were significantly higher in the experimental (rug) condition (see figure 2). This result was revealed for total SSQ scores ($t_{21} = 2.7$, $p = 0.014$), as well as nausea ($t_{21} = 2.5$, $p = 0.02$), oculomotor symptoms ($t_{21} = 2.8$, $p = 0.01$), and disorientation ($t_{21} = 2.1$, $p = 0.05$) sub-scores. Mean ratings of perceived self-motion were also significantly higher ($p = 0.004$) in the experimental condition (4.7) compared to the control condition (2.7). Collectively, results suggest that simply viewing a 'rug' can lead to motion-sickness symptoms. Furthermore, self-motion was perceived more intensely when the rug was viewed, even though participants were instructed to remain motionless in both conditions.

These results are preliminary and hence limited in some ways. Head and body movements were not measured. Perhaps participants did move more when viewing the image of the rug. This is important, given that postural instability has also been identified as a possible cause of motion sickness (Stoffregen and Smart 1998). Nystagmus eye movements have also been associated with motion sickness (Ebenholtz et al 1994). Many participants also reported the perception of a 3-D effect. Perhaps accommodation and vergence information clashed, causing a visual intrasensory conflict. Hence, measuring eye movements might also provide some insights into the sickening-rug phenomenon. Furthermore, some of the symptoms rated in the SSQ are non-specific in that they may indicate some form of motion-sickness or visual stress, the symptoms of which can overlap.

Bottom line: be careful what you buy. You might have to look at it for a while and it might just make you feel sick.

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