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Brief communication

The relationship between susceptibility to nausea and vomiting and the possession of conditioned food aversions

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Abstract

Because nausea and vomiting play an important role in the formation of conditioned food aversions, individual differences in susceptibility to nausea and vomiting may contribute to interindividual variation in conditioned food aversion acquisition. Two surveys reveal that, among female participants, self-reported motion sickness susceptibility is positively correlated with the number of conditioned food aversions possessed, but no such correlation appears among male participants.

Keywords: Motion sickness; Nausea; Vomiting; Conditioned food aversions

Individuals vary in the number of conditioned food aversions (CFAs) possessed (de Silva & Rachman, 1987; Garb & Stunkard, 1974; Logue, Ophir, & Strauss, 1981; Mattes, 1991). At present, little is known about the proximate causes of this variation. Nausea and vomiting following the ingestion of toxins or toxin-producing pathogens facilitate the formation of CFAs (Bernstein, 1999). Accordingly, in addition to possible stochastic and behavioral factors, variation in CFA acquisition may derive from variation in susceptibility to nausea and vomiting.

Motion sickness susceptibility predicts both postoperative nausea and vomiting due to anesthesia (Busoni et al., 2002; Kenny, 1994) and nausea and vomiting following chemotherapy (Golding, 1998; Molassiotis et al., 2002; Morrow, 1985), and is somewhat correlated with the frequency of nausea and vomiting due to many routine causes (Golding, 1998). Motion sickness susceptibility thus appears to usefully index individual differences in the ease of elicitation of nausea and vomiting. We therefore conducted two studies examining the relationship between this trait and CFA possession.

After obtaining IRB approval, we recruited unpaid UCLA undergraduate volunteers for a paper-and-pencil survey on motion sickness and food aversions. Participants received Golding's (1998) Motion Sickness Susceptibility Questionnaire (MSSQ; only questions concerning the last decade were used), and were given a description of CFAs together with an example, then asked to list foods to which they had developed CFAs during the last decade. Information on age and sex was also collected. Alcohol use is a potential confound when examining the relationship between susceptibility to nausea and vomiting and CFA possession, as alcohol use may be negatively correlated with the former yet, due to emetic effects, positively correlated with the latter. Participants were therefore asked to indicate how frequently they drink alcohol using a five-point scale ('never' to '>3 times per week'). Lastly, olfaction may be a first line of defense in toxin avoidance. Sharma and Aparna (1997) found a correlation between olfactory sensitivity and susceptibility to motion sickness, hence we asked participants to indicate on a five-point scale how sensitive they are to bad smells relative to other people.

Five hundred and seven surveys were collected, of which 23 were discarded due to incompleteness, producing a sample of 140 men and 344 women, with a mean age of 21 (SD 5.2), a composition reflecting that of the courses in which recruitment took place Mean female MSSQ score was 15.12 and mean male score was 10.89, a significant difference ($t_{481}=3.43$, $p=0.0007$; Cohen's $d=6.4\times10^{-5}$).

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Women also reported more CFAs, averaging 1.03 aversions per person compared to 0.82 aversions among males, a difference that marginally failed to reach significance ($t_{378}=1.95$; $p=0.052$).

Age was negatively correlated with MSSQ score in males ($r=-0.19$; $p=0.024$), hence subsequent calculations used partial correlations controlling for age, performed separately by sex. Odour sensitivity correlated with MSSQ in females ($r=0.14$; $p=0.010$) but not males ($r=0.04$; $p=0.467$). MSSQ score was positively correlated with number of CFAs for females ($r=0.17$, $p=0.004$) but not males ($r=0.06$, $p=0.650$). Splitting the samples into thirds revealed that the correlation found for females was driven by participants with the highest reported number of CFAs ($r=0.56$, $p<0.0001$), whereas correlations were not significant for the lower and middle thirds of the sample; equivalent reanalysis did not change the results for males. Frequency of alcohol consumption was correlated with number of CFAs for females ($r=0.14$, $p=0.030$). Controlling for alcohol use, MSSQ still correlated with number of CFAs in females ($r=0.14$; $p=0.023$) but not males ($r=-0.01$; $p=0.734$).

The distribution of foods targeted in CFAs was relatively patterned: of 409 CFAs reported, 26% were either meat, fish or eggs; 22% were fruits and vegetables; 15% were alcoholic beverages; 10% were starches; 10% were sweets; 8% were dairy products, and the remaining 9% consisted of spices, nuts, coffee, tea, and other beverages.

Consistent with the proposition that individual differences in CFA acquisition are in part a function of differences in the ease of elicitation of nausea and vomiting, our initial investigation revealed a small positive correlation between motion sickness susceptibility and number of CFAs. However, this correlation occurred only among females. We worried that our instrument might have failed to adequately measure male experience, since (a) males consume more alcohol, yet our measure of alcohol use was crude, (b) our sample was young and, due to gender stereotypes, young men may underreport susceptibility to motion sickness, and (c) participants were not instructed to explicitly indicate if they possessed no CFAs, creating ambiguity for some respondents. In addition, for both sexes, the mean number of CFAs per person was substantially lower than might be expected (cf. de Silva & Rachman, 1987; Garb & Stunkard, 1974; Logue et al., 1981; Mattes, 1991), suggesting that our questionnaire may have failed to elicit complete reporting.

In our second survey, we replaced the solitary question on alcohol consumption with four questions asking "How many glasses of [beer/wine/mixed drinks/hard liquor] do you drink per week?", each paired with a 0–30 scale. To decrease impression management effects, we employed an Internet-based method that both (a) enhanced anonymity, and (b) accessed a wider range of ages and backgrounds than our paper-and-pencil survey of university students. Participants used 0–20 scales to indicate how many CFAs they possessed for each of 19 different food types, a method that both differentiated between complete and incomplete responses and reduced the memory demands of reporting CFAs acquired over a decade.

After obtaining IRB approval, we recruited participants age 18 and up through a link labeled 'Motion Sickness and Food Aversions Survey' posted on psychological research clearinghouse web sites and related listservs (list available on request). Participation was anonymous. No compensation was offered.

Four hundred and eighty two surveys were collected, of which 46 were discarded due to incompleteness, producing a sample of 87 men and 349 women, mean age 32 (SD 12.5), a gender composition that reflects that of Internet surveys on diverse topics which we have conducted previously Mean female MSSQ score was 19.85 and mean male score was 12.38, a significant difference ($t_{434}=4.61$, $p<0.0001$; Cohen's $d=9.6\times10^{-6}$). Although women reported more CFAs, averaging 16.16 aversions per person versus 10.76 among males, this difference was not significant ($t_{434}=1.64$, $p=0.102$). Age did not correlate with MSSQ score ($r=-0.06$; $p=0.189$), but was negatively correlated with number of CFAs (females: $r=-0.16$; $p=0.002$; males: $r=-0.23$; $p=0.036$). Subsequent calculations were conducted separately for males and females using partial correlations controlling for age. Odour sensitivity correlated with MSSQ in both females ($r=0.23$; $p<0.0001$) and males ($r=0.23$; $p=0.034$). Addressing the key prediction at issue, there was again a significant correlation between MSSQ score and number of CFAs for females ($r=0.13$, $p=0.013$) but not for males ($r=0.02$, $p=0.791$). Splitting the samples into thirds on the basis of number of CFAs reduced this correlation to a nonsignificant level in all subsamples. Summing frequency of consumption across types of alcohol, we found significant correlations between alcohol consumption and number of CFAs for both sexes, but no significant correlations between MSSQ score and frequency of alcohol consumption for either sex. Controlling for frequency of alcohol consumption, the correlation between MSSQ score and number of CFAs remained significant for females ($r=0.12$; $p=0.021$) and nonsignificant for males ($r=0.01$; $p=0.901$).

The distribution of foods targeted in conditioned aversions varied slightly from that found in Study 1, more closely resembling results previously reported in the literature: Of 6574 food aversions, 36.6% were either meat, fish or eggs; 10.9% were fruits and vegetables; 11.0% were alcoholic beverages; 4.0% were starches; 6.2% were sweets; 6.5% were dairy products, and the remaining 24.8% consisted of spices, nuts, coffee, tea, and other foods.

Our Internet survey replicated others' reports of a sex difference in motion sickness susceptibility, and we likewise found a trend toward a sex difference in number of CFAs; the 10-fold increase in the number of CFAs per person brought our results into line with what would be expected based on other investigators' reports. Like others, we found

(a) a negative effect of age on number of CFAs, (b) a positive correlation between motion sickness susceptibility and sensitivity to bad odors, and (c) a pattern in which meats and related foods figure prominently as the targets of CFAs. These parallels make it reasonable to assume that our improved instrument functioned as intended. It is therefore significant that, using a sample with a greater average age, and a greater age range, than that employed in our first study, and an improved method characterized by greater anonymity, this survey produced the same result as our paper-and-pencil survey of UCLA undergraduates, namely a small but significant positive correlation between motion sickness susceptibility and number of CFAs in women, but no such correlation in men. Indeed, the correlation between female MSSQ and number of CFAs found in Study 2 ($r=0.12$; $p=0.021$) is nearly identical to that found in Study 1 ($r=0.14$; $p=0.023$).

Although we tried to minimize impression management effects, gender role conformity may still have led male participants to underreport motion sickness susceptibility, producing the above sex difference. Relevant evidence is mixed. Physiological measures of responses to nauseogenic motion stimuli do not differ across the sexes (Cheung & Hofer, 2002; Jokerst et al., 1999; Park & Hu, 1999), suggesting that impression management may be prominent in this domain. However, the sex difference in reported incidence of motion sickness occurs even in individuals, such as world-class sailors (Turner & Griffin, 1995), among whom both sexes are presumably highly motivated to suppress both motion sickness and reports thereof. Future investigations of the relationship between nausea and vomiting susceptibility and CFA possession should employ methods, such as physiological measurements of induced motion sickness, that preclude impression management effects.

Although consistent across our two studies, the size of the correlation among female participants between motion sickness susceptibility and CFA possession is small. Survey instruments are a crude tool for measuring both factors, hence noise may have been introduced, limiting the size of the correlation. CFA acquisition may involve the formation of implicit memories not readily accessible to recall, thus reducing the number of CFAs that individuals consciously identify when surveyed (Bernstein, 1999). Susceptibility to motion sickness is an imperfect index of the ease with which nausea and vomiting are elicited, as the correlation between motion sickness and nausea and vomiting due to other causes is incomplete (Golding, 1998). These limitations may suffice to explain the small size of the correlation which we found between motion sickness susceptibility and number of CFAs possessed by women. However, we cannot rule out the possibility that this correlation is small because the ease of elicitation of nausea and vomiting plays only a minor role in individual differences in CFA acquisition. Likewise, we cannot eliminate the possibility that, rather than illuminating the relationship between CFA possession and individual differences in the ease of elicitation of nausea and vomiting, our investigation actually measured the extent to which naturally-occurring motion sickness acts as an unconditioned stimulus in CFA acquisition (Bernstein & Borson, 1986).

Our failure to find the predicted correlation among male participants begs explanation. Holding aside the question of impression management effects, given that women are both more susceptible to motion sickness than men and more likely to possess CFAs, one possibility is that our methods are sufficiently crude such that we were only able to detect the correlation in the sex in which overall magnitudes are larger. A speculative alternative involves the proposition that, over the course of human evolution, ingestible toxins posed a greater threat to women than to men (Fessler, 2002). If so, the force of natural selection favoring the ability to learn to avoid toxins would have been stronger on women, conceivably resulting in a sex difference in the intimacy of the linkage between susceptibility to nausea and vomiting and CFA possession.

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