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Neurosensory Systems: Gender on Space Adaptation

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ABSTRACT: Few studies have looked specifically at the differences in neurological responses between men and women during and after spaceflight, despite the fact that sex and gender differences have long been a research issue of interest. Due to the considerable gender imbalance in the astronaut corps, knowledge in this area is scarce. According to research, there are general neurological and sensory variations between the sexes, including differences in the lateralization of amygdala activity, the sensitivity and discrimination of vision processing, and the pathways that control neuronal cell death (apoptosis). For astronauts who flew on both short- and long-duration missions, women may experience post-flight vestibular instability at higher rates than men, as well as entrance and space motion sickness. The expected gender disparities in hearing thresholds are seen in the crewmembers' hearing and auditory function, with female astronauts having higher hearing thresholds. There is no evidence of sex-related disparities from spaceflight based on longitudinal examinations of crewmember hearing thresholds, despite the regular age-related declines that are reported. By making spaceflight more accessible and sending more women into space, we can better understand the effects of sex and gender disparities. We will only be able to tell if men and women react to missions with progressively longer durations in significantly different ways through this method.

KEYWORDS: Cognition, Long-term spaceflight, Neurosensory Systems, Gender, Space Adaptation

I. INTRODUCTION

The majority of astronauts have been men, and this trend has not changed, despite the significance of having both sexes equally represented in most human research. As a result, the roles of sex and gender in spaceflight are not well recognised. We are concerned with all aspects of spaceflight when talking about sex and gender differences, not just those that could be specifically relevant to the microgravity portion of flight. Men and women have different neurophysiological, sensory, and sensory-motor characteristics that are relevant to spaceflight. The neuronal structure and functional responses are where we may most clearly observe these differences, but the consequences of Uncertainty surrounds these variations.

II. NEUROLOGICAL VIEWS

There are significant sex differences in the brain's physical anatomy, neuronal development, and neurochemical processes, as well as reactions to environmental stimuli like stress.¹ Additionally, many disorders of the central nervous system—including, but not limited to, Alzheimer's disease, post-traumatic stress disorder, anxiety disorders, schizophrenia, stroke, multiple sclerosis, autism, addiction, fibromyalgia, attention deficit disorder, irritable bowel syndrome, Tourette's syndrome, and eating disorders—show differences in their incidence and nature according to gender. 2–4 Memory processing studies repeatedly show that men and women both prefer the right amygdala for memory of emotional content (often visual images), but that women prefer the left amygdala for memory of the same material. 5–7 This laterality, "women left, men right," is consistent with what is observed when the subject is at rest, suggesting that the reaction to emotional stimulus results from a baseline that is already "tilted" differently for men and women. Men and women experience neuronal cell death through different routes. Male cells more frequently experience caspase-independent, apoptosis initiating factor-mediated cell death, whereas female neurons more frequently experience traditional, caspase-dependent apoptosis. This discovery may be significant in the development



of therapies for stroke-related neurodegenerative diseases or damage. 8 The thalamus and amygdala are two areas of the brain that exhibit considerably differing levels of opioid receptor binding in men as compared to women. These variations may affect how each sex reacts to pain medications. 9 Men are noticeably more sensitive to small details and fast-moving stimuli, although women are better at discriminating between colours. This is partly because colour blindness, an X-chromosome-related genetically inherited condition, affects many guys, and is more common among them. 10,11 Although there isn't much research on sex variations in touch perception, some distinctions are known. On the whole, women are more sensitive to pressure and touch than males are. Men perform better than women on a number of haptic tasks, but women seem to be more sensitive to temperature changes (object or position recognition involving touch and proprioception). Although there are various biases that might affect how pain and pain sensation are reported (social, gender, ethnicity, culture, etc.), women do generally tend to be more sensitive to pain than males. This is likely because of biological mechanisms as well as psychological and psychosocial variables. 12 Assessment of the vestibular system is notoriously challenging. Anatomy, central physiology, and processes influenced by vestibular input, such as postural reactions, spatial orientation, reactions to strong motion stimuli, and the incidence of disease, are all relevant research areas. grotesque anatomy Women are more likely than males to suffer several vestibular illnesses, including vertigo, which has been confirmed by epidemiological studies^{16,17}. This may help explain why women are more likely to acquire fewer total myelinated axons in the vestibular nerve than men. 13 In comparison to women, men have much larger otoliths, utricles, saccules, and superior semicircular canals. 14 hormones and the vestibular nucleus. There is some indication that the medial vestibular nucleus synaptic transmission and plasticity in rats may be affected by the estrus (menstrual) cycle. Circularvection (orientation in a rotating environment), field dependence (perceiving orientation solely from visual cues), perception of veridical vertical with body tilt (accurately identifying the true vertical to the ground when the body is tilted), and perception of the morphological horizon have all been linked to gender differences. 18,19 Although some data suggests that cognitive training involving attention to cues can reduce these sex differences, these differences have been partially attributed to biological differences in the vestibular system, particularly the difference in otolith size. 20 Testing in the lab for motion sickness. It's a frequent misconception that women are more prone to motion sickness than men are. This prejudice has likely been influenced by both social factors and research design. More than 200 people participated in a range of motion sickness tests as part of a study being done in the Neurosciences Laboratory at the NASA Johnson Space Center (coriolis sickness susceptibility [CSSI], sudden stop, off- vertical rotation, parabolic flight, etc.). Men and women were shown to be equally susceptible, and testing females at any point in their menstrual cycle had no effect. Variable responses were given to different tests. For instance, during the CSSI test, some people experienced nausea, but not during the off-vertical axis rotation test. 21,22 The post-flight debriefs of astronauts who flew on the short-duration Space Shuttle (564 male, 100 female) and long-duration International Space Station (32 male, 10 female) reveal the incidence of motion sickness, which reveals that on average, female crew members who flew on both the space station and shuttle reported both space motion sickness and entry motion sickness (EMS) symptoms more frequently than male crew members (these data were mined from the NASA Lifetime Surveillance of Astronaut Health [LSAH] database). The one exception is that after returning from a lengthy space journey, men who were crew members on the space station reported a higher prevalence of EMS than women. Ataxia of the posture: space travel. The symptoms of post-flight vestibular instability, such as feeling unusually heavy, clumsiness, vertigo, persistent sensation aftereffects, or difficulty walking in a straight line, were generally reported by female crew members who travelled on both the space station and the space shuttle more frequently than by male crew members (these data were also mined from the LSAH database). All of the comments were purely subjective, and as part of the customary post-flight medical debrief, they were all given to a flight doctor. The debriefing never specifically mentioned the symptoms. Analyses of sensory organisation test results in a study of computerised dynamic posturography before and after long-duration bed rest indicate no differences between men and women. 23

Numerous epidemiological studies comparing the variations in hearing sensitivity between men and women have been undertaken. These research have confirmed that hearing sensitivity decreases with age, even in groups that have been screened for a history of noise exposure. 24–26 These studies have also demonstrated that men experience a faster reduction in hearing sensitivity than women do at most ages and in most of the frequencies examined (as measured by traditional pure-tone audiometry). 27 According to the most recent National Health and Nutrition Examination Survey²⁸, men were 5.5 times more likely than women to experience this type of hearing loss. However, hearing levels and longitudinal patterns of hearing change are highly varied, even in studies that carefully screen for ear illness and



noise exposures. This variation has been linked to cardiovascular risks, hereditary risk, and smoking. 29 Even among populations with relatively low-noise occupations and without any signs of noise-induced hearing loss, sex differences in age-associated hearing loss do occur. Hearing sensitivity is particularly vulnerable to hazardous noise exposures (e.g., in industrial, military, and recreational environments). 25 The status of peripheral hearing has also been evaluated using distortion product otoacoustic emissions (DPOAEs), in addition to pure-tone audiometry. Audiometry may miss small cochlear changes, which are thought to be shown by DPOAEs. 30,31 According to studies, aged men exhibit higher declines in DPOAE amplitudes than ageing women. The amount of hearing loss is frequently inversely correlated with this drop in DPOAEs. 31,32 Throughout their active astronaut careers, crew members are subjected to audiometric testing as part of a special hearing-monitoring programme run by NASA (and even more frequently when assigned to space missions). Former astronauts may have hearing tests for the rest of their life when taking part in NASA's LSAH programme. With the help of this database, it is possible to examine longitudinal variations in hearing sensitivity observed in male and female astronauts throughout a lifespan of up to five decades (Fig. 1). Starting in their mid-30s, roughly the age when most astronauts start their careers, women in the LSAH database have better hearing thresholds than men at every stage of life when comparing high-frequency hearing sensitivity. All female astronauts exhibit similar hearing thresholds in both ears, with the exception of those over 55 (albeit the sample size for this population is small). The left ear thresholds are marginally superior to the right ear thresholds at that age (which is relatively tiny). This finding is consistent with numerous demographic studies, especially those in which right-handed subjects have shot shoulder-fired weapons (exposing the left ear to the majority of the blast wave from the weapon's muzzle), as male astronauts exhibit greater hearing loss in the left ear than in the right ear at every age. Such guns are frequently used in the professional and recreational activities of many astronauts, both military and civilian. The fact that men and women do not appear to be affected differently by spaceflight, despite the fact that men and women exhibit the expected age-related disparities in hearing loss, is an important result from this database (unpublished data).

III. CONCLUSION

It is uncertain how gender and sex affect the neurophysiological alterations seen before, during, and after flight. When we talk about this, there are many questions that may and ought to be raised. For instance, does space travel amplify or minimise preexisting differences? Are all current defences equally successful for both genders? Is there an inherent advantage to either being a man or a woman in spaceflight, or are there risks connected with sex differences? We must establish suitable risk scenarios that may be approached as testable hypotheses in order to make spaceflight accessible to everyone with the lowest risk possible. The solutions to the questions of sex and gender differences will be crucial as we continue to explore the cosmos. More women should be sent into space, and more crew members—especially women—should be aggressively encouraged to take part in studies that are intended to answer critical concerns about sex and gender. We won't know if men and women react to growing longer-duration spaceflights in dramatically different ways until crew members and NASA management make a commitment to the research. Appropriate countermeasures for both sexes cannot be devised without the required data.

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