Astronaut mental health: A review

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## **Abstract**

As space administrations begin preparations for longer term space missions, addressing the potential mental health problems that can arise in astronauts will become mission critical components for future missions. Early American mental health analysis began during NASA’s Project Mercury, astronauts with certain preferred characteristics; both physiological and psychological, would be labeled as “the right stuff.” No longer are our missions confined to short term flights in **LEO** (low earth orbit), but rather ones in preparation for a trek to the red planet. This review attempts to address causes and problems associated with the mental health of astronauts, while concluding with monitoring and mitigation strategies and possible avenues of future research. Problems include: interpersonal disputes among astronauts, missing family, stress, loneliness, depression. These, among others, are problems already faced by astronauts on the **ISS** (International Space Station). Naturally there is an expectation that a future lunar or Mars mission would exacerbate these problems. It is vital that we provide our astronauts with mitigation methods such as: on staff psychologists, mixed **VR**/**VR**(virtual reality) architecture, adjusted exercise routines, special smells. These developments, while a good step forward, and a evidence of progress since the neonatal space psychology research of the Space Race era, it is clear that astronauts need more help before a mission to the red planet is appropriate.

### **Introduction**

Space exploration is very risky. Cosmic rays, micrometeorites, among other things, are constant dangers of human spaceflight. Nevertheless, just as relevant are the within vehicle dangers. Despite their extensive training and preparations, astronauts are still human and can fall victim to the dangers of mental health crises.

Interorganizational endeavors have presented both new opportunities and challenges to mission planners. No longer are space agencies building homogenous teams, but rather across the spectrum, different ethnic, educational, linguistic, national backgrounds. While this provides ample opportunity for joint learning and pride, cultural differences can quickly arise. Consider being an American astronaut on Mir immediately following the Soviet invasion of Afghanistan, flaring tensions could easily derail the mission, or worse bring the superpowers to a new zone of confrontation.

The invention of the semiconductor has brought a litany of new avenues of astronaut health monitoring. Previously, flight surgeons were limited to simple heart rate monitors, cumbersome ground-based machines, and surveys. Currently, mission control use miniature scanners, optical computer recognition technology (from cameras), and other technologies like speech recognition. The future of space monitoring looks to be in the field of advanced biosensors; in-flight data of mental health biomarkers could be vital in helping astronauts mentally survive the hardships of space.

Mitigation techniques encompass both psychological and physiological efforts. Online mental health software modules, modified lighting schemes, occupational therapy, and exercise have all been shown to boost moods in test subjects. As missions become longer and more dangerous, these techniques will need to be used in concert, providing astronauts a fighting chance in **ICE** (isolated, confined, extreme), environments.

The purpose of this literature review is to identify the causes, problems being faced, monitoring methods, and possible solutions to the mental health challenges that astronauts face, and will continue to face in the years ahead. In sifting through academic, government, and industry research this paper will be divided into the four sections labeled in the previous sentence, and attempt to pinpoint the contemporary research, historical context, and ideas for the future to come.

**CAUSES**

**Radiation:**

Space is one of the most extreme environments humans have ever ventured into. Radiation and galactic cosmic rays are two of the deadliest dangers astronauts face. Without radiation shielding, astronauts on a Mars mission of approximately 30 months are exposed to approximately 900 millisieverts of radiation1. This is far above the radiation level that NASA allows its astronauts to be subject to during a career. Dangers of overexposure include carcinogenesis, central nervous system damage, and degenerative tissue damage, 2,3.

**Microgravity:**

Other than a select few, humans spend their entire life in a 1g environment. Understanding the human body’s adaptation to microgravity is imperative to mission success. While there is some research showing that microgravity provides a facilitatory effect on perspective taking abilities 4, it more dangerously: impedes early T-cell activation, alters the organization of the cell cytoskeleton, causes changes in the neuroendocrine system, sleep disruption, and among others, stress 1.

**Non-standard light cycle**

Orbiting the earth so frequently the ISS is subject to non-24 light cycles. Without appropriate lighting mitigation, non 24 hour light cycles, cause disruption in human circadian rhythms which directly cause sleep deprivation, stress, and increases in workplace error 5.

**Heterogenous Crews:**

No longer are crews only men from one nationality. Men and Women from many different countries have participated in crewed spaceflight. Soviets, Americans, French, Israeli, Japanese, and many others have all come together on missions into outer space. However, astronauts are not made equally. American astronauts and Russian cosmonauts have very different upbringings. Russians value individualism much less than their American counterparts, while Americans are far more extroverted 6. While these differences may seen small at first, over the course of many months in close proximity these differences can blow up. For example, Russians have little concept of privacy, so much so that Russian does not have a word for it 7. In space, without understanding that Americans may simply want to be alone, could lead to sharp conflicts in the crew. In addition, these multicultural crews do not all speak English as a first language. While English has become a lingua franca, Americans must remember that slang and idioms are challenging to ESL speakers and need to be cognizant of the frustration it can place on their international counterparts who may not initially understand them 7.

Unfortunately, sexism still occurs in space 8. The paper referenced in the sentence previously has not documented a direct causality on why women still face gender and sex bias in space. However, it is important to note, each country has views on gender norms 6,9 and how people should adhere to them, and perhaps it is for this reason that astronauts come to conflict with each other during missions. While there are some noted sex wise differences between men and women astronauts, there is little evidence to show that including women in crews is cause for higher incidences of interpersonal problems amongst crew members 10,11.

**Isolation and Confinement**

Astronauts are locked in a small space, little areas for privacy, and have infrequent communication with people on Earth. Stress, territorial conflict, social monotony, can run rampant on the stations12. Similarly on earth in submarines or ice bases, common issues that develop are crowding, anger, social withdrawal, decreases in motivation and group cohesion 13.

**Inadequate Clothing**

Mental health and physical comfort are never reduced when the astronaut has the appropriate apparel14. For astronauts taking part in extra vehicular activities, there are serious dangers from not being appropriately protected. The need for temperature and pressure regulation, radiation shielding, and tethering to the vehicle is vital for astronaut survival. Badly designed ones can directly cause exhaustion and injury2.

**PROBLEMS:**

Astronauts can quickly begin to face mental health stress immediately upon entering space. Microgravity in addition to immune system disruption, can begin to cause sleep disruption and stress 1. Rats subjected to a simulated complex space environment (suspended tail, noise at 65 db, 1.5 hour light dark cycles, and confinement) for 21 days began presenting depression like behavior and increased oxidative stress levels15. These problems quickly compound upon themselves. Sleep deprivation can lead in increased risk of accidents 16, while high levels of work pressure among American crews 7 can push astronauts to their mental limits. In earth side analogous studies, subjects in Antarctica who had long term exposure to cold developed changes in thyroid function, show casing as fatigue, depression, and sluggishness 17. It would seem reasonable that this could translate into a spaceflight analog.

The stress inducing nature of spaceflight, whether it be from microgravity, work pressure, or other environmental stressors, immune systems are directly compromised. Continuing studies into space induced immunity reduction have shown reduction in T cell/NK function, elevated plasma cytokine profiles, as well as persistent inflammation 18. Reactivation of herpes virus in space is common. Minimal preflight shedding of the herpes viruses Cytomegalovirus (CMV) and Epstein Barr Virus (EMV) and no preflight shedding of Varicella Zoster Virus (VZV), all demonstrated a marked increase in shedding inflight 18.

Work pressure is high for American astronauts 7. Americans simply haven’t found a way to resolve their high levels through any means yet, even after ISS alternations to make it a more user-friendly environment.

Ironically, long instructions and long manuals can be detrimental to work performance. In highly motivated individuals such as astronauts, unnecessarily long instructions (especially for a simple task) can be considered tedious, leading to frustration and irritation19.

**MONITORING:**

Equally as important as identifying mental health stresses are developing means of monitoring them. Currently monitoring methods include: miniature scanners, optical computer recognition, speech recognition, surveys, and monitoring of biomarkers 20.

**Surveys:**

Surveys continue to be a key qualitative to quantitative measurement technique for monitoring of astronaut health. Profile of Mood States (POMS – short form), Visual Analog Scales (VAS), and Social Desirability Scale (SDS – 17) , continue to be useful in modern research 21. However, it should be strongly noted that these surveys are not all encompassing, these surveys are quantitative and do not take into account whether crew members are underreporting their distress, or if the surveys are appropriate for crew members of different backgrounds 21.

**MITIGATION TECHNIQUES**

**Exercise:**

Exercise is a practically universally agreed upon as a mitigation technique, anecdotally and evidence based. Anecdotally, astronauts commonly agree that exercise reduces stress and maintains moral 22. A post mission analysis project on recommendations from the Apollo missions documents the explicit need that “exercise is a must.” 12,23

**Change outlook:**

Spaceflight can be an incredibly meaningful experience for those who have the chance to venture. Looking out the windows at the earth is said to be life changing. Astronauts show increases in appreciation for earth’s beauty, greater appreciation for its beauty and fragility 24.

**Virtual Reality:**

Virtual reality (VR) provides means for engaging astronauts in new fashions. In the same fashion that games provide new simulated environments for gamers, astronauts could be transported similarly to new environments. Even a short exposure could reduce stress 13. Mixed virtual reality can be an improvement on traditional VR. By adding special smells to the environment, astronauts can achieve a deeper level of immersion while simultaneously reducing stress levels. In mice with a 28 day hind limb unloading, limonene dispersion for the mice showed relief effects in their memory, learning ability, and physical health declines 25. These immersive, and eventually personalized VR environments could eventually become both new methods for crew training, mental health stimulation, and a new tool for psychological health 26.

**Specialized Architecture:**

Put bluntly, design architecture that is more amenable for astronauts. Habitats should: have enough volume for comfort and efficiency, enough room for storage, be easy to repair, be simple 27. Lighting can be another knob to play with. Cooler light seems to correspond with making future errors and perform multiple tasks at the same time 28. Some recommendations include: having non-living areas be at temperatures of 18 degrees Celsius and muffling of noises to below 50-55 decibels; living areas should be at approximately 20-22 degrees Celsius with muffling of noises to below 35-40 decibels 29. Additionally, have the astronauts be part of the pre flight design process, this way reasonable preferences can be built into the craft 9.

**Hypnotic Drugs**

Considering the high level of sleep depravation in astronauts, despite NASA regulations, use of hypnotic sleep drugs is pervasive 30. These drugs are heavily in use to try and reduce human error due to poor sleep and stress.

**Improved Nutrition:**

“Ideal food cannot ensure psychosocial comfort, while a grandma style pie can.” Space nutrition fulfills multiple roles. The first is clear, provide sufficient nutrients and calories for astronauts to complete their mission31. The second piece is to provide comfort, perhaps a shared bonding experience among the crew. Special dishes could be added to fight homesickness 2.

**Improved medical management Specialized therapists – pyschologists occupational therapy**

Astronauts could benefit from a reprioritization of skills taught or by the addition of an additional crew member to act as a designated medical officer (such as Dr. Leonard McCoy in Star Trek). Medical events are a serious threat to crew well being and survival. Having specialized crew members to deal with medical issues that arise in space could heavily prevent mental health distress arising from “events not going to plan” 32. Its for this reason there are strong recommendations to have astronauts trained in medical skills or have a doctor/surgeon as a crew member on board33.

**Software:**

Multiple software packages have been tested for use in long manned space missions. Packages like EARTH 34, WinSCAT 35, and an online version of the Cognitive test battery 36 have been shown to be useful monitors of study members and useful enough at providing psychological support software.

**Crew selection:**

Crews are no longer homogenous. Having astronauts with multiple capabilities and strengths lets a litany of different research happen during the same flight. However, in order to prevent crew member clashing, space agencies need to be prudent about who is selected with each mission. A test battery in development needs to identify knowledge, skills, abilities and other traits (KSAOs) 37. This will provide a quantitative survey of the abilities each crew has, prevent overlap, and create an international standard with which to compare astronauts.

**Additional Support**

Astronauts need to have a mental health professional on staff 38. Tension preflight and mid-mission can boil over through pinging or teasing; and can rip apart the cohesion that is necessary for a safe and successful mission. Additionally spouses could benefit from receiving personalized support, receiving similar care and guidance that military families are provided with who deal with separation and reunion38–40.

**Rewards**

**FUTURE RESEARCH:**

**Advanced biosensors:**

As semiconductors become smaller and smaller, tech companies have begun attempting to design labs on a chip. Consider the ability for chips to be able to measure different biomarkers. Abbot Labs has created the i-STAT, that measures pH, pp Carbon Dioxide, electrolytes, glucose, and hematocrit; while MIT is designing a biosuit to measure blood pressure, O2 level, and electrophysiology 41. These devices can be lower weight, volume, and power consuming ways for monitoring astronauts on missions, rather than bringing aboard larger equipment.

**Predicting events:**

Proactive measures could be key in preventing astronauts from ever reaching a dangerous mental event. By testing astronauts in different situations, space agencies can begin predicting probabilities for human mental (or physical) failures for the situations, thereby building mathematical models for an analogous situation in microgravity 42,43. Using some combination of surveys, biosensors, monitors, fuzzy logic; the end goal is to have a viable model that can predict when an astronaut will have a failure point and prevent the mental distress from ever occurring 8,44,45.

**Architecture design:**

New habitat architecture designs can be previewed in the Antarctic 27. There astronauts can decide for themselves over a long period study what types of architectures will work in space, and which will not.

**Brain Stimulation:**

Noninvasive brain stimulation could be a safe way to artificially stimulate positive therapy into affected astronauts. These electrical pulses could, administered in different ways, potentially help train motor learning and non-dominant hands 46. This could either help astronauts train more efficiently, recover after space flight, or mitigate an during-mission event from becoming worse.

**Rewards:**

A novel concept for a reward system is being considered to provide temporal rewards to astronauts who complete novel tasks. The concept is to provide a secret reward inside an egg or a matryoshka doll to be opened at the same time on earth. The hope is to create a sense of non-verbal connection and communication with loved ones on earth, providing some means of well-being to astronauts on long missions away from fast communication with family and friends on earth 47.

**Conclusion:**

This paper has been an attempt to try and conglomerate some of the modern astronaut mental health problems and some of their mitigation strategies. Some causes and general mental health problems astronauts face were presented. Mental health monitoring and mitigation strategies were discussed, especially in ways that future space agencies could use in an operational and human performance context. It is clear further mitigation strategy research is necessary, continuing to keep astronauts mentally healthy is vital for mission success, their safe return home, and the continued success of space agencies across the globe.

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| --- | --- | --- |
| Tea Use | Kruskal-Wallis | 0.9951 |
| Coffee Use | Kruskal-Wallis | 0.9915 |
| Other Stimulant Beverage Use | Kruskal-Wallis | 0.9841 |
| Crisis Length Expectancy | Kruskal-Wallis | 0.5887 |
| Trust In Authorities | ANOVA | 0.1640 |
| Compliance with Lockdown | Kruskal-Wallis | 0.9774 |
| Seriousness of COVID-19 Threat ;  SI-Adjusted | Kruskal-Wallis  Kruskal-Wallis | 0.8507  *<0.001* |

*Mood States & State Anxiety*

Analyzing the POMS categories for each of the mood states, the majority of the POMS did not change over time. Depression, Anger, Tension, Vigor and Fatigue did not see any overall change over time on an individual level. Running a Kruskal-Wallis test leads to none of the POMS having a significant change over time. However, the State Anxiety did see a decrease over week 0 to week 48 the final week of the survey. SI-adjusted Anxiety further showed decreases at week 42 over week 0.

*Loneliness*

Loneliness tended to decrease over time, with significantly lower states at weeks 48 when compared to week 1, but the SI-adjusted comparison revealed additional decreases at week 18 and 42 when compared to weeks 0 and 1.

*Physical Activity*

Other than time spent sitting, no physical exercise category changed over time. Time spent sitting showed a slight decrease over time. But otherwise, no other statistically significant results were found. All these tests were run using a Kruskal-Wallis after checking to see if the data was parametric. Time spent sitting had a null hypothesis of, “no change over time”, however a p-value of 0.0360, leads us to reject the null hypothesis, and claim that there is a difference in time spent sitting across time. All other p-values were larger than .98.

*Stimulant Use*

None of the stimulant use showed any change over time. Tobacco was not tested as a stimulant due to insufficient data- nearly all responses over the survey were “none”. All tests were run using a Kruskal-Wallis test after checking the data for parametricity. All p-values were larger than 0.98.

*Covid-19*

SI-adjusted comparison of the COVID-19 threat assessments showed diminished values at weeks 12, 18, and 48 when compared to week 0. Week 48 was also lower than weeks 1 and 30.

### Sex Differences

Respondents self-identified their preferred SEX as either “Male”, “Female”, or “Undecided/Prefer Not To Say” in the initial survey and this question was not repeated in subsequent surveys. Owing to the low sample size of the latter category (Median = 0), it could not be included in statistical analyses. Therefore, this dimension was analyzed in a binary fashion as either “Male” or “Female” only. Table 2 summarizes the results of sex comparisons across all time points, and Figure 3 displays any detected differences at each time point of the survey. However, 2-ways analyses of variance for SEX x TIME were not conducted for this paper, nor are they SI-adjusted.

Table 2 : Comparisons of central tendency by sex at all collected time points.

|  |  |  |
| --- | --- | --- |
| **Measure** | **Test Used** | **Result**  **(p-value)** |
| Loneliness | Wilcoxon Rank-Sum | 0.0996 |
| Sleep Quality | Wilcoxon Rank-Sum | *< 0.001* |
| Anxiety | Wilcoxon Rank-Sum | *< 0.001* |
| Tension | Wilcoxon Rank-Sum | *< 0.001* |
| Depression | Wilcoxon Rank-Sum | *0.0042* |
| Anger | Wilcoxon Rank-Sum | 0.2606 |
| Fatigue | Wilcoxon Rank-Sum | *< 0.001* |
| Vigor | Wilcoxon Rank-Sum | *< 0.001* |
| Sleep Quality | ANOVA | *< 0.001* |
| Vigorous Exercise Days | Wilcoxon Rank-Sum | *< 0.001* |
| Time/Day - Vigorous Exercise | Wilcoxon Rank-Sum | *0.0025* |
| Moderate Exercise Days | Wilcoxon Rank-Sum | 0.4699 |
| Time/Day - Moderate Exercise | Wilcoxon Rank-Sum | 0.9476 |
| Walking Days | Wilcoxon Rank-Sum | 1 |
| Time/Day - Walking | Wilcoxon Rank-Sum | 0.7928 |
| Time/Day - Sitting | Wilcoxon Rank-Sum | 0.7928 |
| Total Exercise | Two sample T-test | *0.0017*  *(means)*  *0.0021*  *(medians)* |
| Tobacco Use | Insufficient data to run tests | N/A |
| Beer Use | Wilcoxon Rank-Sum | 0.2739 |
| Wine Use | Wilcoxon Rank-Sum | 0.2599 |
| Liquor Use | Wilcoxon Rank-Sum | *0.0193* |
| Tea Use | Wilcoxon Rank-Sum | 0.6682 |
| Coffee Use | Wilcoxon Rank-Sum | *0.0031* |
| Other Stimulant Beverage Use | Wilcoxon Rank-Sum | *0.0445* |
| Crisis Length Expectancy | Wilcoxon Rank-Sum | *<0.001* |
| Seriousness of COVID-19 Threat | Wilcoxon Rank-Sum | *0.0027* |

*POMS Depression*

Using a Wilcoxon Rank sum test compared all the male variables to all the female variables, testing was based on the null hypothesis that males and females experienced the same levels of depression. With a p-value of 0.0042 rejected the null hypothesis and led to belief that there was a difference between male and female with females having larger levels of depression. As seen in Figure 3, panel a, males and females began with similar scores but quickly diverged and remained separated throughout.

*POMS Vigor*

Vigor comparison was done comparing columns of Male data to female data utilizing the Wilcoxon rank sum test, running this test with the null hypothesis that Male and female experienced the same amount of vigor. The low p-value led to a rejection of null hypothesis. The largest separation in sex as seen in figure 3, panel b, with a p-value much less than 0.001 means a likely a large difference in vigor experienced by each sex.

*POMS Tension*

Tension also had a high degree of difference between the males and females. This was tested with the Wilcoxon Rank-sum test to yield a p-value much less than 0.001. The null hypothesis tested was if each sex experienced the same level of Tension. With the low p-value calculated we rejected the null hypothesis in favor of the difference between male and female tension experienced as can be seen in figure 3, panel c, with females staying nearly always above males on all time points.

*POMS Fatigue*

Fatigue varied from one sex to the other as well upon testing. Using the Wilcoxon Rank sum test to compare both data sets. We reject the null hypothesis that both male and females experienced the same amount of fatigue. Looking at figure 3, panel d, we can see that females tend to have increased median fatigue compared to males over the time period.

*POMS Anger*

Analysis of Anger did not yield statistically significant results after not being able to reject the null hypothesis that both genders experienced the same anger due to p-value greater than 0.05.

*State Anxiety*

State Anxiety comparison led to the likelihood that females experienced higher levels of anxiety than the males, testing all females vs the males with the Wilcoxon rank sum test with the null hypothesis that males and females experienced the same levels of anxiety. With the p-value much less than 0.001 we reject the null hypothesis in favor of likelihood that there is a difference between sexes. Looking at figure 3, panel e, can see that females tended to be higher on nearly all data points.

*Physical Activity*

After checking the data for parametricity and testing with a Wilcoxon Rank Sum test, a null hypothesis where men and women exercised the same, a p-value of < 0.001 was returned. As seen in figure 3, panel i, we can see that men spent more days of the week engaging in vigorous physical exercise.

The time spent per day of vigorous exercise was tested under the null hypothesis that men and women spent equal amounts of time vigorously exercising. Returning a p-value of 0.0025 from a Wilcoxon Rank Sum, we reject the null hypothesis and take note that in figure 3, panel k, on days of vigorous exercise men spent more time vigorously exercising.

For a dataset of days spent moderately exercising, the data was tested for parametricity, and a null hypothesis stating men and women spent the same number of days moderately exercising. Using a statistical Wilcoxon Rank Sum test, we report a p-value of 0.4699 and fail to reject the null hypothesis.

The time spent per day of moderate exercise was tested under the null hypothesis that men and women spent equal amounts of time moderately exercising. Returning a p-value of 0.9476 from a Wilcoxon Rank Sum, we fail to reject the null hypothesis.

For a dataset of days spent walking, the data was tested for parametricity, a null hypothesis stating men and women spent the same number of days walking, and a statistical Wilcoxon Rank Sum test, we saw a p-value of 1 and failed to reject the null hypothesis.

The time spent per day of walking was tested under the null hypothesis that men and women spent equal amounts of time per day walking. Returning a p value of 0.7928 from a Wilcoxon Rank Sum, we fail to reject the null hypothesis.

The time spent per day sitting was tested under the null hypothesis that men and women spent equal amounts of time sitting. Returning a p value of 0.7928 from a Wilcoxon Rank Sum, we fail to reject the null hypothesis.

Total exercise was tested using a 2-sample t-test on both means and median data. A null hypothesis claimed that both men and women had an equal total exercise value. However, with returned p-values of 0.0017 for the mean data set and 0.0021 for the median data set, we can safely reject the null hypothesis. As seen in figure 3, panel j, we note that men scored higher on their total exercise value than women.

*Stimulant/Depressant Use*

As mentioned above, there was insufficient data to run tests as the median respondent did not report any tobacco use.

Number of glasses of beer drunk in the last 7 days was tested using a Wilcoxon Rank Sum test with the null hypothesis that men and women drank the same number of glasses of beer per day. A returned p-value was equal to 0.2739 so we fail to reject the null hypothesis.

Number of glasses of wine drunk in the last 7 days was tested using a Wilcoxon Rank Sum test with the null hypothesis that men and women drank the same number of glasses of wine per day. A returned p-value was equal to 0.2599 so we fail to reject the null hypothesis.

Number of glasses of liquor drunk in the last 7 days was tested using a Wilcoxon Rank Sum test with the null hypothesis that men and women drank the same number of glasses of liquor per day. A returned p-value was equal to 0.0193 so we reject the null hypothesis. As seen in figure 3, panel n, we note that women are having more glasses of liquor than men.

Number of cups of tea drunk in the last 7 days was tested using a Wilcoxon Rank Sum test with the null hypothesis that men and women drank the same number of cups of tea per day. A returned p-value was equal to 0.6682 so we fail to reject the null hypothesis.

Number of cups of coffee drunk in the last 7 days was tested using a Wilcoxon Rank Sum test with the null hypothesis that men and women drank the same number of cups of coffee per day. A returned p-value was equal to 0.0031 so we reject the null hypothesis. As noted in figure 3, panel m, we see that men drink more cups of coffee than women do.

Number of cans of other caffeinated drinks drunk in the last 7 days was tested using a Wilcoxon Rank Sum test with the null hypothesis that men and women drank the same number of cans of caffeinated drinks per day. A returned p-value was equal to 0.0445 so we reject the null hypothesis. Seen in figure 3, panel l, we note that women are drinking more cans of caffeinated drinks than men.

*COVID-19*

Many of the COVID related questions did not produce a statistically significant difference between males and females. The only question that produced parametric data was the one that inquired the extent to which they trusted authorities. A 2-tailed t-test was conducted between the means and medians which produced p values of 0.8483 and 0.3252 respectively thus the null hypothesis of no differences between sexes could not be rejected. For all other questions, a Wilcoxon Rank Test was conducted and resulted in p-values greater than 0.05 thus no difference could be concluded between females and men.

One difference between females and males was found in the expectancy of the length of the crisis and the perception of the seriousness of the coronavirus threat. As can be seen in figure 3, panel g, women were more likely to think the crisis would last long and perceived the coronavirus as a more serious threat.

*UCLA Loneliness*

Loneliness was tested both with means and median data. A null hypothesis claimed that both men and women felt lonely equally. The Wilcoxon Ranksum test returned p values of 0.1486 for the mean data set and 0.0996 for the median d