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Stubborn Stereotypes: Exploring the Gender Gap in Support for Space[☆]

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ABSTRACT

With the National Aeronautics and Space Administration (NASA) ramping up efforts to return the United States to the moon, they have made concerted efforts to appeal to women, including naming the effort after the twin sister of Apollo, Artemis. Survey data from the General Social Survey indicate a persistent gap between men and women in terms of support for greater spending on space exploration. This research undertakes an exploration of the dynamics of this gender gap and the underlying attitudinal influences. I find evidence that the attitudinal foundations of support for space spending differ between men and women. For women in particular, knowledge, as measured by a science knowledge index and the number of college science classes they have taken, predicts a significant increase in spending support whereas for men, implicit attitudes regarding science in general play a larger role. This suggests that different methods may be necessary to generate greater levels of support for space among women than among men.

"'At least from available information, she was apparently in what United States space officials have come to call 'the chimp mode.' Like a chimp, she was 'along for the ride' and likely lacked the required skill to maneuver her craft into docking position with another. An unnamed NASA spokesman had a more visceral reaction. The talk of putting an American woman into space 'makes me sick to my stomach." [1].

The flight of Soviet cosmonaut Valentina Tereshkova, the first woman in space, was generally derided by American officials and reactions such as those quoted in the previous paragraph were common. Historians and cultural commentators have long noted the absence of women and people of color from the early ranks of the American astronaut corps. To be sure, some NASA officials at the time, including William Randolph Lovelace, who conducted the physical tests of early astronaut candidates, believed female astronauts would be preferable to men; however, the overall assessment of NASA and society was that it was unnecessary. None other than John Glenn, testifying before a House subcommittee on the possibility of women astronauts, stated that "the men go off and fight the wars and fly the airplanes and come back and help design and build and test them. The fact that women are not in this field is a fact of our social order" [2]. It would not be until Sally Ride's launch on the Space Shuttle *Challenger* in 1983 when an American woman entered space.

To a significant extent, the exclusion of women from the early American space program was a reflection of mid-20th century social norms. However, over the past seventy years, the acceptability of women not just working outside of the home but in nontraditional fields including science and engineering has increased. Concerted efforts have been made, not just by NASA but by groups throughout society, to increase female engagement in science, technology, engineering, and math (STEM) and encourage women's participation in such career fields. Books such as *Hidden Figures* (and its associated movie) have highlighted the role that women, specifically women of color in this case, played in the early space race [3]. Even Lego released a building set featuring the "Women of NASA" with Nancy Grace Roman, Margaret Hamilton, Sally Ride, and Mae Jemison. On NASA's part, the recently reinvigorated push to return to the moon by 2024 has been named Project Artemis after the twin sister of Apollo [4]. The first all-female spacewalk outside the International Space Station occurred in October 2019 increasing public attention to the space program and the effect of gender differences in space. Acknowledging the need to reach out to women, NASA Administrator Jim Bridenstine has made a concerted effort to note that Artemis would land the first woman on the Moon.

☆ The views presented here are solely the author's and do not necessarily reflect the official policy or position of the United State government, Department of Defense, or any of its related agencies.

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Despite these efforts, large gender gaps continue to persist. One such area where a gender gap remains is in support for space exploration funding. The General Social Survey (GSS) has asked its respondents since the 1970s whether they believe spending on the space exploration program is too little, about right, or too much.[1] Fig. 1 shows the percentage of male and female respondents saying too little from 1973 to 2018. On average, 20.2% of men responded there is too little spending compared with an average of 8.87% of women. This difference is statistically significant: the resulting t-statistic equals −33.633 and is significant at the $p < 0.000$ level. While generally growing through the 1970s, the gender gap actually fell in the mid-1980s before peaking in 1988 with a gap of 19.7% points. The size of the gap fell once again during the 1990s, but it has been slowly building in the 2000s with a differential of 12.5% points in 2014 and 10.8 points in 2018. These findings are intriguing for several reasons. First, the gender gap in support for space exploration funding grew substantially throughout the 1980s. That gap has since shrunk, a positive and encouraging trend.[2] Although it is unclear whether the gender gap is growing, the fact remains that the gender gap remains stubbornly present, despite increases in female involvement in STEM which are discussed in the following paragraphs. This article asks why more women do not support more space exploration funding?

The article proceeds as follows: First, I briefly review previous findings on the role of gender in public opinion on space. Second, drawing on the findings of the broader STEM literature, I propose several hypotheses as to why there remains a gender gap in support of greater space exploration funding. Finally, I provide the results of a logistic regression examining some knowledge and attitudinal causes of female support for spending in space exploration finding that there do indeed appear different influences in attitude formulation on space between men and women.

1. Gender gap in space exploration

Issues of gender have continually occurred in the American space program. In the late 1950s and early 1960s, a group of women who have come to be known as the Mercury 13 lobbied Congress and NASA to include women in the astronaut corps (for a further history, see Weitekamp [5]). A variety of reasons were given as to why women were excluded: it would slow down a much needed program, women would not be able to cope with the stresses of space (despite some medical tests showing that women might better perform physically in space), and that space was a man's realm and not a woman's realm. When women were finally admitted into the astronaut corps in the late 1970s, the first female astronauts faced a host of integration issues including the need for women-only restrooms and locker rooms in training facilities, appropriate clothing, and the design of space suits for launch and use in space [6]. More broadly, Griffin [7] argues that space discourse in the US is “predicated on a heteronormative discourse of conquest, that reproduces the dominance of heterosexual masculinity(ies), and which hierarchically orders the construction of other (subordinate) gender identities”.

Given the nature of space exploration (high cost, low salience, sensitive to short-term funding changes), NASA has often paid attention to public support for its programs. Scholars in turn have sought to characterize support for a policy that is all too often, nonsalient [8,9]. In focusing specifically on opinion differences between men and women, Whitman Cobb [9] first highlighted gender differences in a 2011 analysis of GSS data but concluded at the time that the gap in support appeared to be narrowing. In a survey of college undergraduates that looked at the relationship between scientific literacy and support for space exploration, Cook et al. [10] found that attitudes on space exploration differed by gender only with men being more supportive. Importantly, their study sample, although divided based on major, had no differences in scientific literacy scores by gender. Finally, Nadeau [11], using GSS data, models support for greater space exploration funding premised on sociodemographics plus attitudes toward science. Nadeau [11] finds that in terms of demographics, “the odds of wanting to increase funding for space exploration are significantly higher for white, male Babyboomers with a higher socio-economic status, a fondness for organized science, and a post-secondary science education”. While these studies highlight the role that gender plays in determining support for space exploration, this research seeks to understand the potential underlying causes for such a difference.

2. Hypotheses

Scholars have long recognized a gender gap in STEM fields; unfortunately, despite some gains, the gap remains quite large today: just 35% of STEM bachelor's degrees are granted to women and women make up less than 22% of the STEM workforce [12]. In the mid-20th century, early quantitative studies found significant performance differences between girls and boys in terms of science and math [13]. Much of this difference was caused by cultural beliefs about the role of men and women with the idea that women did not need an advanced education because their role would be primarily in the home. As such, girls were often not provided with education in technical fields nor largely encouraged to pursue careers in what would come to be called STEM career paths.

The Soviet launch of Sputnik in 1957 caused many Americans to rethink the entire educational system under the belief that Soviet children were receiving a higher quality education than their American counterparts. Fear of a supposed space and missile gap contributed to a number of policy moves including the National Defense Education Act which, for the first time, provided federal funds for science and mathematics education, as well as K-12 education. While the focus was primarily still on male students, societal upheavals in the 1960s, including the women's movement,

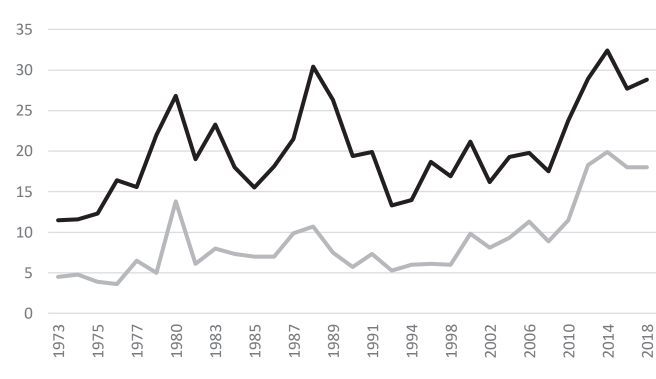

Fig. 1. Percent responding “too Little” spending on space exploration program, 1973–2018.

[1] Beginning in the 1980s, the GSS introduced an alternative version of this question with a subset of respondents that merely omits the word “program.” Although there are some differences in the size of the gender gap between these two questions, I do not use the alternative question format because the sample size is far smaller.

[2] Unfortunately, due to data limitations, this article is unable to explore the dynamics of these 1980s shifts.

began to break down barriers in terms of access to education for women.

The second half of the 20th century represented a period of significant change in the relationship between women and science in general. First, there were significant legal changes that opened up greater opportunities for women in the workplace in general. The 1964 Civil Rights Act prohibited discrimination in employment on the basis of sex, race, color, religion, and national origin; combined with the Equal Employment Opportunity Act of 1972, the legislation forced employers to confront discriminatory hiring practices. Rossiter [14] details the many ways in which these pieces of legislation would affect women scientists, writing that "it outlawed the rampant discriminatory behavior that riddled academia, government agencies, industry, and private clubs". This included NASA who realized that the legislation would particularly affect the recruitment of astronauts, who, at that time, were all men [6]. The growth of lobbying organizations on behalf of women in science and increased federal funding for women scientists sought to further eliminate the gender gap in STEM fields. Terzian [15], for example, details the experience of the magazine *Science World* that sought to encourage the science-oriented dreams of young female high schoolers beginning in the late 1950s. Changes at the university and college level opened up greater opportunities for women to take science courses to begin with. The formation of the Association for Women in Science and other like-minded groups further contributed to a greater interest in science on the part of women. This context is important as many of these changes directly impacted the experience of young women in and with STEM fields that can impact attitudes on science and space exploration in general.

Legal changes and the efforts of advocacy organizations appear to be paying off. While not yet at comparable levels, since the 1950s, general educational achievements for women have increased significantly with women earning 57.3% of all awarded bachelor's degrees in 2013 [16]. What is more, this trend appears to be accelerating; according to the National Center for Education Statistics, in 2008–2009, 143,018 women earned a STEM degree compared with 2015–2016 when 212,471 women did [17]. These figures are important because Rossiter [18] points out that "the single most important indicator or predictor of a woman's experience in science is the proportion, though changing over time, of women in her field or subfield". Female performance in math and science has risen and even reached parity with men, but there are still significant differences in terms of interest in STEM fields [13]. The National Girls Collaborative Project notes that even though women make up half of the total US college–educated workforce, only 29% of the science and engineering workforce are women [16]. There are also significant differences across science subfields: 35.2% of chemists, 11.1% of physicists and astronomers, 33.8% of environmental engineers, 22.7% of chemical engineers, 17.5% of civil, architectural, and sanitary engineers, 17.1% of industrial engineers, 10.7% of electrical or computer hardware engineers, and 7.9% of mechanical engineers are women [16]. Furthermore, women tend to leave STEM careers at far higher numbers than women in non-STEM professional roles [19].

Knowledge of and about particular activities has the potential to greatly impact support for them. Bak [20] finds that levels of education and education in science specifically can affect public attitudes on science. As it regards NASA, Steinberg [21] has shown that both men and women tend to overestimate NASA's budget; informing respondents about NASA's true budget "led to a 29% increase for support of increased NASA spending." Furthermore, he found that women are more likely than men to overestimate spending for NASA. Knowledge about science in general, then, might make individuals more supportive of spending for space exploration. And if women are not pursuing advanced education in STEM-related fields, their lack of information about science in general and space in particular may lead to the gender gap in support for space exploration funding. Given these findings, I propose the following hypothesis:

H1. To the extent that women may have lower levels of knowledge about science, their support for space exploration funding may also be lower.

Moving from knowledge about science, beliefs about the role of science may also be important in determining support for space exploration funding. From climate change to immunizations, there has been an increasing tendency to discount sound scientific findings for various reasons. At the same time, science-based policy issues rarely crack the top tier of what the public considers to be a major policy problem and, even when they are on the agenda, individuals may not know enough about them to come to any solid judgment. Ryan [22] argues that, in this case, implicit beliefs can be important predictors for voters who are indifferent. As this relates to the case under study here, individuals without an explicit attitude about space exploration spending may rather rely on implicit beliefs and attitudes about science in general or government spending in general. Because of differences in STEM education, women may have perceptibly different attitudes as it regards the scientific realm. This results in the following hypothesis:

H2. To the extent that women differ in their beliefs that science is productive or a positive contribution or that the government should be spending money on or supporting scientific endeavors, their support for more space exploration spending may also be lower.

Aside from the fact that women pursue STEM careers at a lower, albeit growing, level, there is also the question of why. Wang and Degol [23] summarize six possible explanations for the gender gap in STEM fields: "(a) cognitive ability, (b) relative cognitive strengths, (c) occupational interests or preferences, (d) lifestyle values or work-family balance preferences, (e) field-specific ability beliefs, and (f) gender-related stereotypes and biases". In their meta-analysis of global data, Janet S. Hyde and Janet E. Mertz find no evidence to support the notion that men have the capability of performing better in math than women suggesting little evidence for the cognitive or field-specific ability hypotheses [13]. However, achievement gaps begin to appear in some studies by the time students are in high school. This is important for future career paths as Wang [24] reports that one of the strongest factors influencing college major choice is achievement (or lack thereof) on math exams. Niederle and Vesterlund [25] argue that apparent differences in exam scores between men and women are not necessarily due to any actual skills gap. Instead, "competitive pressures associated with test taking may result in performances that do not reflect those of less-competitive settings …. Due to the way tests are administered and rewards are allocated in academic competition, there is reason to suspect that females are failing to realize their full potential or to have that potential recognized by society" [25]. While there may not be a gender gap in actual STEM ability, the gender gap in test taking may be causing women to doubt their academic potential and choose non-STEM career paths.

There is significant evidence supporting theories regarding the influence of gender stereotypes, lifestyle and work-life balance, and occupational preferences. For example, Baram-Tsabari and Yarden [26] show in their survey of 5000 K-12 students that, while there was no difference in interest between girls and boys during early childhood, by high school, there was a stereotypical divergent pattern of interest observed. Nosek et al. [27] find stereotypes regarding male dominance in science to be especially powerful internationally. Their study of 8th graders across 34 countries found that in those countries with stronger implicit male-science stereotypes, female achievement in STEM was lower [27]. These stereotypes are in turn further perpetuated in college classrooms, further discouraging women from STEM careers [28]. Nosek and Smyth [29] find evidence that implicit attitudes about female performance in math were stronger among women than men leading to higher rates of negativity regarding capability, demonstrating that the stereotypes need not be cognitively available and explicit for such views to have a harmful effect on female performance.

If negative stereotypes have led to women not pursuing careers in STEM-related fields, we might also expect that those same women will be less likely to support more space exploration funding. In this case, lack of knowledge about science acts as a sort of intervening variable with negative stereotypes being the direct cause of not pursuing science-related education. This leads to a second hypothesis:

H3. Individuals with strong traditional beliefs about the role of women will less likely pursue STEM-related careers, leading to less knowledge of science and to less support for space exploration spending. Thus, to the extent that women differ in traditional beliefs about the role of women, they are likely to have different levels of support for more space exploration funding than men.

3. Data and methods

3.1. Dependent variable

This research, similar to previous scholars, uses long-term data provided by the GSS, a representative survey of Americans that is now conducted every two years. Since the 1970s, the GSS has asked respondents whether they believe the US spends too much, too little, or about right on the space exploration program, thus providing one of the only long-term sources of public opinion data on space. The survey, which used to be administered on a yearly basis, has data for the following years: 1973, 1974, 1975, 1976, 1977, 1978, 1980, 1982, 1983, 1984, 1985, 1986, 1987, 1988, 1989, 1990, 1991, 1993, 1994, 1996, 1998, 2000, 2002, 2004, 2006, 2008, 2010, 2012, 2014, and 2016.

While the data for the dependent variable are available in the longer time period, data for all of the independent variables are not. As such, this analysis is limited to a pool of respondents from 2006, 2008, 2010, 2012, 2014, 2016, 2018 and therefore builds on Nadeau's which was limited to 2006 and 2008 and did not cover the 2010 Barack Obama space policy shift which Nadeau found to be a particular limitation [11]. Furthermore, the pool of respondents is necessarily smaller, and the findings are likely not generalizable over a longer period of time. On the other hand, we can have more confidence that the analysis is relevant to current gender dynamics and patterns which can give insights into future policy actions.

This variable (whether a respondent believes the US spends too much, too little, or about right on the space exploration program) is ordinal in nature, and an ordinal regression model could be used; however, I have chosen instead to recode the variable to focus on those respondents who believe that too little is spent on space exploration (coded 1 with the responses about right and too much coded 0), thereby allowing for the use of binary logistic regression. I have chosen this method over ordinal regression for several reasons. One, I am interested in why more women do not support more funding for space exploration; including the about right category in the binary recoding, while perhaps addressing the more general question of support, does not speak to this more specific research question. Two, binary logistic regression provides more readily interpretable results specifically through the odds ratio and it allows us to focus on the category of interest, those who believe there is too little spending on space. This is an important point: Believing that there is too little money spent on space exploration is distinct from supporting more funding. One can think that there is too little spent while not agreeing with the proposition that the government should be the one increasing the funding. However, given the difficulty of compiling long-term, reliable polling data (see [30]), it is assumed here that if an individual believes there is too little funding that they will likely be more supportive of space exploration. This assumption is also made in the studies by Whitman Cobb [9], Nadeau [11], and Steinberg [31]. Three, if multinomial logistic regression was used, there would be added interpretation issues because it reports coefficients for each value of the interval and categorical variables used as independent variables. Finally, because this question is looking at the reasons underpinning female support (or lack of it) for funding of space exploration, the analysis is performed for male and female respondents separately so that the model results can be compared across gender.

3.2. Independent variables

3.2.1. Scientific literacy

To test H1 regarding knowledge of science, I include a scientific literacy index in line with Nadeau's study. The index is based on 14 true/false and yes/no questions (Appendix A) where respondents are given 1 point for a correct answer and 0 for a wrong answer. Scores closer to 14 indicate higher scientific literacy, whereas scores closer to 0 are lower levels of scientific literacy. To maximize the number of cases available for the quantitative analysis, respondents are included if they answered at least one of the questions. I also include a separate variable that indicates how many science classes a respondent took at the college level. While Nadeau also includes in this a respondent's answer to whether they had a college-level science course at all, I have omitted it because it overlaps significantly with the number of college courses a respondent possibly had.

3.2.2. Science attitudes

To capture general attitudes regarding science, I recreated Nadeau's attitudinal index based on three questions: (1) whether the respondent agreed or disagreed with the statement "Because of science and technology, there will be more opportunities for the next generation"; (2) whether the respondent agreed or disagreed with the statement, "Science makes our way of life change too fast"; and (3) whether the respondent believed the "Benefits of scientific research have outweighed the harmful results." The resulting index is a 7-point scale with values closer to 0 indicating less trust in science and values closer to 7 indicating more trust in science.

3.2.3. Government spending on science

I include one question to measure a respondent's attitudes on government spending: whether a respondent strongly agrees (coded 4), agrees (coded 3), disagrees (coded 2), or strongly disagrees (coded 1) with the statement that science research is necessary and should be supported by the government.

Table 1
Logistic regression results, women (with traditional beliefs question).

Variable	B(SE)	Sig.	Exp(b)	Percentage change in odds
Constant	−3.486 (2.694)	0.196	–	–
Scientific literacy index	0.359 (0.126)	0.004	1.432	43.2
Scientific attitude index	0.172 (0.182)	0.346	1.187	18.7
Number of college science courses	0.045 (0.023)	0.051	1.046	4.6
Better for man to work, woman to tend to home	−0.008 (0.324)	0.979	0.992	−0.8
Scientific research should be supported by government	0.259 (0.359)	0.471	1.296	29.6
Generational cohort	−0.566 (0.292)	0.053	0.568	−43.2
Education	−0.563 (0.326)	0.084	0.569	−43.1
Socioeconomic index	−0.077 (0.243)	0.752	0.926	−7.4
Ideology	−0.255 (0.297)	0.389	0.775	−22.5
Race	−0.551 (0.597)	0.356	0.576	−42.4

Chi-square = 32.071 ($p = 0.000$). Cox-Snell $R^2 = 0.066$. Nagerlkerke $R^2 = 0.190$. N = 469.

3.2.4. Traditional beliefs

The GSS has not asked respondents about science-related stereotypes. Instead, I include whether respondents strongly agree (coded 1), agree (coded 2), don't know (coded 3), disagree (coded 4), or strongly disagree (coded 5) with the statement, “It is much better for everyone involved if the man is the achiever outside the home and the woman takes care of the home and family.” Unfortunately, this question has only been asked of a subset of respondents; including it as a variable reduces the number of cases for analysis by a substantial amount (from 668 for men without the question to 412 with it and from 775 for women without the question to 469). However, because it is the only question that the GSS offers that touches on H3, I report two analyses in the following paragraphs, one including this question and one that does not.

3.2.5. Demographic controls

In addition to the number of science courses noted earlier, I also include several demographic variables as controls following with previous studies. Age is measured via generational cohorts: 1883–1924 (coded 1); 1925–1945 (coded 2); 1946–1964 (coded 3); 1965–1986 (coded 4); and 1986–1998 (coded 5). Adding this variable should also capture any potential lags as a result of changes in society, the curriculum, or stereotypes over time; if these factors have indeed changed, we would expect that younger generations would be more supportive of increased spending. The GSS provides a measure of education that provides the number of years of schooling completed. I have collapsed these to four categories: less than a high school degree, high school degree, less than four years of college, and four or more years of college. Socioeconomic status is also included and is based on the GSS's socioeconomic (SES) index, an interval-level variable, which is then broken down into four equal quartiles: low SES, medium SES, medium-high SES, and high SES. Political ideology is measured collapsing the GSS's 0–7 scale to liberal (coded 1), independent (coded 2), and conservative (coded 3). Finally, I include race with white coded 1 and black coded 2.

4. Analysis

Tables 1 and 2 present the binary logistic regression results for women only; Table 1 presents the model with the question on traditional women's roles included and the model of Table 2 excludes this variable. In the first model, one variable reaches clear statistical significance (scientific literacy) while several others (number of college science courses, generational cohort, and education) hover around the 0.05 mark. As a respondent's score on the scientific literacy index increases by one, the chances of them responding there is too little spending for the space exploration program increases by 43.2%. This aligns well with the number of college science courses; for every additional college science class, the chance of responding there is too little spending increases by 4.6%. Where this does not align is in terms of education generally. This model predicts that a respondent's chance of saying there is too little spending decreases by 43.1% with each additional category of schooling. Given that women have typically been underrepresented in STEM majors, this could indicate a significant difference between women with and without STEM classwork or degrees. The finding in terms of generation also suggests that the chances of responding there is too little spending drop as a respondent gets younger. However, given that neither generation nor education in general is significant in the second model could be indicative that this is an artifact of a smaller sample.

Table 2, which leaves out the traditional values variable, supports the finding that science literacy and classes increases a woman's chances of responding there is too little spending. For every additional point on the knowledge index, the chances of a woman responding that there is too little spending increases by 14.6% and for every additional science class, the chance increases by 4.4%. It is important to note, however, that despite removing the traditional values variable and thereby increasing the sample size, the model in Table 2 performs worse overall than Table 1, suggesting that there may be some interaction happening with more traditional attitudes regarding the place of women in society.[3]

Tables 3 and 4 show the same model results for men. In the first model including the traditional beliefs question, the only variable that attains statistical significance is the belief that scientific research should be supported by government. As with women, as men more strongly agree with the premise, they are 89.9% more likely to respond there is too little funding for the space exploration program. This finding is also confirmed in the second model. However, Table 4 presents some contradictory findings. While the men that believe scientific research should be supported by government are more likely to respond there is too little funding, the second model indicates that for each additional point on the scientific attitude scale (which increases as attitudes become more positive), men are 17.6% less likely to respond that there is too little space exploration funding. The p-value for this finding, though, is slightly more than the statistical threshold. One final variable also approaches significance in Table 4, scientific literacy, which suggests that, as men score higher on the index, they are 12.7% more likely to believe there is too little funding for the space exploration program. Unlike in Tables 1 and 2, the model performs better for men when the traditional values variable is left out.

[3] I tested two potential interaction terms, traditional values and the number of science courses and traditional values and taking any college science course. These variables were insignificant likely owing to the low N of the traditional values variable.

Table 2
Logistic regression results, women (without traditional beliefs question).

Variable	B(SE)	Sig.	Exp(b)	Percentage change in odds
Constant	−3.681 (1.682)	0.029	–	–
Scientific literacy index	0.137 (0.077)	0.075	1.146	14.6
Scientific attitude index	0.030 (0.134)	0.824	1.030	3
Number of college science courses	0.043 (0.019)	0.020	1.044	4.4
Scientific research should be supported by government	0.432 (0.254)	0.089	1.540	54
Generational cohort	−0.264 (0.204)	0.196	0.768	−23.2
Education	−0.198 (0.259)	0.445	0.820	−18
Socioeconomic index	0.029 (0.176)	0.869	1.029	2.9
Ideology	−0.032 (0.185)	0.863	0.968	−3.2
Race	−0.586 (0.401)	0.144	0.557	−44.3

Chi-square = 24.947 ($p = 0.003$). Cox-Snell $R^2 = 0.032$. Nagerlkerke $R^2 = 0.084$. N = 775.

Table 3
Logistic regression results, men (with traditional beliefs question).

Variable	B(SE)	Sig.	Exp(b)	Percentage change in odds
Constant	−2.569 (1.799)	0.153	–	–
Scientific literacy index	0.053 (0.079)	0.502	1.055	5.5
Scientific attitude index	−0.155 (0.130)	0.234	0.857	−14.3
Number of college science courses	0.019 (0.013)	0.159	1.019	1.9
Better for man to work, woman to tend to home	−0.207 (0.210)	0.324	0.813	−18.7
Scientific research should be supported by government	0.641 (0.283)	0.023	1.899	89.9
Generational cohort	−0.001 (0.208)	0.996	0.999	−0.1
Education	−0.059 (0.270)	0.826	0.943	−5.7
Socioeconomic index	0.119 (0.180)	0.508	1.126	12.6
Ideology	−0.298 (0.192)	0.120	0.742	−25.8
Race	−0.480 (0.359)	0.182	0.619	−38.1

Chi-square = 18.490 ($p = 0.047$). Cox-Snell $R^2 = 0.044$. Nagerlkerke $R^2 = 0.084$. N = 412.

Table 4
Logistic regression results, men (without traditional beliefs question).

Variable	B(SE)	Sig.	Exp(b)	Percentage change in odds
Constant	−3.456 (1.333)	0.010	–	–
Scientific literacy index	0.120 (0.062)	0.055	1.127	12.7
Scientific attitude index	−0.171 (0.100)	0.086	0.824	−17.6
Number of college science courses	0.005 (0.011)	0.630	1.005	0.5
Scientific research should be supported by government	0.434 (0.209)	0.038	1.544	54.4
Generational cohort	0.059 (0.161)	0.714	1.061	6.1
Education	0.075 (0.213)	0.723	1.078	7.8
Socioeconomic index	−0.014 (0.132)	0.915	0.986	−1.4
Ideology	−0.157 (0.139)	0.257	0.854	−15
Race	−0.497 (0.266)	0.062	0.609	−39.1

Chi-square = 21.671 ($p = 0.010$). Cox-Snell $R^2 = 0.032$. Nagerlkerke $R^2 = 0.060$. N = 668.

To turn to the three main hypotheses, hypothesis 1 proposes that, to the extent that men and women differ in terms of science knowledge, their tendency to support more funding may also differ. There is indeed a statistically significant difference in both the number of college science classes and scientific literacy for men and women—women in this sample had fewer college science classes (a mean of 5.47 compared with 7.66 for men) and lower scores on the scientific literacy index (the mean for women is 4.1 and for men, 4.4). In the two models for women respondents, both scientific literacy and the number of college science courses either attain statistical significance or near it; increasing levels of both increase the chances that women will respond there is too little space exploration program spending by as much as 43.2% (Table 1). For men, scientific literacy approaches significance in only one of the two models and reports a more moderately sized exp(b). Given the difference between men and women in both of these variables, it appears that college science courses have a more significant impact on female support for more space exploration funding than those courses have for men lending significant weight to hypothesis 1.

Hypothesis 2 tests the role of implicit attitudes such as the role of science and whether the government should be supporting scientific research. Two variables were included to assess this, the scientific attitude index and the question of whether scientific research should be supported by government. Men and women did not differ significantly in the attitude index though there is a significant difference in government support for science. For women, only one of these variables approaches statistical significance in one of the models: that scientific research should be supported by government in Table 2. Despite its p-value of 0.089, it suggests that, as women agree more strongly with the premise, they become 54% more likely to respond that there is too little spending on the space exploration program. For men, implicit attitudes have a much stronger impact on the likelihood of a too little spending response. In Table 4, both of these variables are significant though in opposite directions; the same opposing pattern is also in Table 3, although only the belief that government should support science research is significant. More research is clearly needed to tease out this relationship for men, but these findings are indicative that implicit attitudes play a larger role in men's beliefs regarding space spending as compared with women. When taken with the evidence for hypothesis 1, this lends more weight to the idea that men and women have different bases of support for their attitudes about space spending. In other words, women tend to rely more on knowledge bases and men on attitudinal ones.

Finally, hypothesis 3 proposes that more traditional views on the role of women will lead to a decreased likelihood of support for more space spending. For both men and women, the result is negative and not statistically significant. Furthermore, there was no significant difference in the responses of men and women to the question to begin with.

5. Conclusions

It has been clear for some time that there is indeed a difference in support for space exploration between men and women. While Whitman Cobb [9] noted a descriptive difference in the data and Nadeau [11] modeled the likelihood of men and women to support space exploration, this study takes the finding one step further by trying to understand the causes of such a difference. Several hypotheses were considered including differences in scientific literacy and knowledge, implicit attitudes about science and government, and more traditional views on the role of women. While Cook, Druger, and Ploutz-Snyder [10] did not find scientific literacy to be a significant influence on women's support for space exploration, these data show that scientific knowledge, gained from college science courses, is important.[4] The findings regarding the role of implicit attitudes are also suggestive that men and women place different emphasis on beliefs versus fact with knowledge playing a bigger role in women's support and attitudes a bigger role in men's support. Finally, traditional views of women did not have an impact on support for space exploration.

Admittedly, the conclusions that can be drawn from these data are thin and suffer from several limitations. There are a number of factors which are likely omitted here because of a lack of data available through the GSS. This research is indeed an exploration and not an explanation, but it is also a starting point in trying to better understand why more women do not support more funding for space exploration. These findings indicate that for women, scientific knowledge is a bigger influence on beliefs about spending for the space exploration program, whereas for men, implicit attitudes play a larger role. As the number of women graduating with STEM degrees continues to increase, we might expect that the number of women taking college science courses will also increase leading to a reduction of the gender gap. Given that this increase has only happened over the past decade, this pattern may simply not yet be reflected in the GSS data as they only conduct their survey every two years.

Future research is clearly called for to further address this question. Because of its perennial status as a minor policy issue (excepting rare circumstances in which there is a massive failure or national security threat), regular polling on space-related issues is scarce. While a long-term panel study would be ideal to tease out the relationships between early childhood learning, the influence of stereotypes, the impact of advanced education, and attitudes about space exploration, researchers might also take advantage of newer services such as those provided by Amazon's Mechanical Turk to create experimental studies to explore the dynamics of support for space exploration. Surveys of school-aged children might also be used to understand if the gender gap in support for space exploration is similar in younger people and, if so, when in life attitudes begin to shift.

Public opinion, particularly when it involves deeply ingrained notions of identity and social standing, is not something that is changed quickly or easily. From that perspective, the findings here do not speak so much to whether NASA is or has been successful in stimulating female support as to barriers to their doing so. In the future, NASA, and other scientific organizations, should focus time and attention on younger audiences to further erode potentially harmful stereotypes regarding women in STEM. For example, despite proposals from the Trump administration to defund NASA's office of education, such a unit may be particularly impactful in reaching young women and men in an effort to increase science and space engagement. In a study of women in computer science, Legesen [32] finds that increasing the number of women in the field, creating a critical mass, was the most important strategy in rectifying the gender gap. This would also be a strategy for NASA to pursue to ameliorate the gender gap in space. For older populations, further education in science in general, what NASA does, and its importance may be helpful if information and knowledge is a bigger influence on women's attitudes as these early data show. In addition to symbolic moves such as the naming of Project Artemis and the enhanced rhetorical emphasis on the first woman on the moon, adult education may go an even longer way to generating more support and enthusiasm among American women.

Author statement

The author has conceived, researched, written, and compiled this article on his/her with no other coauthors.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A

GSS Questions Used to Create Scientific Literacy Index.

1. First, the center of the Earth is very hot. (true or false?)
2. All radioactivity is man-made. (true or false?)
3. Lasers work by focusing sound waves. (true or false?)
4. Electrons are smaller than atoms. (true or false?)
5. The universe began with a huge explosion. (true or false?)
6. The continents on which we live have been moving their locations for millions of years and will continue to move in the future. (true or false?)
7. Now, does the Earth go around the Sun, or does the Sun go around the Earth?
8. How long does it take for the Earth to go around the Sun: one day, one month, or one year?
9. It is the father's gene that decides whether the baby is a boy or a girl. (true or false?)
10. Antibiotics kill viruses as well as bacteria. (true or false?)
11. Human beings, as we know them today, developed from earlier species of animals. (true or false?)
12. A doctor tells a couple that their genetic makeup means that they've got one in four chances of having a child with an inherited illness. Does this mean that if their first child has the illness, the next three will not have the illness?

[4] One of the potential causes of this discrepancy is that the Cook et al. [10] sample was drawn from college undergraduates (who may not have completed any or many of their science courses) and these data from a sample of the American population.

13. Does this mean that each of the couple's children will have the same risk of suffering from the illness?
14. Two scientists want to know if a certain drug is effective against high blood pressure and see how many of them experience lower blood pressure levels. The first scientist wants to give the drug to 1000 people with high blood pressure and see how many of them experience lower blood pressure levels. The second scientist wants to give the drug to 500 people with high blood pressure and not give the drug to another 500 people with high blood pressure, and see how many in both groups experience lower blood pressure levels. Which is the better way to test this drug?

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