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A PLACE AMONG THE STARS? THE INFLUENCE OF RELIGION AND CREATIONISM ON ATTITUDES TOWARDS SPACE EXPLORATION AND BELIEFS IN EXTRATERRESTRIAL LIFE

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THESIS

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ABSTRACT OF THESIS

A PLACE AMONG THE STARS? THE INFLUENCE OF RELIGION AND CREATIONISM ON ATTITUDES TOWARDS SPACE EXPLORATION AND BELIEFS IN EXTRATERRESTRIAL LIFE

Space exploration continues to expand humanity's understanding of the universe. And, while Americans have widely favorable attitudes towards efforts to explore outer space, certain religious beliefs appear to be associated with more negative attitudes towards space exploration and the search for extraterrestrial life. The current study explored the role of religion and creationism on attitudes towards space exploration and the search for extraterrestrial life. Priming techniques were used to test whether increasing the accessibility of religious and creationist concepts led to more negative attitudes towards space exploration and beliefs about extraterrestrial life. Participants (N = 230) encountered an explicit prime of religion, creationism, or a control prior to completing a word fragment task and measures of attitudes towards space exploration and beliefs about extraterrestrial life. The results of Bayesian estimation and hypothesis testing did not support the prediction. However, exploratory analyses indicated very strong evidence of atheists having more positive attitudes towards space exploration and beliefs about extraterrestrial life than theists. These findings suggest that while priming religion and creationism did not appear to influence reported attitudes, attitudes towards space exploration and the search for extraterrestrial life may differ based on belief in god.

KEYWORDS*:* Space Exploration, Extraterrestrial Life, Religion, Creationism, Attitudes Towards Science, Priming

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The Earth is the cradle of humanity, but mankind cannot stay in the cradle forever.
-Konstantin Tsiolkovsky, as cited in NASA, 2010

Chapter 1: Introduction

Space exploration has altered human history, perhaps best represented by the famous words, "That's one small step for [a] man, one giant leap for mankind" spoken as humans first stepped foot on the Moon (Wolchover, 2012). Estimates suggest 600 million people watched as the astronaut's words were transmitted live (Heller, 2015). This impressive feat quickly became one of biggest news stories of the 21st century, second only to news of atomic bombs being dropped in World War II (Associated Press, n.d.). NASA's efforts in exploring outer space have influenced the very geopolitical, economic, and cultural identity of the United States (Krige, 2013). Just as early astronomers challenged religious beliefs with evidence of the Earth revolving around the sun, the goals of space exploration may question certain religious explanations and beliefs about creation, the origins of life, and humanity's larger place in the cosmos.

Americans have largely positive attitudes towards the exploration of outer space (Gallup, 2009; Pew, 2015b). Yet, interest and support for space exploration is lowest among Evangelical Christians (Ambrosius, 2015) – a group that includes 25.4% of Americans (Pew, 2015a). Evangelicals are also the least likely to believe in the existence of extraterrestrial life (Ambrosius, 2015). Conflict between science and religion is not uncommon in the United States and often emerges with topics of evolution and the origin of the universe (Pew, 2015c; Kahan, 2015; 2016). Such scientific explanations may inherently conflict with religious beliefs, as each offers ultimate explanations of the universe (Preston & Epley, 2008). Since

space exploration represents the scientific exploration of the universe, it may threaten certain religious beliefs – particularly beliefs about creationism.

For many creationists, scientific ventures to understand the origins of the universe, human evolution, and search for life beyond Earth are believed to be secular ploys to disprove intelligent design (Strauss, 2015). If space exploration and the search for extraterrestrial life are perceived as conflicting with religious explanations of the universe, it may help explain why Evangelicals hold more negative attitudes towards these endeavors (Ambrosius, 2015). The current study examined the impact of religion and creationism on attitudes towards space exploration and beliefs in extraterrestrial life. Priming was used to test whether increasing the accessibility of religious and creationist concepts would negatively affect religious believers' reported attitudes towards space exploration and the search for extraterrestrial life.

Attitudes

Attitudes towards space exploration and extraterrestrial life do not develop in isolation. Rather, like all attitudes, they emerge from a complex and interacting system of affective, cognitive, and behavioral components (Zanna & Rempel, 1988). Exact definitions of what comprises an *attitude* vary in social psychology (Bohner & Dickel, 2011). However, they are widely conceptualized as evaluations of an object – including physical items, specific persons and groups, events, behaviors, and abstract objects such as ideas (see Albarracín, Wang, Li, & Noguchi, 2008; Bohner & Dickel, 2011; Fishbein & Ajzen, 1974). Differences in the definition of attitudes emerge as to whether attitudes are primarily stored as more stable evaluations within a person's memory (Fazio, 1986; 2007; Petty, Brinol, & DeMarree, 2007), constructed in real time (Conrey & Smith, 2007; Gawronski & Bodenhausen, 2007;

Schwarz & Bohner, 2001), or a combination of both (Eagly & Chaiken, 2007; Cunningham, Zelazo, Packer, & van Bavel, 2007).

Attitudes develop and exist both explicitly and implicitly. Explicit attitudes refer to those that are traditionally considered to arise from a conscious, deliberate, or controlled process (Olson & Kendrick, 2008), whereas implicit attitudes involve evaluations that develop through a less deliberate process that may lack awareness as well conscious control (Devos, 2008). This lack of awareness may also involve being unaware of the source, content, or impact of the attitude (see Gawronski, Hofmann, & Wilbur, 2006; Olson & Kendrick, 2008). The extent to which explicit and implicit attitudes converge is debated, with proposals that explicit and implicit attitudes both reflect one "true" attitude (Olson, Fazio, & Hermann, 2007) and or represent two distinct attitude systems (Wilson, Lindsey, & Schooler, 2000).

The formation of both explicit and implicit attitudes can take numerous paths involving a combination of affect, cognition, and behavior (see Olson & Kendrick, 2008). Thus, attitudes can be learned through socialization and influence from parents (Degner & Dalege, 2013; Francis, Penny, & Powell, 2016; Sinclair, Dunn, & Lowery, 2005), peers (Brechwald & Prinstein, 2011; Miklikowska, 2017; Poteat, 2007), media and advertising (Mulgrew, Stalley, & Tiggermann, 2017; Scharrer & Ramasubramanian, 2015; Slater, 2015), culture (Dunham, Baron, & Banaji, 2008; Hayes & Lee, 2006; Naumann, Benet-Martínez, & Espinoza, 2016), and direct experience with the attitude object (Fazio & Zanna, 1981). Implicit attitudes have also been suggested to arise from early life experiences, automatic affective responses, cultural biases, and pressure to hold consistent attitudes (Rudman, 2004).

Attitude formation involves numerous interacting processes and sources of influence. However, one straightforward way attitudes may become more positive is by simply encountering the attitude object more frequently. According to the mere exposure paradigm (Zajonc, 1968), attitudes may grow more positive as exposure to the attitude object increases. For example, frequently seeing the NASA logo may result in the formation of more positive attitudes towards NASA. Implicit attitudes have been argued to be more affective and may, therefore, be more readily influenced by mere exposure to attitude objects (Olson & Kendrick, 2008). Seeing the NASA logo every time someone plays their favorite video game could also influence the formation of their attitudes towards space exploration through the process of evaluative conditioning. Evaluative conditioning occurs when an attitude grows more positive towards a neutral attitude object upon it being repeatedly paired with an attitude object that is viewed either positively or negatively (de Houwer, Thomas, & Baeyens, 2001). Proposed explanations for evaluative conditioning include both associative (i.e., automatic or implicit) and propositional (i.e., conscious or explicit) processes (de Houwer, 2007).

The importance of an attitude, or the attitude's strength, can be considered in terms of how impactful (e.g., how much it affects thoughts and behaviors) and how durable it is (e.g. how stable and unaffected by challenge; Krosnick & Petty, 1995; see Bassili, 2008). The strength of an attitude corresponds with how easy it is to change. For example, extreme attitudes (i.e., very positive, very negative) are associated with assuming others share the attitude and are more resistant to persuasion (Bassili, 2008). The strength of an attitude is thought to correspond with its cognitive accessibility (e.g., how quickly it comes to mind), with stronger attitudes being more easily activated than weaker attitudes (see Bassili, 2008). Attitudes may also be ambivalent, including more positive and negative evaluations (e.g.,

wanting humans to colonize Mars but opposing NASA funding). Greater ambivalence is associated with attitudes having less impact and durability (Conner & Sparks, 2002).

Strongly held attitudes can lead to biased processing of information that favors information congruent with existing attitudes (Brannon, Tagler, & Eagly, 2007). This selective exposure in the way information is sought out (e.g., selecting news medium, where information is found) may also be influenced by motivational factors (defending existing attitudes, seeking accurate information; Hart et al., 2009). The more personally important an attitude is, the more likely the person is to acquire and recall related information (Holbrook, Brent, Krosnick, Visser, & Boninger, 2005). Social and interpersonal influencers also impact information processing, as perceived attitudes of an audience (real or imagined) may bias how information is accessed, accepted, and communicated (Echterhoff, Higgins, & Levine, 2009). For example, hearing about SpaceX launching a Telsa into space while with a friend who really likes space exploration may result in more having a more positive or shared attitude.

Research on attitude change has often highlighted dual-process models, such as the heuristic-systematic model (Chaiken, Liberman, & Eagly, 1989) and the elaboration likelihood model (Petty & Wegener, 1998). Both models propose that attitude change occurs through two pathways that are influenced by how much someone is motivated and able to process the presented information (see Bohner & Dickel, 2011). According to these models, when presented with a persuasive message, those who are motivated and able to process information will engage in a more active and effortful process of analysis and consideration of the information content. When such cases are met, attitude change may occur if the message or information is convincingly strong (Crano & Prislin, 2006). When motivation or ability are low, people tend to rely on less effortful and more automatic processes informed

by heuristics (e.g. mental shortcuts, intuitions) or peripheral cues (e.g., perceived expertise, attractiveness; Bohner & Dickel, 2011; Bohner, Erb, & Siebler, 2008). This dual-processing of information has important implications for attitudes, as those formed through more effortful systematic processes tend to be more resistant, stable, and influential (Azen & Cote, 2008).

Although little research has examined the formation of attitudes towards space exploration and beliefs about extraterrestrial life, understanding the broader nature of attitudes and the processes by which attitudes evolve is crucial to the understanding of all attitudes towards science. Since attitudes towards space exploration and the search for extraterrestrial life exists within a larger context of science attitudes, they may follow similar trends and attitude patterns. Thus, recent developments in the understanding of attitudes towards science may provide valuable insight into the potential factors influencing people's attitudes towards space exploration and the search for extraterrestrial life.

Science Attitudes

Attitudes towards space exploration are relatively unexplored in the social sciences. However, research investigating attitudes towards science has increased in recent years providing insight into the factors contributing to the acceptance and rejection of science (Rutjens, Heine, Sutton & van Herreveld, 2018). While most science topics do not elicit strong public reactions, research on evolution, climate change, vaccines, and genetically modified organisms have become increasingly controversial and stratified across religious and political lines (see Gifford, 2011; Häkkinen, & Akrami, 2014; Kahan, Jenkins-Smith, & Braman, 2011). These seeming "controversial" science topics have resulted in heated, and often politicized, public debate (Achenbach, 2015).

Distrust of science may be increasing in the United States (Pittinsky, 2015).

Explanations for distrust and denial of science often consider social and cognitive factors associated with science attitudes both generally and towards topics often subject to public controversy. For instance, scientific understanding can be muddled by cognitive constraints. This includes a general preference for explanation and testimony over empirical data (Shtulman, 2015). For instance, most adults are confident that electrons exist without being able to provide any scientific justification or firsthand knowledge of their existence (Shtulman, 2013). This reflects both an affinity towards information acquired from trusted sources (e.g., parents and teachers saying electrons exist) and inferred from perceived consensus (e.g., everyone thinks electrons exist; see Guerrero, Enesco, & Harris, 2010; Harris & Koenig, 2006; Shtulman, 2013; 2015).

Along with favoring testimony and explanations, cognitive constraints may include a reliance on intuitive and supernatural theories that are incompatible with scientific findings (Shtulman, 2015). The tendency to hold intuitive, yet incompatible theories can be seen in the ways many adults incorrectly explain natural phenomena (see Shtulman, 2015 for review). For example, many adults incorrectly express an intuitive explanation of changes in the Earth's seasons being a result how close it is in orbital distance to the sun (Lee, 2010). Incompatible theories also emerge in explanations implicating supernatural sources that may come more naturally than scientific explanations (Bloom, & Weisberg, 2007). For example, many people – especially in the United States – tend to favor spiritual explanations of death over physical ones (Watson-Jones, Busch, Harris, & Legare, 2016; Rosengren et al., 2014) as well as creationist theories over evolutionary explanations (Blancke, De Smedt, De Cruz, Boudry, & Braeckman, 2012; Lombrozo, Shtulman, & Weisberg, 2006; Miller, Scott, & Okamoto, 2006). Given cultural variations observed in these preferences, religious exposure and cultural learning are to likely influence the reliance on certain supernatural theories over

scientific theories.

In addition to the cognitive hurtles involved in scientific understanding, some science topics (e.g., evolution, climate change) may be perceived as threating to certain religious ideologies (Bloom & Weisberg, 2007; Gifford, 2011; Häkkinen & Akrami, 2014). Science can serve many purposes in human culture. For some, science may provide a sense of order and control (Rutjens, van Harreveld, van der Pligt, Kreemers, & Noordewier, 2013; Rutjens, van Harreveld, & van der Pligt, 2010), support for the belief in progress (Meijers & Rutjens, 2014; Fielding & Hornsey, 2016), and even offer a source of existential meaning (Farias, Newheiser, Kahane, & Toledo, 2013; Preston, 2011; Rutjens et al., 2018). Yet for others, these benefits may compete with deeply held religious beliefs and explanations about the origin and nature of the universe.

Over half of Americans (59%) believe that religion and science often conflict (Pew, 2015c). Perhaps the most prominent current conflict between science and religion is on the topic of evolution. In 2015, only 25% of US adults reported believing life evolved solely from natural processes, rather than as a result of a supernatural being (Pew, 2015c). In a study of college students in the Southern United States, religion played a far greater role in the endorsement of evolution than education (Rissler, Duncan, & Caruso, 2014). Further, the acceptance or endorsement of evolution is seemingly unrelated to having an actual understanding of basic evolutionary principles (Bishop & Anderson, 1990; Demastes, Settlage, & Good, 1995; Shtulman, 2006). Instead, questions regarding evolution serve as better measures of religious belief than scientific comprehension (Kahan, 2015; 2016). Still, others suggest such questions more specifically serve as measures of creationist beliefs (Roos, 2012).

Scientific explanations of the universe have been argued to present an automatic

threat to religious belief, as both may offer ultimate explanations, accounts that alone may function to explain and understand the universe (Preston & Epley, 2008). As both can be used as ultimate explanations, science and religion subsequently offer competing explanations for the universe. And, weakness in one explanation strengthens the automatic evaluation of the other. The negative association between science and religion, argued to be two inclusive systems of beliefs, may incite an automatic opposition between them (Preston & Epley, 2008). Thus, religious believers may automatically perceive certain scientific findings to threaten their beliefs.

Opposition between science and religion is often seen among creationists – who reject certain scientific explanations and instead believe that a supernatural God was solely responsible for the creation of the universe (National Academy of Sciences, 2008). Creationism correlates with belief in biblical literalism and political conservatism (Hill, 2014; Miller, Scott & Okamoto, 2006) and is commonly associated with Christianity in Western societies. While many Christians accept evolution and scientific explanations of the universe (National Academy of Sciences, 2008), evolution is considered an anathema to creationism (Deckman, 2002). Some creationists go so far as to argue "Satan himself is the originator of the concept of evolution" (Morris, 1975, p. 75 as cited in Berry, 2001). Many creationists consider the endorsement of evolution to be harmful to personal spirituality, feelings of life having a greater purpose (Brem, Ranney, & Schindel, 2003), and even society as a whole (Deckman, 2002). Advocates for the acceptance of evolution have also received an array of negative accusations from creationists ranging from cowardly, sadistic, psychotic, racist, to unqualified (Nieminen, Ryökäs, & Mustonen, 2015). Scott (1997) suggests that creationists' opposition to evolution may in part be due to the fear that children will no longer believe in God if they learn about evolution.

Perceiving scientific findings to be threatening may lead to motivated resistance to scientific theories. Reflecting the interacting systems of social, cognitive, and motivational factors associated with such science attitudes, motivated cognition suggests that individuals' values can cognitively bias their perceptions and interpretations of facts (Kahan, 2017). This Further, people are often motivated to accept or dismiss evidence based on whether it reflects the values and beliefs of their social or cultural group (Kahan, 2017; Lewandowsky & Oberauer, 2016). This biased processing of scientific information could have troubling implications for the support of scientific endeavors (e.g., opposition towards research on climate change, lack of support for funding NASA).

Attitudes towards Space Exploration

Given that outer space is commonly depicted in popular culture, attitudes about space and extraterrestrial life likely begin to develop early in life. Children can be introduced to space exploration through numerous sources including their parents, teachers, and by an array of media targeting children featuring astronauts, rocket ships, and outer space (e.g., books, videos, toys, clothing). Similarly, such media often includes depictions of extraterrestrial life, with friendly, whimsical, and often green aliens (some riding in UFOs). According to the mere exposure paradigm (Zajonc, 1968), attitudes towards space exploration may grow more positive as a result of encountering space related stimuli (e.g., media, information).

As children age, exposure to topics of space exploration may begin to occur more formally through science teachers, educators, and curriculum specifically covering earth and space science. In the 2012 - 2013 academic year, space science concepts were assessed at the secondary level in 47 U.S. States, many in both middle and high school (Center for Geoscience Education and Public Understanding, 2013). Exposure to space exploration and

the search for possible life in the universe can also occur through field trips and outside of formal school settings. An investigation into the impact of visiting the UK National Space Centre on school children's attitudes found a short term positive increase in attitudes towards space exploration and interest in being a scientist following visits (Jarvis & Pell, 2002; 2005).

In a study of children's knowledge of space exploration, British schoolchildren (ages 13 to 15) were asked to list their three favorite topics relating to space. Of the 240 children surveyed, the most common responses included: planets (47.5%), stars (38.3%), solar system (30.0%), aliens and UFOs (21.3%), blackholes (13.8%), and space travel (13.3%; Jones, Yeoman, Cockell, 2007). Children were also asked what would they like to discover if they were a space scientist. Most common discoveries included: A new planet (25%), Life on other planets (18.8%), A new universe/galaxy/star (11.7%), and Aliens (9.6%; Jones, Yeoman, Cockell, 2007). These findings provide insight into early attitudes about efforts to explore space. They also indicate that many children associate the notion of aliens and the search for life in the universe with space exploration.

In a survey of adult's childhood dream jobs, being an astronaut was the fifth most commonly reported dream job among males in the United States (LinkedIn, 2012). This suggests that attitudes towards space exploration are likely rather positive during childhood, perhaps more so among boys than girls. While research has yet to uncover specific influencers of attitudes towards space exploration and extraterrestrial life, they may follow similar trends as science attitudes and achievement more generally. Thus, several factors potentially relevant to promoting interest in space exploration in childhood include parental attitudes and support (Dewitt et al., 2011; Perera, 2014; Sun, Bradley, & Akers, 2012;

Szechter & Carey, 2009) gender (Diekman, Brown, Johnston, & Clark, 2010; Eccles, 2015), peer attitudes (Riegle-Crumb & Morton, 2017), and socioeconomic status (Sun et al., 2012).

While attitudes towards space exploration and extraterrestrial life begin to develop in childhood, they continue to evolve throughout adulthood. For most Americans, formal education relating to space science likely ends after secondary education. Still, topics relating to space exploration and the search for extraterrestrial life can be encountered both in popular culture and media (e.g., films, documentaries, science fiction) as well as news coverage (e.g., reporting on NASA, Space X). While exposure to space related media may increase positive attitudes, the perceived credibility of the source of information (see Johnson, Maio, & Smith-McLalle, 2005) may influence its impact on attitudes towards space and beliefs about extraterrestrial life.

Overall, attitudes are largely positive towards space activities. In 2015, 68% of Americans had favorable opinions of NASA (Pew, 2015b). However, people may hold ambivalent attitudes towards space exploration or beliefs about extraterrestrial life. For example, in 2009, 58% of Americans believed NASA was going a good or excellent job (Gallup, 2009). Yet, when asked directly about support for funding, only 14% of Americans supported an expansion of NASA funding (Gallup, 2009) – despite NASA funding being at its lowest percent of the federal budget since 1959 (NASA Transition Authorization Act, 2017). Still, it is unknown how strong and stable these attitudes may generally be. Space exploration and extraterrestrial life could also elicit a sense of apathy. Beyond exposure through news coverage and pop culture, space exploration may not be something people often consider or even care about.

Attitudes towards the importance and future of space exploration seem to vary across groups. Men tend to report more interest in space exploration than women (Cook,

Druger, & Ploutz-Syder, 2011; Entradas, Miller, & Peters, 2011; Nadeau, 2013). In addition to gender differences, younger generations appear less interested in space exploration than their older counterparts both in the U.S. (Ambrosius, 2015; Dittmar, 2006) and Europe (Jones, Yeoman, & Cockell, 2007; Ottavianelli & Good, 2002). In an analysis of the 2006 and 2008 U.S. General Social Survey, predictors of increasing funding of space exploration included being male, college-educated, a Baby Boomer, of higher socio-economic status, and trusting in organized science (Nadeau, 2013). Since attitudes towards in space exploration seem to differ across demographics, examination of religious belief may also reveal divergences in space attitudes.

Space Exploration and Religious Beliefs

People's attitudes towards space exploration and beliefs about extraterrestrial life may be influenced by their religious beliefs. For example, the online group *Christians Against Space Exploration* (CASE, n.d.) currently has over 4,800 members. CASE's described their opposition to space exploration the statement:

> We believe it is a huge waste of money that could be otherwise spent on more useful things such as spreading the word of Christ through the building of churches and various other ministries. Pursuing or encouraging the pursuit of interstellar discovery is an abomination. Those engaging or propagating these acts are directly or indirectly in league with Satan. (CASE, n.d.)

In their conclusion, CASE references a bible passage from Psalm 115:16 that reads, "the heavens, even the heavens, are the LORD's: but the earth has he given to the children of man" (American King James Version). While this group is not representative of all religious believers, it highlights how certain religious interpretations and beliefs could conflict with endeavors to explore outer space.

In many ways, space exploration and the search of extraterrestrial life seek to investigate some of the questions that, for some, religion may answer. For example, questions of how human life came to exist, whether humans are the only intelligent lifeforms, how the universe originated, and whether the Earth will continue to be a habitable planet for future generations. While little empirical research has examined the influence of religion on space attitudes, a study combining data from the Pew Research Center and the General Social Survey reported several key findings on the association between religious beliefs and attitudes towards space exploration and the search for extraterrestrial life (Ambrosius, 2015).

First, Evangelicals (i.e., born-again protestants) were found to be the least interested in space exploration, and the least supportive of funding for space exploration, and the least knowledgeable about space compared to both nonreligious participants and those of other religious traditions. In addition to Evangelicals being the least supportive of funding for space exploration, they were also significantly more likely to report disbelief in the possibility of discovering extraterrestrial life. This doubt in the existence of extraterrestrial life was suggested to be a potential driver of Evangelicals attitudes towards space exploration (Ambrosius, 2015).

Second, support for the funding of space exploration was highest among those of Eastern religious traditions and those with no religion affiliation. Additionally, Eastern traditions (e.g., Hinduism, Buddhism), Jews, and those of no religion had significantly more positive attitudes about the perceived benefits of space exploration. Third, attendance of worship services was significantly negatively correlated with space knowledge, support for the funding of space exploration, and belief that space exploration is beneficial to society. The saliency or importance of religion in a person's life was also significantly negatively

correlated with space knowledge and support of funding. Finally, the endorsement of evolution was also significantly positively correlated with knowledge, interest, funding support, and the perceived benefits of space exploration (Ambrosius, 2015).

Space exploration's connection with evolutionary explanations may function as a deterrent to religious believers and creationists. To some religious believers, the research and teaching of evolution are seen as attacking the belief in a creator and threatening the notion of human uniqueness (Scott, 2009). This hostility towards evolution is well summarized by the Discovery Institute, a conservative think tank, which argued "the Darwin Brigades have also been eager to undermine human exceptionalism. Why? The alleged ordinariness of the human race was vital in establishing common ancestry as a plausible theory" (Bethell, 2013, para 9). The exploration of space may prove that the Earth and human race are both quite ordinary in the sense of the larger universe – thus posing a threat to creationist explanations. Yet, it is unknown if, and to what extent, the public perceives space exploration as extending scientific theories on the origins of the universe. If this connection is commonly perceived, those with strongly held beliefs opposing evolutionary explanations may be less likely to support space exploration. However, rather than opposing space exploration, some believers may view such efforts as unnecessary given their belief in religious and creationist explanations of the universe.

Another element of space exploration that may challenge religious and creationist beliefs is efforts to colonize other planets. The number of planets discovered beyond our solar system has grown dramatically in recent years (Impey, 2013). In 2012, estimates suggest there are over 100 million terrestrial planets in the Milky Way around sun-like stars. Of those, millions could be both Earth-like and habitable (Cassan et al., 2012), positioned in what has been called a "Goldilocks zone" (NASA, 2003). NASA is currently working to send

humans beyond Earth's orbit for the first time since the Apollo Program with the goal of landing humans on Mars. Several private and commercial spaceflight companies have also gained public attention with their own plans to send humans Mars and beyond. In 2016, SpaceX announced their mission to colonize Mars, with a live stream that has now gathered over 1 million views (SpaceX, 2016).

The public seems optimistic for future colonization efforts. In a 2010 survey, 81% of Americans believed that by 2050 astronauts will have landed on Mars, 53% believed ordinary people will have traveled in space, and 50% believed evidence of life elsewhere in the universe will have been discovered (Pew, 2010). Further, one third of Americans expect that humans will have colonized planets other than Earth by 2054 (Pew, 2014). These endeavors are likely to draw the eye of the public, including those of religious believers and creationists. Since creationism is centered around the divine creation of the Earth and humanity's role is overseeing the planet, efforts to colonize other planets could be viewed as unnecessary – and even as a rejection of God's plan for humanity.

The search for extraterrestrial life. Space exploration and the search for extraterrestrial life are inherently intertwined. The possibility of life existing elsewhere in the universe has been a topic of longstanding scientific and popular speculation. Further, it is a question at the forefront of NASA's recent exploration of Mars and several upcoming missions (NASA, 2017a; NASA, 2017b). Many, including chief scientists at NASA, are confident this search will soon reveal evidence of life in the next 20 to 30 years (Mazza, 2015). The connection between space exploration and the search for life is also reflected in public attitudes. In a survey conducted in the United Kingdom, those who believed in the existence of life beyond Earth placed greater importance on their country being at the forefront of space exploration (Entradas et al., 2011). Disbelief in extraterrestrial life is also

associated with a stronger desire to decrease government funding for space exploration (Entradas et al., 2011).

The discovery of extraterrestrial life would likely be a monumental event in human history (Dick, 2013). The recent increase in the discovery of exoplanets seemingly capable of sustaining life provides has provided many with hope that life will soon be discovered to exist beyond Earth (Traphagan, 2016; Neal, 2014). However, several events throughout history support the substantial impact such a discovery could have on humans including the Moon Hoax of 1835 (Dick, 2013), the Lowellian canals of Mars (Dick, 1996), to the notable "The Wars of the Worlds" radio broadcast of 1938 (Cantril, 1940; Dick, 2013) that elicited dramatic public reactions – and in some case, widespread panic – to believed evidence of extraterrestrial life.

The discovery of extraterrestrial life could have a differentially large impact on religious believers (Dick, 2013; Peters, 2013). The more religious and anthropocentric a person is, the less likely they are to affirm the existence of extraterrestrial intelligence (Vakoch & Lee, 2000). Moreover, support for the search for extraterrestrials and funding for space exploration may be lowest among Evangelical Christians (Bainbridge, 1983). In a nationally representative sample, 54% of Americans believed extraterrestrial life exists, 24% did not, and 22% did not know (YouGov, 2015). Of the disbelievers, 65% reported that their reasoning for not believing in extraterrestrial life was due to believing that humans were created by God and 31% because they believed the Earth was unique and the only planet capable of supporting intelligent life (YouGov, 2015).

Evidence of life existing elsewhere in the universe could threaten certain religious and creationists beliefs about the uniqueness of humanity and the uniqueness of the Earth. Religious rejection of the existence of extraterrestrial life is demonstrated by the founder of

the Creation Museum who stated, "the search for extraterrestrial life is really driven by man's rebellion against God in a desperate attempt to supposedly prove evolution!" (Ham, 2014, para 2). Since creationism relies on the belief that humans alone were created uniquely in the image of God, creationists could seemingly be more likely to disbelieve or reject any possibilities of life existing beyond Earth.

Yet, belief in god or creationism hardly disqualifies interest in space exploration or the possible existence of extraterrestrial life. The International Space Station has housed astronauts of various religious faiths (Justo, 2007; Malik, 2011). Even Wernher von Braun, a leading architect of American spaceflight, believed science and religious belief to be complementary (Stuhlinger & Ordway, 1994). Moreover, some religious individuals may welcome the notion of encountering intelligent extraterrestrial life. In the large Peters ETI Religious Crisis Survey*,* religious believers widely disagreed that the confirmed discovery of extraterrestrial intelligent life would result in a crisis of their beliefs or religious tradition (Peters & Froehlig, 2008). Rather, non-religious respondents were the most likely to believe the discovery of extraterrestrial life would result in a crisis of world religions.

Overall, space exploration and the search for extraterrestrial life may conflict with certain religious beliefs and explanations about the universe. Moreover, this could be particularly true of creationists, whose beliefs may provoke stronger opposition to the goals of space exploration and the possible existence of extraterrestrial life. If religious beliefs elicit such opposition, believers may have more negative and unsupportive attitudes towards these scientific ventures. Given the lack of empirical research, the question remains as to whether religious and creationist beliefs negatively impact attitudes towards space exploration and belief about extraterrestrial life.

Study Overview

The current study tested the effect of priming concepts of religion and creationism on attitudes towards space exploration and the search for extraterrestrial life. Religious priming offers the opportunity to experimentally explore the influence of religion on various aspects of human life (Shariff, Willard, Andersen, & Norenzayan, 2015). Religious priming exposes participants to religiously themed stimuli to measure their impact on behavior, attitudes, and reported beliefs. Priming has been found to affect factors including prosociality (Shariff & Norenzayan, 2007), racial prejudice (Johnson, Rowatt, & LaBouff, 2010), negativity towards outgroups (Johnson, Rowatt, & LaBouff, 2012), death anxiety (Jackson et al., 2017), and neurophysiological error-related negativity associated with conflict detection (Good, Inzlicht, & Larson, 2015; Inzlicht & Tullett, 2010).

Although priming may allow for the examination of the effects of religion, its use is not without its fair share of criticism (see Cesario, 2014; Kahneman, 2012; van Elk et al., 2015; Wagenmakers, 2014). In a meta-analysis assessing the robustness of various religious priming across outcomes, it was reported that priming yields a moderate effect size (Hedges $g = 0.40$), with contextual and explicit primes producing larger effects than both subliminal and implicit primes (Shariff et al., 2015). Nevertheless, a reanalysis of the data seeking to correct for publication bias offered mixed support for the effect of religious priming (van Elk et al., 2015). Thus, a large scale registered replication was recommended to obtain more accurate estimates of the effect of religious priming (van Elk et al., 2015).

Given the nature of creationist beliefs, there is inherent overlap with religion. Thus, priming creationism subsequently primes religion. While it is possible that priming religion also activates cognitions about creationism, the relationship between priming religion and priming creationism was conceptualized as a one-way dependency – such that priming

creationism also primes religion, while priming religion does not inherently prime creationism. Rather, creationism is dependent upon religious belief, whereas religious belief is not dependent upon creationism.

This study sought to distinguish, as much as possible, between the impact of religion and creationism on space attitudes and beliefs about extraterrestrial life. In effort to differentiate religion and creationism, explicit priming was used to allow for more control of the priming content. While explicit methods may produce demand characters, they allow for the priming of more specific constructs than implicit and subliminal priming (Shariff et al., 2015). By using religious priming to encourage people to think about religion and creationism, this method allowed for the testing of a causal relationship between religion and creationism and attitudes towards space exploration and extraterrestrial life. Before examining the current study, the general analytic approach will be explained and preliminary findings will be discussed.

Chapter 2: General Analytic Approach

All data analyses were conducted using Bayesian estimation and Bayesian hypothesis testing. Bayesian analyses offer many benefits over null hypothesis significance testing (Wagenmakers et al., 2017a). Unlike frequentist statistics such as confidence intervals, Bayesian estimation is conditional only on what is known from the current data being modeled rather than about the model across an infinite number of hypothetical data sets (Wagenmakers et al., 2017a). Moreover, it allows for estimating the credibility of a parameter occurring within a specific interval and the probability of a particular value occurring compared to another (Wagenmakers, Morey, & Lee, 2016). It also gives researchers the ability to integrate existing knowledge through setting what is known as a prior distribution. Priors can be highly specialized based on previous estimates or assigned more uniform

distributions when uncertainty is high. In Bayesian estimation, the prior distribution and the likelihood (i.e., information generated by the data) are joined to create the posterior distribution. Priors selected to be minimally informative have little influence or biasing power, allowing the data to drive the on the resulting posterior distribution (Kruschke, Aguinis, & Joo, 2012). The resulting posterior distribution summarizes current knowledge about a parameter given the data collected (McElreath, 2016).

The posterior distribution is created by repeated sampling (such as Markov chain Monte Carlo methods, MCMC) from the data to form a representative sample allowing for the estimation of a distribution of credible parameter values (Kruschke, 2013; Wagenmakers et al., 2017a). The resulting posterior distribution can be assessed through visual inspection. Graphical depiction of posterior distribution illustrates the shape of the credible values. That is, the credibility of the parameters increases relative to the height of the distribution. Thus, the taller the peak of the distribution, the more credible the parameter estimates will be. The peak of the posterior distribution (the posterior mean) provides the most credible point estimate for the parameter. Along with this point estimate, Bayesian estimation allows for the calculation of highest posteriors density intervals (HPDIs) representing a range of the most credible or probable values (Kruschke, 2013; Wagenmakers et al., 2017a).

Bayesian credible intervals (or HPDIs) provide a distinct advantage to traditional frequentists approaches in their interpretability. Whereas classical confidence intervals speak to the probability of an interval containing the true population parameter over a vast number of replicated samples, Bayesian credible intervals provide a more intuitive interpretation. Because credible intervals are calculated based on the posterior distribution – detailing what is known about the data – they allow for statements of the probability the true value of the parameter is located within a certain interval (see Morey, Hoekstra, Rouder, Lee, &

Wagenmakers, 2016 for review). This is possible because Bayesian inference is dependent only upon what is known (i.e., observed) about the data and not on long-term test performance across hypothetical samples (Wagenmakers et al., 2017a).

In addition to the abovementioned benefits of Bayesian parameter estimation, Bayesian hypothesis testing through the use of Bayes factors offers several practical advantages. Unlike more traditional approaches to null hypothesis significance testing, Bayes factors provide information about the relative evidence for the null or alternative hypotheses given the data collected (Rouder, Speckman, Sun, Morley, & Iverson, 2009). This approach is valuable not only for examining the strength of evidence for the alternative hypothesis, but also for assessing the strength of evidence for the null hypothesis (Wagenmakers et al., 2017a). The stability of a resulting Bayes factor can be assessed through sequential analysis and robustness checks providing a visual representation of the "evidence flow" as the data was collected (Wagenmakers et al., 2017b, p. 9) as well as the convergence of the Bayes factors for the set prior in addition to wider priors (Schönbrodt, Wagenmakers, Zehetleitner, & Perugini, 2015). Finally, another advantage of the use of Bayes factors is their assessment of relative predictive evidence. This weighs the evidence for the null against evidence for the alternative hypotheses, rather than only evidence against the null (see Edwards, Lindman, & Savage, 1963; Wagenmakers et al., 2017a). Given these advantages, both the preliminary findings and results of the current study used a Bayesian approach in data analysis.

Chapter 3: Preliminary Findings

As an initial investigation of attitudes towards space exploration and their relationship with religious beliefs, undergraduate participants (N = 346) were recruited to complete an exploratory study in exchange for research credit. In this study, participants completed an online survey that included measures of religiosity, creationism, attitudes

towards space exploration, colonization of other planets, and the possibility of extraterrestrial life. All methods and materials were preregistered on Open Science Framework. Since no scales assessing attitudes towards space exploration had been developed, or at least published, items were adapted from Ambrosius (2015) and the Pew Research Center (2015b).

Creationism was measured using the Creationism and Evolutionary Theory Scale (Francis & Greer, 199). Religious variables including belief in god (from 0 -100), church attendance, and prayer frequency were assessed using one-item measures. While these measures of religious belief and behavior may address different aspects associated with religion, they all reflect a larger latent construct of religiosity. For descriptive and exploratory purposes, these variables were assessed individually rather than combined into one measure. Nevertheless, interpretation of these results should consider the potential psychometric similarities and overlap among these measures.

Correlations among measures of creationism, religiosity (i.e., belief in god(s), church attendance, and prayer frequency), political ideology, and items assessing attitudes towards space exploration and beliefs about extraterrestrial life can be seen in Table 1. Overall, Bayesian correlations indicated evidence that creationism, church attendance, and prayer were all negatively associated with how much participants believed space exploration should be a priority. However, belief in god did not appear to be associated with space attitudes. Beliefs relating to extraterrestrial life were negatively correlated with nearly every measure of religiosity. Political conservativism was also negatively associated with the belief that space exploration should be a priority as well as belief in the existence of extraterrestrial life.

To explore which factors uniquely affect attitudes towards space exploration and belief in extraterrestrial life, Bayesian linear regressions were conducted using JASP Version

0.8.6 (JASP Team, 2018). This approach tested all possible combinations of models to compare the predictive support for each variable, averaged across all models tested (see Rouder & Morey, 2013). This provides several key results including a Bayes factor indicating evidence for each model against all other models (BF_M), a Bayes factor indicating evidence for the alternative hypothesis against the null (i.e., the absence of an effect) for each model (BF_{10}), the amount of variance explained by the model (R^2), and a Bayes factor indicating evidence for the inclusion of each variable in all possible models ($BF_{Inclusion}$). All analyses were performed using a JZS prior (Jeffreys-Zellner-Siow; r = 0.354) reflecting a multivariate Cauchy distribution. This combines an inverse gamma distribution around the intercept that scales to the variability of the dependent measure and covariates with a Cauchy distribution that compares the effect of the covariates to the null model (see Rouder & Morey, 2013).

Table 1

Correlations between Creationism, Religion, and Attitudes towards Space Exploration and Beliefs in Extraterrestrial Life

	Creationism	Church	Prayer	God	Politics
Priority of					
Space exploration	-.22***	-.23***	-.16**	-.08	-.16**
Interplanetary colonization	-.11	-.21***	-.11*	.01	-.14
Search for ET life	-.23***	-.21**	-.13	-.12	-.11
Excitement about					
Humans visiting planets	-.15*	-.19**	-.10	-.08	-.09
Interplanetary colonization	-.11	-.20**	-.10	-.08	-.06
The discovery of ET life	-.29***	-.21**	-.23***	-.19*	-.14
Belief in					
The existence of ET life	-.41***	-.35***	-.32***	-.25***	-.24***

Note. $BF_{10} > 3$. **$BF_{10} > 30$. ***$BF_{10} > 100$. Creationism = creationist beliefs; Church = church attendance; Prayer = prayer frequency; God = belief in god (0 - 100); Politics = political ideology.

To assess the predictors of attitudes about the prioritization of space exploration, the following variables were included in a Bayesian linear regression: creationism, belief in god, prayer frequency, church attendance, and political ideology. A summary of the resulting 10 best models can be seen in Table 2. Results of the Bayesian linear regression indicates evidence for the effect of creationism (BF_{10} = 15.74; $BF_{\text{Inclusion}}$ = 9.92), belief in god (BF_{10} = 9.53; $BF_{\text{Inclusion}}$ = 4.97), church attendance (BF_{10} = 2.02; $BF_{\text{Inclusion}}$ = 1.92), and political ideology (BF_{10} = 1.15; $BF_{\text{Inclusion}}$ = 1.25) and a lack of effect of prayer frequency (BF_{10} = 0.27; $BF_{\text{Inclusion}}$ = 0.28).

Table 2

Bayesian Regression Model Comparison of the Prioritization of Space Exploration

	Model	BF_M	BF_{10}	R^2
M_1	Creationism + God + Politics + Church	8.63	12105.05	.102
M_2	Creationism + God + Church	7.24	10514.86	.091
M_3	Creationism + God + Politics	3.75	5999.97	.088
M_4	Creationism + God	3.55	5702.24	.078
M_5	Creationism + God + Politics + Church + Prayer	1.95	3287.68	.102
M_6	Creationism + God + Politics + Prayer	1.54	2622.88	.092
M_7	Creationism + God + Church + Prayer	1.51	2580.34	.092
M_8	Politics + Church	1.40	2403.70	.073
M_9	Creationism + God + Prayer	1.26	2167.73	.082
M_{10}	Creationism + Politics + Church	0.73	1270.57	.079

Note. Creationism = creationist beliefs; God = belief in god (0 - 100); Politics = political ideology; Church = church attendance; Prayer = prayer frequency.

Similar analyses were used to examine predictors of belief in the existence of extraterrestrial life and included the same six variables: creationism, belief in god, prayer frequency, church attendance, and political ideology on attitudes towards space exploration and belief in extraterrestrial life. A summary of the resulting 10 best models can be seen in

Table 3. Results of Bayesian linear regression indicate evidence for the effect of creationism (BF_{10} = 58,168.63; $BF_{\text{Inclusion}}$ = 3,012.69), church attendance (BF_{10} = 7.97; $BF_{\text{Inclusion}}$ = 5.94), and belief in god (BF_{10} = 5.90; $BF_{\text{Inclusion}}$ = 6.17), and a lack of effect of political ideology (BF_{10} = 0.38; $BF_{\text{Inclusion}}$ = 0.38) and prayer frequency (BF_{10} = 0.24; $BF_{\text{Inclusion}}$ = 0.27) on belief in extraterrestrial life.

Overall, these data provide some preliminary evidence of a negative relationship between religiosity and creationism and attitudes towards space exploration and beliefs in extraterrestrial life. To continue investigating the impact of religion and creationism, the current study expanded from this preliminary study in attempts experimentally manipulate attitudes towards space exploration and beliefs in extraterrestrial life through priming religion and creationism.

Table 3

Bayesian Regression Model Comparison of Belief in Extraterrestrial Life

	Model	BF_M	BF_{10}	R^2
M_1	Creationism + God + Church	23.56	2.33×10^{12}	.198
M_2	Creationism + God + Politics + Church	6.03	8.77×10^{11}	.202
M_3	Creationism + God + Church + Prayer	3.55	5.53×10^{11}	.200
M_4	Creationism + Church	2.45	3.94×10^{11}	.179
M_5	Creationism + God	1.78	2.92×10^{11}	.177
M_6	Creationism + God + Politics + Church + Prayer	1.42	2.35×10^{11}	.204
M_7	Creationism + God + Prayer	1.07	1.80×10^{11}	.185
M_8	Creationism + Politics + Church	0.78	1.33×10^{11}	.183
M_9	Creationism + God + Politics	0.59	9.98×10^{10}	.181
M_{10}	Creationism	0.53	9.09×10^{10}	.160

Note. Creationism = creationist beliefs; God = belief in god (0 - 100); Politics = political ideology; Church = church attendance; Prayer = prayer frequency.

Chapter 4: Methodology

I report how I determined my sample size, all data exclusions (if any), all manipulations, and all measures in the study (Simmons, Nelson, & Simonsohn, 2012). A link to a preregistration will be included with any publications that may result from this study. I will make de-identifiable data and code publicly available through Open Science Framework upon publication.

Participants

Following the sampling plan preregistered on the Open Science Framework, participants were recruited over a four-week period from the UK psychology subject pool. Participants included 231 undergraduates recruited in exchange for research credit. Data was excluded from one participant who did not complete the study due to a computer error, resulting in a final sample of $N = 230$. The sample was largely female (66.5%) with a mean age of 19.6 years ($SD = 1.95$). Most participants identified as Caucasian (70.9%), followed by Black or African American (10.0%), Asian (4.9%), Hispanic, Latino, or Spanish Origin (4.3%), as well as additional or multiple racial and ethnicity identities (9.6%). The most commonly reported religious affiliation was Christian (73.1%), no religion (8.7%), agnostic (6.5%), atheist (3.9%) and Muslim (3.0%). Similarly, most participants reported that they believed in a god or gods (82.2%). The mean reported strength of belief in god(s) was 75.6 out of 100 ($SD = 33.3$). Around half of participants reported attending religious services once per month or more (51.3%) and praying a few times per month or more (49.6%).

Procedure

Participants were greeted by a research assistant and seated in a small room in front of a computer where they completed the study. Upon informed consent, participants were randomly assigned into one of three conditions (creationism, religion, or control). In each

condition, participants were asked to read and respond to a passage of literature. In the creationism condition, participants read from Genesis 1 (New International Version). Participants in the religion condition also read a passage from Psalms 119. Participants in the control condition read a poem about sports (Candler, 2014), see Appendix for full materials. After reading the passage, participants wrote a response to the prompt for have a period of 5 minutes. Following this task, participants completed a word fragment completion task that served as a manipulation check and the Space Exploration Attitudes Scale and the Extraterrestrial Beliefs Scale. The manipulation check and completed scales were counterbalanced to control for order effects. Finally, participants completed basic demographics and several items assessing religiosity. Upon completion, participants were thanked for their time, debriefed, and offered a copy of the consent form.

Materials

Priming prompts. The wording of the primes was adapted from DeBono, Shariff, Poole, and Maraven (2016) and Inzlicht and Tullet (2010). The passages presented in each condition were similar in length and ranged from 780 to 834 words. In the creationism condition, participants were given the following instructions followed by a passage from Genesis 1:

> Please read the following passage from the Bible. We want you to really think about what this passage means to you and how it applies to your beliefs about creation. After you have read the passage, you will be asked to write a paragraph describing what creationism means and explains in your life.

In the religion condition, participants were given the following instructions followed by a passage from Psalms 119:

> Please read the following passage from the Bible. We want you to really think about

what this passage means to you and how it applies to your beliefs about God. After you have read the passage, you will be asked to write a paragraph describing what God means and explains in your life.

Finally, the control condition featured a poem about baseball (Candler, 2014) and used similar instructions:

> Please read the following passage from a poem. We want you to really think about what this passage means to you and how it applies to your views about sports. After you have read the passage, you will be asked to write a paragraph describing what sports mean and explain in your life.

Word fragment completion task. To assess the effects of priming on activating religious and creationist cognitions, a word fragment completion task was included (see Preston & Ritter, 2012; Zhong & Liljenquist, 2006). Participants were presented with 15 word fragments (e.g., p _ _ y; _ _ _ i g n) and asked to complete each as quickly as possible with the first word that came to mind. Fragments included five words with creationism targets (e.g., design, garden), five words with religious targets (e.g., pray, cross), and five neutral words that had no specific target. Word fragments were presented in random order.

If the religious priming was successful in increasing the accessibility of religious concepts, participants should complete more of the religion related word fragments. Participants in the creationism condition were expected to complete more of the creationism target word fragments. The creationism prime was predicted to also increase the completion of the religion target words, given the overlap between creationism and religion.

Space Exploration Attitudes Scale. The Space Exploration Attitudes Scale (SEAS; Schiavone, unpublished raw data) is a 30-item scale developed to measure attitudes towards the exploration of outer space. This scale includes two factors. The first includes 17-items

assessing attitudes regarding the importance of space exploration. Example items include "Space exploration should be a priority for humans" and "The value of space exploration is worth its financial cost." The second factor includes 13-items and assess attitudes towards efforts to colonize other planets. Example items include "Humans should colonize other planets" and "Colonizing another planet is an excellent use of resources." Higher scores reflect more positive attitudes towards space exploration and colonization. Internal consistency reliability in the current sample was .98.

Extraterrestrial Beliefs Scale. The Extraterrestrial Beliefs Scale (EBS; Schiavone, unpublished raw data) is a 14-item scale developed to measure belief in the possibility of extraterrestrial life in the universe. This scale provides an alternative to existing measures that have taken a largely conspiratorial approach to beliefs about extraterrestrial life that have included items ranging from alien abductions, UFOs, to government cover-ups (Chequers, Joseph, & Diduca, 1997; Routledge, Abeyta, & Roylance, 2017; Swami, Furnham, Haubner, Stieger, & Voracek, 2009). Belief in extraterrestrial life has even been included alongside items about believing in the abominable snowman and Loch Ness monster in an ostensible measure of paranormal beliefs (Tobacyk, 2004). While certain beliefs about extraterrestrial life may reflect paranormal thinking, these measures conflate paranormal belief in aliens with the recognition of the scientific possibility of life existing elsewhere in the universe.

The Extraterrestrial Belief Scale includes two factors. One factor includes 9 items assessing beliefs about the possible existence of extraterrestrial life. Example items include "There is more than likely life on other planets" and "Extraterrestrial life probably exists somewhere in the universe." The second factor includes items assessing beliefs about the search for extraterrestrial life. Example items include "Humanity should search for evidence of extraterrestrial life" and "Searching for extraterrestrial life is an important scientific

venture." Item are scored using a 6-point Likert-type response scale ranging from 1 (*Strongly disagree)* to 6 (*Strongly agree*). Higher scores reflect stronger beliefs in extraterrestrial life and greater support for searching for life. Internal consistency reliability in the current sample was .96.

Hypotheses

This study tested whether priming religion and creationism led to more negative attitudes towards space exploration and disbelief in the existence of extraterrestrial life. Thus, it was predicted that participants in the religion and creationism priming condition would report less positive attitudes towards space exploration and less belief in the existence of extraterrestrial life than those in the control condition. Additionally, priming creationism was expected to have a more negative impact on attitudes towards space exploration beliefs about extraterrestrial life than priming religion more generally.

Chapter 5: Results

Data Exclusions

Data were excluded from participants who reported they did not believe in god(s), given that religious priming tends to only generate robust effects among religious participants (Shariff et al., 2015). Thus, 41 nonbelievers were excluded from the primary analyses, resulting in a sample size of N =189.

Analytic Approach

Bayesian estimation was used to assess the certainty and magnitude of differences in reported interest in space exploration and belief in extraterrestrial life between conditions. Analyses were performed in R version 3.3.1 (2016) using the following packages: rethinking (McElreath, 2016), brms (Bürkner, 2017), ggplot2 (Wickham, 2009), tidyverse (Wickham, 2017), and rstan (Stan Development Team, 2017). All prior distributions were set to be

minimally informative as to have little influence on the resulting posterior distributions and be mildly regularizing to combat model overfitting.

In addition to Bayesian estimation, Bayes factors were calculated using the open source software package JASP Version 0.8.6 (JASP Team, 2018) to quantify support for the null and alternative hypotheses. The Cauchy prior width was set to $r = 0.4$ for all Bayesian hypothesis testing. This creates a prior effect size distribution centered at $d = 0.4$, reflecting the smallest effect size of interest (Lakens, Scheel, & Isager, 2018). All interpretation of the strength of evidence of the Bayes factors was based on Lee and Wagenmakers' (2013) classification scheme.

Word Fragment Completion Task

Bayesian estimation was conducted to test whether priming religion and creationism increased the accessibility of related concepts measured by the number of target word fragments completed. Posterior distributions of the completed religion and creationism target word fragments were estimated with zero-inflated Poisson distributions given their heavily right-shew with zero being the most common value. A summary of the completion of religion, creationism, and neutral words across conditions can be seen by in Table 4.

Religion word fragments. Completion rates for the target religion word fragments were low. Average completion of the five target words was less than one word across conditions, see Table 5. Results of zero-inflated Poisson Bayesian estimation suggest participants in the religion and creationism conditions completed more of the target religion word fragments than those in the control condition, see Figure 1. Estimated posterior distributions indicated similar effects of the religion and creationism priming conditions on target religion word fragment completion.

Table 4

Word Fragment Completion by Condition

	Creationism (n = 62)			Religion (n = 59)			Control (n = 68)		
	Target	SC	UC	Target	SC	UC	Target	SC	UC
Creationism									
Design	17	35	5	15	29	10	17	37	9
Eden	2	54	0	0	49	2	0	55	5
Life	15	62	0	10	53	5	2	61	5
Garden	5	28	5	6	24	3	3	32	11
Creation	26	48	5	12	31	7	7	32	10
Religion									
Pray	10	52	5	7	44	4	1	59	4
Cross	2	43	1	5	33	3	5	45	5
God	8	66	0	8	55	0	0	66	2
Bible	16	57	1	19	45	6	4	53	9
Church	13	36	2	15	35	8	11	37	10
Neutral[a]									
_ o _ k		61	0		58	1		64	1
_ e _ d		53	2		51	2		60	2
t h_ _ _		60	1		55	3		61	5
_ _ _ o w		24	9		18	7		29	8
f _ r _ _		48	2		41	1		47	5

Note. [a] Neutral word fragments had no target word. Target = completion with target word, SC = successful completion with any of the possible words, UC = unsuccessful completion attempt.

Point estimates suggest the expected number of target words completed following the religion prime was 2.9 times the expected number completed following the control prime, see Table 5. Thus, being in the religion priming condition instead of the control increased the probability of completing the target word fragments by 191.5%. The expected target word completions in the creationism condition was 2.61 times the expected number in

the control condition. Or, the probability of completing the target word was 161.2% greater in the creationism condition than the control.

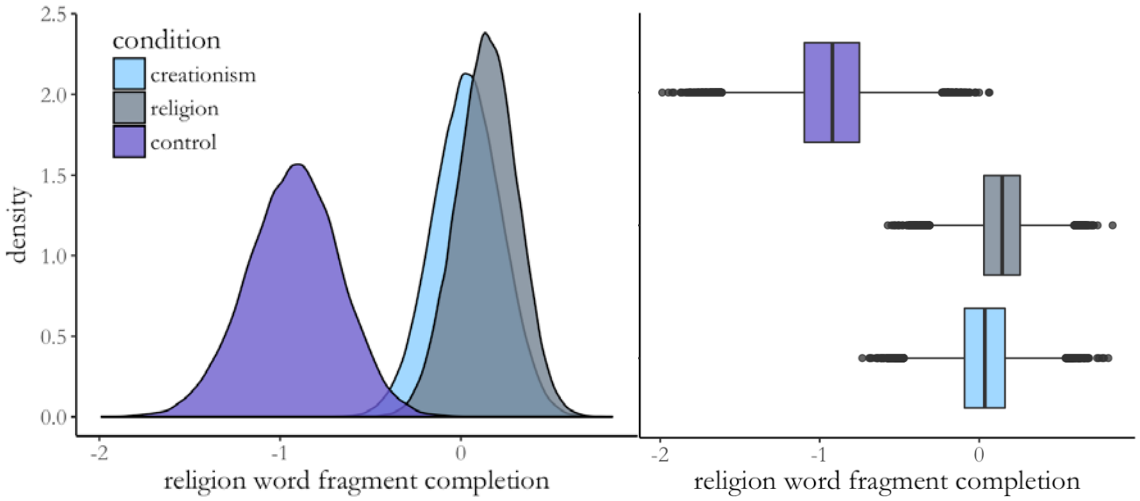

Figure 1. Posterior Distributions of Religion Word Fragment Completion

Table 5

Summary and Point Estimates of Religion Word Fragment Completion

Target	Raw Mean (*SD*)	Estimate	97% HPDIs	*P*(β > control)
Control	0.31 (0.58)	-0.93	[-1.49, -0.37]	
Creationism	0.79 (1.04)	0.96	[0.36, 1.59]	> 0.99
Religion	0.92 (1.06)	1.07	[0.47, 1.67]	> 0.99

Note. *P*(β > control) is the posterior probability that the estimate is greater than the control.

Although overall completion of the target word fragments was quite low, priming religion and creationism appeared to increase the number of religion word fragments completed compared to the control. Thus, the explicit priming of religion and creationism may have been successful in activating religious cognitions allowing for the religious words to come more readily to mind during the word fragment completion task.

Creationism word fragments. Differences in the number of creationism target word fragments completions were assessed using zero-inflated Poisson Bayesian estimation to sample posterior distributions for each condition. Completion rates of the target creationism word fragments were highest in the creationism priming condition, followed by the religion priming condition, and lowest in the control condition, see Figure 2. Point estimates of the expected number of target words completed suggest that creationism priming resulted in 2.39 times the expected number completed following the control prime, see Table 6. That is, the religion prime increased the probability of completing the target word fragments by 138.69% compared the control prime. The expected target word fragment completions in the religious priming condition were 1.67 times the number expected in the control condition. Thus, the probability of completing the target word fragments was 66.53% greater in the religion condition than the control.

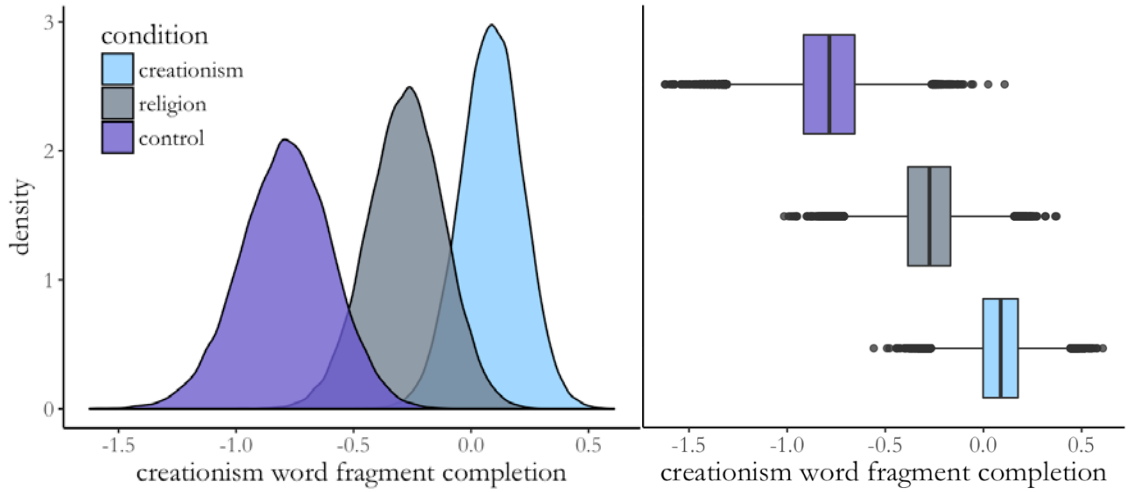

Figure 2. Posterior Distributions of Creationism Word Fragment Completion

Table 6

Summary and Point Estimates of Creationism Word Fragment Completion

Target	Raw Mean (*SD*)	Estimate	97% HPDIs	*P*(β > control)
Control	0.44 (0.61)	-0.79	[-1.22, -0.37]	
Creationism	1.05 (0.97)	0.87	[0.40, 1.38]	> 0.99
Religion	0.73 (0.81)	0.51	[-0.12, 1.05]	0.98

Note. *P*(β > control) is the posterior probability that the estimate is greater than the control.

As predicted, the most target creationism word fragments were completed by those who had experienced the creationism priming. Religious priming also appears to have increased creationism word fragment completion compared to the control priming, reflecting the overlap between religion and creationism. While average completion of the target word fragments was fairly low overall, the data provide some evidence that the creationism priming successfully increased the activation of creationism-related concepts.

Neutral word fragments. Poisson Bayesian estimation was used to simulate posterior distributions of the total number of neutral word fragments completions across the three conditions. As depicted in Figure 3, neutral word fragment completion looked similar across condition. Point estimates from the posterior distributions suggest that the expected neutral word fragments completions for participants in the creationism condition was expected to be 1.03 times those in the control condition, or the probability of completing the neutral word fragments increased by 3.1% in the creationism compared to the control, see Table 7. Participants in the religious priming condition expected neutral word fragment completion was 0.98 times participants in the control condition. Thus, the probability of completing the neutral word fragments decreased by 2.0% in the religion condition

compared to the control condition. As expected, no evidence of noteworthy differences was seen in the effects of priming on the completion of neutral word fragments.

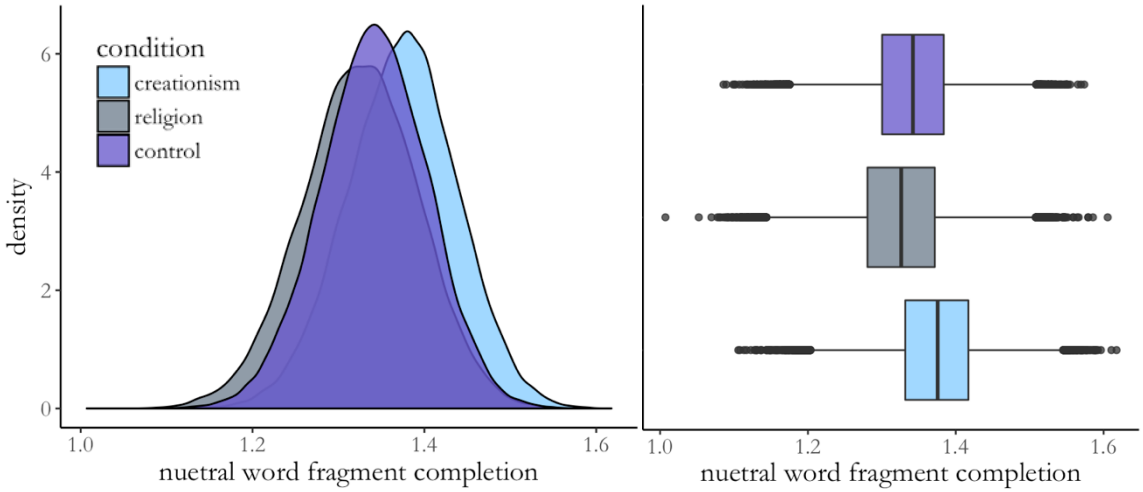

Figure 3. Posterior Distributions of Neutral Word Fragment Completion

Table 7

Summary and Point Estimates of Neutral Word Fragment Completion

Target	Raw Mean (*SD*)	Estimate	97% HPDIs	*P*(β > control)
Control	3.84 (1.22)	1.34	[1.21, 1.48]	
Creationism	3.97 (1.01)	0.03	[-0.16, 0.22]	0.64
Religion	3.78 (1.13)	-0.02	[-0.21, 0.19]	0.43

Note. *P*(β > control) is the posterior probability that the estimate is greater than the control.

Main Analyses

Attitudes towards space exploration. To test hypothesis that priming creationism and religion would the impact of priming on reported attitudes towards space exploration, Bayesian estimation was used to compare posterior distributions across priming conditions. Visual inspection of the estimated posterior distributions suggests participants in the creationism and religion priming conditions had slightly more positive attitudes towards space exploration than those in the control condition, see Figure 4. Results of this analysis,

including raw means, the most credible estimates, 97% HDPIs, and posterior probabilities can be seen in Table 8. Since the posterior distributions for the creationism and religion priming conditions were nearly identical, the two conditions were combined and compared to the control condition in subsequent analyses.

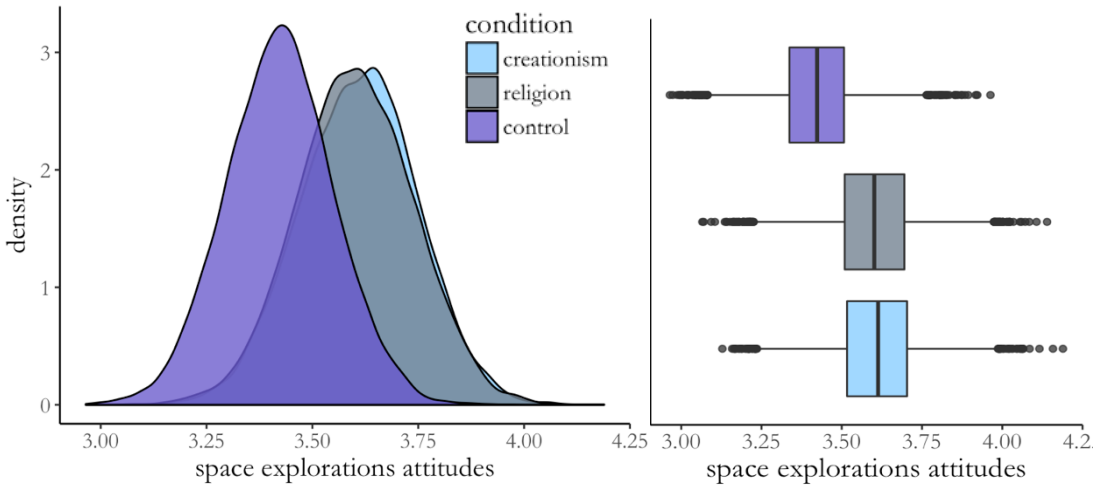

Figure 4. Posterior Distributions of Attitudes towards Space Exploration

Table 8

Summary and Point Estimates of Attitudes towards Space Exploration

Target	Raw Mean (*SD*)	Estimate	97% HPDIs	*P*(β > control)
Control	3.42 (1.15)	3.42	[3.15, 3.70]	
Creationism	3.61 (0.98)	3.61	[3.32, 3.90]	0.85
Religion	3.60 (1.07)	3.56	[3.30, 3.90]	0.83

Note. *P*(β > control) is the posterior probability that the estimate is greater than the control.

Estimated posterior distributions using the combined religion and creationism priming conditions to compare attitudes towards space exploration to the control condition can be seen in Figure 5. The distribution for the combined conditions allowed for estimating a more credible estimate and thus, a more narrow distribution. The most credible estimate for attitudes towards space exploration in the combined condition was 3.61 [3.40, 3.83] and

3.42 [3.14, 3.70] in the control condition. The posterior probability of attitudes towards space exploration being more positive in the combined conditions than in the control condition was .88. However, the estimated difference between groups was quite small. A Bayesian t-test conducted with a small Cauchy prior width (0.4) revealed an estimated Bayes factor of 2.16 in favor of the null hypothesis. Thus, the data were 2.16 times more likely to occur under the null rather than alternative model, suggesting moderate evidence against the hypothesis that priming religion and creationism affects attitudes towards space exploration. Overall, these results do not provide support for the predicted hypothesis that activating religious cognitions would result in less positive reported attitudes towards space exploration.

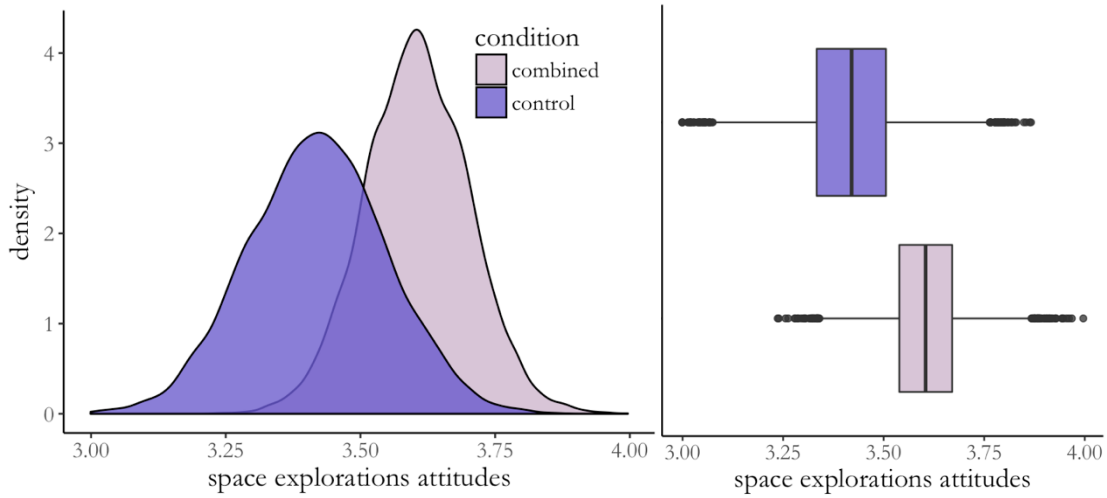

Figure 5. Posterior Distributions of Attitudes towards Space Exploration with Combined Conditions

Beliefs in extraterrestrial life. Results of Bayesian estimation comparing the effects of priming on beliefs in extraterrestrial life suggested that reported beliefs were slightly weaker in the control condition compared to the creationism and religion priming conditions, see Table 9. Visual inspection of the estimated posterior distributions (see Figure

6) indicated very similar effects of the creationism and religious priming on beliefs in extraterrestrial life. Thus, the two conditions were combined and Bayesian estimation was performed to compare the combined priming conditions to the control condition.

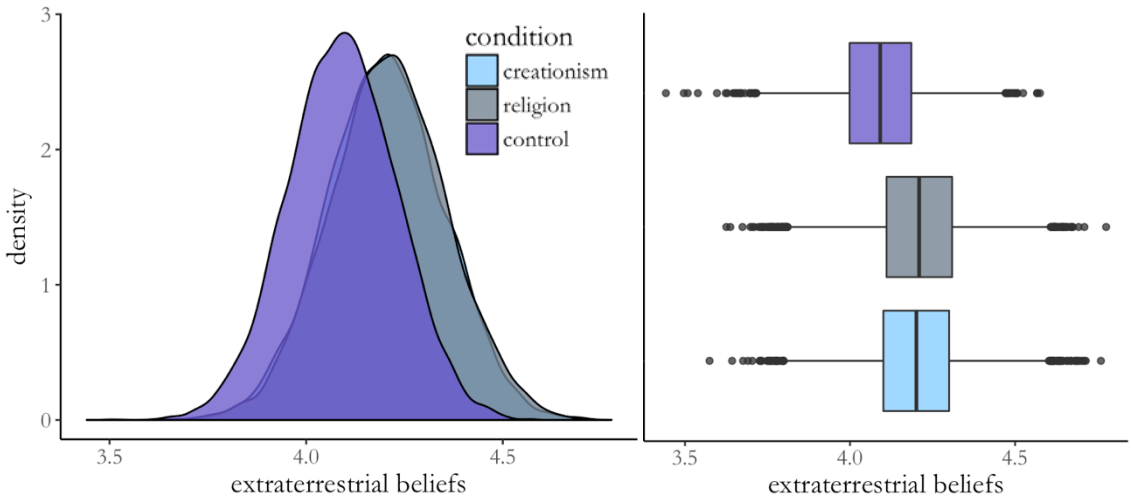

Figure 6. Posterior Distributions of Beliefs in Extraterrestrial Life

Table 9

Summary and Point Estimates of Beliefs in Extraterrestrial Life

Target	Raw Mean (*SD*)	Estimate	97% HPDIs	*P*(β > control)
Control	4.11 (1.23)	4.01	[3.79, 4.39]	
Creationism	4.21 (1.17)	4.20	[3.88, 4.51]	0.71
Religion	4.21 (1.09)	4.21	[3.89, 4.55]	0.73

Note. *P*(β > control) is the posterior probability that the estimate is greater than the control.

The estimated posterior distributions using the combined religion and creationism priming conditions to compare beliefs in extraterrestrial life to the control condition can be seen in Figure 7. The most credible estimate for beliefs in extraterrestrial life in the combined condtion was 4.21 [3.98, 4.43] and 4.09 [3.80, 4.41] in the control condition. The posterior probability of beliefs in extraterrestrial life being more positive in the combined conditions than in the control condition was .75. However, the estimated difference between

groups was quite small. A Bayesian t-test conducted with a small Cauchy prior width (0.4) revealed an estimated Bayes factor of 3.23 in favor of the null hypothesis. Thus, the data were 3.23 times more likely to occur under the null rather than alternative model, suggesting moderate evidence against the hypothesis that priming religion and creationism affects beliefs in extraterrestrial life. Thus, support for the predicted hypothesis that activating religious cognitions would result in less reported beliefs in extraterrestrial life was not found.

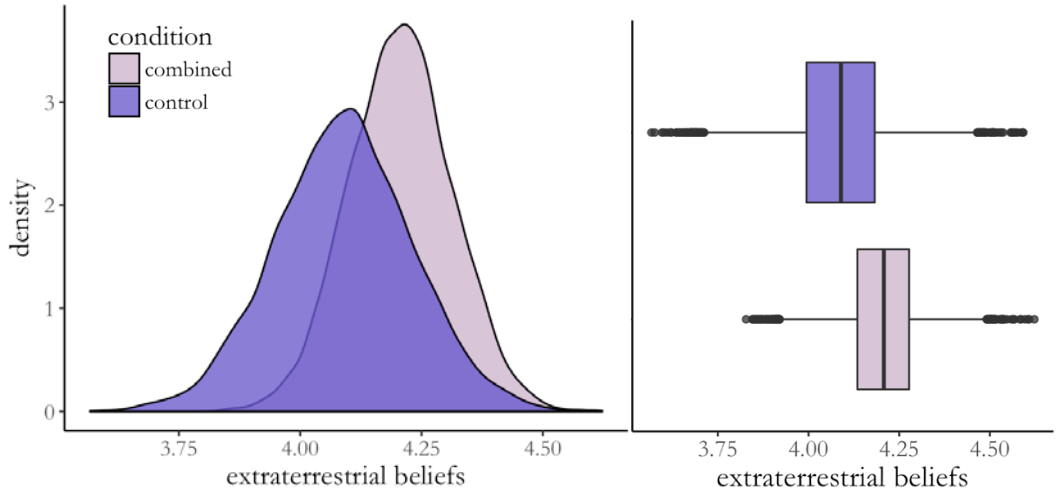

Figure 7. Posterior Distributions of Beliefs in Extraterrestrial Life with Combined Conditions

Exploratory Analyses

In addition to testing the primary hypotheses, several exploratory analyses were conducted investigating various demographic differences in attitudes towards space exploration and beliefs in extraterrestrial life. The effects of priming on reported religiosity were also examined.

Space attitudes among atheists and believers. Differences in attitudes towards space exploration were assessed among religious believers and disbelievers using Bayesian estimation and t-tests. Estimated posterior distributions suggest atheists have more positive attitudes towards space exploration than believers, see Figure 8. Results indicated an estimated difference in means of 0.62 [0.23 to 1.02]. The posterior probability of atheists

having more positive attitudes towards space exploration than believers was > 0.99. Results of a Bayesian t-test with a small Cauchy prior width (0.4) indicated that atheists reported more positive attitudes towards space exploration (*M* = 4.18, *SD* = 1.06) than religious believers (*M* = 3.54, *SD* = 1.07). The estimated Bayes Factor suggested that the data were 39.23 times more likely to occur under the alternative hypothesis than the null. This indicates very strong evidence of a difference in attitudes towards space exploration between atheists and believers.

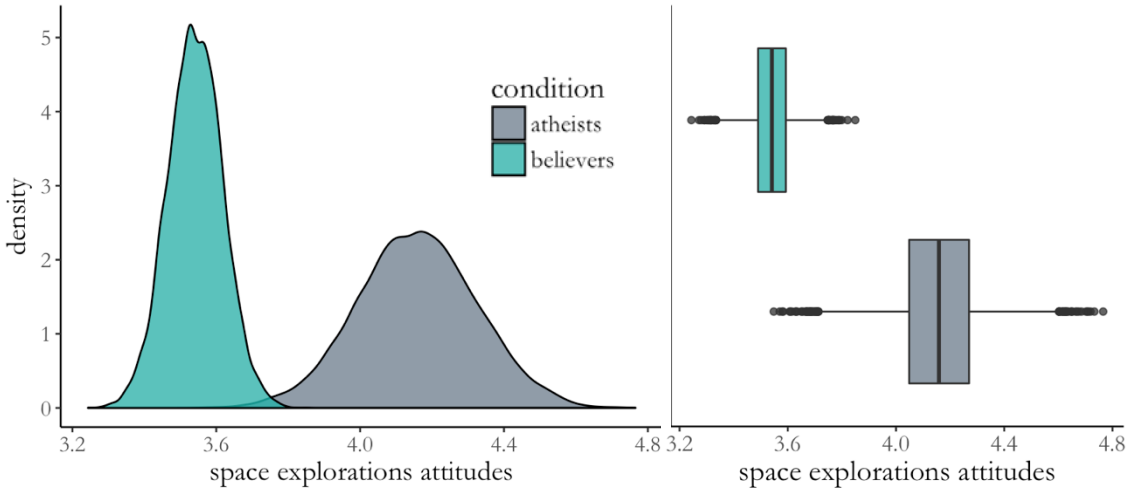

Figure 8. Posterior Distributions of Atheists and Believers' Attitudes towards Space Exploration

Extraterrestrial beliefs among atheists and believers. Similar analyses were conducted to test for differences in beliefs about extraterrestrial life between atheists and believers. Visual inspection of the estimated posterior distributions indicates stronger beliefs in extraterrestrial life among atheists than believers, see Figure 9. The estimated mean difference in beliefs in extraterrestrial life between atheists and believers 0.67 [0.25 to 1.06]. The posterior probability of atheists having more positive attitudes towards space exploration than believers was > 0.99. A Bayesian t-test with a small Cauchy prior width (0.4) also suggested atheists had more positive attitudes towards space exploration (*M* =

4.86, *SD* = 0.86) than religious believers (*M* = 4.17, *SD* = 1.16). The estimated Bayes Factor indicated that the data were 56.73 times more likely to occur under the alternative hypothesis than the null, suggesting very strong evidence of a difference between atheists and believers' beliefs about extraterrestrial life.

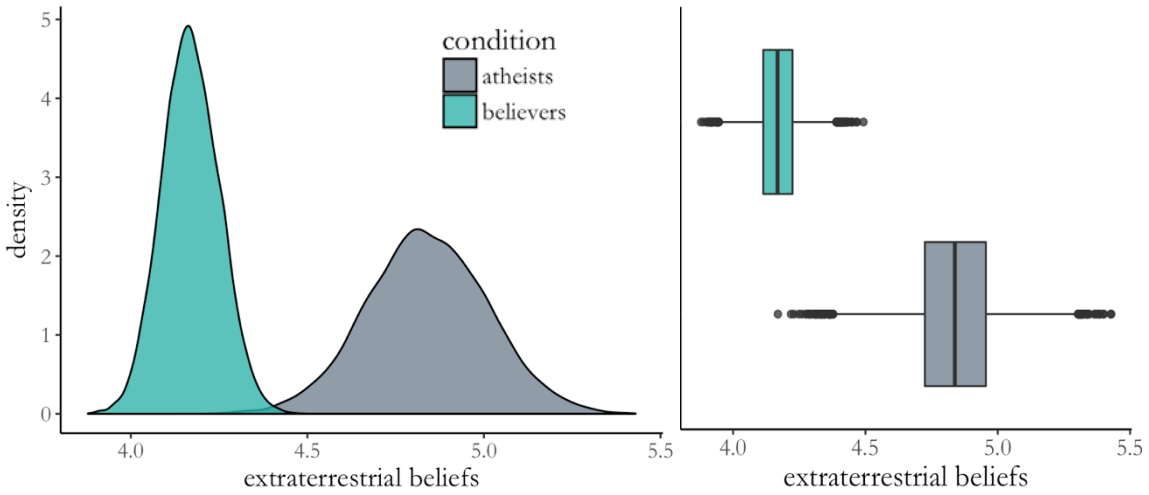

Figure 9. Posterior Distributions of Atheists and Believers' Beliefs in Extraterrestrial Life

Chapter 6: General Discussion

The current study examined the effects of priming religion and creationism on attitudes towards space exploration and beliefs about the possible existence of extraterrestrial life in the universe. Specifically, the study tested the prediction that increasing the accessibility of religious and creationist concepts would result in less positive attitudes towards space exploration and beliefs in extraterrestrial life. However, the results of the current study provide no evidence in support of this prediction. In addition to testing the confirmatory hypotheses, the results of exploratory analyses indicated that atheists had more positive attitudes towards space exploration and beliefs about extraterrestrial than theists. In general, these findings have implications for future research on space attitudes, extraterrestrial beliefs, as well as the use of religious priming more broadly.

Results of this study estimated very similar effects of creationist and religious

priming on attitudes towards space exploration ($\beta_{creationism}$ = 3.61 vs. $\beta_{religion}$ = 3.56). Comparison of these conditions to the control indicated the data were 2.16 more likely to occur under the null hypothesis (i.e., no differences in attitudes) than the alternative hypothesis (e.g., a difference in attitudes). Following Bayesian interpretations, this provided moderate evidence against the original prediction. The estimated effects of creationist and religious priming on beliefs in extraterrestrial life were also quite similar ($\beta_{creationism}$ = 4.20 vs. $\beta_{religion}$ = 3.21). Comparison of the control condition to the creationism and religion conditions, revealed moderate evidence against the original prediction that priming religion and creationism would result in less reported belief in extraterrestrial life, with the data being 3.23 times more likely under the null hypothesis.

The results of this study leave perhaps more questions than answers as to how they should be interpreted. Possible interpretations of the current findings diverge down three paths of potential conclusions: (a) the method and measures used to test the prediction were inadequate; (b) the original prediction was, quite simply, wrong; and (c) both the method and measures were inadequate and the original prediction was wrong.

Following the first path in examining the experimental method and measures submits two primary questions that may complicate the interpretation of the results. The first is whether the priming procedures were effective in activating religious and creationist cognitions. And second, whether the measures used were adequate in capturing attitudes towards space exploration and beliefs about extraterrestrial life.

The primary independent variable relied on priming – a method that has received scrutiny as to the replicability of published priming effects (see Cesario, 2014; Kahneman, 2012; Ramscar, 2016; Wagenmakers, 2014). This debate continues, with both emerging "failed" replications (see Gomes & McCullough, 2015; Klein et al., 2014; O'Donnell et al.,

2017; Pashler, Rohrer, & Harris, 2013) and evidence supporting the effect of priming on behavioral outcomes (see Payne, Brown-Iannuzzi, & Loersch, 2016; Weingarten et al., 2016; Zwaan et al., 2017). In addition to controversy over priming more broadly, the specific use of religious priming has also been called into question (see van Elk et al., 2015). Perhaps the most popularly studied effect of religious priming is its influence on prosocial behavior (see Shariff & Norenzayan, 2007; Willard, Shariff, & Norenzayan, 2016). In a meta-analysis of 93 studies, Shariff et al. (2015) concluded religious priming has a small, yet robust, effect on behavioral measures. Further, the strongest effects were found with explicit primes (verse implicit or subliminal) and among religious participants. However, in a re-analysis of religious priming data, van Elk and colleagues (2015) found conflicting evidence for the effect of religious priming upon controlling for publication bias. Thus, they proposed that a large-scale preregistered replication should be conducted to assess the effects of religious priming (van Elk et al., 2015).

Given the current lack of certainty surrounding religious priming methods, this study sought to increase the chances of obtaining an effect by (a) using an explicit prime and (b) excluding data from those who do not believe in god. Thus, passages from the bible were presented followed by writing prompts asking participants to reflect on religion and creationism. A word fragment completion task was used as a manipulation check. Results indicate that both the religious and creationist primes led to fairly similar increases in the completion of the religious words compared the control (191.5% and 161.2%). This suggests both primes increased the accessibility of religious concepts and reflects the inherent overlap of creationism with religion. However, the data also indicate that the creationism prime led to a greater increase the completion of creationism word fragments (138.69%) than the religious prime (66.53%). Thus, this difference offers some support that while priming

creationism also primes religion, priming religion may not inherently prime creationism. Despite indications that the primes increased the completion of related words fragments, participants overall completed very few of the target words – even within the religion and creationism conditions. While this could indicate priming had only a small effect on increasing the accessibility of the related concepts, it may also indicate weakness in the ability of the manipulation check to measure possible effects.

Word fragment and word stem completions tasks are often used to assess the effects of priming (see Dong & Lee, 2017; Hayes & Schimel, 2018; Preston & Ritter, 2012; Yilmaz & Bahçekapili, 2015; Zhong & Liljenquist, 2006). However, these methods vary widely. In the current study, the number of possible ways the word fragments could be completed may have affected the completion rate of the target words (e.g., the more options, the less likely the target word might have been used to complete the fragment). Concerns of the effectiveness of word completions tasks are likely not unique to this study. Overall, research using word completion tasks would benefit greatly from an investigation addressing the following questions: How completion rates differ between the use of word stems versus word fragments? How the number of possible completion options affects the completion rate of the target word? And, what processes should researchers follow in the selection of words?

In addition to uncertainty surrounding the manipulation check, the measurement of the primary dependent variables also presents limitations hindering the interpretability of this study. This study relied on measures still currently in the refinement process of development, given the lack of published and validated measures of attitudes towards about space exploration and extraterrestrial beliefs. And, despite both the Space Exploration Attitudes Scale and Extraterrestrial Beliefs Scales seeming to have face validity and scores with high

reliability, many psychometric questions remain answered. For instance, it is unknown how well their factor structures replicate and differ across populations. Moreover, further assessment into the content validity of these measures is needed. Since there are numerous psychometric properties yet to be tested, it remains uncertain whether these measures reflect genuine representations of attitudes towards space exploration and beliefs about extraterrestrial life or whether the results were riddled by measurement error. Thus, conclusions drawn from the current should be hedged with some skepticism.

Following the second interpretive path examines whether the original prediction was, quite simply, wrong. That is, creationism and religious belief may not influence space attitudes and beliefs about extraterrestrial life in a meaningful way. Space exploration, after all, does garner largely positive support among Americans (Gallup, 2009; Pew, 2015b). Efforts to explore outer space may not been be perceived as threatening to people's beliefs. Or, such possible threats to creationism and religious explanations (e.g., scientific explanations of the universe and origins of life, the discovery of other life forms) may not be widely associated with space exploration. Thinking about space exploration may generally elicit positive reactions (e.g., a sense of awe about humans landing on the moon, being impressed with Space X's launch of a Tesla into space; Resnick, 2018). Thus, people might not think or care about the broader implications that space exploration may have on both scientific and religious explanations of the universe.

Exploratory findings from this data suggest very strong evidence of atheists having more positive attitudes towards space exploration (Bayes factor = 39.23) and beliefs about extraterrestrial life (Bayes factor = 56.73) than religious believers. While this difference was observed, it does not indicate the cause of this disparity. Since the effects of religious priming are unreliable among nonbelievers (Sharrif et al., 2016), atheists in the current study

may have reported more positive attitudes towards space exploration and extraterrestrial beliefs in response to religious or creationist primes. Nevertheless, with few atheists in the current sample ($N = 41$), such inferences cannot be made. Another possible explanation reconciling these findings is that while demographic differences may exist, attitudes towards space exploration and beliefs about extraterrestrial life might be fairly stable and unaffected by the degree of accessibility of religious and creationist cognitions. Differences in theists and atheists' attitudes and beliefs might be better understood and explained by factors unexplored in the current investigation. Such variables may include knowledge about current space activities, interest in science broadly, political ideology, perceived attitudes of peers and authority figures, or even personality factors such as openness to experience.

Additional limitations of this study include the desired sample size not being reached, as only 240 of the desired 350 participants were recruited. This, along with data exclusions, resulted in small sample sizes per condition (ranging from 59 to 68). Nevertheless, one benefit of Bayesian inferences being drawn based on the data collected rather than assumptions of repeating replications is there is no need to correct for sequential testing (Wagenmakers et al., 2017a). Thus, as preregistered, data collection may resume to achieve the desired sample size.

Beyond the discussed concerns relating to methods and measures, several additional statements should be noted on the constraints of generalizability of the current study. Given the geopolitical differences in space activities, the measures used to assess attitudes towards space exploration and beliefs about extraterrestrial life would not be adequate for use among populations without national space agencies or those early in development. Moreover, the sample included undergraduate students who were mostly young, Caucasian, religious, and female. Thus, the findings of this study would not be expected to replicate in non-WEIRD

samples (Western, Educated, Industrialized, Rich, and Democratic; Henrich, Heine, & Norenzayan, 2012). These results also may not replicate in non-undergraduate samples. While the results would likely be replicable in similar subject pools, they may differ among more diverse undergraduate samples.

Future studies should continue to investigate how attitudes towards space exploration and beliefs about extraterrestrial life may differ with religious belief. Perhaps a place to start would be developing instruments that can measure these attitudes with greater certainty. Thus, future work could continue to examine the dimensionality of the Space Exploration Attitudes Scale and Extraterrestrial Beliefs Scale. Such efforts should carefully scrutinize the validity of scores on these scales to assess how well they capture attitudes towards space exploration and beliefs about extraterrestrial life. These investigations should also consider how scores on each measure differentiate from other variables, how groups may differ in responding, and the ways in which scores should be appropriately used and interpreted.

Beyond improving specific measures, future studies should explore how attitudes towards space exploration and beliefs about extraterrestrial life relate and differ from attitudes and beliefs about both science and religion more broadly. Doing so may allow for more precise predictions and an overall better understanding of the relationships between religious belief and attitudes towards space exploration and beliefs about extraterrestrial life. In addition to exploring these relationships, future work should test whether the differences found between atheists and believers replicate in larger and more diverse samples.

Overall, this study sought to build upon previous findings suggesting a negative relationship between religious beliefs and attitudes towards space exploration and beliefs about extraterrestrial life (Ambrosius, 2015). By using priming, this study tested whether

increasing the accessibility of religious and creationist cognitions negatively influenced attitudes towards space exploration and beliefs about the existence of extraterrestrial life. While this hypothesis was not supported, the results nevertheless add to the current knowledge in several ways. First, it extends the use of priming to assess whether there are differential effects of attempts to prime religion and creationism. Here the current data suggest that priming religion and creationism both increased the accessibility of religious cognitions, while priming creationism led to a greater increase in creationist concepts compared to religious priming, as measured by word fragment completion. Second, although the predicted effect of priming was not supported, results indicated that atheists and believers seem to differ in their attitudes towards space exploration and beliefs in extraterrestrial life.

The space industry continues to grow and expand humanity's reach beyond the Earth. Yet, research exploring attitudes and beliefs about space travel, the search for extraterrestrial life, and general motivation to explore the universe is limited. While religious believers and disbelievers appear to differ in their attitudes towards space exploration and beliefs about extraterrestrial life, explanations for this disparity remain unknown. If humanity continues the current trajectory of seeking out new life and going where no one has gone before, understanding how beliefs affect these endeavors may provide valuable insight into the complex relationship between science and religion.

Appendix: Materials

Creationism condition

Please read the following passage from the Bible. We want you to really think about what this passage means to you and how it applies to your beliefs about creation. After you have read the passage, you will be asked to write a paragraph describing what creationism means and explains in your life.

Genesis 1: 1-31 (Excerpt from New International Version)
"In the beginning God created the heavens and the earth.
Now the earth was formless and empty,
darkness was over the surface of the deep,
and the Spirit of God was hovering over the waters."

Please spend the next five minutes writing a paragraph describing what creationism means and explains in your life.

Religion condition

Please read the following passage from the Bible. We want you to really think about what this passage means to you and how it applies to your beliefs about God. After you have read the passage, you will be asked to write a paragraph describing what God means and explains in your life.

Psalm 119: 1-56 (Excerpt from New International Version)
"Blessed are those whose ways are blameless,
who walk according to the law of the Lord.
Blessed are those who keep his statutes
and seek him with all their heart"

Please spend the next five minutes writing a paragraph describing what God means and explains in your life.

Control condition

Please read the following passage from a poem. We want you to really think about what this passage means to you and how it applies to your views about sports. After you have read the passage, you will be asked to write a paragraph describing what sports mean and explain in your life.

Legend of the Red October Run (Excerpt from Candler, 2014)
"Over fifty years, boy and man, I've been a Sooners fan
Watched and reveled in their glories, every one;
But there's no more glorious "Sooner Magic"
Than the Red October Run."

Please spend the next five minutes writing a paragraph describing what sports mean and explain in your life.

Word Fragment Completion Task

Note: Target words are bolded followed by examples of other potential words

Creationism

_ _ _ i g n (**design** – assign, benign, cosign, ensign, malign, resign)

_ _ e n (**eden** – been, even, keen, omen, open, oven, oxen, seen, teen, then, when)

l i _ _ (**life** – liar, lice, lick, lids, lied, lies, lift, like, limb, limp, line, link, lint)

g a _ _ e _ (**garden** - gabbed, gables, gadget, gagged, gained, ganged, gasket, gawker)

_ _ _ _ t i o n (**creation** – adaption, addition, adoption, ambition, aviation, election)

Religion

p _ _ y (**pray** – play, prey, pity, ploy, pony, puny)

_ r _ _ s (**cross** – brass, brags, brews, cries, crops, drags, dress)

_ o _ (**god** – bog, bow, box, boy, dog, dot, fog, hog, hop, jog, joy)

b i _ _ _ (**bible** – bicep, biker, biked, bills, blinds, binge, birch, birds, birth)

_ _ u _ c h (**church** - brunch, clutch, crunch, crutch, launch)

Control (*Note*: the control word fragments had no target words)

_ o _ k (bonk, book, cook, cork, look, lock, mock, pork, rock, sock, soak, took)

_ e _ d (bend, dead, feed, head, held, lend, meld, mend, need, nerd, read, send, weed)

t h _ _ _ (thaws, theft, their, theme, there, thick, thief, thing, think, third, threw)

_ _ _ o w (allow, arrow, below, elbow, throw, widow)

f _ r _ _ (farms, ferry, fired, fires, first, force, fords, forge, forgo, forks, forth, forts)

Space Attitudes and Extraterrestrial Beliefs

Instructions:
Please indicate how much you agree or disagree with each of the following statements.
Strong disagree, Disagree, Slightly Disagree, Slightly Agree, Agree, Strongly Agree

Space Exploration Attitudes Scale (Schiavone, in prep)

The Importance of Space Exploration
The potential benefits of space exploration are worth the financial risk
The danger associated with space exploration is worth the potential benefits
I enjoy talking about space exploration
Space exploration should be an important part of the federal budget
Space exploration should be a priority for humans
The accidental loss of human life in space is an acceptable risk of spaceflight
Space travel is a good use of human resources
The possible loss of money is worth the risk of developing new technologies for space travel
Humans should accept the risk of possible harm astronauts may experience in space
The money invested in space exploration is worth the risk
It is exciting to hear about current missions in outer space
I love learning about astronauts
The benefits of space exploration are worth the risks of human space flight
The long-term benefits of space travel are worth the funding required
The value of space exploration is worth its financial cost
Traveling to space is important regardless of the possible dangers that may occur
I seek out information about space exploration

Interplanetary Colonization
It would be exciting to see humans colonize Mars
It would be very exciting for humans to live on other planets
Humanity's future should not be limited to living on Earth
Searching for other planets capable of supporting human life should be a priority
Earth should not be human's only home in the universe
Humans could find other planets to live on by exploring space
Humans should colonize other planets
Colonizing another planet would be one of humanity's greatest accomplishments
Colonizing another planet is an excellent use of resources
It is essential that humans colonize other planets
I would love to be part of a human colony on another planet
Living on Mars would be a great opportunity for humanity
We should create cities on other planets that can support human life

Extraterrestrial Beliefs Scale (Schiavone, in prep)

Beliefs about the Existence of Extraterrestrial Life
Extraterrestrial life probably exists somewhere in the universe
Humans are most likely not alone in the universe
It makes sense for there to be life existing beyond Earth

I doubt Earth is the only planet that is supporting life
There is more than likely life on other planets
I would not be surprised if extraterrestrial life exists
It is unlikely that life only exists on Earth
There is some form of extraterrestrial life out there
I expect life exists on other planets

Beliefs about the Search for Extraterrestrial Life
Humanity should invest in the scientific search for extraterrestrial life
Searching for extraterrestrial life is an important scientific venture
Investigating signs of life beyond Earth is worth the funding required
Searching for life beyond Earth should be a priority for humans
Humanity should search for evidence of extraterrestrial life

Demographics

How old are you? ____

How would you describe your gender identity?
- Male
- Female
- Non-binary
- Self-describe _____

How would you describe your race/ethnicity?
- American Indian or Alaskan Native
- Asian
- Black or African American
- Hispanic, Latino, or Spanish Origin
- Middle Eastern or North African
- Native Hawaiian or Pacific Islander
- White
- Not listed (Self-describe) _____

We are interested in your political beliefs. Would you consider yourself more liberal or conservative?
- Very Liberal
- Liberal
- Slightly Liberal
- Moderate
- Slightly Conservative
- Conservative
- Very Conservative

Do you believe in a god or gods?
- No
- Yes

How strongly do you believe in God or gods (from 0-100)? To clarify, if you are certain that God (or gods) does not exist, please put "0" and if you are certain that God (or gods) does exist, then put "100." ____

What is your current religion?
- Christian (Catholic)
- Christian (Baptist)
- Christian (Other)
- Hindu
- Buddhist

- Muslim
- Jewish
- Sikh
- None
- Atheist
- Agnostic
- Not listed (Self-describe) _____

Outside of weddings and funerals, how frequently do you attend church or other religious services?

- Never
- A few times per year
- Once per month
- Every other week
- Once per week
- More than once per week

How frequently do you pray?

- Never
- A few times per year
- A few times per month
- A few times per week
- Once per day
- More than once per day

In your opinion, generally do you think

- Science and religion are often in conflict
- Science and religion are mostly compatible

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Professional Publications

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