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The Effects of Familiarity and Persuasion on Risk Assessment

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THE EFFECTS OF FAMILIARITY AND PERSUASION ON RISK ASSESSMENT

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ABSTRACT

Cognitive biases influence decisions and the analyses of risk. They are often derived from two separate processes: bias based on familiarity (familiarity bias) and bias as the result of influences from outside sources (persuasion bias). Research suggests that familiarity-based bias may lead to acceptance of an activity's drawbacks and a leniency of its risks.

In addition, research has tried to measure and analyze different types of biases individually, but few have compared the interactions of more than one bias at once. Because different biases may derive from different mental phenomena it is important to tease out the distinctions, and observe how they interact with each other. This study conducted an empirical test that attempted to answer the following questions: Does familiarity and affiliation of the topics of radiation, low-earth orbit, and space travel result in a lesser concern, and therefore leniency, of the risks involved? How effective is on-the-spot persuasion when discussing risk assessment? How well does increased familiarity of a high-risk activity protect against on-the-spot persuasion?

Surveys were distributed to 409 students from Embry-Riddle Aeronautical University. The surveys were meant to collect the familiarity and preference levels of the participants regarding commercial space travel; they were also meant to expose the participants to persuasion conditions in order to influence their perceptions of risk. Non-parametric tests were performed in order to test the interactions. Data show that no significant bias occurred as the result of persuasion; however significance was detected between participants with high familiarity and low familiarity when they were not intentionally persuaded. Implications of these results are included.

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LIST OF ABBREVIATIONS

Bq	Becquerel
DV	Dependent variable
ERAU	Embry-Riddle Aeronautical University
FB	Familiarity Bias
Gy	Gray
HighFam	High familiarity condition
HighThreat	High threat persuasion condition
HLR	High leniency of risk
IV	Independent Variable
LEO	Low-earth orbit
LLC	Low leniency of risk
LowFam	Low familiarity condition
LowThreat	Low threat persuasion condition
LS	Likert scale
mGy	Milligray
mSv	Millisievert
NoPersuade	No persuasion condition
PB	Persuasion Bias
RPD	Recognition-primed decision making
SDT	Self Determination Theory
Sv	Sievert
VAS	Visual analog scale

Introduction

Risk is inherent is most activities; assessments are therefore necessary for any activities that may have increased risk. Information alone however is not enough, for it is often influenced by many factors. These factors include ways in which information is delivered, the expectations of the recipients (DeSteno, Petty, Rucker, Wegener, & Braverman, 2004), and the time available for processing the information (Ubel, 2002). Predictable patterns in the way that these factors influence the information processing are known as biases, and they alter interpretation of information as it travels from the informer to the informed. Therefore, for it to be properly conveyed, information must be presented using an understanding of how organizers, as well as the public, process information (Kahneman, 2003).

Commercial space tourism, for example, is currently an activity whose risks are a fresh topic of interest to private companies and to the public. Travel to or beyond low-earth orbit (LEO) was traditionally only available to government space programs like the National Aeronautics and Space Administration (NASA) and the Russian Federal Space Agency (Roscosmos) (NCRP, 2000; Turner, Farrier, Mazur, Walterscheid, & Seibold, 2008). Space travel is now considered to be a big business venture and investment. Some individuals have already paid millions of US dollars to simply sit-in on missions to earth's orbit, but the average current asking price for such an activity is approximately $200,000-$300,000 (Crouch & Laing, 2004). Plans have been drafted in order to send civilians into LEO commercially for the past decade, and seats have already begun to sell (Turner et al., 2008).

Crouch and Laing (2004) report that “There is no doubt that the successful emergence of the industry will depend to a very great extent on the efforts of the industry to inform and educate the public.” The assessment of risk relies on the information that is available, and opinions of commercial spaceflight are varied. It is in the interest of future private investors to understand what people think about this activity, why they think that way, and how an understanding of this can affect how people respond to it (Crouch & Laing, 2004). It is therefore important to identify the biases of the public as well as biases of the project organizers. For example, the material in informed consent documents and training programs are under-addressed issues, especially when it comes to risk assessment and decision making (Turner et al., 2008; Ubel, 2002). Given the dangers inherent in space travel, it is likely that the new space tourists will have to agree to the terms and conditions specified in an informed consent document, and participants may need to receive some training prior to their journey.

Lastly, studies in human cognition have thus far attempted to examine individual biases as well as their behaviors and origins. Few studies however have simultaneously compared the interactions of more than one (potentially conflicting) bias. The discussions that follow will provide support that different types of biases may be the aftermath of different types of mental activity. Measuring the differences between these underlying activities, as well as how they behave in the presence of others, is necessary in order to understand a wider perspective of bias influence.

This study discusses biases and their effects on preference, risk perception and risk assessment. It explores contemporary theories, defines types of biases, and attempts to understand their interactions with each other. Finally the results of an empirical test of influence will be described that, it is hoped, will help better understand how biases affect each other as well as how they can affect the perceptions of risks and threats.

Cognitive Biases

The mind has a tendency to misrepresent reality (Birch & Bloom, 2007; Sharp, Viswanathan, Lanyon, & Barton, 2012). Biases that are responsible for this are the products of experience (Gibbons, Houlihan, & Gerrard, 2009; Klein, Cosmides, Tooby, & Chance, 2002; Sargeant, Majowicz, Sheth, & Edge, 2010), selective perception (Cavalheiro, Vieira, Ceretta, Trindade, & Tavares, 2011; Corazzini, Pavesi, Petrovich, & Stanca, 2010; Gilovich, 1993; Greenwald, 1980; Kahneman, 2003; Öhman, Flykt, & Esteves, 2001), limited rationality (Camerer, Loewenstein, & Weber, 1989; Corazzini et al., 2010; Fehr & Tyran, 2008; Kahneman, 2003), habits (Kahneman, 2003; Levesque, Copeland, & Sutcliffe, 2008; Stewart & Payne, 2008; Taylor, 2009), an illusion of control (Greenwald, 1980; Kos & Clarke, 2001), and/or opinion versus fact discrepancies (Greenwald, 1980). These can develop through a person's conscious or unconscious self-interests (Levesque et al., 2008).

Gilovich (1993) says that “beliefs are like possessions, of which we are possessive.” Beliefs are strongly attached to the formation of biases; these beliefs and prior experiences affect how, and to what, people pay attention (Bogaerts, et al., 2010; Gibbons et al., 2009; Kahneman, 2003). People often notice or ignore things that they have been conditioned to notice or ignore. This selective perception is subjective because it varies between individuals (Cavalheiro et al., 2011; Gilbert & Osborne, 1989). For example, phobics tend to have sensitivities to things like snakes or spiders (Öhman et al., 2001), and people are more sensitive to stimuli if they perceive them as threatening

(Bogaerts et al., 2010; Senay & Kaphingst, 2009). In addition, people have extreme difficulty ignoring things that are exclusive and/or important to only them (Camerer et al., 1989; Das, de Wit, & Stroebe, 2003; Sharp et al., 2012) like their names (Harris & Pashler, 2004). Greenwald (1980) explains that the ego causes this limited perception, and therefore people only assess the world based on how, or if, it affects them in some way.

Traditionally judgments have also been considered biased if they exhibit a bounded and limited rationality (Cavalheiro et al., 2011; Camerer et al., 1989; Charness & Gneezy, 2003; Corazzini et al., 2010; Ubel et al., 2009; Fehr & Tyran, 2008; Kahneman, 2003) as a result of emotions and misperceptions (Gibbons et al., 2009; Gilbert & Osborne, 1989; Meschiari, 2009). This is called systematic irrationality, and it is a deviation or deficit in the use of practical and pragmatic frameworks, models, or procedures of thought and inquiry (Fehr & Tyran, 2008; Kahneman, 2003; Meschiari, 2009; Sharp et al., 2012). This occurs more frequently when assisted by egocentricity (Birch, 2005; Birch & Bloom, 2007; Greenwald, 1980), cognitive business (Gilbert & Osborne, 1989; Stewart & Payne, 2008), ill health (Ubel, 2002), emotion (Cavalheiro et al., 2011; DeSteno et al., 2004; Ubel, 2008), stress/fatigue (Epley, Keysar, Van Boven, & Gilovich, 2004; Stewart & Payne, 2008), vagueness/uncertainty/ambiguity (Bogaerts et al., 2010; Cavalheiro et al., 2011; Charness & Gneezy, 2003; Donaldson, Gooler, & Scriven, 2002; Gilovich, 1993; Lin, Lin, & Raghubir, 2003; Sharp et al., 2012), or persuasion (Corazzini et al., 2010; Demarzo, Vayanos, & Zwiebel, 2003). The end result is faulty decision making based on deficient judgmental capabilities. For example, Fehr and Tyran (2008) conducted experiments involving financial simulations. During these simulations participants were placed through a sequence of scenarios, and their methods of navigating the scenarios were measured. The results of this study support the idea that people, when distracted by environmental and inter-personal stimuli, may deviate from rational and systematic decision-making models, and then they will make choices based on this (sometimes misleading) input (Sharp et al., 2012).

Habits also reinforce bias, for they may be formed by the subjective drives of an individual (Levesque et al., 2008; Stewart & Payne, 2008), influences of the environment (Berry, Shanks, & Henson, 2006; Senay & Kaphingst, 2009), or by biology and evolution (Meschiari, 2009; Nairne, Pandeirada, Gregory, & Van Arsdall, 2009). The social environment is one of the strongest determinants of habits, for it can install a sense of value, purpose, belief, or belonging (DeSteno et al., 2004; Gibbons et al., 2009; Tversky & Kahneman, 1974). Once people become comfortable with routine, it can often be difficult to change. Therefore biases that are formed from habits are often difficult to undo (Kahneman, 2003; Öhman et al., 2001). Levesque et al. (2008), for example, help support the theory that perceptions and behaviors are automatically and unconsciously guided by primed stimuli. This means that people will often react to situations in ways consistent to past similar experiences and exposure.

Biases sometimes radically affect an individual's locus of control, also known as the illusion of control, which is the degree that a person believes that he/she directs things that may be uncontrollable (Kos & Clarke, 2001; Taylor, 2009). This fallacy occurs when people lead themselves to believe that they govern aspects of their lives, or aspects of the world, that are mostly the effects of chance. For example, Charness and Gneezy (2003) found that some gamblers believe that they can control probabilities of a known game of chance; this is also known as gambler's fallacy (Gilovich, 1993). In addition, other individuals that participate in group projects may mistakenly assume that they hold sole responsibility for the project's results instead of attributing them to the contributions of the entire group (Greenwald, 1980).

Lastly, people can often be led by how they believe the world should be instead of how it actually exists (Ball, 2002; Gilovich, 1993). The difference between the actual and the ideal can sometimes become indistinguishable, and people may tend to believe that their situation, or view of the world, is unchangeable regardless of overwhelming evidence against it (Flyvbjerg, 2008). These are known as opinion versus fact discrepancies (Greenwald, 1980).

To continue exploring how biases are formed the next few sections are dedicated to their theories of origin. Afterwards an exploration of the different types of biases will be presented. Because there are many forms of bias, most beyond the scope of this report, only a handful will be discussed. The two main focal points will be familiarity bias and persuasion bias, for they are the variables of influence for the current experiment. Others, such as optimism, attribution, confirmation, hindsight, order, and knowledge biases, will also be briefly discussed.

Explanations of Bias: History and Theories

Egocentricity, beneffectance, and cognitive conservatism.

Greenwald (1980) theorized that the three drivers of bias are *egocentricity*, *beneffectance*, and *cognitive conservatism*. According to Greenwald, egocentricity occurs when someone refers to their knowledge and experience as more valid sources of truth than the input from outside sources. Beneffectance is a tendency for people to only claim responsibility for things that are positive, like success, and to refuse to claim responsibility for things that are negative, like failure. Lastly, change can be undesirable because it is perceived as difficult, uncomfortable, detrimental, or otherwise completely unnecessary (Gilovich, 1993). Therefore many people prefer the concept of conservatism. Conservatism is defined by an attempt to preserve what is already established; therefore cognitive conservatism is people's attempts to retain a current belief or state of mind. This desire to preserve is so strong that some are reluctant to admit that they have changed their mind even if they have (Greenwald, 1980). This is reflected in the studies of confirmation bias and hindsight bias; both of these will be discussed later. Egocentricity, beneffectance, and cognitive conservatism can be demonstrated by professionals and lay people alike, and awareness of these factors does not necessarily fix their influence (Flyvbjerg, 2008).

The role of memory.

Biases and memory share a mutual relationship. This is because memory is constantly shaped by bias, and similarly, biases require memory to exist (Greenwald, 1980). To explain further, the consolidation of memory from experiences condition people, and they subsequently effect how people consolidate future memories (Tversky & Kahneman, 1974). For example Nairne et al., (2009), as well as Tversky and Kahneman (1974), argue that learning and memory are at the mercy of how an individual codes each memory.

Some studies support the idea of a unitary memory system. For example a study conducted by Berry et al. (2006) found no evidence of any influence of multiple memory systems; however the findings of Klein et al., (2002) argue that the brain supports at least five different memory processes: working (short-term memory and attention), procedural (memory of skills), perceptual (memory of the senses), semantic (memory of concepts), and episodic (memory of events). Biases may develop through each of these types of memories, or by combinations of them (Berry et al., 2006; Green, Fugelsang, & Dunbar, 2006; Klein et al., 2002; Seitz, Nanez, Holloway, Koyama, & Watanabe, 2005).

The studies of Kahneman (2003), Levesque et al. (2008), Wolfe, Butcher, Lee, and Hyle (2003), support the philosophies of unconscious memories, such as unconscious priming and memory consolidation, as well as their strong effects on behavior. Biases formed by any of these can be easily developed, and they are often difficult to extinguish (Öhman et al., 2001). Gilbert and Osborne (1989), Kahneman (2003), Senay and Kaphingst (2009), and Stewart and Payne (2008) found that bias must be corrected early, by corrective/effortful thinking, or the effects of nonconscious priming will be long-lasting. The original focus of Gilbert and Osborne's (1989) studies was to explore stress and cognitive busyness as ways of intensifying bias decision making. While they demonstrated that bias judgment occurs during times of cognitive busyness (e.g., distractions or stress), they also found that the effects can be corrected as long as participants can recall the original influences that affected their judgment in the first place. The act of mentally tethering knowledge to its source is called source monitoring (Birch, 2005; DeMarzo et al., 2003) or mindfulness (Kahneman, 2003; Levesque et al., 2008). If people cannot recall the origins of their bias then the influences that generated it become untethered from conscious awareness, and the bias therefore remains (Wood, 2000). Gilbert and Osborne (1989) use the term *metastasized* to explain the biasing effects of untethered information (unconscious priming or implicit memories). This is due to the term's use in health and medicine: a cancerous tumor is much more difficult to treat when portions of it metastasize (disconnect and spread around the body). To explain all of this in another way, when primers or other influencers become disconnected from explicit memory, and people are unable to recall from where they received their information, then these influences are more likely to become internalized and cause bias (Levesque et al., 2008; Wood, 2000).

Schemata and cognitive heuristics.

Biases are often derived from *schemata* (singular: schema) and *cognitive heuristics*. Both of these are the product of automatic thinking (Bartlett, 1932; Stewart & Payne, 2008). Schemata are basically clusters of knowledge that have been compartmentalized into memory units; these units are quickly accessible to a person in order to identify and define the properties, activities, and relationships among stimuli (Brewer & Nakamura, 1984; Meschiari, 2009). Heuristics are groups of schemata that are arranged in specific ways in order to reach immediate conclusions about things (e.g., people, activities, or ideas). The main differences between the two are that schemata are used in identification, and heuristics are used to form judgment. Both are, as said by Meschiari (2009), the "primary paradigm of our species to interpret the complexity of reality." In other words they are mental short-cuts that allow for less inner cognitive deliberation; this saves time and mental effort (Adaval, 2003; Brewer & Nakamura, 1984; Cavalheiro et al., 2011; Chaiken & Maheswaran, 1994; Gilovich, 1993; Hall, Ariss, & Todorov, 2007; Kahneman, 2003; Tversky & Kahneman, 1974).

Studies carried out by Klein et al. (2002) helped support the idea that human behavior relies on a relationship between mechanisms that modify behavior based on new information (named “decision rules”), memory systems that store this information, and processes that can retrieve and access the information at a later time (named “search engines”). Engel, Fries, Singer (2001), Gilovich (1993), Greenwald (1980), Kahneman (2003), Klein et al.(2002), Levesque et al. (2008), Meschiari (2009), Nairne et al. (2009), and Öhman et al. (2001) support the idea that the cognitive and memory processes that allow for biases derive from an evolutionary need for survival. The point is to establish quick adaptive behaviors (Klein et al., 2002; Levesque et al., 2008), or to preserve some type of order (Greenwald, 1980). Useful information that cause significant or beneficial results for people will continue to influence behaviors at later times; the significant information in these cases is then said to be *primed* (Levesque et al., 2008; Wolfe et al., 2003). Primed information then develops cognitive recall priority more than other types of information (Klein et al., 2002). Collections of information inevitably develop into mental networks; this then leads people to exhibit automatic judgments and behaviors. Those mental networks are considered the blue prints of schemata and cognitive heuristics.

Fehr and Tyran’s (2008) financial simulations demonstrated that the constant use of rational frameworks for decision making can be cognitively taxing. Therefore heuristics can be formed by convenience. In addition, they may be encouraged by effective mental 'weights' that are tied to them such as emotional reactions, religion/beliefs, moralities, or social/cultural factors (Cavalheiro et al., 2011; DeSteno et al., 2004; Gibbons et al., 2009; Kahneman, 2003). Overall, most schemata and heuristics are developed by experiences and conditioning imposed by others or imposed by one's self (Adaval, 2003; Bartlett, 1932; Brewer & Nakamura, 1984).

Klein et al. (2002) showed that semantic-type generalizations (e.g., broad concepts) are faster and easier to recall, but they can sometimes be deficient in accuracy. Episodic memories (e.g., memories of events) provide better accuracy, but they are burdened by slower and methodical serial (or controlled) processing. Therefore mental-default heuristics occur in parallel (or automatic) processing (Chaiken & Maheswaran, 1994; Gibbons et al., 2009; Stewart & Payne, 2008). They may be semantic in nature because they are used most during times of stress, fatigue, distractions, or other situations when cognitive resources are hindered (Gilbert & Osborne, 1989; Stewart & Payne, 2008; Ubel, 2002). The only exception to this appears to be under extreme forms of stress or physiological activity (e.g., exercise) when no energy is available for even top-down biases to occur (Bogaerts et al., 2010). Because the use of heuristics is easier then overhauling a person's current belief system they tend to be initially used unless there is sufficient reason to deviate from them (Gilovich, 1993). Some reasons for deviation are incentives and contradicting evidence (Das et al., 2003; Epley et al., 2004; Sharp et al., 2012), or the persuasive guise of incentives or contradicting evidence (Corazzini et al., 2010). This is ultimately how many biases are formed: experience-derived generalizations are preferred over tedious detail extrapolation.

Internal versus external.

Although the idea of stimulus-driven and goal-driven processes is seen throughout studies of memory and cognition, their proper nomenclatures sometimes change depending on the phenomena being investigated. For example, the terms bottom-up/top-down tend to be used in studies regarding information processing (Engel et al., 2001; Wolfe et al., 2003), the terms preattentive/postattentive have been used during studies of attention (Öhman et al., 2001), the terms inceptive/derived have been used during studies of memory (Klein et al., 2002), and the terms informational forces/motivation forces have been used in some cases of bias studies (Greenwald, 1980). Despite the arenas in which these nomenclatures exist, they all describe the interactions of the ascending and the descending perceptual pathways of the central nervous system.

One of the earliest models to propose this concept was the adaptive resonance theory by Grossberg (1987); it was then later refined with the help of Carpenter and Grossberg (2002). This real-time network model helps describe supervised and unsupervised learning, and it suggests that information is synthesized or recognized by the interplay of memory and the senses. The internal/external relationship and interaction is the backbone of this theory. It states that data is originally received by the senses, and it travels up ascending pathways to memory. Memory then guides further perception by regulating the senses via descending pathways (Engel et al., 2001; Carpenter & Grossberg, 2003; Grossberg, 1987).

What results from these models is the idea that decisions are made somewhere within the parameters of the *inside view* and the *outside view*. Table 1 displays how strengths of biases can be measured on one of these scales; one end is considered the inside view and the other end is considered the outside view. The inside view represents the egocentric side of the spectrum. It allows an individual to be tightly bound to their own position; this is the position that they use to assess any new information. The outside view is the opposite, for people develop their understandings based on actual real-world information. Basically, the inside view is internally driven, and the outside view is externally driven (Engel et al., 2001; Flyvbjerg, 2008; Öhman et al., 2001; Wolfe et al., 2003).

Table 1. Inside View/Outside View Spectrum

Inside View		**Outside View**
Top-Down		Bottom-up
Post-attentive	←——————————————————→	Pre-attentive
Derived		Inceptive
Motivational sources		Informational sources

Self-determination theory.

Because most biases are internally driven, it is important to discuss motivation and how it becomes internalized. The *self-determination theory* (SDT) currently stands in the forefront of this research. Constructed by Deci and Ryan (2000) this macro-theory of motivation, personality, and optimal functioning basically explains that human motivation occurs through different stages or avenues (Deci & Vansteenkiste, 2004). The processing through which people place themselves in order to become motivated can affect the quality and autonomy of their resulting motivation. What this means is that motivation is weaker and more effortful if people are driven to something when it *leads to* the goal; in contrast, motivation is stronger and more automated when people are driven to do something when it *is* the goal (Deci & Ryan, 2000).

SDT relies on three critical principles. First, humans are innately proactive instead of passively controlled by all external sources. Next, humans are not the sole result of social programming, but they instead self-organize in order to grow, develop, and integrate. Lastly, although all of these qualities are inherent in humans, people still require the right type of nurturing environments in order to capitalize on these inner capabilities. The idea is that people have inner drives to act, and their environments can either hinder or encourage these drives (Deci & Vansteenkiste, 2004).

SDT also explains that motivation is a regulatory process that may involve several stages: amotivation, extrinsic motivation, and intrinsic motivation. Table 2 displays each of these steps from absence of motivation to internalized motivation (Gagné & Deci, 2005). Amotivation represents a lack of drive; this occurs in the beginning before people become interested or, in the end, when people lose interest. Motivation then becomes activated through four types of extrinsic motivations: external regulation, introjected regulation, identified regulation, and integrated regulation. During extrinsic motivation people are driven to something as a means to a goal (e.g., exercising in order to look attractive). Once intrinsic motivation is achieved people are driven to do something as the goal itself (e.g., exercising because they enjoy doing it) (Gagné & Deci, 2005; Levesque et al., 2008).

Table 2. Stages of SDT and Motivation (Gagné & Deci, 2005)

Amotivation	**Extrinsic Motivation**				**Intrinsic Motivation**
	External Regulation	Introjected Regulation	Identified Regulation	Integrated Regulation	
Absence of intentional regulation	Dependent on reward and punishment	Dependent on self-worth within a community	Important for goals, values, and regulations	Assists goals, values, and regulations	Interest and enjoyment of the task
Lack of motivation	Controlled motivation	Moderately Controlled Motivation	Moderately Autonomous Motivation	Autonomous Motivation	Inherently Autonomous Motivation
Impersonal	External	Somewhat External	Somewhat Internal	Internal	Internal

Several methods of bias formation and attitude change follow similar avenues. For example the *transtheoretical model of behavioral change* has been used by health psychologists as a model similar to SDT. This model utilizes a five-stage process that people may use in order change unhealthy behaviors. These stages are precontemplation, contemplation, preparation, action, and maintenance. The precontemplation stage is similar to amotivation because both involve the indifferent period of time before the person is interested in psychological change. The contemplation and action stages are similar to extrinsic motivation because they involve making the changes in response to something (e.g., become healthier or save money). Lastly, the maintenance stage involves keeping the desired behaviors. According to the theory, the maintenance stage is reached after six months of adopting the new behavior; it may be during this time that the person has associated the new behavior as a part of themselves. The transtheoretical model of behavioral change is therefore another example of how SDT may be used practically in real world settings (Prochaska, DiClemente, & Norcross, 1992; Prochaska, 1994).

Anchoring and adjustment theory.

According to the egocentric *anchoring and adjustment theory* (Tversky & Kahneman, 1974), also known as recognition-primed decision making (RPD) (Klein & Klinger, 1991; Klein, 2008; Klein, Moon, and Hoffman, 2006; Lipshitz & Strauss, 1997), people assess new situations and ideas by variously adjusting from their own knowledge (Epley et al., 2004; Fehr & Tyran, 2008; Kahneman, 2003; Senay & Kaphingst, 2009). They do not completely abandon these beliefs in the presence of new ones, but instead use their own experiences as check-points of judgments known as *anchors*. People initially secure their own perspective, and then they selectively adjust it based on new incoming information. The adjustments are typically discrete, and they will shift just enough until people believe that they have encompassed the new perspective. If it is not encompassed, then more adjustments are needed. The idea is that the “anchoring” (or securing) comes naturally and instinctively to the person, and then the “adjustment” involves the conscious effort needed to cross the divide between their own anchor and the anchors of others. If this divide is overcome, and the connections are established, then an agreement or understanding is reached between the two perspectives (Epley et al., 2004; Fehr & Tyran, 2008; Kahneman, 2003; Tversky & Kahneman, 1974; Senay & Kaphingst, 2009). These adjustments are not necessarily meant to bring people closer to accuracy, but instead closer to another position. For example, when you talk to your friends you are not necessarily trying to get them to understand what is correct; instead, you are simply trying to get them to understand you or your perspective.

The idea of perception and perspectives is an important one. Pickens (2005) proposed that perception is the process by which organisms interpret and organize sensation, and this produces a meaningful experience of the world. In humans, this is largely influenced by prior experiences. The same event can be experienced in different ways, and our perceptions are bound to our experiences (Kahneman, 2003). Birch and colleagues (2007) found that, as children, biases tend to be at their strongest (Birch, 2005; Birch & Bloom, 2007). They then ease away with age because people learn laws of nature as well as the perspectives of others. Under the right circumstances we are eventually trained to abandon egocentricity in favor of the adaptive advantage of understanding. For example, it is sometimes in the favor of people to understand the views of the group instead of fixating on their own, or it benefits them to understand both sides of an argument. As mentioned earlier, we will continue to see the world within the parameters of our own biases unless given evidence or incentives to do otherwise (Das et al., 2003; Senay & Kaphingst, 2009). To some degree however we continue to allow our perceptions to be egocentrically driven. In this case biases are not necessarily formed, but they are instead maintained from birth (Epley et al., 2004; Tversky & Kahneman, 1974).

Anchoring and adjustment bias can be overridden or deactivated however. People are inclined to adjust their perspectives more under persuasion techniques (DeMarzo et al., 2003), or when incentives for accuracy are offered. Examples of these incentives are rewards, like getting good grades, by understanding the points of view from other people. Incentives for accuracy can be positive or negative, and can be represented by cash rewards, or the risks of harm and death (Das et al., 2003; Senay & Kaphingst, 2009; Sharp et al., 2012; Wood, 2000). Another way to maneuver around anchoring and adjustment is to have information delivered from trusted sources such as friends, family, or others within the same social group (e.g., political, religious, or ideological; Anolli, Zurloni, & Riva, 2006; DeSteno et al., 2004). These are cases when “anchors” are less likely to be initially dropped, and therefore people are more susceptible to a complete overhaul of their beliefs (Epley et al., 2004; Tversky & Kahneman, 1974).

As mentioned earlier other situations can have a reverse effect, and they can instead encourage anchoring and adjustment. Due to impairment of cognitive resources, errors due to biases occasionally thrive under stress. One reason for this is because some types of memories are more resilient than others. Because short-term memory is much more vulnerable to stress than long-term memory, people will often rely on aged and trusted heuristics that they have maintained for a long time (Martinussen & Hunter, 2009). Epley et al. (2004) conducted experiments to identify the mechanisms with which this phenomenon occurs. They found that adjustments are effortful, and are therefore taxed under circumstances that exhaust mental resources. Examples of these circumstances are time pressures, fatigue, and other stressors (Chaiken & Maheswaran, 1994; Kahneman, 2003; Stewart & Payne, 2008). They are factors that inhibit people's efforts to effectively utilize their cognitive abilities like attention and judgment; therefore they will be less capable of optimally performing the mental work of adjusting. In these cases the instinctive “anchor” will be dropped, but there will be less energy with which to “adjust” very far from it. As a result people will more likely judge information from their own perspectives instead adjusting or compromising with others’. In other words, we are more egocentric when hurried or stressed (Epley et al., 2004; Gilbert & Osborne, 1989).

Phenomenon of unidimensional opinions.

Biases can be created from other biases; different types of biases can also attract and adhere to each other. DeMarzo et al. (2003) explored models based on these occurrences. They called them the *phenomenon of unidimensional opinions,* and they explain that individuals’ beliefs regarding multiple issues can easily converge into one extreme polar position (Gilbert & Osborne, 1989; Gilovich, 1993). One example that is given is the “left-right” spectrum in U.S. politics (DeMarzo et al., 2003). If a person has a powerful opinion on a single topic, such as pro-choice or pro-life, then they may eventually feel inclined to associate and collaborate with others who maintain this same opinion-such as liberals or conservatives respectfully (Callahan, 2004). Continued exposure to these groups inevitably causes other tangential opinions to merge with that of the groups’ (Senay & Kaphingst, 2009). As a result, many people will begin to adhere to the beliefs of their respective social communities.

This is because mental consistency is satisfying for people. Any inconsistencies may lead to *cognitive dissonance* which is the inner mental conflict people have when their attitudes, values, and behaviors conflict with one another. Cognitive dissonance occurs more dominantly when there is some type of behavioral, motivational, or emotional commitment to one or more of the conflicts between opinions (Greenwald & Ronis, 1978; Wood, 2000). Wood (2000) provides an example of cognitive dissonance in one of her studies. Both she and Callahan (2004) found that people who defined themselves as Christian conservatives expressed pro-welfare attitudes when they were identified by their religious positions (Christian), but they then expressed anti-welfare attitudes when they were identified by their political position (conservative). In order to overcome these contradictions higher order mental strategies are used; these will be discussed shortly.

There are several theories on why beliefs and heuristic biases can become clustered and connected. DeMarzo et al. (2003) explain that some beliefs relate to others so well that they form thick mental associations. These associations become widespread and inevitably merge different beliefs into clustered groups. Once the connections are established, and the framework is laid out, it is sometimes difficult to see where one belief ends and another begins-regardless of how many degrees of separation are present. Propaganda, censorship, and marketing for example, often make it very easy to polarize almost any discussion; they often encourage people to choose and maintain a specific side (DeMarzo et al., 2003; Rankin-Box, 2006).

Other relationships however are harder to tie together. For example, in the United States, those who belong to the traditional right endorse the idea of preserving life by abolishing abortion; however the same groups also support gun ownership, war, and the death penalty. The question then forms: How can a group cherish human life, and then support so many other forms of death? This leads some people to adopt the theory of multiple attitudes. This theory explains that people can, in fact, own different and contradicting opinions and attitudes instead of integrating them in a unidimensional way (Wood, 2000).

Other theories are offered however that explains that, as different and conflicting as some attitudes can be, they have the potential to be abstractly assimilated, related, and unified. Green et al. (2006a) conducted studies of human analogical thinking and how this allows people to lump ideas into categories and contexts. The relationships of some broad ideas, or semantics, are obvious; for example "hand is to glove as foot is to sock" provides very easy analogical mapping (hands wear gloves and feet wear socks). This is called *conventionalized semantic relation*. Their study provided support for two main concepts. The first concept is that categorization is a necessary mechanism for analogical mapping; this means that in order to establish a relationship between two concepts they first must be viewed as belonging within one specific group. For example hands go into gloves just like feet go into socks. The second concept is that analogical and categorical thinking can be unconsciously primed (Levesque et al., 2008; Wolfe et al., 2003); this means that it is easier to make associations between two components if a context has already been provided to aid in the pairing. Going back to the example of preserving life, it is difficult to sell the idea that abolishing abortion will preserve life just like guns/war/the death penalty will preserve life. If a context is provided however, such as "the world is a dangerous place" and "protection from dangerous people makes the world less dangerous," then the idea that guns, war, or the death penalty will preserve life (primarily your life) seems more convincing and understandable. This is further compounded if people's cherished beliefs are invoked and manipulated (Callahan, 2004). Once the category is established, then the analogy between two seemingly abstract ideas can be produced; this is a process called *abstract relational integration* (Green et al., 2006a). In another study, Green et al., (2006b) demonstrated that the parts of the left frontopolar cortex of the brain is primarily activated during abstract relational integration; this area is assisted by the parieto-frontal area which is normally activated during every day working memory tasks. Although Green et al. (2006b) discuss this philosophy in regard to thought processes of an individual person, its relevance is equally noticeable when applied to broader social group thinking (Anolli et al., 2006; Rankin-Box, 2006).

Another consequence of the unidimensional nature of people's beliefs is that ideas are often lumped into moral categorical extremes. This means that ideas will not only be placed into the left-right spectrum, but they may also be placed into right-wrong or good-bad spectrums (Anolli et al., 2006; Kahneman, 2003). Therefore it is sometimes difficult to deliver some information in a neutral way. People come equipped with certain sensitivities to issues that can turn the most harmless concept into a terrifying concern (Das et al., 2003; Klein & Harris, 2009; Öhman et al., 2001; Senay & Kaphingst, 2009). Strong emotions produce stronger polarizing and unidimensional decisions. Therefore successful persuaders have learned that opinions are more susceptible if intense emotions are invoked (Cavalheiro et al., 2011; DeSteno et al., 2004; Kahneman, 2003; Ubel, 2002). At least initially, using topics or words that are dangerous or taboo in nature will capture attention (Aquino & Arnell, 2007), and they will spark intense attitudes that can launch beliefs into extremes (Öhman et al., 2001).

Unidimensional opinions may be guided by informational influence, which is information obtained for the sake of understanding knowledge. It may also be guided by normative influence, which is information obtained for the sake of fitting into a group or society (Gilovich, 1993; Wood, 2000). In either case, evidence of the phenomenon of unidimensional opinions has been so overwhelming that people's eventual position can often be predicted based on their social networks (DeMarzo et al., 2003; Sargeant et al., 2010). It could therefore be applied to commercial space travel. For example people may discourage this activity if they are uncomfortable with the ideas of flying, upper atmospheric environments, or human existence beyond planet earth. According to the phenomenon, their pro-space travel or anti-space travel opinions may begin with one single preference, and then related preferences will be absorbed until they eventually grow into a multi-faceted, yet polarized, position.

Biological basis of bias.

Now that some basic psychological theories have been discussed, it is of value to review the interactions between the physical components inside the body that may allow for bias behaviors. Our nervous system, to include the brain, functions as a result of the communication or "firing" between the individual cells called neurons. The firing of these neurons causes mental processes such as memory, perception, attention, and behaviors. Top-down influences begin in the prefrontal and parietal cortexes; these are the areas in the top-front and top-middle portions of the brain. The influences are shaped by positive reward signals and negative fear signals that are delivered primarily from the nucleus accumbens and the amygdala respectfully; both of these are located in the core of the brain. These signals travel to higher cortical areas causing repeated neuronal firing, or they travel down and out to lower levels of the nervous system through trails called efferent pathways.

Bottom-up influences however begin in the sensory organs and nerve endings located in the eyes, ears, nose, tongue, and skin. These influences move up along portions of the spinal cord called afferent pathways. Eventually sensory information reaches another core-section of the brain called the thalamus. With the exception of the sense of smell, the thalamus redirects all afferent sensory input to higher levels of the brain. For more on the nervous system or the biological basis of behavior, see Pinel (2000).

Engel et al. (2001) compiled findings from neuroscientific studies in order to theorize a biological sequence of events that cause bias behaviors. They argue that large-scale interactions occur between the higher and lower brain areas. Signals from afferent sensory pathways bombard the higher cortical cells (Engel et al., 2001). Continuous activation of these cells then increases their sensitivity for subsequent activation; this means that the more a cell is fired, the more it will fire when prompted by tangent cellular activity (Klein et al., 2002). Translated into mental behavior, if cellular firing is tied to a specific mental process, like memory, then the repetition of that thought process should increase the likelihood of it happening again-as well as increase its speed when it does.

This process eventually causes clusters of cells to become internally synchronized, which means that they fire within milliseconds of each other. Specific data is encoded into specific cells that fire in unique patterns when the data is later recognized by upward afferent information. Persistent firing can eventually initiate large scale influences; this means that they spread to other multiple regions of the nervous system and recruit other groups of brain cells. All of these areas become integrated, and they are then used simultaneously. When this happens, external stimulus is no longer necessary to initiate cellular activity in these regions. Together these events encourage types of memories, goals, decision making, anticipation, and other types of internal mental phenomena (Engel et al., 2001).

Some of the signals generated from all of this activity are termed *bias signals* because they become automated and may occur regardless of input from external sources (Engel et al., 2001). Bias signals primarily operate in the gamma range frequency; this means that they are the consequence of brain cells firing at a frequency of 20 to 100 hertz-with or without external stimulus. The bias signals from these higher areas are then carried down to sensorimotor circuits where they can affect or prime these areas, that way data is either swiftly recognized or ignored (Levesque et al., 2008). Both consequences are caused by the continuous use or non-use of neurons, and they will either encourage neuronal activation or suppress it respectively. This then allows data to be recognized faster and with higher reliability, or cause it to be overlooked (Engel et al., 2001). In other words, brain cells can be programmed for bias. They therefore affect that which we attend to or ignore, or they affect what we find valuable or neglectable (Carpenter & Grossberg, 2002).

In addition to the dynamic nature of higher cortical areas, *neuroplasticity* (the structural and functional changing of neurons and their connections) is also observed in lower-level processes like in the sensory organs. This is termed *perceptual learning*, and it leads to automated biological consequences known as *perceptual biases*. Seitz et al.

(2005) conducted studies that support the theories that environmental exposures can program sensory thresholds in lower-level cellular areas of data processing. Their experiments presented unsuspecting pilots with a virtual flight task. During the simulations, 200 low-luminance dots, hidden in the display, moved in specific directions. Although the pilots seemed unaware of the movements, directions, or presence of the dots, the unconscious stimuli led to a false detection of motion after the dots were later removed. Although top-down, higher cortical, processes cannot be completely ruled out, this phenomenon can happen completely independent of attention and consciousness. This effect can be seen not only for sight, but through other sensory modalities such as smell, hearing, taste, and touch; refer to Seitz et al. (2005) for more on this.

Data/Frame Theory.

The Data/Frame theory provides alternative explanations to those that are offered by theories of bias. According to Klein, Moon, and Hoffman (2006) people make sense of the data they receive by mentally organizing all of it into frameworks of information; these are known as *frames*. A frame can be considered as someone's perspective or point-of-view. One reason for developing and utilizing frames is to create cause and affect relationships that may be used later, and this saves time that is normally consumed by extensive or difficult thinking. This is similar to heuristic biases with one exception: biases are consciously or unconsciously designed by an individual in order to automatically deliver immediate conclusions. Frames however are designed to be malleable constructs that are changed and modified based on new information (Klein et al., 2006; Tversky & Kahneman, 1974). Table 3 shows the primary differences between frames and heuristic biases. There is a close relationship between the two, however. For example, Klein et al. (2006) explain that frames can often affect the way information is interpreted, and therefore frames may also be responsible for misperceptions normally attributed to biases. In addition, Stewart and Payne (2008) provided evidence that some of the most stubborn biases can demonstrate malleability, and they can change under the right contextual, motivational, or attentional circumstances (e.g., priming and corrective thinking).

Table 3. The Differences between Frames and Heuristic Biases.

Frames	Biases
Used to make sense of the world by gathering and assessing new information	Used to make sense of the world by making definitive conclusions
New data is used to change/modify when needed.	New data is perceived/interpreted in order to complement existing belief
Function as hypotheses about connections between data	Functions as solid unchangeable beliefs about connections between data
Knowledge that is malleable/dynamic	Knowledge that is fixed/static

Cognitive bias discussion.

It is the goal of existentialism to define the meanings in, and of, life; therefore it enriches the discussion to end this section with existential theories of how bias is allowed to exist. In this case the appropriate question may be: What drives people to believe, or behave, how they do? Four ideas are provided in response to this question. Fredrick Nietzsche offers the *will-to-power*; this explains that people do what they do in order to gain control of their lives and become the masters of their domains. Sigmund Freud offers the *will-to-comfort*; this explains that people do what they do in order to gain pleasure or satisfaction (e.g., physical satisfaction or mental satisfaction). Victor Frankl offers the *will-to-meaning*; this explains that people do what they do in order to gain understanding about the world and their place within it (Pervin, 1960). Lastly Pickens

(2005) explained how Fritz Heider brings the above theories together. He explained that people do things in order to understand their world, so that they can feel in control of it. This understanding and control over their lives then leads to general satisfaction (Pickens, 2005).

So far it appears that biases therefore stem from people's need to achieve meaning. It is an innate human need to identify patterns in nature, and there is an attempt to extract an understanding based on these patterns. In this aspect, most humans often tend to display characteristics of apophenia. Apophenia, introduced by Conrad (1958) as Apophänie, is a psychological phenomenon in which people attempt to attach patterns and meaning to otherwise completely random data. Meschiari (2009) discusses apophenia as well as its visual and auditory manifestation: pareidolia. He explains how pareidolia allows people to consolidate items in their vision in order to make a complete image: "In a system of dark and light spots, the eye, stimulated by confused forms devoid of autonomous meaning, analogically completes outlines and ambiguous masses, based on the model of known images (pg. 6)." Examples provided by Meschiari are string figures (an international game which interprets meaning from woven patterns of string between fingers) and paleolithic art (ancient art in which the artists graphical emphasized random dark spots on cave walls in order to transform the discolorations into animals or other characters). Another example could include Rorschach tests; these are tests with which people identify pictures in symmetrical and ambiguous images (Wood et al., 2000).

Apophenia, pareidolia, and other mental phenomena similar to them, are very well known, and theories have been made regarding how they work. For example Treisman and Gelade (1980) proposed the feature-integration theory of attention. This theory explains that pieces of sensory data, such as vague geometric shapes, first transverse through multiple pathways of the brain. The initial areas code for things like colors, shapes, locations, or movements; later areas of the brain, such as the parahippocampal place area and the retrospenial cortex (Meschiari, 2009), are responsible for assembling the pieces in order to combine them into a unified image. Also according to the feature-integration theory, certain combinations are cognitively "glued" together automatically whereas more complicated images require attention. People instinctively integrate their sensory experiences into a unified perception (Treisman & Gelade, 1980); similarly they also show an instinctual desire to integrate various characteristics of their environments into a unified understanding of the world (Meschiari, 2009).

These sense-making internal mechanisms that lead us towards "hyper-interpreting natural signals (Meschiari, 2009, pg. 10)" have advantageous survival characteristics from an evolutionary perspective (Gilovich, 1993; Kahneman, 2003; Levesque et al., 2008; Meschiari, 2009). However some instances, as are the cases of some vestigial features of humans (e.g., wisdom teeth or philoerection), these functions may be useless or undesired by-products or side-effects, and they are derived from some other necessary biological activity (Klein et al., 2002; Tversky & Kahneman, 1974). Some of these cognitive side-effects lead to persistent misperceptions that are unhelpful and sometimes even potentially harmful (Charness & Gneezy, 2003; Gilovich, 1993; Kahneman, 2003; Stewart & Payne, 2008). Taking everything together, it then appears that biases are ways of allowing people to believe that they understand aspects of themselves and their world. These perceptions of understanding may be inaccurate compared to real world contextual information, but regardless the perceptions may become grounded and persistent due to the satisfaction that accompanies them (Meschiari, 2009).

Bias Types

The above section discussed theories of bias formation and modification. This next section will present the different ways that biases manifest. As will be demonstrated, each bias has its own behaviors as well as underlying cognitive mechanisms. Because an evaluation of all types of bias is beyond the scope of this report, only biases related to the experiment are offered. These are optimism bias, attribution bias, confirmation bias, hindsight bias, order bias, knowledge bias, familiarity bias, and persuasion bias.

Optimism bias.

Optimism bias, or organizer bias, is typically found in people who are developers of projects (e.g., commercial space travel). It is important not to confuse this type of bias, an unintentional form of deception, with strategic misrepresentation, which is an intentional form of deception (Flyvbjerg, 2008). Formerly known as the “planning fallacy,” it normally occurs when people fail to compare their particular situations with prior similar ones (Sargeant et al., 2010).

Lin, Lin, and Raghubir (2003) refer to optimism bias as self-positivity. They conducted three experiments that tested self-positivity, the effects of mitigation, and their effects on the perception of cancer risk. Those with high general optimism perceived their probabilities of being diagnosed with cancer as lower than that of the rest of the population. These perceptions changed when real-world statistical data, or base-rates, were used as bias mitigation (Lin, Lin, & Raghubir, 2003).

Like most biases, optimism bias tends to stem from an egocentric view, and this leads people to believe that they are somehow exceptions to the norm (Kos & Clarke, 2001). One example of this bias is the Pollyanna principle, or the Pollyanna effect (Matlin & Stang, 1978); this is when people intentionally avoid confronting or contemplating potential problems. They instead assume that everything will work itself out (Lipshitz & Strauss, 1997). Optimism bias involves a tendency to over-inflate advantages and underestimate disadvantages in order to perceive improvement where it may not exist (Greenwald, 1980). It often involves underestimating costs, risks, and timelines associated with projects and project completion. Optimism bias can be beneficial at times by reducing anxiety (Kos & Clarke, 2001; Meschiari, 2009), to increase self-esteem, or to just generally feel happy (Lin, Lin, & Raghubir, 2003), however it can also lead to neglect-related problems like negative health consequences (Kos & Clarke, 2001; Lin, Lin, & Raghubir, 2003; Sargeant et al., 2010).

Sources of optimism bias may not originate from within the person alone, but also come from outside sources such as political pressures, organizational pressures, morals, ethics, or culture (Anolli et al., 2006; DeSteno et al., 2004; Hirsch & Baxter, 2010; Flyvbjerg, 2008; Sargeant et al., 2010). Optimism bias can be complicated by other mental phenomena such as skill decay (Wisher, Sabol, Sukenik, & Kern, 1991) or anchoring and adjustment bias (Epley et al., 2004; Tversky & Kahneman, 1974). In a strong professional culture, this can produce individuals whose confidence dangerously outshines their actual skill level (Cavalheiro et al., 2011).

When people are convinced that they are well-informed in a topic, regardless of how well they actually know it, then they are prone to use limited information in order to come to conclusions (Fehr & Tyran, 2008; Huberman, 2001; Kahneman, 2003). This can be a problem if an accurate conclusion requires more information outside of the knowledge that is available to them (Hall et al., 2007; Gilovich, 1993).

Attribution bias.

Attribution bias, also known as blame bias or self-serving bias, influences where blame is placed. It often occurs between an observer and a participant. Because the points of view of an event are often different, attributions of the event vary between the perspectives of individuals. To put it in another way, determining causes of accidents and risks is dependent on who is making the decisions (Gilovich, 1993; Martinko & Thomson, 1998). Normally people who are directly involved in an incident will place blame on factors outside of their control. Others that are not directly involved, like spectators or upper management, will place the blame on factors inside the control of the participants (Kouabenan, 2009; Martinko & Thomson, 1998). Attribution bias is similar to the idea of beneffectance proposed by Greenwald (1980) as it agrees with the idea that people attach themselves to positive consequences while also distancing themselves from negative consequences. This occurs for risk assessment as well; this means that your view of risks can change if you are an active participant instead of a spectator (Kouabenan, 2009; Martinko & Thomson, 1998).

Confirmation bias.

There are other examples in which knowledge can override perception. For example, people will sometimes unconsciously seek ways to affirm what they already believe; they choose to maintain their preferences and aversions, and they will often only pursue sources that reinforce them (Cavalheiro et al., 2011; Das et al., 2003; Gilbert &

Osborne, 1989). This is called *confirmation bias* (Klein et al., 2006) or the illusion of validity (Gilovich, 1993; Tversky & Kahneman, 1974).

Gilbert & Osborne (1989) say “The fabric of belief is indeed so tightly knit that the dropping of a single stitch can induce a run throughout the entire bolt-and yet, this basic psychological truism is not a conspicuous piece of our cultural wisdom.” People who demonstrate this bias find it very difficult to be proven wrong. Confirmation bias is also similar to Greenwald's (1980) explanation of cognitive conservatism, because it is an attempt to preserve beliefs or states of mind that are already established. Confirmation bias is, however, an attempt to preserve or fortify one's beliefs and perceptions by actively pursuing and collecting input that compliment or affirm them (Greenwald, 1980). Those who exhibit confirmation bias will be attracted information that complements their beliefs, and they will avoid, or show indifference, to things that conflict with them. This tends to happen regardless of the strengths of either argument. Confirmation bias is dangerous when combined with familiarity bias (explained below) or optimism bias. This is because, collectively, these biases can lead people to think that they know all information about a specific topic, and therefore they prohibit new vital information from getting through.

Klein et al. (2006) use the Data/Frame Theory to argue that confirmation bias is not a bias at all, but it is instead a frame that helps guide decision making. Gilbert and Osborne (1989), as well as Tversky and Kahneman (1974), however argue that these may be two different types of mental processes. As stated earlier, data/frame theory involves the alteration of mental constructs in order to accommodate new information, and confirmation bias relies on the alteration of new information in order to preserve already established mental constructs.

Hindsight bias.

When people receive information from outcomes, some mistakenly believe that they knew-it-all-along even if they did not; this is known as *hindsight bias*. Cognitive conservatism explains that some people prefer to think that their beliefs are fixed and unchangeable. They are therefore unwilling to admit that they have changed their beliefs even if they had done so (Greenwald, 1980). For example, Fischhoff (1975) conducted studies that presented historical stories, such as the battle of Hastings, to participants. Based on the group, the participants were or were not provided a conclusion to the story. The participants who were provided the conclusion were much more likely to believe that they would have already known the results beforehand. The opposite was the case for the participants who had to guess the conclusions (Fischhoff, 1975). It therefore appears that people assimilate and revise their opinions, whether they realize it or not, based on information or influences to which they are exposed.

Order bias.

The sequence in which information is delivered can also influence how information is processed (Greenwald, 1980; Ubel et al., 2009). A bias that is based on a specific sequence of incoming information is called an order effect, or *order bias.* It involves information that affect people’s attention and memory based on the order that it is delivered (Morgan & Rothoff, 2010; Tversky & Kahneman, 1974).

Primacy and recency biases (or effects) are examples of these. Primacy bias occurs when people are more influenced by information that is delivered first

(Greenwald, 1980); recency bias occurs when people are more influenced by information that is delivered last (Ubel et al., 2009). To put it another way, their opinions depend on the first or last things that they see or hear. This may be contributed to the natural way in which people consolidate memory; memory formation appears to be stronger for beginnings and ends of strings of data. Because people tend to be better memorizers of recent data, recency bias tends to be stronger than primacy bias (Morgan & Rothoff, 2010).

Olympic judges, for example, have demonstrated a favor of competitors who perform toward the very end of an event. This is so well known that competitors will quarrel for the order of participation, often in attempts to perform later (Morgan & Rothoff, 2010). In addition people are much faster on word identification tasks when they are required to search or remember based on the first and last letter of a word (Tversky & Kahneman, 1974). Lastly, Taylor (2009) discusses that for health information to be received strongly, it should be delivered to patients in the beginning or the ending of a message instead of somewhere in the middle.

Sequential bias, or social comparison bias, is also an example of an order effect, for it is a biased assessment of one bit of information dependent on the information it follows. For example, if you heard stories from informants A through Z, then you would compare informant B's story with that of informant A's, informant C's story with that of informant B's, informant D's story with that of informant C's, and so on, instead of assessing each of them individually (Morgan & Rothoff, 2010; Ubel et al., 2009).

Knowledge bias.

Although it is intuitive to assume that bias forming based on knowledge should be labeled “knowledge bias,” scientists have instead used this term to describe a different type of mental-state phenomenon. The term *knowledge bias* is another form of false-belief reasoning, but it is the bias that observers have for other people based on what the observers know, or think that they know, about the people. This is also known as social perception (Pickens, 2005). As described below, knowledge bias can be demonstrated in several different ways.

Birch (2005, 2007) explains that the *curse of knowledge bias* is when observers have difficulty appreciating more ignorant perspectives: they assume that others know what the observers know. Self-reporting also tend to reflect knowledge bias. This means that, when asked, people will often believe that others’ knowledge and beliefs are, or should be, similar to their own (Epley et al., 2004). Returning to Fischhoff’s experiments (1975), for example, the participant groups who received the conclusion to the stories not only believed that they were more likely to have already known the ending beforehand anyway, they also believed that other people would already know it as well. The opposite was the case for those who had to guess the endings to the stories; these participants did not believe that they, or anyone else, would already know the ending without first being told. The point is that each group projected their levels of knowledge onto others; they assume everyone else knows, or should know, what they know (Gilovich, 1993).

Camerer et al. (1989) first introduced the term curse of knowledge bias in studies of market data. Although the term was intended for the sake of economics, Birch (2005, 2007) fleshes out the theory to explain how it affects all people in daily life. She explains that this phenomenon begins at childhood when people exhibit the highest faults in mental-state reasoning: inaccurately assuming that others think and know the same as them. Unchecked, this then carries over into adulthood (Gilbert & Osborne, 1989).

Perloff (2010) describes knowledge bias as the bias people have of others' characteristics and intensions. This is a tendency for people to stereotype others based on limited impressions (Stewart & Payne, 2008) or context (e.g., us versus them; Anolli et al., 2006). For example Oakes (2009) discovered that some students tend to have negative impressions of people who are susceptible to the placebo effect. The students viewed placebo responders as gullible, undisciplined, overindulgent, lazy, impulsive, deceptive, or even dishonest. If these students then were to meet a placebo responder who did not fit these characteristics however, then the bias could be potentially undone (Perloff, 2010).

Taken together, knowledge bias is the bias of people for other people. This type of bias is closely tied to attribution bias. The difference is that attribution bias assesses the circumstances surrounding a person in order to analyze blame, whereas knowledge bias involves an observer assessing the circumstances surrounding other people in order to predict people's knowledge, intensions, attitudes, and/or behaviors (Kouabenan, 2009).

Familiarity bias.

Familiarity of something comes from exposure; this can come in the forms of knowledge (Hall et al., 2007), experience (Klein, 2008; Klein, & Klinger, 1991; Levesque et al., 2008; Lipshitz & Strauss, 1997), or types of unconscious priming (Kahneman, 2003; Wolfe et al., 2003). This may eventually lead to a comfort, affiliation, or some other type of cognitive bond with the topic (Crouch & Laing, 2004). This is termed home bias or *familiarity bias*. Compared to knowledge bias (when an observer's own knowledge of something affects their abilities to accurately assess other people's knowledge of the same thing) familiarity bias is when an observer's own knowledge or exposure of something affects their own reasoning.

The theories of familiarity bias are challenged by the idea that “familiarity breeds contempt;” this phrase originated in Aesop’s fable “The Fox and the Lion”; the phrase has since been used in reference to the disdain felt by people due to overexposure to something (e.g., a relationship). Psychotherapist Schwartz (2010) explains however that it may not be familiarity that causes the contempt or disdain, but instead it is the context and dynamics that occur between the person and the activity. Negative familiarity can come from mediocrity, the cessation of satisfaction, or other seeds of unhappiness (Schwartz, 2010). In most other instances where certain negativities do not arise, familiarity can have the reverse effect.

For example, Hall et al. (2007) performed experiments that tested how superfluous knowledge could affect people's decision making capabilities. In these studies participants had to predict the wins of a specific basketball team. The participants were provided non-relevant information on their sports teams, such as the players' names, and then they were asked to make their predictions. The experiment found that the additional non-essential information increased the confidence of the participants' predictions, but it did not increase their accuracy. The idea is that familiar information could potentially overwrite other real-world statistical data (e.g., wins and losses); this leads to faulty decision making (Kahneman, 2003**)**. The experimenters termed this the *illusion of knowledge effect* (Hall et al., 2007).

In addition, Huberman (2001) performed cross-national studies of investors. He discovered that people tend to place their money in familiar or domestic markets even if it is detrimental to their financial return. In several instances, the investors knew what areas would be more profitable, and yet they continued instead to place their money in the familiar. Fox and Levav (2000) performed a similar study of investment, and they found that participants voted that familiar scenarios were much more likely to happen than unfamiliar scenarios. This means that they were not only attracted to familiar circumstances, but they also believed that likelihood of occurrence was directly proportional to their familiarity. In the Huberman (2001), Fox, and Levav (2000), studies, familiarity gave investors the illusion of an advantage: they know more about something, and therefore they believe that they can catch details that others may miss. They develop an affiliation with their familiarities, and they therefore maintain a comfort with them. This comfort guides their decisions even if it conflicts with valuable statistical data (Cavalheiro et al., 2011; Huberman, 2001; Kahneman, 2003).

Lastly, Adaval (2003) conducted several experiments that studied how brand names induce familiarity bias. This can occur because familiar themes of the brand names develop into heuristics that direct judgment, or they inhibit the decision maker to acquire any other knowledge in order to analyze other choices. Brand names also endorse the use of heuristics by creating memories and experiences for specifically recognizable features and traits (e.g., “golden arches” or “the copper-top”). Salience of these attributes allows them to be recalled faster than other important details of the brand (e.g., calories per serving or inflated prices). This newly developed brand loyalty becomes an active (or conscious) as well as a passive (or unconscious) process (Levesque et al., 2008). For example when someone is pressed for time, or in other cognitive-limiting situations, participants will prefer familiar brands. It is as if the brands have become a default choice for the participant. These heuristics are often formed based on the way the brand is advertised. If delivered in just the right way, the brand can become seated into a prime-time cognitive position that gives it more recall priority over any other related brand.

The basic understanding of familiarity bias is that knowledge of a topic can lead to a familiarity and a potentially affiliation or preference with it (Adaval, 2003). According to the theory of the availability heuristic, comfort and affiliation with a topic is the result of its convenient availability to a person's mental recall; this provides a mental ease-of-access with the topic (Cavalheiro et al., 2011; Huberman, 2001; Kahneman, 2003; Tversky & Kahneman, 1974). People are more content and confident when immersed in a topic with which they feel competent, and they often feel inadequate and awkward when forced into topic they know little about (Huberman, 2001).

Persuasion bias.

Due to the optimism, attribution, confirmation, and familiarity biases, people will often reject information that conflicts with their beliefs. The urge to reject conflicting new data gets stronger if it involves a subject that is important to them (Greenwald, 1980). Therefore effective methods of persuasion are necessary in order to maneuver around this. *Persuasion bias* explains mental heuristics that are formed due to outside influences. People can become persuaded due to their inability to recognize certain persuasion techniques. The main objective of these bias forming strategies is to use communication in order to influence and lead others' opinions. For example, using communication to induce fear is called “fear appeals,” and they are often used in health education (Das et al., 2003; DeSteno et al., 2004). There are four primary methods of effective persuasion bias: first-person anecdotes, a well-sourced persuader, emotionally charged words, and tactical repetition of persuasion.

Anecdotes (Ubel, 2002, 2008), also termed expert interviews or testimonials (Haskins et al., 2010), are highly effective methods of persuasion bias. This is because the act of simply reciting statistics can confuse and induce stressful and misguided decisions in listeners (Nelson, Han, Fagerlin, Stefanek, & Ubel, 2007). Ubel (2008) found that people want to hear facts from someone who has been in similar situations. This presents problems however. Testimonials and first-person witness accounts are plagued with bias, and biases can influence intension and memory (Greenwald, 1980). It is a fallacy that someone else's experiences and opinions will be the same as yours. People experience things in different ways; therefore first-person testimonials only provide certain perspectives. This also assumes that the anecdotes are from people who are delivering them honestly. It is for these reasons that many professionals often discourage the serious considerations of anecdotes (Ubel, 2002, 2008). Regardless of this, they are still powerful suggestors, and therefore are very influential when used in persuasion.

How people perceive the source of the persuasion can influence whether or not it is effective. For example, persuasion bias also works well when it is delivered from multiple sources at a time (DeMarzo et al., 2003) such as from friends, the media, or authority figures (Anolli et al., 2006; Chaiken & Maheswaran, 1994; Gilovich, 1993; Groeling, 2008; Rankin-Box, 2006). The same effect can also be reached by a single person who is perceived as having several sources of knowledge. Regardless of the accuracy of their information, some of the most influential persuaders are those who are perceived as well sourced and connected (Chaiken & Maheswaran, 1994; DeMarzo et al., 2003), or if they are perceived as being in positions of knowing and power (Benedetti, 2002). Health psychologists have recognized that people are more prone to altering unhealthy behaviors if information is delivered to them by an expert and credible physician than by other outlets (Benedetti, 2002; Taylor, 2009). This idea is similar to a behavioral-modification technique called modeling, where people are influenced by others' ideas and behaviors and therefore these behaviors are adopted and mimicked (Taylor, 2009).

Once persuaders convince others that they are well-sourced, they then have to tailor how they choose to deliver their persuasion. The most effective way to do this is to give emotional significance to the information (Cavalheiro et al., 2011; DeSteno et al., 2004; Kahneman, 2003; Tversky & Kahneman, 1974). Therefore the wording that is used to describe a topic, such as romantic or threatening, can affect the way that it is perceived or remembered (Kahneman, 2003; Taylor, 2009; Tversky & Kahneman, 1974). Words that encourage or resonate with specific moods or emotions are known as charged words. Harris and Pashler (2004) conducted studies to evaluate negative emotionally charged words, and they found that these initially attract attention to stimuli. Certain threatening or taboo words, especially those related to health and survival, seem to cause visceral reactions in people that add significance to a concept or memory into a person's mind. These emotionally-driven reactions cause high salience to be attached to a memory or idea (Aquino & Arnell, 2007; Anolli et al., 2006; Benedetti, 2002; Cavalheiro et al., 2011; DeSteno et al., 2004; Kahneman, 2003; Nairne et al., 2009; Taylor, 2009; Tversky & Kahneman, 1974).

After the wording has been selected, persuasion is more effective if it is delivered continuously. This is because persuasion bias is the most effective when data is repeated; this is also known as repetition priming (Berry et al., 2006). There are three potential explanations for this, and they all have to do with the availability of memory (DeMarzo et al., 2003; Gilbert & Osborne, 1989). The first explanation is salience; this means that something can be confused as more valid if it is recalled more easily (Kahneman, 2003; Tversky & Kahneman, 1974). Another explanation goes back to familiarity, which means that repeating a topic also induces familiarity with it; as explained previously, familiar topics will then merit higher cognitive priority than unfamiliar topics. The last explanation has to do with limited memory; this means that repetition can be confused with accuracy due to our limited memory processes and storage (DeMarzo et al., 2003). All of this suggests a ceiling effect for memory, and the concepts are basically the cognitive equivalent of picking a name out of a hat: if someone cheats and places a name in the hat more than any of the other names, then that name is more likely to be selected.

In addition to repetition, the perceivers' inability to account for the repetitions is also necessary for persuasion bias. This means that if people are aware of how many times they have been exposed to an argument, or they can remember each exposure, then they are less likely to be persuaded. However if people are distracted or otherwise unable to detect the repetitions of a persuader, then they are more likely to be persuaded (Levesque et al., 2008). To truly understand how this works, it is best to analyze the differences between implicit and explicit memories. Implicit memories are derived from previous experiences which the person is sometimes unable to remember; these experiences provide primed information that affects decision-making and behavior

(Wolfe et al., 2003). Explicit memories are derived from previous experiences which the person is able to remember; these memories may then be traced to their source experiences. Therefore implicit memories are more prone to persuasion than explicit memories.

Klein et al. (2002) argue that the same can be said for semantic and episodic memories. They claim that episodic memories, retrieved from the right frontal cortical regions of the brain, are recalled from memorable experiences, but semantic memories, received from the left frontal cortical regions of the brain, are recalled by general summary representations that can be independent of memorable experiences. Regardless, all of these types are produced by experience, and they can affect behavior. They are then categorized based on whether they are explicitly or implicitly stored and recovered (tethered or untethered) to their origins or source experiences (Berry et al., 2006; Gilbert & Osborne, 1989; Levesque et al., 2008; Wolfe et al., 2003).

Taking all of this together, effective persuasion bias does not only rely on repetition, but it also capitalizes on the stealth of that repetition (DeMarzo et al., 2003). This is when people, who are communicating through social networks, are unable to account for the repeating information. The structure of the network therefore encourages social influence (DeSteno et al., 2004; Corazzini et al., 2010). Returning to the name-out-of-a-hat metaphor: although cheating and placing a name into a hat more than once increases the chances of that name getting selected, dependence on everyone else's ignorance of this is vital for the plan's success.

The ultimate objective of persuasion bias is to instill bias in people through intentional, persistent, and convincing exposure. Wood (2000) discusses that the objective may not be to change the attitude of something, but rather to change the definition or meaning of it. This is because the attitude should change simultaneously with the meaning. The most successful types of persuasion techniques are those that cause people to change their minds without admitting any change had ever occurred. If undetected, persuasion bias will eventually breed familiarity bias in the group of people who are targeted (Greenwald, 1980). It is often used in propaganda to distort perceptions of risks in order to promote agendas hidden or known. The media is often cited as using persuasion bias as an effective tool for propaganda, censorship, political spin, or when they are trying to endorse a position that is not popular or intuitive to the population (Anolli et al., 2006; DeSteno et al., 2004; Gilovich, 1993; Greenwald, 1980; Groeling, 2008; Rankin-Box, 2006). People tend to rarely follow up and fact check what they receive from others. As a result, many people will only believe information based on how it is presented to them (DeSteno et al., 2004; Rankin-Box, 2006). It is therefore important to consider the agendas of informants; it is also important to consider how delivery of your information will affect those who you are trying to inform (DeMarzo et al., 2003).

Bias Mitigation

This final section of biases will briefly discuss methods that attempt to minimize or undo bias. Senay and Kaphingst (2009) argue that mitigating bias leads to more accurate risk perceptions, and therefore it assists in better risk assessment. This tends to be the case not only for specific risk assessment scenarios (e.g., assessing risk of high-threat activities) but also for tangential decision-making circumstances (e.g., evaluating one's general state of health).

Inadequate predictions and judgment based on bias can be reduced when decision-makers are provided real-world data (Kahneman, 2003**)**. Even the simplest statistical models have encouraged medical patients to make sounder decisions. According to Hall et al. (2007), impairing decision-makers' prior knowledge may sometimes be in their best interest. If situations elicit familiar sources (or heuristics) of knowledge, then the individuals will assess the scenario based on the content of those heuristics (based on their current familiarities). Providing mitigation, like contextual decision aids, allows the decision-makers to rely on other, potentially more accurate, types of data sets (Hall et al., 2007; Lipshitz & Strauss, 1997).

"Decision aids are educational materials, informed by decision analysis, that structure information in a way that makes patients aware of the tradeoffs inherent in their treatment choices" (Ubel, 2008). Decision aides are also known as a type of contextual information (Ubel et al., 2009), reference class forecasting (Flyvbjerg, 2008), or prior probability base-rate frequency information (Lin, Lin, & Raghubir, 2003; Tversky & Kahneman, 1974). They are basically ways of presenting real-world information in an easy to understand way; they then assist people in making the best possible decisions. This is because they help to temporarily suspend biases by providing a real-world driven standard of comparison. Decision aids can be represented in many different ways, but the most effective are graphical representations of comparisons, like pictographs. These are effective against most types of biases as well as sources of bias. For example, reference class comparisons are effective tools against optimism and organizer bias. Pictorial information is powerful in engaging attention (Öhman et al., 2001), and it has also been shown to override order effects and other biases that are influenced by first-person testimonials (Ubel, 2008; Ubel et al., 2009). Therefore decision aids, although developed for specific bias-driven fallacies, have been found to mitigate most human biases (Flyvbjerg, 2008; Ubel, 2008; Ubel et al., 2009).

Ubel (2002, 2008), however, also argues that, instead of interpreted factually, decision aids may lead people into making decisions based on how the aids are interpreted. They may even lead to systematic irrational decisions under certain circumstances (Ubel, 2002). Decision aids that are full of statistics and jargon can confuse people. They will either cause the person to disengage due to boredom, or they may induce extra stress (Taylor, 2009). In both cases this will then impair decision making and cause default-driven biases to run unchecked. To complicate things further, some developers of decision aids may attempt to change or withhold factual information under the noble intent of minimizing confusion, but this can be considered unethical. In addition, even if all of the information is present in the decision aids, and they are understood, then they can still be misleading (Nelson et al., 2007). For example the presence of too many side effects can deter patients from choosing to take a medication that will save their lives. In this case decision aids may help the person to understand some aspects too well, so that other equally important aspects are not as clear. In addition, decision aids may be used as a persuasion technique, by highlighting certain aspects and downplaying others, in order to influence decision making. These are examples that, if performed incorrectly, could cause decision aids to induce bias rather than mitigate it (Ubel, 2002, 2008).

In addition to decision aids, corrective (or effortful) thinking is also deployed in an attempt to reduce bias (Gilbert, & Osborne, 1989; Kahneman, 2003; Senay &

Kaphingst, 2009). Stewart and Payne (2008) performed three experiments in order to reduce racial stereotyping in participants. They discovered that the lack of racial stereotyping was much more automatic in participants that first engaged in counter-stereotyping thinking, a technique they call implementation intention, prior to the exercises. It was argued by Stewart and Payne (2008) however that this strategy does not necessarily mitigate biases, but instead it encourages the development of new biases that replace the existing ones.

Perception of Risk

If perception is the process by which organisms interpret and organize sensation to produce a meaningful experience of the world (Pickens, 2005), then perception of risk is how organisms interpret sensory data as it relates to threat or danger. This relies on the information available, the context of the risk, and the individual who is assessing (Hirsch & Baxter, 2010; Kahneman, 2003). Nairne et al. (2009) passed participants through two scenarios to test memory of a list of objects. One scenario prompted participants to memorize lists in survival-relevant scenarios (e.g., food gathering for a tribe), and the other scenario prompted participants to memorize the list in survival non-relevant scenarios (e.g., scavenger hunt). Although the lists were the same, memorization was better for those in the survival scenario. Öhman et al. (2001) discovered that certain threats, primarily the instinctual ones, are evolutionarily relevant. Some of the threats explored were snakes, spiders, and angry faces. Other threats, however, must be learned (Das et al., 2003), such as the biological effects of radiation. Regardless, fear-relevant threats are detected much quicker, and far better, than any other type of stimulus. This speed and proficiency are increased in phobics or other people who have heightened sensitivity for specific stimuli (Das et al., 2003; Klein & Harris, 2009; Öhman et al., 2001; Senay & Kaphingst, 2009; Sharp et al., 2012).

Risk Assessment

The perception of safety ultimately determines the success or failure of most commercial activities. Within the organizations, there is a significant amount of overlap between the definitions of safety culture and safety climate. Martinussen and Hunter (2009) studied human factors and safety. Based on their analysis of practiced norms, they argue that a safety culture is usually defined as a set of shared norms, values, and perceptual constructs (e.g., the attitude of safety), and a safety climate is defined as manifestations and measurable aspects of those (e.g., the practice of safety). In both cases, active involvement is required from all levels of the organization, as well as from those affected by the organization, if safe practices are to be successfully implemented (Martinussen & Hunter, 2009). Ball (2002) found that there are several ways that organizational climates influence the perception of risk and how individual factors contribute to this. According to his findings, risk management consists of three parallel and intertwined processes: science-based risk assessments, stakeholder involvement, and risk management decision making. Science-based risk assessment comes from statistical analyses and assessment of perceived risks, stakeholder analysis involves understanding how those risks are interpreted by people who participate, and risk management decision making comes from the successful interaction of them all (Ball, 2002).

Identifying the appropriate risk management strategy seems to be the most difficult task. Ball (2002) argues that this stems from misunderstandings between the safety and risk analysis specialists (e.g., NASA and OSHA) and those with which the risk exists, like spaceflight participants (Ball, 2002). For example, some safety implementations from safety experts, such as procedures or extra equipment, may not be completely understood by lay people. This then may cause confusion or animosity to these new changes by participants or a workforce; this may then lead people to completely disregard the safety implementations. Therefore the safety experts have to discover ways to mitigate risk as well as configure methods that will be taken seriously once they are introduced to the people who must practice them.

Several structured and professional methods of decision making have been proposed and used within organizations. Examples are the Multi-Attribute Utility Analysis, the Decision Analysis (Klein & Klinger, 1991), and the procedures offered by the INCOSE Systems Engineering Handbook (Haskins et al., 2010). Tables 4 and 5 display the inputs and outputs that INCOSE offers of each. According to Haskins et al. (2010), the purpose of the systems engineering decision making processes is to select the best possible action out of several options. A successful way to approach a decision is to define choices, analyze the decision information, and then track the decision you have made.

Table 4. Inputs and Outputs of the Decision Management Process (Haskins et al., 2010)

Inputs		Activities		Outputs
		Controls -Applicable Law and Regulations -Industry Standards -Agreements -Project Procedures and Standards -Project Directives		
		v		
-Decision Situation	>	-Plan and Define Decisions -Analyze the Decision Information -Track the Decision	<	-Decision Management Strategy -Decision Report
		^		
		Enablers -Organization/Enterprise Policies, Procedures, and Standards - Organization/Enterprise Infrastructure -Project Infrastructure		

Also according to Haskins et al. (2010), the purpose of the systems engineering risk management processes is to establish a continuous and vigilant system for risk identification and assessment. In order to do this you have to plan your risk management system, define risks, define acceptable levels of each risk, analyze the risks in different scenarios, treat the risks that have high-unacceptable levels, monitor your risks, and follow-up on your program often.

Table 5. Inputs and Outputs of the Risk Management Process (Haskins et al., 2010)

	Controls	
	-Applicable Law and Regulations -Industry Standards -Agreements -Project Procedures and Standards -Project Directives	
Inputs	**Activities**	**Outputs**
-Candidate Risks and Opportunities	-Plan Risk Management -Manage the Risk Profile -Analyze Risks -Treat Risks -Monitor Risks -Evaluate the Risk Management Process	-Risk Strategy -Risk Profile -Risk Report
	Enablers	
	-Organization/Enterprise Policies, Procedures, and Standards - Organization/Enterprise Infrastructure -Project Infrastructure	

Normal outcomes are delivered in the form of reports, profiles, and strategies like the *risk matrix*. Figure 1 is an example of a risk matrix. Although several versions have been developed, the point of a risk matrix is to categorize and compare the likelihood of a risk with its severity, and to portray it in an easy to read format (Haskins et al., 2010).

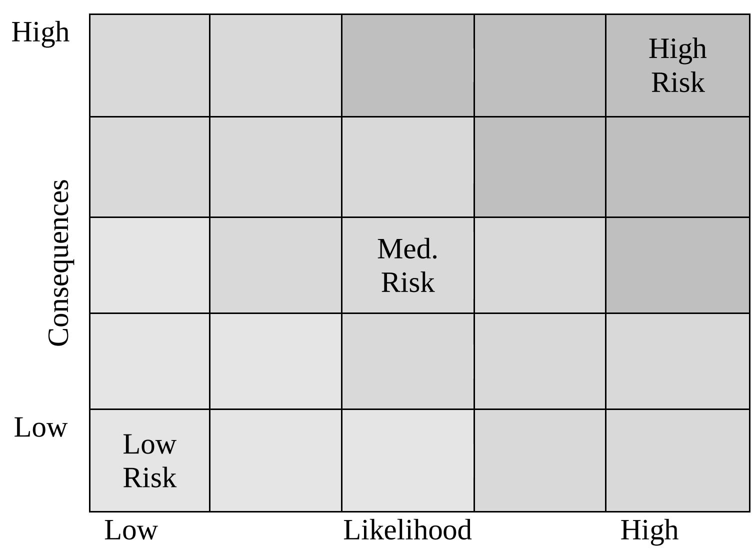

Figure 1. Risk Matrix (Haskins et al., 2010)

These professional decision making and risk assessment protocols are not always practiced. The models often become inadequate in certain real-world situations. This is because of time constraints and improperly defined factors (Cavalheiro et al., 2011; Klein, 2008; Klein & Klinger, 1991; Lipshitz & Strauss, 1997). Furthermore, paying customers of a recreational activity, like commercial spaceflight, may not be expected to evaluate the risks using those procedures. Therefore organizations have to be responsible for two additional tasks. The first task is to perform risk assessment procedures for the customers. The second task is to understand how the average person assesses risk, so that the organization can then provide special ways of delivering information that customers can understand. This is specifically important when developing information issuing methods like informed consent documents or training programs (Turner et al., 2008).

As seen in everyday tasks, as well as professional activities (e.g., health care, military operations, and disaster response), people tend to use a method called naturalistic, or recognition-primed, decision making (Klein & Klinger, 1991; Klein, 2008; Lipshitz & Strauss, 1997). This involves on-the-spot decision making and risk assessment based on one's prior knowledge and experience. As discussed earlier, anchoring and adjustment bias is a version of recognition-primed decision making, and therefore it can predispose people to making the wrong decisions if previous experiences led to misperceptions. The more these decisions are used the more they will continue to be used even if they are derived from faulty input or practice: practice makes permanent, not perfect. Lipshitz and Strauss (1997) developed several theories in order to provide the most modern and informative model of naturalistic decision-making. Their studies support the theory that people in real-world situations use specific intuitive strategies when making decisions. They termed this set of techniques the Reduction, Assumption-based reasoning, Weighting pros and cons, Forestalling, and Suppression (R.A.W.F.S.) heuristic. Each method covered under this strategy tackles specific ways of decision-making under uncertainty. Table 6 pairs the strategies with the situations that can be encountered. Reduction involves reducing uncertainty by collecting additional information, seeking advice, and utilizing standard operating procedures. Assumption-based reasoning involves replacing gaps in hard knowledge with best guesses. Weighting pros and cons involves making a list of advantages and drawbacks in order to ascertain which options are superior. Forestalling involves preparation and planning for worst-case scenarios. Lastly, suppressing uncertainties involve ignoring uncertainties and taking risks in spite of them (Klein, 2008; Lipshitz & Strauss, 1997).

Table 6. R.A.W.F.S. Strategies and Situations (Lipshitz & Strauss, 1997)

Strategies	**Situations**
Reduction	Inadequate understanding
Assumption based-reasoning	Incomplete information/reasoning
Weighing pros and cons	Conflict among alternatives
Forestalling (back-up)	Most used for all forms of uncertainty
Suppression (back-up)	Least used for all forms of uncertainty

According to Öhman et al. (2001), risk is also assessed along the inside/outside, stimulus-driven/goal driven, processes mentioned before. The stimulus-driven process involves a passive processing that is fast and automatic. It is an ongoing cognitive function that reacts when threatening stimuli are instinctual such as snakes or snake-like objects. Goal-driven processes involve an active processing that is slower and more deliberate. They become engaged when higher mental effort takes place in order to identify threats, and it is often recruited for non-instinctual threats. Examples of these non-instinctual threats are potential risks like the biological effects of radiation; these things may not be intuitive or obvious dangers. Explained in another way, heuristic, stimulus-driven, processes are activated by simple perception, and systematic, goal-driven, processes are activated by attentional scanning (Chaiken & Maheswaran, 1994; Öhman et al., 2001).

Naturalistic decision making is an example of the fact that, despite the intervention of science, risk management is ultimately defined by the value systems of those who actually practice it (Ball, 2002). Risks also occur due to situations being interpreted in several different ways based on the perspectives of the individuals (Kouabenan, 2009). Humans' lack of adherence to risk assessment strategies is primarily due to misunderstandings between the safety system designers and human nature. These misunderstandings are usually due to miscommunication (Senay & Kaphingst, 2009). The safety engineers, although very educated in their specialty, fail to include human psychology-centered ways of delivering advice (Ball, 2002).

In addition to inadequate information transfer, perceptions of risk are dependent on upon social, psychological, emotional, political, and cultural factors (Anolli et al., 2006; Cavalheiro et al., 2011; DeSteno et al., 2004). Information gathered by Kouabenan (2009) suggests that the cultures of certain countries are more accepting of risks, like Asian and African countries, and individuals may even sometimes seek out dangers in order to define themselves as brave or capable of overcoming obstacles. Sharp et al. (2012) report that similar phenomena can be found domestically as well in the United States. Certain beliefs can encourage or discourage risk, and some people will try to gain control of risks by relying on superstitious, religious, spiritual, or magical practices. It is beneficial to recognize these influences, their sources, and how they behave (Kouabenan, 2009).

Taylor (2009) discusses that the perception of risk is ultimately determined by three things: general health values, beliefs about personal vulnerability to a risk, and the beliefs about the consequences of the risk. The first factor, general health values, is basically the health attitude that someone holds; some people are more concerned about their health and mortality than others. The other two factors, vulnerability to risk and belief about consequences, basically define how likely people believe that the risk will affect them as well as how bad things will be if it does. Many people will make tradeoffs, meaning that they will tolerate a certain amount of risk if there are positive tradeoffs. Examples of these are habits such as smoking or other forms of substance abuse, or they come in the form of personal enjoyment like extreme sports (Taylor, 2009, pg. 57).

Familiarity and the Leniency of Risk.

Hirsch and Baxter (2010) reported that Caucasian males tend to be, on average, less concerned with the hazards and risks associated with things that are familiar. In addition to young people, men, and risk-takers, Crouch and Laing (2004) also discovered that the majority of people who are interested in some high-risk activities, like space travel, are professionals and educated (e.g., degree-seekers and college graduates). One of the greatest concerns for those who do not wish to participate in space travel, non-professionals or non-high school graduates, was the danger involved. The perception of danger was a greater concern for them than the financial price to participate. What this means is that professionals and the educated were much more lenient of the risks of space travel than non-professionals and the less educated (Crouch & Laing, 2004).

Although the benefits of knowledge and familiarity are obvious, they can also contaminate perception under certain circumstances (Gilovich, 1993; Birch & Bloom, 2007). Knowledge about a topic does not always insure truth about it. It is plagued by the reliability of sources, possible partial disclosures, and misunderstandings. If knowledge is then filtered through context, then even the most pragmatic information may be interpreted in several different ways (Benedetti, 2002; Hirsch & Baxter, 2010; Kahneman, 2003; Nelson et al., 2007; Stewart & Payne, 2008).

There is evidence that experts not only demonstrate observable differences between knowledge of hazards and the risks associated with them (Hirsch & Baxter, 2010), but they can also become over-assured in their biased assessments of risk within their specialties (Ball, 2002; Charness & Gneezy, 2003; Kouabenan, 2009). Hall et al. (2007) support the hypothesis that increases in knowledge and familiarity have tendencies to also increase confidence instead of accuracy (Cavalheiro et al., 2011). This is sometimes called the "illusion of knowledge" effect, and it states that the presence of knowledge can sometimes impair sound decision making (Hall et al., 2007). This can be seen in experts across multiple fields (Tversky & Kahneman, 1974). Birch and Bloom (2007), Gilovich, (1993) and Klein and Harris (2009) found that this reasoning further cements biases; this means that a bias is far more difficult to extinguish if it is accompanied by excuses, ad hoc explanations, or other rationale provided for justification. Because experts may become more confident about their proficiencies than novices however, their biases are often harder to mitigate (Ball, 2002; Klein et al., 2006).

While Huberman (2001), Fox, and Levav (2000) demonstrated that familiarity enforces preference and increased perceived likelihood of occurrence, Halpern-Felsher et al. (2001) found that increased familiarity of an activity also led to a lesser concern of the risks associated with it. They found that participants who have engaged in a high-risk activity were less likely to anticipate negative outcomes from it. The opposite was true for participants who had never engaged in the high-risk activity; these participants thought that negative outcomes were much more likely to occur.

Knowledge is further complicated due to the phenomenon known as *skill decay*. This occurs when a skill is deteriorated or lost due to lack of use. Certain skills fade away more quickly than others. For example, motor skills, also known in the US military as muscle memory, can be retained much longer than cognitive skills like rudimentary memory. The main problem with skill decay is that many professionals are unaware, or unlikely to admit, that they have lost the skill. This means that they are not as keen as they once were regarding their training and knowledge, but they mistakenly believe that they are (Wisher et al., 1991).

Professionals know the risks of their specialties better than anyone else, although they eventually disassociate the same level of danger to these risks than those who are unfamiliar with the field (Huberman, 2001; Kahneman, 2003; Kouabenan, 2009). In contrast, people with little experience or exposure in an activity may demonstrate greater discomfort with the potential risks, and they therefore highly overestimate the levels of danger (Hirsch & Baxter, 2010; Tversky & Kahneman, 1974). Professionals however may perceive risk in different ways. Due to national, state, and organizational safety standards, the workplace is the safest it has ever been; this continued environment of safety can sometimes reduce the perception of risk. Although specialists are educated to understand their threats, some of the real dangers are rarely ever encountered. Harris and

Pashler’s (2004) studies helped support the idea that the perception of threatening stimuli can deteriorate over time, and it can sometimes eventually dwindle to nothing. Klein and Harris (2009) discovered that threatening messages could instead be interpreted defensively, and therefore the message of threat would be completely and aggressively ignored. This could mean that, although the experience of an accident can forever cement a threat into a person’s mind, the impact of simply discussing accidents may become overridden by contradicting experience or personal attitude. Eventually the concern of risks can become nonexistent (Harris & Pashler, 2004).

For some, risk-taking is just another part of the job. For this reason, safety oversights tend to occur due to misunderstandings of risks by novices or the disregard of risks by experts (Kouabenan, 2009). Some people become comfortable with something to the point of complacency. This can result in a tolerance of shortcomings like risks (Adaval, 2003; Cavalheiro et al., 2011; Hall et al., 2007; Tversky & Kahneman, 1974). This maybe unrelated however to known hazardous attitudes, such as machismo, anti-authoritarianism, invulnerability, impulsivity, and resignation. Instead a paradox seems to emerge: although some experts may be more aware of the serious dangers of their professional situations (e.g., radiation, chemical toxicity, excessive noise, etc.) they can also exhibit certain types of indifference or non-concern for them (Ball, 2002).

To bring together everything that has been discussed so far, the more information attained about a topic may engender an affiliation to that topic. This familiarity can then distort the perception of risk due to over-confidence, ignorance of limitations, experience-driven misperceptions, inappropriate use of knowledge or specialties, or general complacency. Biased judgments are not necessarily bad judgments however, but greater knowledge does not always lead to the most optimum decisions. Extraneous information, if it is perceived as relevant by the decision maker, may distort judgments rather than help them (Adaval, 2003; Charness & Gneezy, 2003; Fehr & Tyran, 2008; Gilovich, 1993; Kahneman, 2003). When people have reasoned their way into thinking that something is not a threat then it is difficult to convince them of otherwise. Kos and Clarke (2001) say, "The illusion that people do not need to protect themselves from something that is not going to happen anyway may also adversely affect campaigns aimed at increasing precautionary behavior."

The Present Study and Hypotheses

In order to properly measure and experiment with biases, several theories need to be utilized. According to Michie and Prestwich (2010) a theory "provides a common description of what is known within an organizing system." It is a set of definitions and ideas that attempt to explain and predict interactions between variables. Rather than simply used as a loose framework, the theories must be applied functionally in order to identify or induce the specific types of biases that are being studied (Michie & Prestwich, 2010). Currently, more studies are needed in bias research. However scientists, like those discussed in this study, have already discovered a great deal of information on these types of mental phenomena.

The material presented in this report thus far demonstrates that theories have been reached about how biases are formed, how they affect decisions, and how they are mitigated. Also discussed was how heuristics, biases, and other types of automatic thinking can affect decision making and risk assessment. More studies are needed, however, that examine the influences of the interactions or conflicts between two or more different, and sometimes conflicting, biases (especially familiarity and persuasion bias) on risk assessment (Kahneman, 2003). This is because some biases may be the representations of different underlying mental phenomena. As was already discussed, for example, knowledge bias, confirmation bias, and attribution bias may be the behavioral offspring of egocentrism, cognitive conservatism, and beneffectance respectively.

Another example is the evolution of cognitive dissonance theory. Greenwald and Ronis (1978) discuss how the theory of cognitive dissonance has changed over time. It was once thought that it resulted from cognitive conservatism, but the theory was later changed so that it derived from egocentrism and self-esteem maintenance. They go on to discuss how the original theories may have instead been correct, and that these basic changes in perceived origin greatly reshape the overall theory and its future directions. This demonstrates that it is not just the biases themselves that are important to theorists, but also an understanding of the underlying mental origins of the biases.

In order to measure two different biases, as well as their interactions, definable thresholds have to be imposed. Appropriate functional terms must then be provided for each. As discussed earlier, external stimulus-driven versus internal goal-driven behaviors are examined in studies of cognition and decision making. The names that are used for them however are different depending on the phenomena being investigated. (Engel et al., 2001; Klein et al., 2002; Öhman et al., 2001) In this study of biases, the term persuasion bias (PB) represented the external stimulus-driven influence (based on fear appeals), and the term familiarity bias (FB) represented the internal goal-driven influence (based on familiarity). PB and FB were pitted against each in order to measure which bias was the strongest under certain threat conditions.

To apply this practically, PB was presented in a way that people would normally encounter it, such as in informed consent documents and brochures encountered in the decision-making process of a high-risk activity. FB was measured by assessing participants' familiarity of elements surrounding the activity. For this study, commercial space travel was the high-risk activity that was introduced. Space tourism is still new and has attracted international interest. The nature of the activity demands an assessment of risks as well as the public's understanding of these risks; the newness of the topic makes it ripe for this type of investigation. The main materials that were discussed were radiation, LEO, and space travel. To measure independent variables, each participant's familiarity level of the topic was identified by the results of a modest assessment test, and PB was induced with the help some of the most effective types of persuasion strategies. To measure the dependent variable, perception of risk, opinion scores of participants were collected regarding radiation limitation recommendations. Since the data were opinions and few in number, non-parametric procedures were used to assess the results.

Independent Variables

This study attempted to analyze two very specific types of biases. This is somewhat a complicated goal, because there are often overlaps between biases. For example, cognitive dissonance is a mental phenomenon that occurs when people perceive inconsistencies within their adopted attitudes and/or behaviors. Because this leads to discomfort, people will often use mental strategies in order to rectify these inconsistencies (Greenwald & Ronis, 1978; Wood, 2000). Strategies may include: relinquishing responsibility for an act or decision (attribution bias), minimizing the importance of an uncomfortable issue (optimism bias), recognizing new information that is consistent with an attitude or behavior (confirmation bias), or denying, distorting, or selectively forgetting information (selective perception and hindsight bias). It therefore appears that the phenomenon of cognitive dissonance may involve at least four different types of cognitive biases (Das et al., 2003; Pickens, 2005**;** Wood, 2000). Similarly, persuasion bias may eventually become familiarity bias. This is because FB develops from experience and exposure. This could include the influence and persuasion that people receive over time. Because of this, methods were developed for this experiment in order to mitigate certain types of biases while encouraging others.

Familiarity bias.

Two methods were used to determine familiarity of the material: a brief 12 question assessment test of radiation, LEO, and space travel, and a background demographics questionnaire to assess education and experience. Because types of information can vary between different radiation research organizations, the questions for the assessment test were selected based on data universally agreed upon among researchers across the field. Refer to Appendix A for an overview of the material. In an attempt to guard against any floor or ceiling effects, the questions were first administered to ten test participants. These participants answered the questions to the best of their knowledge, and then they rated the difficulty of each question. Twelve questions were selected from the pool based on the results. These included three high-difficulty questions, three low-difficulty questions, and six average-difficulty questions.

It is in the interest of this study to divide the participants into a high-familiarity field and a low-familiarity field in order to appropriately define a threshold for measurement. Therefore the scores of the assessment test were polarized so that there were no in-between groups. The top and bottom 30% of each threat condition were used as high FB and low FB respectfully.

It is important to mention that, although knowledge was being measured to detect the level of bias, knowledge bias was not being measured. Instead this study proposes that a participant's prior knowledge of a topic also increases his/her familiarity with it. Therefore, for the sake of the study, the operational definition of familiarity bias is bias that people have toward a topic based on their exposure to it (e.g., experience, education, or other exposures).

All efforts to minimize FB were made; this is because the hypotheses argue that FB is much more powerful than PB due to internalized motivation and self-regulation. (Deci & Ryan, 2000; Deci & Vansteenkiste, 2004; Gagné & Deci, 2005; Levesque et al., 2008; Taylor, 2009). In addition, Wood (2000) discusses that persuasion-oriented information is often met critically and defensively when it is a topic of familiarity to the person. This means that the bias that is attempted to be persuaded may run into conflict when it encounters a related bias that has already been adopted by an individual.

Persuasion bias.

Contrary to FB, PB was endorsed by using some of the most effective persuasion techniques. Studies of literature reveal that these techniques involve first-person anecdotes, well-sourced persuaders, emotionally charged words, and tactical repetitions of persuasion. Each technique was used to induce or mitigate fear appeals.

For anecdotes, quotes from U.S. astronauts were provided. Quotes from each astronaut were selected based on the specific type of persuasion that was being encouraged. For example, conditions provided negative, but relevant, statements from a deceased astronaut and positive, but relevant, statements from a living astronaut.

A well-learned and well-sourced position was established by listing and quoting from popularly cited sources of space and space radiation research such as the National Council on Radiation Protection and Measures, the International Commission on Radiation Protection, the National Academy of Sciences/National Research Council, and NASA. Although there are conflicts between agencies about certain aspects of radiation, LEO, and space travel, only information universally agreed upon across all sources were used. The same raw information that was used, although colored with persuasion, was provided across all conditions.

A third of the participants received questionnaires with wording that attempted to persuade them that the radiation environment in LEO is threatening and dangerous (HighThreat), another third of the participants received questionnaires with wording that attempted to persuade them that the radiation environment in LEO is safe and not dangerous (LowThreat), and the final third of the participants received questionnaires that attempt to provide no persuasion at all (NoPersuade). The groups under the NoPersuade condition were considered the control group of the persuasion bias variable; these groups received no intentional persuasion, but instead they received neutral or contextual information (a decision aid strategy) in order to mitigate bias. Each type of persuasion strategy that was used was tailored to induce the theme of radiation (threatening, non-threatening, or neutral) in the questionnaire packet.

Each method was implanted strategically and intermittently throughout the questionnaire in order to establish repetition. Participants in persuasion conditions experienced persuasion throughout the experiment, from start to finish, so that order effects did not confound. Strategies were used to endorse the best types of PB as possible. The ultimate goal was to block prior biases from entering the experiment while encouraging persuasion bias influence through influential techniques. The point was that familiarity bias will maintain its influence with participants even when it is repressed and contended against the most effective persuasion strategies.

Lastly, people are more likely to be cognizant of the threats of an activity if they are, or imagine they are, actually participating in it (Nairne et al., 2009). In order to fabricate this through a questionnaire, the participants were presented an example of a waiver that they would encounter before traveling to space. These waivers contained traces of persuasion bias, and they placed the participants in a position to realistically think about the risky activity as well as how it may have affected them. Charged words were carefully selected and added to the waiver's contents in order to influence the participants. According to theories of charged words, these would attract the attention of the participants and therefore provide an influence even if the sections were briefly scanned by the readers (Aquino & Arnell, 2007). The participants were encouraged to read the waiver as if they had to later make a choice on whether or not to sign it.

Dependent Variables

This study measured the preference and perception of risk of the activity (commercial space travel), and how they are affected by the interactions of familiarity and persuasion bias. In the end participants were asked to provide their personal opinions of radiation risk by declaring their preference of suggested radiation limits for space travelers. This was collected through two questions; both questions were selected based on two important concerns regarding the study of radiation on human tissues: level of radiation dosage and length of exposure (NCRP, 2000). According to Kos and Clarke (2001) the length of time that occurs between the start of a risky activity (e.g., length of time in radiation) and the supposed beginning of a negative consequence that can occur from it (e.g., cancer) is known as perceived delay of onset. The first question provided participants with a set length of time (one year) and it asked them about the maximum amount of radiation that they would safely allow for one person during that time. The second question provided the participants with a set level of radiation (0.3 sieverts per year) and it asked them about the maximum amount of days that they would safely allow for one person under that exposure. The questions basically assessed the perceived risk of radiation from two perspectives: regarding time and regarding quantity.

Selecting a higher number of days exposed or higher dosages of radiation reflected participants who had a high leniency of risk (HLR), for it demonstrated that they *were not* as concerned with the dangers of radiation. Selecting a lower number of days exposed or lower dosages of radiation reflected participants who had a low leniency of risk (LLR), for it demonstrated that they *were* concerned with the dangers of radiation. Table 7 displays the high limits/high leniency and low limits/low leniency relationships. Table 8 displays the breakdown of the experimental conditions.

Table 7. LLR versus HCR

<table>
<tr><th colspan="3">LLR</th><th colspan="3">HLR</th></tr>
<tr><td>Low Rad Limits
Rad Dose/Days</td><td>=</td><td>Low Leniency of Risks</td><td>High Rad Limits
Rad Dose/Days</td><td>=</td><td>High Leniency of Risks</td></tr>
<tr><td colspan="3">Participants choose to impose low limits of exposure; are concerned for they are attempting to minimize radiation.</td><td colspan="3">Participants choose to impose high limits of exposure; are not concerned for they are not attempting to minimize radiation.</td></tr>
</table>

In addition, preferences were collected by four questions meant to gauge the participants' preference of various aspects of space travel. The first question asked the participants to state their enthusiasm of space travel, the second question asked them the likelihood of them participating in travel to space, the third question asked them the likelihood of them participating in travel to LEO, and the last question asked them what they thought about the idea of humans in outer space. Collectively these questions would represent the participants' overall preference of the activity.

Table 8. Experimental Conditions (Interactions of Independent Variables)

High familiarity	High threat persuasion
	Low threat persuasion
	No persuasion
Low familiarity	High threat persuasion
	Low threat persuasion
	No persuasion

Because two levels of the threat I.V. were intended to encourage bias towards extremes (very threatening or non-threatening), an appropriate scale was needed that can detect fine changes between the polarized opinions. Three major subjective scales are typically used in order to detect subjective perceptions in participants; these are visual analog scales (VAS), Likert scales (LS), and Borg scales (Grant et al., 1999). Of these, VAS and Borg scales demonstrate better detection of sensitivities to change over LS; in addition VAS appears to be twice as sensitive as Borg scales (Grant et al., 1999). This has been demonstrated in healthy participants (Grant et al., 1999) as well as in post-operative patients (Myles, Troedel, Boques, & Reeves, 1999). In addition, analog range scales tend to be a better unit of measurement when studying cases of egotistic biases (Epley et al., 2004). It is for these reasons that the participants' preferences and personal opinions of radiation limits, the dependent variables, were measured by visual analog scales.

Confound Concerns and Work-Arounds

Since the dependent variables were measured by the interactions of internal and external biases, it is beneficial to know how the participants feel about space travel, flight, outer atmospheric environments, or human existence beyond planet earth. Extremely positive or extremely negative preferences of these themes can bias the risk assessment portion. Participants could not simply be asked beforehand, for this would encourage several confounds such as anchoring and adjustment, cognitive conservatism, and other order effects. It is for this reason that opinions of space travel, flight, outer atmospheric environments, or human existence beyond planet earth were assessed, but this information was collected only after the risk assessment was performed.

Another confound to be considered is hindsight bias (Birch, 2005; Fischhoff, 1975). If participants were asked about their opinions of risk later in the study, then it would be difficult to determine if the answers were their original opinions or if the answers were the results of persuasion. One aspect of Greenwald's (1980) theory of cognitive conservatism is that some people desire mental consistency so intensely that they may not admit a change of opinion even if one has taken place. To determine this, over 400 participants were surveyed, and VAS was used to measure the sensitivity between conditions. If there are differences between the means of participant space-travel preference across each threat condition, then this should be revealed in the data after it is processed. In this way a trend of participant personal preferences can be detected regardless of the persuasion to which they were exposed.

Lastly, other biases of order effects must be considered. As previously stated, this is bias formed by information based on the order in which it was presented. If the assessment test encouraged anchoring and adjustment, and therefore conjures familiarity bias, then it would have done so more effectively if it occurred at the beginning or at the end of the information delivery portion. Although order effects cannot be completely ruled out in this specific study, other studies have demonstrated that people are less likely to successfully adhere to information that is placed in the middle of strings of data (Greenwald, 1980; Morgan & Rotthoff, 2010). Therefore, there was a better chance of inhibiting FB from the assessment test by placing the test in the middle of the survey. So that order effects did not confound PB, persuasion was placed evenly throughout the questionnaire.

The end goal was to determine the opinions that the participants had for the topic (radiation, LEO, and space travel) without activating the confounding variables (biases) mentioned above. According to theories of familiarity bias, the more one knows about a topic, the more comfort and affiliation they will have for it (Adaval, 2003; Huberman, 2001; Hall et al., 2007); accordingly, there is also a potential for leniency of the risks that accompany the familiarity (Halpern-Felsher et al., 2001; Kouabenan, 2009). Table 9 lists the confounds, as well as the work-arounds that were implemented in response to the studies that were reviewed.

Table 9. Confounds and Work-arounds

Confounds	**Work-around**
Anchoring and Adjustment/ Familiarity Bias	Cannot ask participant opinion prior to assessing risk; cannot place knowledge assessment at beginning of survey
Hindsight Bias	Ask participant opinion after survey; measure sensitivities between threat conditions and overall opinions
Order Bias (FB)	Place knowledge assessment in middle of survey
Order Bias (PB)	Evenly distribute persuasion

Studies like the current experiment were performed by Das et al. (2002), in which one independent variable involved fear appeals that influenced and induced threat conditions. In these studies however the other independent variable was the participants' perceived vulnerability to the threat (stress-induced illnesses) instead of their familiarity of it. Their results indicated that higher fear appeals resulted in increased effectiveness of persuasion for participants who perceived themselves as more vulnerable to the threat. This was the case regardless of the strength of the argument for each threat condition.

Due to the nature of the current study, certain aspects of the Das et al. (2002) study could not be replicated or carried over. For example, the Das et al. (2002) study, collected the participants' perceived vulnerability to the threat in the beginning of the experiment. In the current study, however, this type of subjective information was obtained in the middle or end of the experiment in order to avoid anchoring and adjustment bias as well as order bias. Table 10 displays the similarities and differences between the Das et al. (2002) study and the current study.

Table 10. Study Comparisons and Contrasts

Similarities Between Studies	
Distributed surveys in order to collect data (contained questionnaires in order to collect DVs)	
Use of fear appeals/induced persuasion of threat as IV (contained different threat levels)	
Used hidden text within surveys in order to maximize or minimize fear appeals/induced persuasion of threat	
Measured subjective IV (perceived vulnerability in Das et al., 2003; familiarity bias in current study) by dividing participants in high and low groups	
Contrasts	
Das et al., 2003	**Current Study**
Used fear appeals and action recommendations (provided information of how to avoid a health threat)	Used fear appeals only
Used participants' perceived vulnerability of threat as the subjective measurement	Used participants' familiarity and preference to risk activity as the subjective measurements
Collected subjective measurements in the beginning of experiment	Collected subjective measurements in the middle and end of experiment to avoid specific biases
Measured strengths of arguments for each persuasion condition	Used the same argument strength across all persuasion conditions
Participants were (in Experiment 3) provided (false) feedback of their subjective condition: perceived vulnerability to the threat	Participants were not provided feedback on their subjective condition: familiarity of the activity
Used Likert scales	Used visual analog scales

Statement of the Hypothesis

Figure 2 shows the hypothesized perception of risks based on the independent variables. This states that high-familiarity will cause participants to perceive less risk and be less affected by persuasion; low-familiarity however will be highly affected by the persuasion conditions. The main questions that were explored were: Will affiliation of a topic (e.g., radiation in LEO) due to FB result in less concern, and therefore leniency, of risk? How effective is on-the-spot PB when discussing risk assessment? How well does increased FB of a topic, protect against on-the-spot PB? The following hypotheses were examined:

H_0: Variables will show no effect on participant preferences and risk assessment.

H_1: High-threat persuasion will result in a lower leniency of risk. Participants in the high-threat condition will choose lower radiation limits and exposure time reflecting a low leniency of risk (LLR).

H_2: Low-threat persuasion will result in a higher leniency of risk. Participants in the low-threat condition will choose higher radiation limits and exposure time reflecting a high leniency of risks (HLR).

H_3: The effects of persuasion will be greater in the high-threat condition than in the low-threat and no-persuasion conditions. The risk of radiation and cancer is a concern for people. Therefore persuasion will be stronger when it reflects a high-threat activity than when it reflects a low-threat activity. This will be demonstrated by higher concerns for risk limits from high-threat scenarios than lower concerns for risk limits from low-threat scenarios.

H_4: High levels of knowledge will reduce differences among persuasion conditions relative to low familiarity. The different threat conditions will have a lesser effect on participants with high familiarity; in addition, participants with high familiarity will perceive less risk regardless of high-threat conditions, low-threat conditions, or no persuasion conditions. Familiarity bias is often reinforced by confirmation bias (or cognitive conservatism). This means that people will constantly compare new information with what they already know and believe. As a result, they are prone to support their own opinion rather than adopt new positions (Greenwald, 1980).

H_5: High levels of familiarity of the topic will result in higher leniency of risk. Because studies have shown that familiarity may result in acceptance of drawbacks and leniency of threats, those who demonstrate high familiarity with the activity will not be as concerned with its associated risks.

H_6: High levels of familiarity of the topic will result in higher preference of the activity. Participants with high familiarity of radiation, space, and space travel will demonstrate a favorable position with these topics.

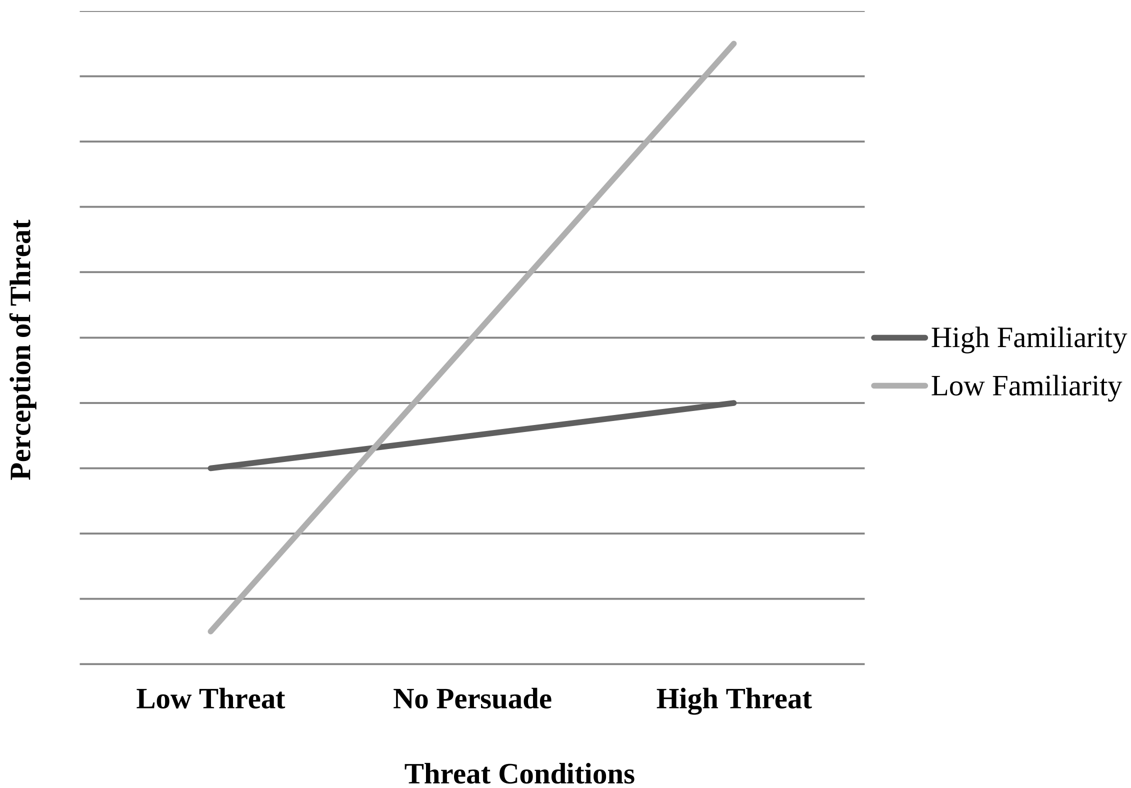

Figure 2. Hypothesized Perceptions of Risk

Methods

Design

Kruskal-Wallis and Mann-Whitney U tests were conducted to compare the effects of threat persuasion and familiarity level (respectively) on risk assessment and preference. This was a fully factorial, 2X3, between-subjects study. Kahneman (2003) argues that between-subject studies are ideal for this type of test. Within-subject studies cause participants to look for patterns and form expectations and anticipations; this would color data and complicate results. The main subject material for this experiment was radiation, LEO, and space travel. The two independent variables were threat persuasion levels (1=HighThreat, 2=LowThreat, and 3=NoPersuasion), and familiarity (1=HighFam and 2=LowFam). The dependent variables were the combined scores of the participants' preference levels of space travel (PrefAverage) as well as the perceived levels of radiation risk (RiskAverage).

Figure 3 displays the questions that were used to measure the participants' final risk assessments. The visual analog scales were arranged so that a low leniency of risk was reflected by marks that were placed on the *right* end of the scales; by comparison, a high leniency of risk was reflected in marks that were placed on the *left* end of the scales. For example, the first question asks the participant how much radiation they would recommend for one person during one year. If the participant perceived radiation as a threat, then they would place their marks closer to 0 Sv (towards the right-hand side); this would mean that they are worried about the effects of radiation, and they recommend that people should be exposed to as little as possible. In contrast, if the participant did not perceive radiation as a threat, then they would place their marks closer to 10 Sv (towards the left-hand side); this would mean that they are not as worried about the effects of radiation, and that they are comfortable recommending higher exposure doses.

One sievert (1), all at once, can cause you to feel mildly ill.
Ten (10) sieverts, all at once, causes death.
The average worldwide background level of radiation (or radiation to which you are already exposed) is
0.0024 sieverts per year.
What is the max level of radiation exposure you would safely recommend for one person for one year?

10 Sv [ ] 0 Sv

Low earth-orbit is known to reach 0.3 sieverts per year.
What are the maximum allowable days you would safely recommend for one person in low-Earth orbit?

364 days [ ] 1 day

Figure 3. Risk Assessment Questions

Figure 4 displays the questions that measured preference for the activity (commercial space travel). In these scales low preference was annotated by placing marks toward the *right* hand side of the scale. In contrast, high preference was annotated by placing marks toward the *left* hand side of the scale. For example, the first question asks the participants how enthusiastic they are about space travel. If the participants were not enthusiastic about the activity then they would place their marks closer towards “Not” (right-hand side). If they were enthusiastic about the activity then they would place their marks closer towards “Very” (left-hand side).

	How enthusiastic are you personally about the prospect of space travel?	
Very		Not
	How likely would you participate in space travel if given the opportunity?	
Likely		Unlikely
	If given a chance, would you consider a trip to low-earth orbit?	
Definitely		Never
	Humans were meant for spaceflight.	
Agree		Disagree

Figure 4. Preference Questions

If participants perceived radiation as more threatening, *or* simply did not prefer space travel, then they would annotate marks closer to the *right*. If they perceived radiation as less threatening, *or* preferred space travel, then they would annotate marks closer to the *left*. This means that marks placed further to the right represented higher perceived threat for the risk assessment portions, and they represented a lower preference for spaceflight in the preference portions.

Participants

A total of 485 surveys were collected. These were students, of varying ages and backgrounds, from Embry-Riddle Aeronautical University. Questionnaire packets were administered during class time with the approval of the instructors. The subjects of each class varied (e.g., psychology & physics) in order to add variety to the sample sizes. No restrictions were placed on participant criteria; however demographics (such as sex, age, nationalities, levels of education, and levels of experience) were collected for informational purposes. Participants were formed into categories depending on which questionnaire was administered. In order to provide a double-blind study, volunteer assistants distributed and collected the completed surveys.

Of the 485 surveys that were collected, 76 were discarded due to incompleteness; this left 409 useable surveys to process. Surveys were then divided into three threat levels: HighThreat (persuasion that the risks in the activity are a threat), LowThreat (persuasion that the risks in the activity are not a threat), and NoPersuasion (no persuasion techniques were intentionally used; bias mitigation was used as often as possible). Afterwards, in order to separate the participants with high-familiarity from the participants with low-familiarity, the top and bottom 30% of familiarity assessment scores were used from each threat condition. As a result, 169 moderate knowledge-level participants were removed. This then left 240 (*N*=240) randomly assigned participants with 40 subjects (*n*=40) in each of the six groups. Table 11 shows the number of participants in each group. The moderate knowledge column represents the mid- level groups that were removed in order to isolate, and compare, the high and low knowledge sample sizes.

Table 11. Experimental Conditions with Participants

	High Knowledge	~~Moderate Knowledge~~	Low Knowledge
No-Persuade	40	~~54~~	40
Low-threat	40	~~54~~	40
High-threat	40	~~61~~	40

Materials

The questionnaires were administered as booklets using average 20-24 weight paper. They were distributed in person by an assistant, and they were completed at the participants' leisure. All information was presented in booklet format. The only exception was the participant debrief; the debrief was delivered as a full take-away sheet at the participants' completion and submission of the questionnaire booklet. The font for all text was Times New Roman, and the font sizes were as follows: title page-26 points, text titles-16 points, text body-10 to 11 points. The surveys were administered to participants in groups in an academic setting. Each participant provided no name, so the data that was provided was anonymous.

According to Taylor (2009) information should be delivered as briefly as possible to participants, and participants should retain an adequate amount of information without allowing them to lose interest due to redundancy. Minimizing the length of time was also beneficial in the interest of persuading threat. According to Harris and Pashler (2004) people can adapt to threatening words or material if they are overly exposed to it. This means that the perception of risk for a specific topic has the potential to decrease over time.

According to Ubel (2008), the wording should be at a 6th-7th grade reading level. This level of reading was increased in specific sections of the booklet (e.g., sections discussing radiation levels). This was not considered to be a problem, however, due to the college-level education of the participants.

There are several benefits in using a questionnaire survey. One of these is the ease of administering a double blind interview. Double blind studies make use of a middleman, a volunteer who administers the experimental conditions instead of the experimenter. Using double-blind studies discourage experimenter bias. Experimenters may sometimes give clues to participants regarding their experimental conditions. This can be done unconsciously through body language or other mannerisms. By using the volunteer to administer packets blindly, then there is less of a chance that the participants can be affected by non-conscious influences of the experimenter.

Double-blind studies have sometimes been used during face-to-face interactions; however, the use of questionnaire surveys requires less training and reduces the likelihood of mishaps regarding the experimenter's volunteers. In addition, double-blind studies may be beneficial if the experimenter cannot be present. For example, during situations where time-constraints are imposed upon a study, the experimenters can utilize the volunteers to administer the tests to large groups at a time while the experimenters attend to other peripheral activities of the study (e.g., finances).

The presence of an interviewing experimenter can induce evaluation anxiety (also known as white coat anxiety in medical settings) which is stress that is induced in some people when they are being tested or evaluated (Benedetti, 2002; Donaldson et al., 2002; Strandberg & Salomaa, 2000). Sources of evaluation anxiety can come from uncertainty, low familiarity with a topic, negative prior experiences with evaluation, excessive ego, or excessive fear of consequences (Donaldson et al., 2002). Some common consequences of evaluation anxiety are decreased performance of participants, compromised data collection, and questionable validity of evaluation results (Donaldson et al., 2002). Since inducing stress and anxiety can encourage familiarity bias, it benefits the experiment to minimize this whenever possible. During the procedure itself this was attempted by trading face-to-face evaluations with anonymous paper surveys that the participants completed privately.

Because the surveys can be administered to groups at a time, they allow large amounts of data collection to be completed in a relatively short amount of time. Some similar studies have been administered over the internet, however this was not preferred. Internet surveys are vulnerable to confounds of the participants' subjective environments or potential cognitive impairments (e.g., inebriation) that could affect data. Instead, the surveys were distributed by a volunteer who was able to judge the mental state of the participants beforehand. The participants were then required to complete the survey in an academic situation without interference of hazardous environmental stimuli such as excessive noise.

In summary, the surveys were constructed in a very specific way in order to optimally encourage certain biases while discouraging others. A double-blind study was used in order to minimize experimenter bias and to utilize time-efficiency. Anonymous surveys were distributed to groups at a time in academic settings in order to minimize evaluation anxiety while still controlling for environmental distractors.

Procedure

Students were naïve as to the real purpose of the experiment. They were given a brief introduction to the study, and they were told that the information collected will help the researchers understand public perception of space and space travel. They were then informed that participation is voluntary, and that participation in the experiment is consent to the researchers for use of their data.

Appendices B-R display the full questionnaire in its various conditions. Experimental independent variables are labeled on each section. The labels identify persuasion themes: high-threat, low-threat, or no-persuade. These labels were not present in the booklets that are issued to the participants. Instead participants received only the sections that matched their specific experimental condition.

The questionnaire began with three introductory sections. The first of these was a title page containing a first-person anecdote, or quote, from a US astronaut. This was the first persuasion strategy. The two influential titles were chosen based on the themed bias of that specific questionnaire (high-threat or low-threat), and no quotes were offered to the control group (no-persuade). The next introductory section was a personal letter to the participants from the experimenter. This letter briefly discussed the project and its implication with Embry-Riddle Aeronautical University. It also contained a brief overview of the questionnaire itself, what the participants could expect during the process, the proposed time limit for completion, and overall instructions. One of two biased statements regarding similar findings of radiation was hidden in this section. The statements were meant to enhance or down-play the mortality data collected from spaceflight participants, and each statement was delivered based on the threat theme of the questionnaire. This was the second persuasion strategy. The control group received a brief historical statement of manned spaceflight and commercial tourism.

The participants were then provided, immediately following the introduction, with a list of references with which the information in the questionnaire was derived. Placing these references at this point in the packet is meant to convince the participants that the packet and researcher were well-sourced. Because perception of a well-sourced informant has been shown in previous studies to increase influence of opinion, this was the third persuasion strategy.

The next section, titled “Section 1: Demographics and Personal Assessment,” collected the participants’ general information including: sex, age, level of education, nationalities, education details, and experience. To avoid initiating pre-experiment bias in the beginning due to egocentric anchoring and adjustment and primacy bias, the participants were not yet asked their personal views regarding radiation or space travel.

“Section 2: Familiarity Assessment” delivered a ten question quiz about radiation, LEO, and space travel. This section was intended to detect the participants’ familiarity of the subject, and the data collected determined familiarity level. Questions were devised to be as pragmatic as possible and were selected based on their neutrality. The questions were meant to detect familiarity bias only; therefore no persuasion strategies were used during this portion.

“Section 3: Waiver Review” was meant to expose the participants to a document containing a paragraph that describes the topic of interest (commercial space travel), and it was delivered in a way that the participants would encounter on a pre-activity waiver. The biased paragraphs were provided to enhance or down-play the dangers of the radiation environment in LEO; each were delivered based on the threat theme of the questionnaire. This was the fourth and final persuasion strategy. The control group received a similar paragraph, however it was provided as contextual information in order to reduce the possibility of PB forming. Examples of the full waivers are available in the appendix.

Two brief opinion questions followed the waiver. These were measured using visual analog scales. Each consisted of a question and a horizontal line. A word or phrase (e.g., Always) was placed at the left side of the line, and its opposite (e.g., Never) was placed on the right side of the line. Participants annotated a mark along the line that best represented their position on the scale. Each line was gridded in millimeters. The grids were not visible to the participants, but instead measured points were added and assessed after the surveys were collected. This section had two purposes. The first purpose was to allow the participants to reflect on the material they had just read; this caused them to think critically about the text and the persuasion bias that was hidden within. The second purpose was to provide a brief tutorial on the visual analog scales so that the participants were comfortable using these scales before they proceed into the final assessment.

"Section 4: Final Assessment" was broken into two subsections. The first subsection allowed the participants to propose radiation limits for both spaceflight participants and the general public by annotating their recommendations on visual analog scales. The second subsection finally gauged the participants' personal preferences regarding the idea of cosmic radiation and space travel. The purpose of this section was to collect the dependent variable: opinions and recommendations. As mentioned earlier, the dependent variables were used to identify and measure the influence and interactions of the two independent variables (familiarity bias and persuasion bias).

Once the packets were completed by the participants, they returned them to the volunteer student administrator. The administrator collected the surveys, annotated the survey threat condition on the participant debrief sheet, and then handed the debriefing forms to the leaving participant. The "Participant Debrief" was intended to expose the hidden nature of the experiment and to explain the agendas to the participants in further detail. It was also used as an opportunity to dissolve any biases that may have been encouraged during the questionnaire. The debriefing form also provided contact information of the experimenter in case the participants had any questions about the study or if they wished to request the project results.

Results

Statistics

Although several studies of risk assessment have utilized Likert scales (Das et al., 2003; Hirsch & Baxter, 2010), visual analog scales demonstrate superiority with detecting sensitivities (Grant et al., 1999; Myles et al., 1999), subjective perceptions, and measurements of egotistic biases (Epley et al., 2004). That is why VAS were used in this study to collect the D.V.s of the participants. The scales were 80mm in length, and they were measured from left (low concern for risk or high preference) to right (high concern for risk or low preference).

Despite the strengths apparent in visual analog scales, there are inconsistencies among the opinions of scientists on exactly how the data should be processed. Scientists like Myles et al. (1999) propose that parametric methods better represent VAS data; they defend that VAS result in wider confidence intervals, that they support conclusions of linearity, and that their ratio scale properties make them ideal to parametric tests. In addition, parametric tests, such as t-tests and analyses of variance, lower Type II error (false negative), and they have been shown to increase power without increasing Type I errors (false positive) (Myles et al., 1999).

Scientists like Kersten, Küç ükdeveci, and Tennant (2012), however, propose that VAS are better suited for distribution-free non-parametric methods. They argue that it is a fallacy to confuse VAS data as interval or ratio, for the data that is derived is ordinal in nature and does not support ratio or interval calculations. They also argue that the subjective change in one participant may represent a different magnitude than the change of another participant, and that the ordinal interpretation of the VAS data takes these confounds into consideration.

For this experiment, non-parametric tests were performed. This is due, in part, to the low sample size as well as the apparent ordinal nature of the collected data. Four Mann-Whitney U tests were used to process the two levels of familiarity (High and Low), and four Kruskal-Wallis tests were used to process the three levels of threat persuasion (High, Low, and No Persuasion). These tests were run using Graphpad Prism version 5.04 for Windows (Prism, 2010).

All figures are presented using the box-and-whisker plots provided by Prism's (2010) software. In the plots, the "boxes" represent quartiles: the top of the boxes display the upper quartiles (the 75 percentile place), the bottom of the boxes display the lower quartiles (the 25 percentile place), and the middle bar within the boxes display the middle quartile (the 50 percentile place) or the median. The "whiskers" extending from the boxes represent the highest and lowest values. For example, the risk levels of HighFam for knowledge-based familiarity (Figure 6) were: highest score- 78, lowest score- 1, upper quartile- 58.3, lower quartile- 19.5, and median- 40.

Risk Assessment.

Figure 5 displays RiskAverage across the two knowledge-based familiarity conditions determined by the familiarity assessment test; Figure 6 displays RiskAverage across all three threat conditions within the knowledge-based familiarity groups. Figure 7 displays RiskAverage across the two experience-based familiarity conditions determined by the total years of exposure; Figure 8 displays RiskAverage across all three threat conditions within the experience-based familiarity groups.

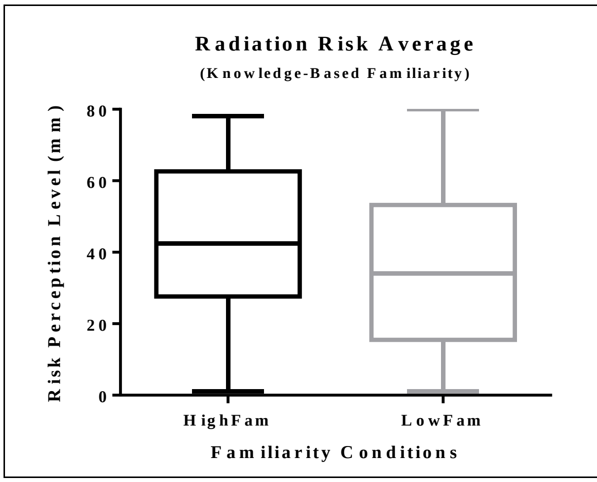

Figure 5. Risk Averages: Familiarity (Kng.)

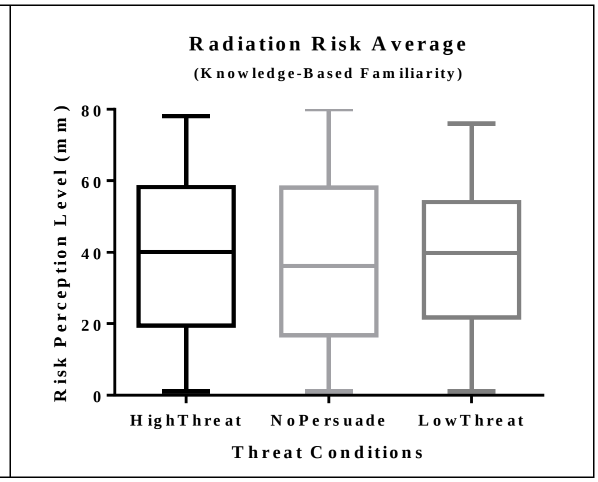

Figure 6. Risk Averages: Persuasion (Kng.)

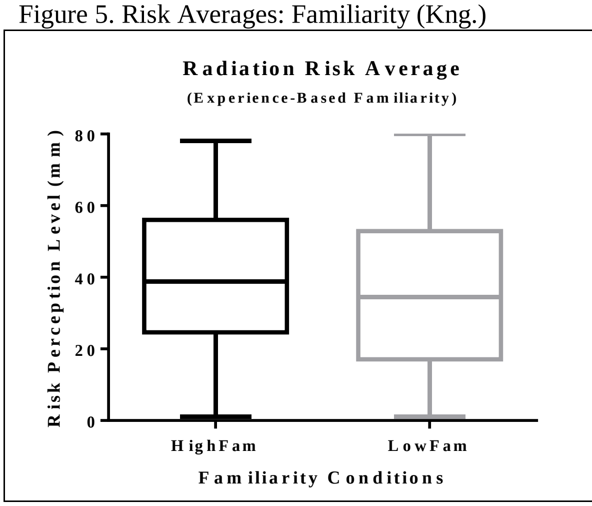

Figure 7. Risk Averages: Familiarity (Exp.)

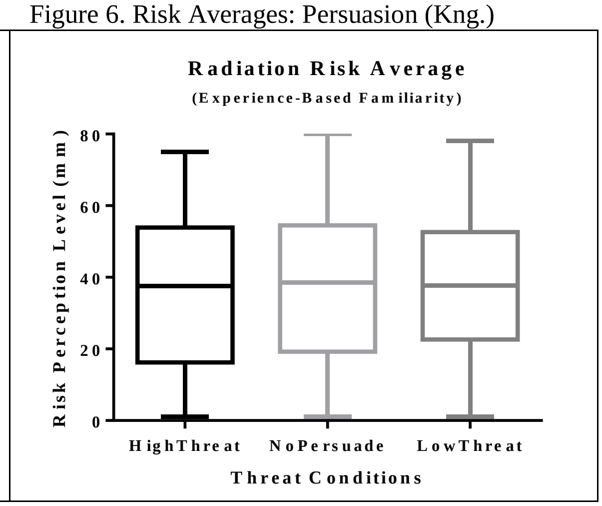

Figure 8. Risk Averages: Persuasion (Exp.)

Preferences.

Figure 9 displays PrefAverage across the two knowledge-based familiarity conditions determined by the familiarity assessment test; Figure 10 displays PrefAverage across all three threat conditions within the knowledge-based familiarity groups. Figure 11 displays PrefAverage across the two experience-based familiarity conditions determined by the total years of exposure; Figure 12 displays PrefAverage across all three threat conditions within the experience-based familiarity groups. As mentioned earlier, the y axis represents the millimeters measured on the scales from left to right; therefore this axis is labeled the "Lack of Preference Level" because higher levels represent less preference for the activity.

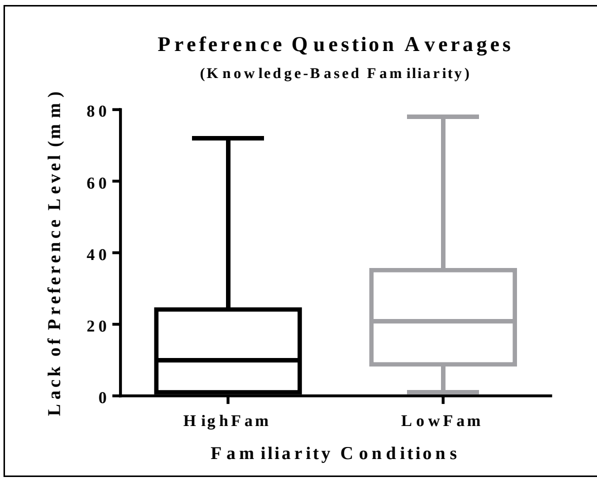

Figure 9. Preference Averages: Familiarity (Kng.)

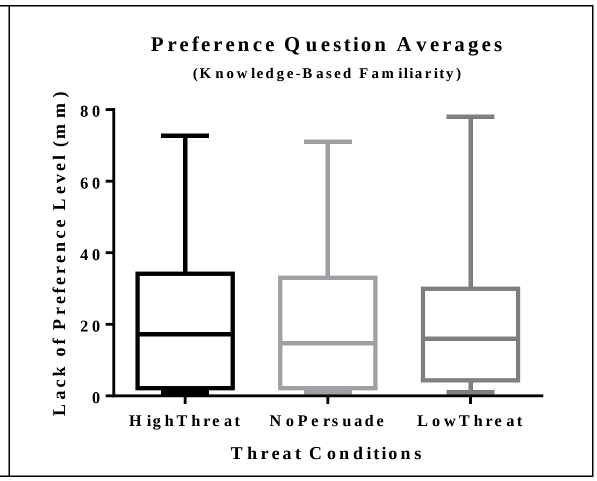

Figure 10. Preference Averages: Persuasion (Kng.)

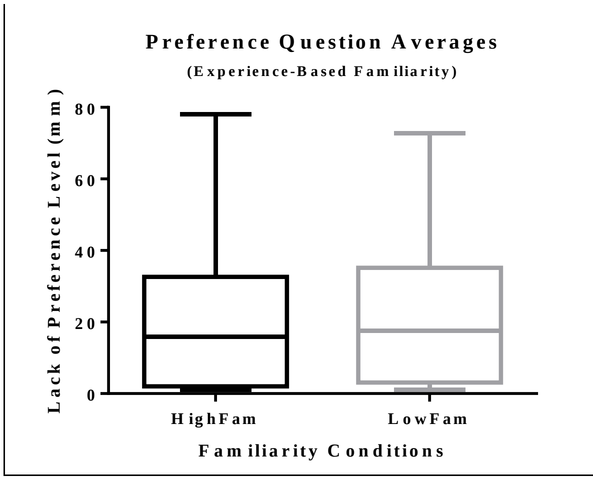

Figure 11. Preference Average: Familiarity (Exp.)

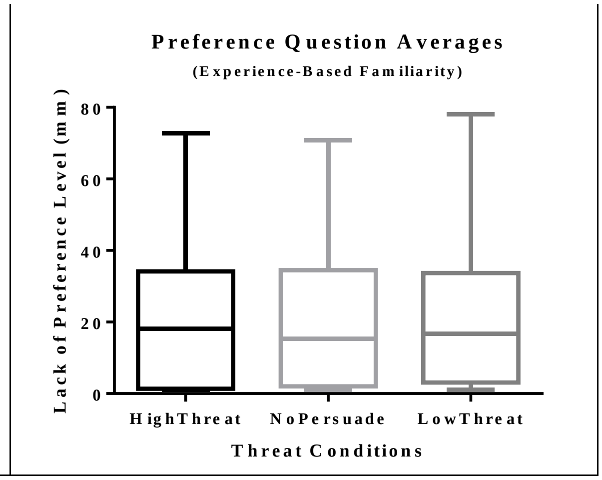

Figure 12. Preference Averages: Persuasion (Exp.)

Hypotheses.

The Kruskal-Wallis tests discovered no significant differences for the threat conditions on RiskAverage between knowledge-based familiarities, $H(2, N = 240) = .41$, $p = .82$, or for exposure-based familiarities, $H(2, N = 240) = .12$, $p = .94$. Regarding PrefAverage, results also did not indicate significance for threat conditions on exposure-based familiarity, $H(2, N = 240) = .18$, $p = .91$, or knowledge-based familiarity, $H(2, N = 240) = .24$, $p = .89$. Therefore no post hoc tests were needed. These findings do not support hypotheses one through three, which state that the persuasion induced by the threat conditions will influence perception of risk.

The Mann-Whitney U tests discovered significance between high familiarity and low familiarity for RiskAverage only within the knowledge-based groups, $U=5617$, $p = .003$. In addition, significance between high familiarity and low familiarity was also exclusively demonstrated within the knowledge-based groups for PrefAverage, $U=5384$, $p < .001$. Specifically, those with high knowledge-based familiarities demonstrated more perceived threat of the risks of space travel, but they also demonstrated a greater preference of the activity. The same results were discovered for experience-based familiarity; however results from this type of familiarity were not statistically significant. These findings do not support hypothesis five (*High levels of familiarity of the topic will result in higher leniency of risk*), but they do support hypothesis six (*High levels of familiarity of the topic will result in higher preference of the topic*) in regards to participants with high knowledge-based familiarity.

Discussion

Hypotheses

Results show that participants with higher assessment test scores, reflecting higher knowledge-based familiarity, had a much greater preference of space travel. Many of the results failed to show significance in various areas, but this does not mean that none exists. The results just indicate that effects and interactions were not detected in some areas according to the methods and other statistical procedures of this study. Therefore, according to the results procured by the experiment:

- High-threat persuasion will not result in a lower leniency of risk.
- Low-threat persuasion will not result in a higher leniency of risk.
- Persuasion will not be significantly greater in the high-threat condition than in the low-threat and no-persuasion conditions.
- High levels of familiarity will not reduce differences among persuasion conditions relative to low familiarity.
- High levels of familiarity of the activity will not result in a higher leniency of risk. Instead they may lead to a lower leniency of risk.
- High levels of familiarity of the activity (based on knowledge) will result in higher preference of the activity.

Limitations and Caveats

Certain controls were implemented earlier in the experiment in order to mitigate confounds. Some of the confounds included mitigation of undesired participant biases such as anchoring and adjustment bias or ordering bias. Other limitations or caveats however still remained. Some of these involved the familiarities of the participants, the effectiveness of the persuasion that was used, and the abilities of the participants to avoid perceptions of threat.

Hypotheses four, five, and six discussed that high levels of familiarity will reduce differences of effects among persuasion conditions, will result in a higher leniency of risk, and will result in higher preference of the topic respectfully. One reason that results between participants in the high familiarity and low familiarity levels did not strongly support these hypotheses may have been due to high levels of familiarity for which the experiment did not anticipate. All participants were students from Embry-Riddle Aeronautical University (ERAU). ERAU is currently the world's largest accredited aeronautical-specific university. Students who attend the university usually have some basis in aviation, aerospace, or related industries. Furthermore, programs and classes at ERAU are very aviation and aerospace rich. For these reasons, the participants have exposure-based familiarity unrelated to the measurement types that were used in this experiment. The results may be very different if the experiment was performed at other institutions of learning, or with different samples of participants, that are less exposed and/or familiar with the topic of space and space travel.

In addition to the familiarity caveat, shortcomings may also exist in the persuasion conditions. DeMarzo et al. (2003) and Corazzini et al. (2010) explain that persuasion sometimes needs to be repeated over long periods of time in order to bias opinions. This experiment tested on-the-spot persuasion, which is persuasion that lasts approximately 10 to 20 minutes (about the length of time it would take for a brief conversation, to listen to a sales pitch, or for a person to read an average informational pamphlet). Some types of persuasion however may take longer to be effective, or different types of persuasion may be necessary for shorter exposure times.

The way that the persuasion was delivered may not have been effective enough for such a short exposure time. According to a meta-analysis performed by Michie, Abraham, Whittington, McAteer, and Gupta (2009), simply providing information and advice may not be enough to encourage some people to internalize the concern for certain health risks. Providing information alone is considered to be a passive intervention, but the best behavioral change interventions appear to be the ones that lead people into self-regulatory practices. If people are provided active interventions that lead them to internalize the importance of an activity or the message with which it is associated, then it will come more automatically to them (Michie et al., 2009). This is understood by clinical behavioral therapists; they often prescribe homework assignments that patients use in order to help modify their behaviors (NACBT, 2011). If similar techniques had been applied to the current experiment then they may have encouraged greater significance between results. For example, participants could be tasked with a game beforehand; in the game the participants would carry a radiation-detection meter on them for 24 hours. Their instructions would be to attempt to avoid areas with higher levels of radiation (e.g., out in the sun). The winners would be the participants who received the least amount of radiation during the game's play period. The purpose of the activity would be to encourage participants to be sensitive to the radiation that they encounter. Therefore it may affect their perception of radiation risks, and this would then affect their radiation limitation recommendations.

In addition to the self-regulation provided by assigning tasks, the face-to-face contact between the experimenter and the participants may have produced more powerful effects with persuasion. This personal one-on-one relationship is another importance stressed by clinical behavioral therapists, and it appears to be more effective than delivering information in a non-personal way (e.g., paper survey format) (NACBT, 2011). Caution should be taken however if this method were used. The face-to-face contact may also encourage evaluation anxiety, and that could produce a carry-over effect. The carry-over due to evaluation anxiety could affect risk assessment scores and it may be mistaken for the perceived threat caused by the threat conditions.

Even if the types and amounts of persuasion were appropriate, the way that the threat is received is still at the mercy of the subjective perceptions of the participants. On some occasions threatening stimuli or persuasion can become saturated. Smith, Loewenstein, Jankovich, & Ubel, (2009) found that the impact of negative stimuli can eventually fade away due to adaptation; this phenomenon is closely related to the expectations of each person. This means that some people can eventually cease to be affected by the negative aspects of some things (e.g., threats) no matter how those topics are delivered. This tends to be very strongly related to optimism bias (Sargeant et al., 2010) and the Pollyanna effect (Matlin & Stang, 1978). Negative stimuli, like the persuasion of threat, may be mentally blocked in favor of positive thinking; some people will mentally avoid attending to threatening information so that it does not induce anxiety. This is also known as anxiety-induced avoidance (Öhman et al., 2001). In addition, Harris and Pashler (2004) also discovered that charged emotional words eventually lose their hold on people's attention, and that the words eventually do not produce the same level of caution after they are used several times. Taken all of this together, the perceptions of some participants may have, in several types of ways, developed a resistance to the persuasions of threat. This effect could have been further reinforced if the participants already had a grounded familiarity with the topic due to attending ERAU.

One potential work-around for anxiety-induced avoidance is locating participants who cannot produce this kind of mental aversion. This would involve locating people sensitive to the specific types of threats, similar to phobics (Das et al., 2003; Klein & Harris, 2009; Öhman et al., 2001; Senay & Kaphingst, 2009; Sharp et al., 2012), and placing them through threat conditions similar to the ones used in this study. One problem with this correction however is external validity: although those threat-sensitive participants may be more reactive to the threat conditions, using a sample size populated only by these types of people may not appropriately represent the entire population.

One final consideration involves optimism bias. Although it is difficult to control for the self-positivity or self-negativity of the participants, detecting them may have revealed an extra influence that could have had greater weight than familiarity bias. Lin, Lin, and Raghubir (2003) write that self-positivity can be the product of three sources: a desire to feel happy, to reduce anxiety, or to increase self-esteem. Future studies would do well to analyze optimism bias in tandem with familiarity.

Any one of the aforementioned caveats and limitations may have contributed to the lack of significance between many of the conditions. Combinations of two or more could have further exacerbated the results. In addition to the biased-avoiding methods used by this study, future experiments are encouraged to also be cautious of the other potential limitations and caveats related to participant backgrounds, participant perceptions, and types of persuasion techniques.

Conclusion

Applications from the findings of this study suggest that more thorough techniques should be applied when delivering persuasion. Although other studies support the efficacy of threat appeals, no substantial results were demonstrated by the techniques used by this experiment. Furthermore this study supports the idea that some persuasion techniques may be wasted on people who have high familiarity of the subject, but this is significantly the case if a high preference of the activity is meant to be preserved in those people. This is because people with high familiarity may prefer the activity when they are not under any persuasion techniques.

In the realm of activity projects, such as commercial space tourism, it is important to understand how automatic thinking shapes the perception of the project organizers as well as the perception of the paying participants. This is essential for informed consents, advertising, training programs, and other scenarios that require adequate and accurate information exchange. Successful safety communication mitigates danger while still preventing participation attrition.

Regardless of the limitations and caveats that were presented, this study opens the door for comparison examinations across multiple types of biases. Because all biases may not be made the same, an understanding of the interactions between different versions of them, and their sources, is harmonious with the intensions of human cognition studies: intensive investigations of behavior, its origins, and its consequences. This study attempted to tease apart the mental phenomena of bias into more easily identifiable compartments. Therefore, it also adds to the ever-growing bodies of research that investigate the individual and social factors that influencing risk assessment and decision making.

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APPENDIX A
Radiation Environment in Low-Earth Orbit

Low-earth orbit (LEO) is generally considered to be approximately 100 to 1500 miles above the earth's surface. The International Space Station, at 220 miles, lies within these limits, but communication satellites extend far beyond them by over 22,000 miles (Barratt & Lienhard, 2010; Strughold, Haber, Buettner, & Haber, 1951). A topic that is still uncertain is exactly how people are affected by the radiation environment in LEO. In order to understand the material that was provided in the experiment, the reader must have a general familiarity of radiation, LEO, and space travel. This section will introduce the terms that were used in the study.

Radiation Overview

Radiation is energy in transit. It exists as waves or particles of different intensities. These properties and intensities determine radiation's influence once it encounters matter or other types of radiation (Reitz, 2008). Common types of radiation are alpha particles, beta particles, and gamma rays (Zapp, 2010). The penetrating power of these energies, whether they are ionizing or non-ionizing, is determined by the radiation's strength. Non-ionizing radiation, at wavelengths associated with visible light and micro waves, is fairly weak and will not disturb the properties of an atom (UNSCEAR, 2000; UNSCEAR, 2008). Ionizing radiation, at wavelengths associated with neutrons and gamma rays, is stronger and will destabilize an atom by manipulating or removing the atom's electrons (Martinez, 2010; NCRP, 2000). This typically happens when one of an atom's tightly bound electrons is knocked loose from the atom's orbit. Radiation then transforms the atom into an ionized, unstable, or radioactive version of itself (Coderre, 2004; NCRP, 2000).

Radiation is measured by sensitive detection devices like Geiger counters. Traditionally space radiation has been measured by dosimeters (UNSCEAR, 2000; UNSCEAR, 2008). Dosimeters are active (particle attracting) or passive (particle catching) detectors that are designed to identify radiation as it passes through their monitoring field (NAS/NRC, 2006a; NAS/NRC, 2006b). During space travel these devices can be worn on astronauts or distributed throughout the spacecraft (Cucinotta et al., 2002; Reitz, 2008; Zapp, 2010). Detectors that compare radiation against living tissues are biodosimeters. An example is the tissue equivalent proportional counter (TEPC). The TEPC was flown in several space shuttle missions; it uses tissue-simulating plastics and cell-simulating low pressure gases (Dunbar & Boen, 2011; Zapp, 2010). The amount of information gathered by these devices depend on their sophistication, and therefore later versions give a much more accurate picture of radiation environments beyond earth as well as their influence on specific types of human tissues (Johnson, Golightly, Weyland, et al., 2002; Waters, Bloom, & Grajewski, 2001).

Radiation is categorized according to its behavior and/or how it reacts with material. Common international standards of radiation measurements are becquerels, grays, and sieverts. Becquerels (Bq), similar to Curies in the US, are used to describe radiation that is emitted from a source; this means that it is radiation moving away from its point of origin. One Bq is defined as one particle/emitted per second. Grays (Gy), similar to rads in the US, are the most basic unit of radiation measurement. Gy's measure how much radiation is being absorbed by something; this means that it is radiation moving into its destination. One Gy is defined as one joule of energy absorbed by one kilogram of material (Coderre, 2004; Cucinotta et al., 2002; Kim, Hu, Nounu, & Cucinotta, 2010; NCRP, 2000; Zapp, 2010).

Sieverts (Sv), similar to rems in the US, are Grays (Gy; absorbed radiation) that account for the type of radiation being absorbed or the type material that is absorbing the radiation. This unit of measurement is used because different types of radiation are more powerful than others, and each human tissue has different levels of sensitivity when it encounters ionizing radiation. If Sv's are stated as an equivalent dose (H) then they represent a specific type of radiation (*e.g.* gamma rays, neutrons, etc.); if the Sv's are stated as an effective dose (E) then they represent the sum of specific types of tissues in the human body that are absorbing the energy. Basically a Sv is a Gy that has been converted based on what it is made out of or where it is being delivered.

Table 12 displays the conversions from Gy's to each type of Sv's. For example, if 100 joules of energy are being absorbed by 5kg of material. Then, according to the absorbed dose portion of the chart, that material is receiving 20Gys of radiation (100J/5kg=20Gys). If energy that is being absorbed by the 5kg of material are 3 MeV neutrons, the equivalent dose is 200Sv (H) (20Gys * 10=200Sv).

Table 12. Radiation Dose Conversion Chart

Radiation Dose Conversion Chart

Absorbed Dose (D)						**Effective Dose (E)**							
J / Kg	=	Gy	*	***Radiation Weighing***	=	Sv(H)	*	***Tissue Weighing Factor (WT)***				=	Sv(E)
				Photons all energies	1			0.01	0.05	0.12	0.20		
				Electr., positr, muons	1			Bone Surface	Bladder	Bone Marrow	Gonads		
				Neutrons, energy:				Skin	Breast	Colon			
				< l0 keV	5				Liver	Lung			
				10 keV to 100 keV	10				Esophagus	Stomach			
				>100 keV to 2 MeV	20				Thyroid				
				>2 MeV to 20 MeV	10				Remainder				
				>20 MeV	5								
		Equivalent Dose (H)											

Figures 13 and 14 show the various levels of intensity of a sievert based on the equivalent or effective dose. Notice that, when evaluating the type of equivalent radiation dose, the ratio is 1:1 unless it is comprised of neutrons. This means that one Gy equals one Sv for all energies except neutron radiation (Coderre, 2004; NCRP, 2000; Cucinotta et al., 2002; Kim et al., 2010; Zapp, 2010). The three sets of weighing factors were derived from the National Council on Radiation Protection and Measurements (NCRP) 132 (2000), the International Commission on Radiological Protection report (ICRP) 103 (ICRP, 2007), and the United States Nuclear Regulatory Commission's (NRC) 10 CFR Part 20 (NRC, 2002).

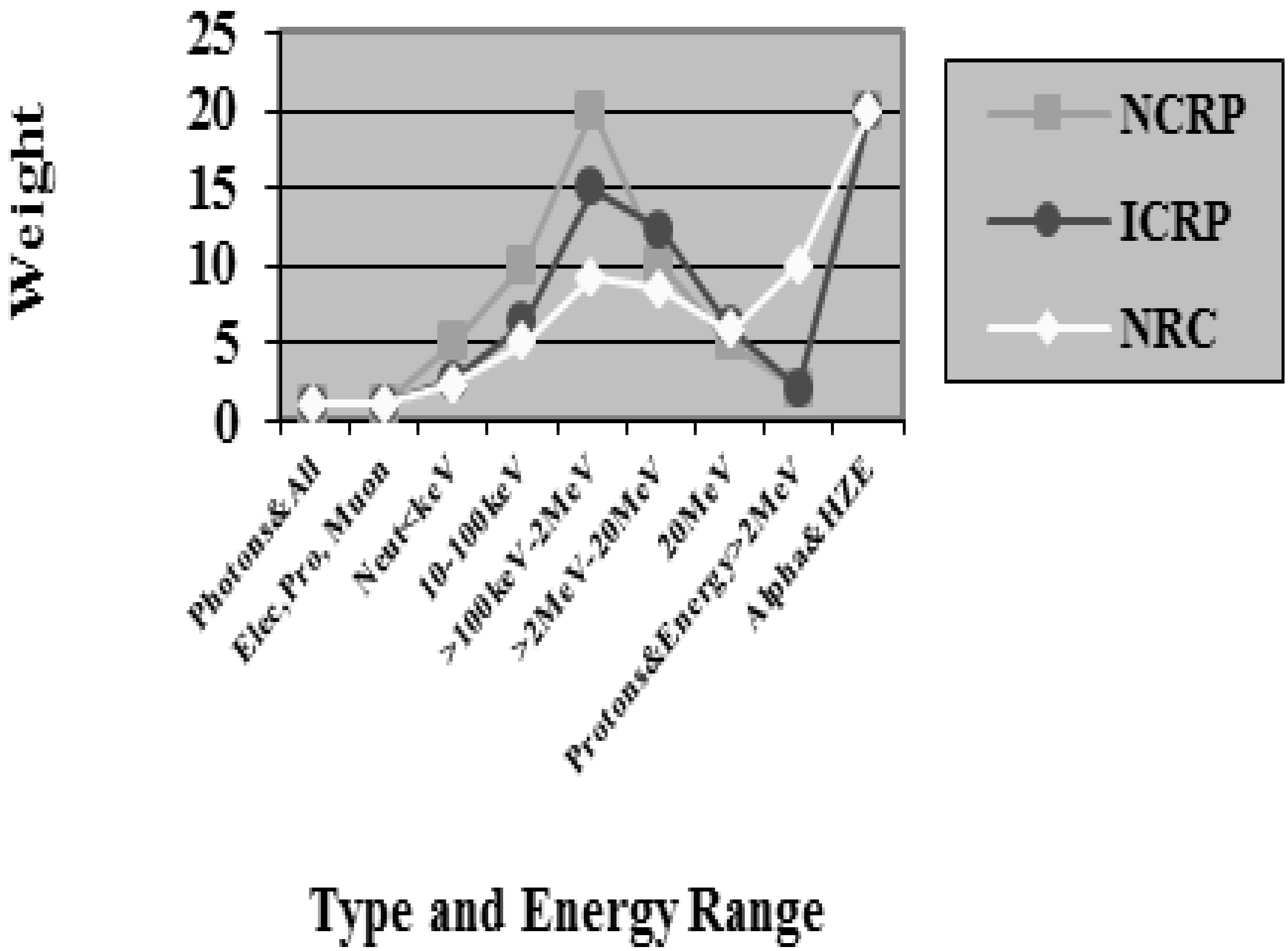

Figure 13. Equivalent Dose Chart

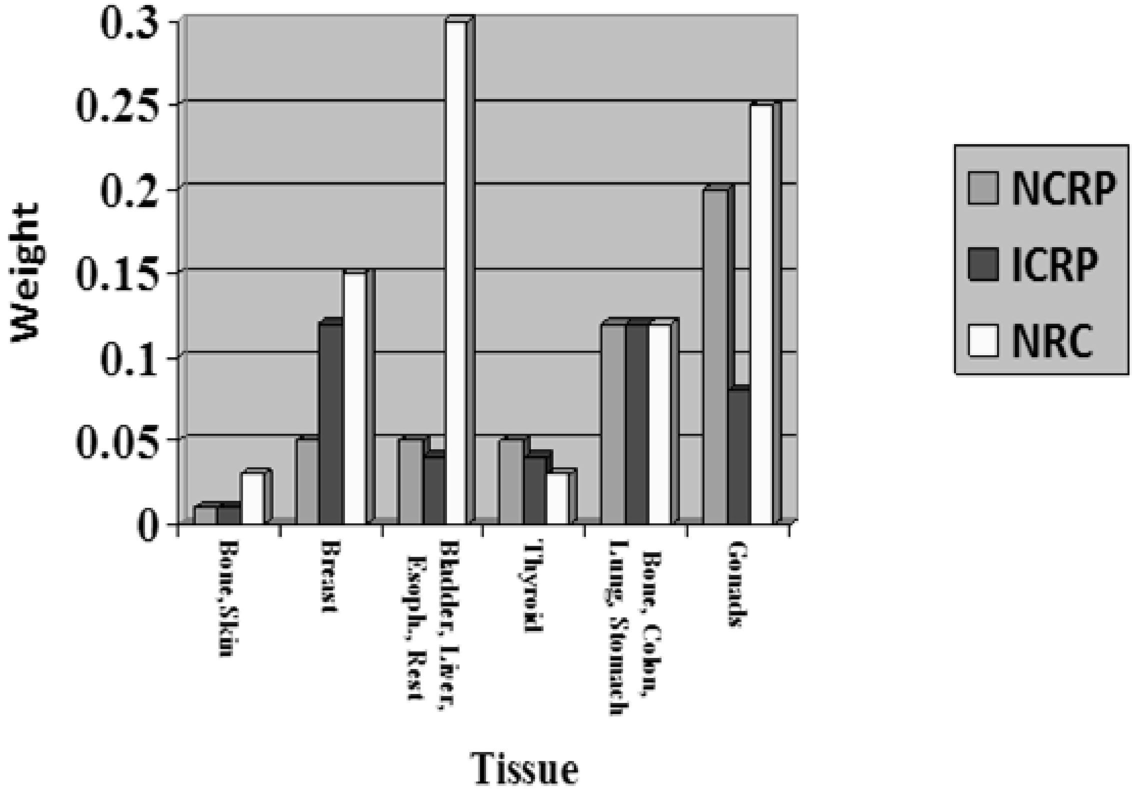

Figure 14. Effective Dose Chart

Radiation can come from anywhere that energy is transmitted. On earth, humans encounter approximately 30% of radiation from space, 52% from the earth, and 18% from radioisotopes within their own bodies (UNSCEAR, 2000). Radiation encountered in space is derived from trapped belt radiation, solar particle events, and galactic cosmic radiation. Trapped belt radiation (or Van Allen Belt Radiation) is defined as terrestrial (earth-bound) energy that begins approximately 1,860 miles above most of the earth's surface (Turner et al., 2008). Belt radiation consists of protons, electrons, energetic helium, carbon, and oxygen. A solar particle event (SPE) occurs when abnormally large amounts of coronal energy eject from the sun; this energy showers areas of our solar system depending on its solar point of origin (Martinez, 2010). SPEs are mostly comprised of protons, alpha particles, and x-rays (Zapp, 2010). Galactic cosmic radiation (GCR) is energy that enters our solar system from deep space (Reitz, 2008). GCR can be generated from special star activity (such as supernovas or black holes) or active galaxies (Johnson et al., 2002). It is composed of protons, electrons, and high-energy heavier ions called HZE radiation (ICRP, 2007; NAS/NRC, 2006b; NCRP, 2000; UNSCEAR, 2000; UNSCEAR, 2008). Aside from direct radiation exposure to solar, cosmic, or terrestrial radiation, spaceflight participants may encounter something called nuclear secondaries, or secondary particles, which are the consequences of high-energy radiation as it passes through high-density material (NAS/NRC, 2006b; Turner et al., 2008). The interaction creates and releases new types of energized hydrogen, helium, and other heavier ions (Coderre, 2004; Zapp, 2010).

Levels of space radiation are higher in or beyond the earth's atmosphere. This is because the magnetic field of the earth absorbs and filters certain types of energy. Therefore radiation is lower at ground-level, and higher in altitude (Cucinotta et al., 2002; Waters et al., 2001). Beyond the atmosphere, high-threat radiation comes in the form of SPEs and specific types of GCR (Kim et al., 2010). Two hundred and twenty five (225) of these solar anomalies have been recognized since 1976 to 2011(Kunches, 2011), and approximately two hundred and twenty six (226) space missions have overlapped these periods (Braeunig, 2010). Solar event doses can exceed 50mSv (Kim et al., 2010), which can be a higher concern in the presence of geomagnetic storms that reduce the strength of the earth's protective magnetic field. (NAS/NRC, 2006b; Martinez, 2010; Reitz, 2008). Heavier HZE radiation, found in GCR, is the most complicated type of radiation encountered in space due to its unpredictable nature. (Cucinotta et al., 2002; Longnecker, Manning, Worth, 2004; Reitz, 2008). HZE is the most dangerous because of its penetrating power; it has demonstrated major damage to biological tissues in laboratory settings (Welton & Lee, 2010; Wilson, Chun, Badavi, et al., 1991).

Radiation Studies in Biology

Relative biological effectiveness (RBE) is another way that radiation is measured as it passes through living tissue; this is the reaction that occurs between energies and biology. Information regarding the RBE of radiation has come from various types of studies including laboratory animals, volunteer convicts, nuclear environment workers, and radio therapy patients. Data is also derived from real-world events such as the aftermaths of the Japanese atomic bombings, the accidents at Three-Mile Island and Chernobyl, and the testing in the Marshall Islands (DOE, 2011; ICRP, 2007; NAS/NRC, 2006a; NCRP, 2000). Collectively, these studies have shown that the human biological effectiveness of radiation is determined by gender, dose of radiation, current age, age of first exposure, body mass index (BMI), and the type of tissue exposed (Cucinotta et al., 2002; NCRP, 2000). In addition it also depends on how much time the person has been exposed to radiation; this can depend on time in altitude, orbital inclination, and the period of the sun's 11 year solar cycle (seven year maximum and four year minimum) (UNSCEAR, 2000; UNSCEAR, 2008; Waters et al., 2001; Zapp, 2010). The effects of cosmic radiation can produce further complications in a human body under the effects of microgravity (Martinez, 2010; Reitz, 2008).

NASA has maintained databases on astronaut health and radiation exposure since 1959, and they have conducted longitudinal studies of astronaut health since 1992. These studies compare hundreds of male and female astronauts with comparison participants, a 1:3 ratio respectively, in order to detect how spaceflight occupational exposures contribute to morbidity and mortality. The use of medical histories, physical examinations, laboratory tests, medical images, and other forms of diagnostic tests are used as evaluation data (Longnecker et al., 2004).

The excess relative risk of fatal cancers limit for astronauts is determined based on a three percent career estimate of cancer mortality. This estimate comes from the data collected from various human population studies, animal studies, physical phantom studies, and combined mathematical and computational models (Zaidi & Tsui, 2009). It means that NASA, the NCRP, and other radiation investigation agencies define a lifetime career risk of cancer compared to the exposure in the most hazardous types of occupations. They have agreed that only three percent over the estimate of this occupation will be tolerated for the activities of US astronauts (ICRP, 2007; NCRP, 2000). Due to readings detected in LEO, three percent is a much higher probability than is expected in earth orbit, and has therefore been selected by considering longer missions like those to the moon or potentially to Mars (Cucinotta et al., 2002). It shows that risks cannot be completely avoided but instead have to be minimized “as low as reasonably achievable;” this is also known as the ALARA principle (Aurengo et al., 2005; Ball, 2002; NCRP, 2000).

Data is collected and then used in models that develop proposed exposure limits (Zaidi & Tsui, 2009). Table 13 displays recommendations based on the NCRP (2000) and the ICRP (2007). Limits according to the NCRP are calculated by the three percent cancer mortality rating based on gender. Trends continue to show that radiation may have strong effects on human tissues even in low doses (NAS/NRC, 2006a). In light of these findings, dose limits for radiation-induced cancers have gotten lower, and they continue to drop (Cucinotta et al., 2002; NCRP, 2000; Turner et al., 2008). No US astronauts have ever been documented as reaching a lifetime mortality risk of more than one percent. Radiation workers also do not typically reach anywhere near the proposed dose limits (Boice Jr., 2010; Turner et al., 2008), nor due high-altitude pilots who are recognized as reaching exposures of 1mGy to 5mGy during a lifetime of flying (UNSCEAR, 2008; Waters et al., 2001).

Table 13. Human Dose Limit Recommendations

	Human	**1-Year General Population**	**1-Year Radiation Workers**	**1-Year Medical Workers**	**10-Year Career***
ICRP	Male	1mSv	50mSv	5mSv	200mSv
	Female	1mSv	50mSv	5mSv	200mSv
	Fetus	1mSv equivalent dose total limit once pregnancy is known.			
NCRP	Male	1mSv	50mSv	50mSv	1250mSv
	Female	1mSv	50mSv	50mSv	750mSv
	Fetus	0.5mSv equivalent dose limit/month once pregnancy is known			

* Approximated for exposure at 40 years of age

Biological effectiveness of radiation is also categorized based on the predictability of its results. Radiation is considered non-stochastic (also known as deterministic) if its measurements can be directly related to a biological effect; examples of these are cataracts and skin burns (Martinez, 2010; NCRP, 2000; Reitz, 2008). Radiation is stochastic if the effects are more random and cannot be measured by the radiation dose alone; an example of this is cancer. Deterministic effects normally occur during radiation in high levels, and stochastic effects occur later and as a result of continuous low-level radiation (ICRP, 2007; NCRP, 2000).

Damage that occurs in the body as a result of ionizing radiation is classified as cancers, noncancers, and genetic effects (Cucinotta et al., 2002; ICRP, 2007; NCRP, 2000; Turner et al., 2008). Any of these pathologies can result from a phenomenon called linear energy transfer (LET). LET is popularly explained as the stopping power experienced by radiation as it passes through material (Zapp, 2010). It is also the change that occurs as one type of energy transforms into another type of energy while it moves through human tissues, cells, or DNA. Some results are oxidation (primarily from low-LET) or direct chromosomal damage (primarily from high-LET) (Reitz, 2008). During oxidation, radiation enters biological tissue and dislodges orbiting electrons from atoms within (Weiss & Landauer, 2003). These new unstable atoms then initiate a chain reaction by dislodging electrons from neighboring atoms (Welton & Lee, 2010). This causes somatic effects that manifest as free radical damage and cell death (Prasad, Cole, & Hasse, 2004).

Although oxidation and free radical generation can effectively cause cell death, they are only loosely associated with DNA damage. Instead, DNA damage tends to occur through direct contact with the radiation waves or particles (Aurengo et al., 2005; Coderre, 2004; et al., 2002; Prasad et al., 2004; Zapp, 2010). If damaged chromosomal molecules cannot be removed or repaired by built-in DNA correcting mechanisms, or if problems occur during the repair process, then they lead to genetic deletions or abnormalities that engender gene mutation and cell death (Coderre, 2004; NAS/NRC, 2006a; Welton & Lee, 2010).

Genetic mutations can occur as a result of ionizing radiation, and they can manifest as abnormal cell propagation (*e.g.* cancer) and genetic effects, or teratogenic effects (*e.g.* birth defects) (Prasad et al., 2004). Both oxidation and direct chromosomal damage are non-specific, and both can lead to cancers (Welton & Lee, 2010). It takes only four alterations to DNA for a cell to become cancerous (Coderre, 2004; Cucinotta et al., 2002; Martinez, 2010). Because cancer is a genetic disease that increases risk with age, it is influenced by genetic instability from either environmentally-driven or spontaneous mutations occurring throughout a person’s life (Aurengo et al., 2005; NCRP, 2000). Reactions of radiation on chromosomes can lead to cancer within 5 to 30 years from exposure (Martinez, 2010). The average time of life loss from radiation induced cancer death is about 15 years, and the lifetime probability in the US for cancer death is currently 22%. This is still less than other occupational deaths (et al., 2002; ICRP, 2007).

Other examples of noncancer effects that have been directly tied to radiation exposure include gastrointestinal problems, muscle problems (such as atrophy), neural inflammation, premature aging, fatigue, impaired immune system, atherosclerosis, strokes, cardiovascular damage, rheumatoid arthritis, diabetes, and compromised fertility

(Fang, Yang, & Wu, 2002; Martinez, 2010; Rola, Raber, Rizk, et al., 2004; NAS/NRC, 2006a; Turner et al., 2008). Radiation, even in lower doses, can inhibit growth of new healthy cells or promote growth of cancerous cells (Aurengo et al., 2005; Zapp, 2010). The effects can last years after exposure (Martinez, 2010). Defects can manifest even if there are no immediate detectable signs (ICRP, 2007; Prasad et al., 2004).

One Gy equals one thousand milligrays. Milligrays (mGy) or millisieverts (mSv) are the preferred type of measurement due to the normally low dosages of radiation that spaceflight participants encounter (ICRP, 2007; NAS/NRC, 2006b; NCRP, 2000). Figure 15 displays examples of certain biological effects of various doses of radiation; it also gives examples of levels of radiation encountered in some recognized real-world scenarios. Historically, the average space mission doses ranged from less than 0.1mGy to 43mGy. US astronauts on the first 43 shuttle missions were exposed to an average of 1.3mGy (Longnecker et al., 2004).

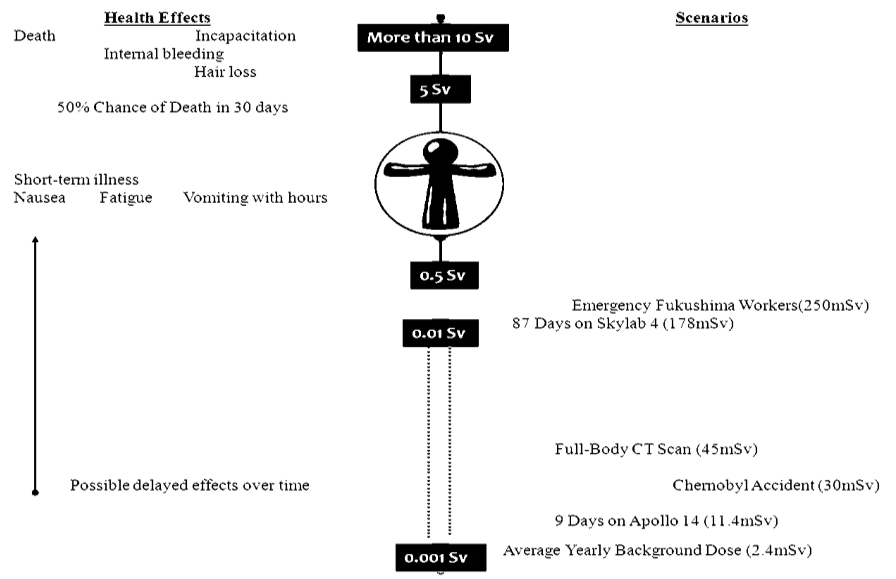

Figure 15. Dose Rates Comparison Chart

Radiation Mitigation

Methods that have been suggested for radiation mitigation are operational strategies, shielding, and biological countermeasures; according to Cucinotta et al. (2002) implementations of these can range from 0 to 1000 days and vary in costs. Operational strategies include time management, pre-activity protection measures, advanced aircraft propulsion (for shorter flight duration), early and adequate alert systems, and specialized radiation storm-shelters onboard for short-term higher radiation occurrences (Cucinotta et al., 2002; Martinez, 2010; Zapp, 2010). One example of an operational strategy is avoidance of the South Atlantic Anomaly; this is a point where the earth's magnetic field dips closer to the planet's surface (as low as 124 miles above ground level) (NCRP, 2000). Another operational strategy involves planning trips around SPEs. SPEs They are fairly unpredictable, but they typically occur during periods of the sun's seven year solar maximum (Johnson et al., 2002; NCRP, 2000).

Experiments have demonstrated that secondary particles can be greatly reduced with shielding that is rich in hydrogen and carbon, like a thermoplastic polymer called polyethylene, instead of traditional aluminum (Cucinotta et al., 2002). These polymers have low atomic mass and absorb energy without initiating harmful nuclear secondaries. They are also cost efficient and dependable types of shielding that protect from most types of space radiation (Martinez, 2010). In addition, some researchers suggest the development and use of active shields like electrostatic fields (Townsend, 2000).

Biological countermeasures are applications or alterations to the human body in order to provide some type of an internal biological protection. Examples of these are gene therapy, and chemopreventers, as well as drugs and vitamins (antioxidants) that reduce the likelihood for radiation induced cancerous growths (Atmaca, 2004; Cucinotta et al., 2002). Many of these techniques have demonstrated success when used on radiotherapy patients as well as in military applications to protect troops against atomic blasts (NCRP, 2000; Weiss & Landauer, 2003).

Radiation: Future Studies

Although a lot of useful data has been collected to help assess the presence and risks of radiation in LEO, more investigation is still needed. Collections of current data are plagued with complications such as complex relationships, difficult factor control, low statistical power, and a strong potential for confounds (NCRP, 2000). Some confounds include carcinogens such as chemical agents, personal lifestyle, or genetics (Cucinotta et al., 2002). Statistical models have been helpful, but they are not yet perfected and are possibly inappropriate representations of the actual data (NCRP, 2000; Zaidi & Tsui, 2009). NASA's longitudinal studies are hampered by inaccurate physical and psychosocial matches between astronauts and their comparison participants, lack of vigilance to the detection of minor health problems within their sample size, and high attrition rates (Longnecker et al., 2004).

Mitigation strategies continue to change as more information is gathered regarding the characteristics of radiation in LEO and the development of stochastic effects like cancer (ICRP 2007). The most beneficial methods of protection are those practiced before the actual flights. Two examples of pre-activity preparation are proper training for the crew and the participants, and extensive medical screening measures (Turner et al., 2008). Models continue to test effective, lightweight, and cost effective shielding (Martinez, 2010; Welton & Lee, 2010; Wilson et al., 1991). Biological countermeasures like radioprotective supplements demonstrate better results when certain substances are combined with others; it therefore stands to reason that the best protection will occur when the right mixtures are met (Fang et al., 2002; Liu, 2010; Prasad et al., 2004). Because it will take time for new discoveries to become implemented practically, studies need to take place as soon as possible in order for the results to be used functionally in commercial spaceflights (Cucinotta et al., 2002).

Further Reading and Materials

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APPENDIX B
Initial Statement to the Participant

Please...

Read each section completely before proceeding to the next,

Do not attempt to compare your survey or answers with others,

Do not discuss your survey with others until the study is complete,
(Study should run for 3-6 months)

Retrieve the 'Debrief' Sheet from the administer after you have completed your survey packet.

Thank you.

APPENDIX C
High-Threat Title

The Dangers of Radiation In Low-Earth Orbit (LEO)

"It's a very sobering feeling to be up in space and realize that one's safety factor was determined by the lowest bidder on a government contract."

"I think all of us certainly believed the statistics which said that probably 88% chance of mission success and maybe 96% chance of survival."

U.S. Astronaut Alan B. Shepard Jr.
Total Time in Space: 9 days
Condition: Died of Leukemia

APPENDIX D
Low-Threat Title

Understanding the Minimal Risks of Radiation In Low-Earth Orbit (LEO)

"I think the drive of human beings to explore is evident from history."

"Everything is accelerating, and we should certainly expect, in the next century, most of the solar system to be populated."

U.S. Astronaut Colin Michael Foale
Total Time in Space: Over 374 days
Condition: Living in Houston Texas

APPENDIX E
No-Persuasion Title

A Brief Look at Radiation & Low-Earth Orbit (LEO)

APPENDIX F
High-Threat Introduction

EMBRY-RIDDLE AERONAUTICAL UNIVERSITY

To the participant,

To date, more than 50 U.S. and Russian spaceflight participants have died of cancers, growths, or other related medical complications. These conditions are potentially traced to the levels of radiation that the participants have encountered during activity in space. It is therefore in the interest of Embry-Riddle Aeronautical University and the Federal Aviation Administration to gauge public awareness of this specific aspect of space travel. The information exchanged in this survey will help develop a foundational framework of the public's perception of cosmic radiation and commercial space travel.

This survey is intended for information collection and distribution. It involves the investigation "**Project: LEO**" tasked to members of Embry-Riddle Aeronautical University by the Federal Aviation Administration. This packet is broken into five sections. Please do one section at a time in the sequence provided. You may end the survey at any time; however you must fill in and submit all sections completely for your data to be entered into the study. The process is estimated to last no more than 15 minutes. The burden during this process is no greater than can be expected for filling out a typical commercial questionnaire.

By completing this survey you understand that participation is voluntary, and that you are giving the experimenters permission to use your data in this project. Be advised that personal information, like your name, will not be disclosed without your direct and written consent. Instead, your results will be referenced by a number assigned by the experimenter. For results and copies of the final report please provide your contact information to the experimenter. This project will be further explained in the debrief sheet you will receive upon completion.

We thank you for participating in this study and look forward to receiving your results.

Sincerely,
Casey Lee Smith
Assistant Researcher
Low-Earth Orbit, Radiation Environment Assessment Team
Embry-Riddle Aeronautical University

APPENDIX G
Low-Threat Introduction

EMBRY-RIDDLE
AERONAUTICAL UNIVERSITY

To the participant,

To date, a very small percentage of spaceflight participants have exhibited any dangerous aftereffects as a result of their activities in space. Of those who have shown illness, it is still uncertain if the effects are due to space travel or other more common lifestyle causes. It is however in the interest of Embry-Riddle Aeronautical University and the Federal Aviation Administration to gauge public awareness of this specific aspect of space travel. The information exchanged in this survey will help develop a foundational framework of the public's perception of cosmic radiation and commercial space travel.

This survey is intended for information collection and distribution. It involves the investigation "**Project: LEO**" tasked to members of Embry-Riddle Aeronautical University by the Federal Aviation Administration. This packet is broken into five sections. Please do one section at a time in the sequence provided. You may end the survey at any time; however you must fill in and submit all sections completely for your data to be entered into the study. The process is estimated to last no more than 15 minutes. The burden during this process is no greater than can be expected for filling out a typical commercial questionnaire.

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We thank you for participating in this study and look forward to receiving your results.

Sincerely,
Casey Lee Smith
Assistant Researcher
Low-Earth Orbit, Radiation Environment Assessment Team
Embry-Riddle Aeronautical University

APPENDIX H
No-Persuasion Introduction

To the participant,

To date, there have been several manned spaceflights conducted all over the world. Some participants have displayed illnesses while most have not. Because potential risks are involved, the welfare of the participants is always the primary concern for this activity. Several factors, such as the radiation environment in space, are an interest to researchers. Embry-Riddle Aeronautical University and the Federal Aviation Administration have teamed up to gather information and to gauge public awareness of this specific aspect of space travel. The information exchanged in this survey will help develop a foundational framework of the public's perception of cosmic radiation and commercial space travel.

This survey is intended for information collection and distribution. It involves the investigation "**Project: LEO**" tasked to members of Embry-Riddle Aeronautical University by the Federal Aviation Administration. This packet is broken into five sections. Please do one section at a time in the sequence provided. You may end the survey at any time; however you must fill in and submit all sections completely for your data to be entered into the study. The process is estimated to last no more than 15 minutes. The burden during this process is no greater than can be expected for filling out a typical commercial questionnaire.

By completing this survey you understand that participation is voluntary, and that you are giving the experimenters permission to use your data in this project. Be advised that personal information, like your name, will not be disclosed without your direct and written consent. Instead, your results will be referenced by a number assigned by the experimenter. For results and copies of the final report please provide your contact information to the experimenter. This project will be further explained in the debrief sheet you will receive upon completion.

We thank you for participating in this study and look forward to receiving your results.

Sincerely,
Casey Lee Smith
Assistant Researcher
Low-Earth Orbit, Radiation Environment Assessment Team
Embry-Riddle Aeronautical University

APPENDIX I
Displayed Sources

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APPENDIX J
Demographics Page

<u>Demographics and Personal Assessment</u>

General

Please provide your information:

Sex: ○ Male ○ Female

Age:____________

Education

Current level of education: ○ High School ○ College (undergrad) ○ College (grad)

Field of study:

____

Years of study in that field:

____

APPENDIX K
Familiarity Assessment Test

Familiarity Assessment

Directions: This section contains 12 questions that will assess your familiarity about the radiation environment in space. Please answer honestly and without help from external sources. It is perfectly fine not to know the answer to most of these questions. Since your identity will remain anonymous, this portion is just to give the researchers an idea of the average population's understanding of the subject.

Which one of the following **is not** a main source of radiation encountered in space or earth orbit?
○ A. Astroidal radiation
○ B. Van Allen belts
○ C. Galactic cosmic radiation
○ D. Solar particle events
○ E. All are equally relevant sources of radiation

Which one of the following **is not** a unit of radiation measurement?
○ A. Rads
○ B. Sieverts
○ C. Becquerels
○ D. Gammons
○ E. Curies

Which one of the following is considered **non-ionizing** radiation?
○ A. Microwaves
○ B. Gamma rays
○ C. X-rays
○ D. Charged particles
○ E. None of the above

Which of the following **is not** a device used to measure levels of radiation
○ A. Dosimeters
○ B. PKE meters
○ C. Geiger counters
○ D. Survey meters
○ E. All are devices used to measure levels of radiation

In regards to radiation, what are considered “secondary particles”?
○ A. Off-spring energies from a combination of two or more types of radiation
○ B. Energized particles produced from radiation and high-density material
○ C. Particles after they lose their radioactivity
○ D. Energized particles that “bleed” off from a larger radioactive source
○ E. None of the above

Effects of radiation are considered stochastic if:
○ A. They are easy to determine
○ B. They are difficult to determine
○ C. They are extremely powerful
○ D. They are extremely weak
○ E. They follow a specific pattern

In regards to radiation, what are free radicals?
○ A. By-products of solar radiation and the earth's atmosphere
○ B. By-products of radioactive decay
○ C. Radioactive particles from an unknown source
○ D. Reactive molecules from radiation-induced oxidation
○ E. Ions that hold their charge longer than others

What is the difference between astronauts and cosmonauts?
○ A. Length of time spent in space
○ B. Astronauts belong to the U.S. and cosmonauts belong to Russia
○ C. Cosmonauts do not require government certification in order to travel in space
○ D. Astronauts belong to the U.S. and cosmonauts belong to all other countries
○ E. There are no differences between the two

Who was responsible for the first manned (involving a human) private (non-government) spaceflight?
○ A. Arianespace (Europe)
○ B. Project Enterprise (Germany)
○ C. SpaceX (United States)
○ D. SpaceShipOne (United States)
○ E. OTRAG (Germany)

Which private company **does not** claim to offer manned commercial trips into space or LEO?
○ A. Virgin Group Ltd
○ B. Masten Space
○ C. Space Adventures
○ D. XCOR Aerospace
○ E. SpaceX

Approximately how much are current commercial space companies charging for trips to LEO?
○ A. $10,000-$90,000
○ B. $100,000-$200,000
○ C. $300,000-$400,000
○ D. More than $500,000
○ E. Over $1 million

What does NASA stand for?
○ A. National Aviation and Space Administration
○ B. National Aeronautics and Space Administration
○ C. National Aerospace and Suborbital Association
○ D. National Aviation and Space Association
○ E. National Aerodynamics and Space Association

APPENDIX L
Waiver Introduction

Waiver Review

Directions: You will now be shown a waiver as you might see before participating in commercial space travel. DO NOT FILL OUT OR SIGN THE WAIVER. Instead, imagine you are about to volunteer for space travel, and read the document carefully before proceeding to the next section.

APPENDIX M
High-Threat Waiver

SPACETOURS INC

Liability Release • Waiver • Discharge • Agreement Not to Sue

THIS IS A RELEASE OF YOUR RIGHTS, READ CAREFULLY AND UNDERSTAND BEFORE SIGNING.

I ______________________________ understand that this is a legally binding Release, Waiver, Discharge and Agree Not to Sue, made voluntarily by me, on my own behalf, and on behalf of my heirs, next of kin, distributes, executors, administrators, guardians, legal representatives, and assigns to SpaceTours Inc.

I understand and acknowledge, as the undersigned Releasor, that I fully recognize that there are dangers and risks to which I may be exposed by participating in commercial space travel (the "Activity"). Some of these include the following:

Flight: Flying in private aircraft necessarily entails the risk of bodily injury, death and property damage from pilot error or other operational errors. In addition, high altitude flights could result in injuries from a combination of factors including but not limited to: mechanical failure, negligent maintenance, range and altitude limitations of aircraft, defects in runways, unimproved landing strips, interference by wildlife, limited or nonexistent air traffic control and radar coverage in remote areas, limited instrument approach procedures to airports, difficult search and rescue in remote areas, unfavorable weather or terrain conditions, latent defects in aircraft, the possibility of contaminated fuel, terrorist acts, lack of sufficient security for aircraft and personnel, or other causes.

Radiation: Although the earth's magnetic field protects from several forms of radiation at sea-level, this protection diminishes substantially in higher altitudes. The atmosphere, aircraft shielding, and other types of mitigation cannot completely protect the space traveler from encountering some of this radiation. Even in small doses, it can accumulate over time and promote harmful, unpredictable, and even fatal medical conditions. While some studies make claim that modest low-doses of radiation contribute to biological repair and adaptation, other studies adamantly reveal that it can cause immediate health defects as well as dormant threats that could eventually compromise fertility and genetic stability. Of the known data collected over fifty spaceflight participants have died of some type of lethal illness. Because deadly diseases (e.g., cancer) typically reflect a lifetime exposure to noxious environmental contributors, like chemical agents, genes, diets, and other lifestyle choices, then lingering in irradiated environments (e.g., low-earth orbit) can expedite these biological risks.

As the undersigned Releasor, I want to participate in this activity despite the possible dangers and risks and despite this Release.

I agree, as the undersigned Releasor, with informed consent and for valuable consideration received (including assistance provided by SpaceTours Inc), that I forever assume all of the risks and responsibilities in any way arising from or associated with this Activity, and I irrevocably release SpaceTours Inc and all of its affiliates, divisions, departments and other units, committees and groups, and their respective governing boards, officers, directors, principals, trustees, legal representatives, members, owners, employees, student volunteers, agents, administrators, assigns, and contractors, from any and all claims, demands, suits, judgments, damages, actions and liabilities of every name and nature whatsoever, whenever occurring, whether known or unknown, contingent or fixed, at law or in equity, that I may suffer at any time arising from or in connection with the Activity, including any injury or harm to me, my death, or damage to my property.

I agree and affirm that I have had instruction, that I understand all aspects of the activity, and that I understand the language used in this Release. I also affirm that I have adequate medical or health insurance to cover any medical assistance I may require, and that I have no physical infirmity or chronic ailment whatsoever except those previously declared. I am not taking any medications of any kind, and I have not taken any alcoholic beverages or drugs within the last twelve hours. I agree not to participate in the activity unless I am medically able and properly trained, and I agree to abide by the decision of the SpaceTours Inc official or agent, regarding my approval to participate in spaceflight.

I have read this entire Release. I fully understand the entire Release and acknowledge that I have had the opportunity to review this Release with an attorney of my choosing if I so desire, and I agree to be legally bound by the Release.

SIGNATAURE OF RELEASOR
Date: ___________________________
Signature ________________________
Print Name: ______________________

WITNESS TO SIGNATURE
Date: ___________________________
Signature ________________________
Print Name: ______________________

In case of emergency, contact:	Relationship:	Telephone:

APPENDIX N
Low-Threat Waiver

SPACETOURS INC

Liability Release • Waiver • Discharge • Agreement Not to Sue

THIS IS A RELEASE OF YOUR RIGHTS, READ CAREFULLY AND UNDERSTAND BEFORE SIGNING.

I ______________________________ understand that this is a legally binding Release, Waiver, Discharge and Agree Not to Sue, made voluntarily by me, on my own behalf, and on behalf of my heirs, next of kin, distributes, executors, administrators, guardians, legal representatives, and assigns to SpaceTours Inc.

I understand and acknowledge, as the undersigned Releasor, that I fully recognize that there are dangers and risks to which I may be exposed by participating in commercial space travel (the "Activity"). Some of these include the following:

Flight: Flying in private aircraft necessarily entails the risk of bodily injury, death and property damage from pilot error or other operational errors. In addition, high altitude flights could result in injuries from a combination of factors including but not limited to: mechanical failure, negligent maintenance, range and altitude limitations of aircraft, defects in runways, unimproved landing strips, interference by wildlife, limited or nonexistent air traffic control and radar coverage in remote areas, limited instrument approach procedures to airports, difficult search and rescue in remote areas, unfavorable weather or terrain conditions, latent defects in aircraft, the possibility of contaminated fuel, terrorist acts, lack of sufficient security for aircraft and personnel, or other causes.

Radiation: Most of the radiation encountered on earth, as well as the higher levels in low-earth orbit, is minimal. It is a typical part of the environment, but increased levels have been correlated with some illnesses. Because of partial protection by the earth's atmosphere, as well as shielding and other mitigation technologies, a large portion of energies are never received by space travelers. While some studies make claim that modest low-doses of radiation contribute to major illness, other studies adamantly reveal that it can actually lead to chromosomal repair, protection, and biological adaptation. Of the known data collected, less than a tenth of spaceflight participants have died from any illness potentially related to space flight. Although radiation cannot be ruled out, illnesses are more likely caused by other factors such as chemical agents, genes, diets, and other lifestyle choices.

As the undersigned Releasor, I want to participate in this activity despite the possible dangers and risks and despite this Release.

I agree, as the undersigned Releasor, with informed consent and for valuable consideration received (including assistance provided by SpaceTours Inc), that I forever assume all of the risks and responsibilities in any way arising from or associated with this Activity, and I irrevocably release SpaceTours Inc and all of its affiliates, divisions, departments and other units, committees and groups, and their respective governing boards, officers, directors, principals, trustees, legal representatives, members, owners, employees, student volunteers, agents, administrators, assigns, and contractors, from any and all claims, demands, suits, judgments, damages, actions and liabilities of every name and nature whatsoever, whenever occurring, whether known or unknown, contingent or fixed, at law or in equity, that I may suffer at any time arising from or in connection with the Activity, including any injury or harm to me, my death, or damage to my property.

I agree and affirm that I have had instruction, that I understand all aspects of the activity, and that I understand the language used in this Release. I also affirm that I have adequate medical or health insurance to cover any medical assistance I may require, and that I have no physical infirmity or chronic ailment whatsoever except those previously declared. I am not taking any medications of any kind, and I have not taken any alcoholic beverages or drugs within the last twelve hours. I agree not to participate in the activity unless I am medically able and properly trained, and I agree to abide by the decision of the SpaceTours Inc official or agent, regarding my approval to participate in spaceflight.

I have read this entire Release. I fully understand the entire Release and acknowledge that I have had the opportunity to review this Release with an attorney of my choosing if I so desire, and I agree to be legally bound by the Release.

SIGNATAURE OF RELEASOR
Date: ___________________________
Signature ________________________
Print Name: ______________________

WITNESS TO SIGNATURE
Date: ___________________________
Signature ________________________
Print Name: ______________________

In case of emergency, contact:	Relationship:	Telephone:

APPENDIX O
No-Persuasion Waiver

SPACETOURS INC

Liability Release • Waiver • Discharge • Agreement Not to Sue
THIS IS A RELEASE OF YOUR RIGHTS, READ CAREFULLY AND UNDERSTAND BEFORE SIGNING.

I ______________________________ understand that this is a legally binding Release, Waiver, Discharge and Agree Not to Sue, made voluntarily by me, on my own behalf, and on behalf of my heirs, next of kin, distributes, executors, administrators, guardians, legal representatives, and assigns to SpaceTours Inc.

I understand and acknowledge, as the undersigned Releasor, that I fully recognize that there are dangers and risks to which I may be exposed by participating in commercial space travel (the "Activity"). Some of these include the following:

Flight: Flying in private aircraft necessarily entails the risk of bodily injury, death and property damage from pilot error or other operational errors. In addition, high altitude flights could result in injuries from a combination of factors including but not limited to: mechanical failure, negligent maintenance, range and altitude limitations of aircraft, defects in runways, unimproved landing strips, interference by wildlife, limited or nonexistent air traffic control and radar coverage in remote areas, limited instrument approach procedures to airports, difficult search and rescue in remote areas, unfavorable weather or terrain conditions, latent defects in aircraft, the possibility of contaminated fuel, terrorist acts, lack of sufficient security for aircraft and personnel, or other causes.

Radiation: Radiation exists in the environment both at sea-level and, to a slightly larger degree, higher in the atmosphere. Most of this radiation is blocked by the atmosphere, shielding, and other mitigation technologies. Given the right circumstances, modest low-doses of radiation can cause destructive as well as beneficial biological effects. Several humans have traveled high into, or beyond, earth's atmosphere. Of the known data collected, some space flight participants later displayed illnesses while others did not. Researchers have concluded that any of these medical complications may have been affected by cosmic radiation as well as other environmental contributors such as like chemical agents, genes, diets, and other lifestyle choices.

As the undersigned Releasor, I want to participate in this activity despite the possible dangers and risks and despite this Release.

I agree, as the undersigned Releasor, with informed consent and for valuable consideration received (including assistance provided by SpaceTours Inc), that I forever assume all of the risks and responsibilities in any way arising from or associated with this Activity, and I irrevocably release SpaceTours Inc and all of its affiliates, divisions, departments and other units, committees and groups, and their respective governing boards, officers, directors, principals, trustees, legal representatives, members, owners, employees, student volunteers, agents, administrators, assigns, and contractors, from any and all claims, demands, suits, judgments, damages, actions and liabilities of every name and nature whatsoever, whenever occurring, whether known or unknown, contingent or fixed, at law or in equity, that I may suffer at any time arising from or in connection with the Activity, including any injury or harm to me, my death, or damage to my property.

I agree and affirm that I have had instruction, that I understand all aspects of the activity, and that I understand the language used in this Release. I also affirm that I have adequate medical or health insurance to cover any medical assistance I may require, and that I have no physical infirmity or chronic ailment whatsoever except those previously declared. I am not taking any medications of any kind, and I have not taken any alcoholic beverages or drugs within the last twelve hours. I agree not to participate in the activity unless I am medically able and properly trained, and I agree to abide by the decision of the SpaceTours Inc official or agent, regarding my approval to participate in spaceflight. **I have read this entire Release. I fully understand the entire Release and acknowledge that I have had the opportunity to review this Release with an attorney of my choosing if I so desire, and I agree to be legally bound by the Release.**

SIGNATAURE OF RELEASOR
Date: ___________________________
Signature ________________________
Print Name: ______________________

WITNESS TO SIGNATURE
Date: ___________________________
Signature ________________________
Print Name: _______________________

In case of emergency, contact:	Relationship:	Telephone:

APPENDIX P
Waiver Assessment

Directions: Below are questions regarding the waiver that you just read. Please annotate your answers by placing a mark in the area of the scales that you feel is most appropriate.
Example:

Agree [|] Disagree

How clearly did the waiver state the agreement?

Very Clearly [ ] Not Clearly

Do you think that the waiver is appropriate for this kind of activity?

Yes [ ] No

APPENDIX Q
Recommendation and Preference Test

Final Assessment

Directions: On the scales below, mark the limits that you personally feel should be implemented. There is no right answer. The point of this exercise is to assess population preferences.

One sievert (1), all at once, can cause you to feel mildly ill.
Ten (10) sieverts, all at once, causes death.
The average worldwide background level of radiation (or radiation to which you are already exposed) is
0.0024 sieverts per year.

What is the max level of radiation exposure you would safely recommend for one person for one year?

10 Sv [ ] 0 Sv

Low earth-orbit is known to reach 0.3 sieverts per year.
What are the maximum allowable days you would safely recommend for one person in low-Earth orbit?

364 days [ ] 1 day

How enthusiastic are you personally about the prospect of space travel?

Very [ ] Not

How likely would you participate in space travel if given the opportunity?

Likely [ ] Unlikely

If given a chance, would you consider a trip to low-earth orbit?

Definitely [ ] Never

Humans were meant for spaceflight.

Agree [ ] Disagree

In addition, what problem do you believe is the most likely to happen to space travelers?
○ A. Crashes
○ B. Complications due to radiation exposure
○ C. Complications due to pressure fluctuations and oxygen
○ D. Complications due to anxiety
○ E. Other (please explain):

APPENDIX R
Debrief

Participant Debrief

Thank you for participating in this study. Your information will assist Embry Riddle Aeronautical University and the Federal Aviation Administration in further understanding the public perception of risk and the radiation environment in low-earth orbit. In addition, your contribution allows us to examine the effects of bias forming on risk perception. During this experiment you may have been exposed to specific persuasion techniques. These were scattered throughout the entire survey, and they were planted in an attempt to persuade your opinions regarding the subject. Depending on which survey you received, you encountered persuasion that intended to encourage one of the three conditions:

1. Radiation environment in low-earth orbit is a threat.
2. Radiation environment in low-earth orbit is not a threat.
3. You received no influence or persuasions.

Please check the back of this debrief to identify your specific condition. The performance of all participants will be evaluated in order to determine whether persuasion bias or familiarity bias (bias depending on your prior level of knowledge measured by the Familiarity Assessment) can be used to predict the outcome of bias forming.

Radiation and space travel are interesting and complicated subjects. There still remain several valid arguments between professionals regarding the risks. All-in-all radiation risk in orbital spaceflight has not been shown to be very substantial, but dangers are still present and could be concernable under certain circumstances. We highly recommend that you perform research of your own before committing to any final conclusions. Copies of this finished study will be available upon request.

We respectfully requested that you not discuss what you have encountered during this experiment until after the results are published.

If you have any questions regarding this project, your participation in the project, or copies of the results, please feel free to contact the researcher (Casey) at smith7a5@my.erau.edu, (386) 871-8164, or through the Human Factors and Systems department of Embry-Riddle Aeronautical University. Results of this study will be published and placed in the Hunt Library (Daytona Beach Campus) upon completion of this project. It may take up to six (6) months to complete and organize everything, so please be patient.

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Thank you again for your contribution!