ABSTRACT

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As with many public health issues, the use of emerging technology such as the incorporation of engineered nanomaterials into consumer products, can become politicized and complicated by a large set of social and scientific factors. Inconclusive risk profiles of some nanomaterials have led to strongly argued claims made by some stakeholders to alter sentiments toward the use of engineered nanomaterials in a variety of applications. Motivated communication campaigners do not necessarily halt their efforts to deliver their message even though toxicologists and material scientists gain ground toward more robust characterization of nanomaterial risks. Such communication campaigns are likely to have demonstrative impacts on individual risk perceptions and risk response intentions, and in turn, on human health. This experimental study informs current debates regarding risk communication campaigns surrounding nanoparticle-formulated sunscreen by experimentally testing the impacts of secondary risk qualifications—communication that a product designed to protect oneself from harm may be introducing a new health risk. This dissertation employs established concepts from Protection Motivation Theory including threat-, and efficacy-perceptions, and behavioral intentions in order to granularly assess the impacts of secondary risk qualifications on mediating perceptual states and persuasive outcomes of risk communication campaigns. Three levels of secondary risk qualifications are assessed using human subject experimentation and results demonstrate that qualifying statements that nanoparticle-formulated sunscreens pose new health risks differ significantly causing audiences to not only shy away from intending to use the product, but also caused them to

view the product as less efficacious in its ability to protect users from risks like skin cancer that affect more than 2 million people in the United States and Australia annually.

Impacts of Communicating Secondary Risks on Risk Reduction Responses:
The Case of Nanoparticle-Formulated Sunscreen

by
Christopher L. Cummings

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APPROVED BY:

David Berube Committee Chair	Deanna Dannels
Jason Swarts	Andrew Binder

DEDICATION

For my parents who have believed in me from day one.

BIOGRAPHY

Christopher L. Cummings was born and raised in Santa Rosa, California. After completing his undergraduate education in Communication Studies at California State University, Chico, he enrolled in graduate coursework at North Carolina State University. His research focuses on providing empirical accounts that improve how risks are communicated between experts, media, and inexpert audiences.

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Let’s celebrate.

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1. Introduction

1.1 Background and Objectives

As with many public health issues, the use of emerging technology such as the incorporation of engineered nanomaterials into consumer products, can become politicized and complicated by a large set of social and scientific factors. The use of nanoparticles in consumer goods bears considerable concern due to the physiochemical characteristics of the materials potentially impacting human health and the environment.

The National Nanotechnology Initiative (NNI), the United States federal research program, defines nanotechnology as 1) research and technology development at the atomic, molecular, or macromolecular levels in the length scale of approximately 1- to 100-nanometer range; 2) creating and using structures, devices, and systems that have novel properties and functions because of their small and/or intermediate size; and 3) the ability to control or manipulate on the atomic scale (The United States Nanotechnology Initiative, 2012). Simply put, nanotechnology can be defined as the control and manipulation of particles to make and utilize very small things (Mu & Sprando, 2010).

Nanoscience experts note that many materials at the nanoscale react, bind, stimulate, and function in novel ways that are distinct from their larger-sized counterparts (Berube, Cummings, Cacciatore, Scheufele, & Kalin, 2011). Nanomaterials are currently being incorporated into a variety of applications in fields including electronics, medicine, optics, and even food applications and cosmetics (The Project on Emerging Nanotechnologies, 2013). The United States, Europe, and Japan, along with other nations have developed programs to assess hazards posed by nanomaterials and improve understanding of how these materials may behave differently from their larger-scale counterparts. These programs seek to catalog reliable and valid risk and safety assessments of nanomaterials to ensure that their negative impacts on human health and the environment are as contained as possible. While there has been over twenty years of extensive research into the novel characteristics of nanomaterials, some characteristics of nanomaterials remain understudied or unknown (Auffan et al., 2009). Of primary concern, the novel properties of materials at the nanoscale not only enable new applications, but also may affect the way these nanoparticle-formulated consumer products interact with human health and the environment.

This uncertainty in the assessment of engineered nanomaterial risk has sustained uncertainty regarding the safe use of some nanoparticle-formulated consumer products. Strongly argued claims made by some stakeholders, those individuals and groups that function as participants in discourse and decision-making around issues of risk, have complicated debates on the safety of engineered nanomaterials in a variety of public forums (Berube, 2008a). Serving as either proponents or opponents, some stakeholder groups have attempted to alter sentiments toward the use of engineered nanomaterials in a variety of applications.

Motivated communication campaigners do not necessarily halt their efforts to deliver their message even though toxicologists and material scientists gain ground toward more robust characterization of nanomaterial risks. Communication campaigns employed by engaged stakeholder groups are likely to have demonstrative impacts on individual perceptions and intentions, and in turn, on human health. As such, initiatives to describe and explain impacts from such debates on risk response need to be addressed.

What must be established next are initiatives to improve the understanding of health decisions made by individuals and groups based upon information they receive regarding consumer products incorporating engineered nanomaterials. By understanding the impacts of public risk communication regarding engineered nanomaterials, we can move to improving persuasive outcomes about health decision-making in future public communication campaigns.

To date, most studies of risk attitudes concerning nanomaterials and nanoparticle-formulated products employ cross-sectional surveying to describe public sentiment. Human subjects' experimentation offers a more robust and structured method to explore the nomothetic impacts of risk messaging. This study seeks to inform current debates regarding risk messaging surrounding nanoparticle-formulated sunscreen (NFS) and to inform future research on the communication of risks of emerging technology.

Most NFS incorporate the inorganic ultra violet (UV) light filters titanium dioxide and zinc oxide. These chemicals have composed the majority of more traditionally construed sunscreens used since the late 1920s. The advantages of using nanoparticle formulations in sunscreens are 1) to improve the efficacy and tolerance of UV filters on human skin, and 2) to make the product more aesthetically pleasing as the formulations rub onto the skin clearly and do not have a noticeable white cast which is believed to encourage reapplication of the product which improves its efficacy as a UV filter (Mu & Sprando, 2010).

While there is concern that the nanoparticles may cause some harm to human health, the United States Food and Drug Administration's (FDA) Director of the Center for Drug Evaluation and Research, Dr. Janet Woodcock, has noted concerning NFS that "the FDA does not currently have reason to warn consumers about their safety," and that the FDA has also "performed testing and found that nanoparticles do not penetrate the skin. If we determine that any of the active ingredients do not meet the safety standards, the FDA will notify the public" (International Medical News Group, 2011).

At this time, discourse surrounding engineered nanomaterials in sunscreens has been loudest in Australia, where individuals, government agencies, and civic groups have made strides to influence regard for sunscreens that are currently available for purchase. These voices not only communicate about the need to protect one-self from the dangers associated with sun exposure, but also communicate about the secondary risks potentially posed by NFS themselves. Communication of this secondary risk tends to manifest in one of three forms; 1) NFS are perfectly safe for use and there is an absence of risks of NFS; 2) NFS are dangerous and should be avoided; and 3) the risks of NFS are yet unknown and caution should be taken in their use and release for public consumption.

Some groups are concerned that the public debates surrounding NFS may result in individuals and groups choosing to not wear sunscreen altogether, which is likely to result in higher incidence and mortality rates of skin cancer. I suggest that improving our understanding of the influences of secondary risk qualifications (SRQs), statements that a protective product like sunscreen may pose new risks, on persuasive outcomes like behavioral intentions and selective avoidance, as well as on mediating perceptual states like threat and efficacy perceptions will improve our ability to communicate about complex issues like the NFS case.

Specifically, the objectives of this research are:

(1) To formulate original research to assess the impacts of SRQs on (i) persuasive outcomes including behavioral intentions and selective avoidance regarding NFS, and (ii) moderating perceptual states including threat and efficacy perceptions regarding NFS.

(2) To prioritize future initiatives to improve human communication theory regarding risks of emerging technology like NFS.

1.2 Literature Review

1.2.1 Risk Assessment

Risk has been defined in a variety of ways ranging from estimates of probability, to perceptions of instability, and to attitudes of vulnerability. As Berube et al (2010) note, the current understanding of the term "risk" is derived from the Italian "*riscare*" meaning to circumnavigate cliffs—an activity rife with uncertainty and potential peril that put an individual or a group at risk.

While the term "expert" has been used to signify individuals with high levels of specialized subject-field knowledge, the terms "public," "lay person," and "inexpert" have been interchanged and conflated with differing connotations. For the purposes of this dissertation, individuals and groups that do not possess specialized subject-field knowledge in nanoscience are referred to as "inexpert" as terms like "public" and "lay" are prone to be used pejoratively.

Risk, as a concept has taken different meanings for expert-, and inexpert audiences. Scientifically-speaking, risk most often has to do with technical probability-estimates of future events and phenomena. However, for many inexpert populations, risk equates more often to "danger" and may be viewed as a highly negative term (Douglas, 1992).

As a scholastic field, risk communication is a subfield of communication studies that is focused on improving decision-making by facilitating appropriate information exchange between stakeholders about hazards (World Health Organization, 2013). While the scholastic field has only recently gained prominence, the communication of risk "is at once a very new and a very old field of interest" (Kasperson & Stallen, 1991, p. 1). Less formally stated, risk communication has occurred throughout human history and civilizations have created a host of systems and operations to detect, anticipate, and respond to hazards. Some scholars note that the analysis of risk dates back at least to the Babylonian era in 3200 BCE (Krimsky & Plough, 1988).

Douglas notes that more technical risk analysis gained traction and held strong influence over the marine transportation industry in the eighteenth century. She notes that "[t]he chances of a ship coming safely home and making the fortune of its owner were set against the chances of its being lost at sea, bringing ruin. The idea of risk in itself was neutral; it took account of the probability of losses and gains… the analysis of probabilities has become the basis of scientific knowledge, transforming the nature of evidence, of knowledge, of authority, and of logic. Any process or any activity has its probabilities of success or failure. The calculation of risk is deeply entrenched in science and manufacturing and as a theoretical base for decision-making" (Douglas, 1992, p. 23).

Since its historical roots of assessing likelihoods of encountering hazards, the field of risk management has grown to be formalized into a host of national and international governing bodies who assess and develop mechanisms for assessing and mitigating hazards. The International Organization for Standardization (2009) defines risk management as "the effect of uncertainty on objectives" and has formalized a set of international standards relating to the identification, assessment, and prioritization of risks (ISO 31000, 2009). The World Health Organization (2013) notes that risk management is a process of weighing and enacting policy options concerning risks with the aim of establishing initiatives to maintain appropriate levels of risk. Often risk managers commission systematic methodologies to calculate risks using probabilistic logic intended to inform decision-making.

1.2.2 Risk Analysis

Risk analyses are based upon the likelihood that an event will occur and the magnitude of that potential event. As a tool, risk analysis is intended to establish reputable and objective data concerning a particular risk event. From this standpoint, risk has been defined by a structured calculus such that:

$$Risk_e = f\,(v_e, p_e)$$

Here, risk is defined as a function of hazard, where f incorporates a variety of complex mathematical schema. Most simply, the quantification of risk assesses $v_{e,}$ the magnitude of a harmful outcome often expressed in terms of mortality or morbidity, and $p_{e,}$ the probability of that the specific event occurs. This multiplicative calculus of dosage and exposure of a specified hazard has been the dominantly used formula to assess risk events for many scientific communities.

Inputs are collected from expert-derived datasets from fields such as toxicology and epidemiology that assess impacts of dosage levels of an agent (whether an environmental hazard, a chemical, etc.) and then use these data along with information provided by regulators and industry to determine potential exposure levels of the agent upon a population. Using this data, a full risk analysis is conducted and the risk of an agent is determined as a potential probability of hazard occurring and its impacts. In simpler terms, this process involves taking "your best measure of magnitude and your best measure of probability, you then multiply them by each other, and you come out with something like expected annual mortality" (Sandman, 1993, p. 5).

This materialist perspective toward risk supposes that a "risk maps directly on to an underlying hazard" (Fox 1999 in Lupton, p. 16), and follows a "simple, logical sequence of steps" to manage risk (Department of the Environment, 1995, p. 5). While an imperfect science, risk analysis has proved a valuable tool in assessing the impacts of a multitude of potential events from diverse arenas ranging from human health, engineering, and even finance. However, this perspective does not account for the complex social dimensions of risk that must take into account the individuals who may assume the risk under scrutiny.

A recent expert community has developed a more critical view of risk as distinct from the technical expert. This community of social and behavioral scientists argue that many individual-level, organizational, and societal considerations affect risk. Among this group, risks are sociocultural constructions that reflect societal conditions of risks. At the fore, “risk is in the eye of the beholder” (Fox, 1999, p. 13).

The conceptualization of the social construction of risk highlights the role played by the motivated application of materialist understandings of risk:

“Insurance experts (involuntarily) contradict safety engineers. While the latter diagnose zero risk, the former decide: uninsurable. Experts are undercut or deposed by opposing experts. Politicians encounter the resistance of citizens’ groups, and industrial management encounters morally and politically motivated consumer boycotts (Beck, 1994, p. 11).

From this perspective, the materialist approach to risk assessment does not equate to formulaic application of information in managing risk. Here “hard facts can only go so far… [a]t some point human judgment is needed to interpret the findings and determine their relevance” (Slovic, Fischoff, & Lichtenstein, 1981, p. 497). The application of technical risk-assessment is rife with communication challenges.

1.2.3 Communicating Risk

Risk communication resides at the juncture between risk managers and inexpert audiences where the analysis and communication of risk attempt to marry scientific rationale with the improvement of human life through the ability to foresee and plan for various hazards. The communication of risk is an iterative process of information exchange about risks between stakeholders and manages how a hazard or potential hazard is represented to multiple audiences.

While there are many challenges to communicating about risk, one significant challenge is the tension between technical-, and sociocultural representations of risk. Sjöberg (2001) notes that risk is often communicated as a social construct, but that the social construct is most often formulated about physical realities. He notes, “If you are run over by a car, it is likely to feel very real, even if we use constructs to talk about such events” (p. 120). Growing recognition that risk communication is a complex and delicate process has led to a similar influx in borrowing and adapting multidisciplinary perspectives to improve how inexpert audiences come to understand and react to risk.

Like many other subjects, risk communication is approached from a diverse set of inconsistent perspectives responding to several reasons risk managers may want to communicate about risks ranging from moral, to institutional, to practical grounds (Kasperson & Stallen, 1991). In all risk environments, interested stakeholders hold a variety of motives that color their perceptions and intentions regarding risk and are likely to make the communication of risk a politicized process.

For instance, some scholars approach the field from an egalitarian premise where risk communication is viewed as “an exchange of information about risk among decision makers, stakeholders, and the public which is intended to supply people with the information they need to make informed and independent decisions about risk ”(Morgan, Fischoff, Bostrom, & Atman, 2002). This perspective of risk communication is one that infers inexpert audiences consist of rational actors and favors that individuals should be allowed to make decisions autonomously and free from persuasive recommendations by some governing body.

This differs from the more autocratically-founded risk communication approaches enlisted prominently by public health campaigners and civic advocacy groups who use risk messaging to persuade and influence individual decision-making. For many risk communicators and health-campaigners the motives for communicating about a risk shift from desiring to inform audiences about the risk so they can freely choose to assume or avoid it, to protecting inexpert audiences through persuasive messaging intended to instill fear of the risk so that they may encourage a particular recommended adaptive behavior to diminish the magnitude and exposure of the risk among the audience.

Thus the manner by which inexpert audiences often learns of risks is politicized and constrained ethically. Are inexpert audiences to be treated as rational actors who self-regulate risks with adequate information? Or should they be persuaded to protect themselves from potential peril?

This project assesses one small feature of risk messaging—the communication that a product designed to protect oneself from harm may be introducing a new health risk. This concept, termed a “secondary risk qualification” (SRQ) is under investigation in this study regarding concerns that sunscreen products incorporating nanoparticles, designed to protect from harmful ultraviolet (UV) radiation that causes skin cancer and premature aging, may be introducing new human health risks.

This dissertation assesses how differences in the communication of SRQs regarding nanoparticle-formulated sunscreens (NFS) cause individuals to perceive sun exposure risks and recommended risk responses differently. What follows is a review of the primary risks of UV radiation exposure—skin cancer and premature aging.

1.3 Sun Exposure Risks

1.3.1 Skin Cancer and Premature Aging

The two primary forms of skin cancer, basal cell carcinoma and squamous cell carcinoma, are by far the most prevalent cancers. It was estimated that in 2006, a total of 2,152,500 people were treated for skin cancers in the United States (Rogers et al, 2006). The third major form of skin cancer, cutaneous melanoma, is less prevalent than the two other forms, affecting nearly 68,700 people in the United States in 2009, but is much more lethal resulting in approximately 8,600 deaths in 2009 (Jemal, Bray, & Center, 2011).

Although the incidence of most cancers has been declining in the United States, the incidence of melanoma has been on the rise (Ries et al., 2000). Since 1973, the observed yearly incidence rate for skin cancers has more than doubled, from an expected rate of 6.8 per 100,00 people to 17.4 cases per 100,000 people in 1999 (National Cancer Institute, 2004). The observed increase is likely to be a function of a host of factors, including increased exposure to UV radiation and improved detection methods (Jemal, Devesa, Hartge, & Tucker, 2001). The mortality rate of skin cancers has also risen approximately 40% since 1973, from 1.9 to 2.7 deaths per 100,000 people. However, through the 1990s, the melanoma mortality rate remained relatively stable among women, but has been less stable among men in the United States (Ries et al., 2000; Hall, Miller, Rogers, & Bewerse, 1999).

Australia has seen similar trends in skin cancer rates, although the country also reports the highest incidence of skin cancer in the world. Australians are also four times more likely to develop forms of skin cancer than any other type of cancer (Australian Institute of

Health and Welfare and the Australasian Association of Cancer Registries, 2004; 2008a). It has been estimated that 2 in 3 Australians will be diagnosed with skin cancer before the age of 70 (Staples et al., 2006). In 2008, 430,000 new cases of non-melanoma skin cancers were diagnosed in Australia; roughly 69% (296,000 new cases) of reports diagnosed basal cell carcinoma and the remainder was squamous cell carcinoma (138,000 new cases)(Australian Institute of Health and Welfare and the Australasian Association of Cancer Registries, 2008a; 2008b). The Australian Institute of Health and Welfare (2012) also reported 11,545 new cases of life threatening melanoma skin cancer in 2009 and in 2010, and there were 1,452 total deaths results from melanoma.

Although skin cancers hold a comparatively low mortality rate than other cancers, the high incidence rate and associated costs of health care contribute to a profound burden on the United State healthcare system. Skin cancer treatment costs an aggregated $2 billion annually in the United States (Hirst, Gordon, Scuffham, & Green, 2012). Another $1.2 billion is spent on treatments for actinic keratoses; highly prevalent skin lesions that are strong risk factors related to skin cancers (Niedecker, Davis-Ajami, Balkrishnan, & Feldman, 2009). In the United States actinic keratoses have an estimated prevalence rate of between 6-25% (Holmes, Foley, Freeman, & Chong, 2007).

Even a decade ago in Australia healthcare costs associated with skin cancer totaled around $300 million AUD (approximately $310 million USD) (Australian Institute of Health and Welfare, 2005). More recently in 2010, it has been estimated that non-melanoma healthcare costs alone have totaled over $512 million AUD (approximately $530 million USD) (Australian Institute of Health and Welfare, 2005). The costs of treating actinic keratoses are also high as the estimated prevalence is much higher than in the United States ranging between 40-60% of the population (Darlington, Williams, Neale, Frost, & Green, 2003).

The relationship between skin cancer and UV radiation exposure is well established. Solar UV radiation is the major environmental cause of skin cancer, although exposure to artificial UV light also contributes to carcinogenic exposure to the skin (El Ghissassi et al., 2009). Higher levels of exposure to UV radiation increase risk of all three major forms of skin cancer, and epidemiological studies demonstrate that approximately 65% to 90% of melanomas are caused by UV exposure (Armstrong & Kricker, 1993). Exposure to UV radiation is known to damage DNA which plays a prominent role in melanoma development (Gilchrist, Eller, Gellar, & Yaar, 1999). Therefore, in theory a sizable portion of skin cancers and their health care costs can be prevented and controlled through simple measures to decrease susceptible populations' UV exposure (Robinson, 2005).

UV radiation exposure has several considerations including duration of exposure, whether the exposure is direct or if skin is protected by shade, the intensity of the light, and whether the skin is protected by clothing, hats, or sunscreen (Saraiya et al, 2004). History of sunburn, especially severe blistering sunburn, is also associated with increased risk for melanoma and basal cell carcinoma (Tsao, Atkins, & Sober, 2004). For melanomas and basal cell carcinoma, short intense exposures to UV radiation are associated with higher risk than less-intense and more chronic UV radiation, even if the cumulative exposure is the same. However, having chronic UV radiation is strongly associated with another form of skin cancer, squamous cell carcinoma, but not with intermittent exposure (Armstrong & Kricker, 2001).

1.3.2 Adolescent and Childhood UV Exposure

There is a well-established link between UV radiation exposure during childhood and young adult life and the future development of melanoma and basal cell carcinoma (11, 12 (Whiteman, Whiteman, & Green, 2001; Westerdahl, Olsson, & Ingvar, 1994). Having a history of one or more sunburns is strongly related to the risk of developing melanoma and basal cell carcinoma later in life (Westerdahl, Olsson, & Ingvar, 1994; Kricker, Armstrong, English, & Heenan, 1995; Armstrong, 1997).

Children and adolescents receive an estimated 25% of their lifetime UV radiation exposure (Godar, Urbach, Gasparro, & Van Der Leun, 2004; Williams & Pennella, 1994). Children and adolescents often have more opportunities than adults to be exposed to sunlight, thus they are more likely to increase their risk of developing skin cancer at some point in their lifetime (Gilchrest et al, 1999; Taylor, Stern, Leyden, & Gilchrest, 1990) . It is also believed that children receive up to three times more sun exposure annually than adults (Wesson & Silverburg, 2003).

One risk factor for skin cancer development is the growth of moles (nevi) that are lesions of pigment forming skin cells. Most moles develop through childhood and young adulthood and sun exposure during this period may increase the number of developing moles which may, in turn, increase melanoma incidence later in life (Armstrong, 1997) 18). Appropriate sun protection during childhood and young adulthood may significantly reduce the risk of skin cancer later in life (Autier et al, 1998).

1.3.3 Personal Characteristics UV Exposure

While anybody can get skin cancer, there are particular characteristics that may put a person at greater risk. Whites are 80 times more likely to develop basal cell and squamous cell carcinoma than blacks and are 20 times more likely to develop melanoma (National Cancer Institute, 2004). Non-Hispanic whites are also at greater risk than Hispanics. Ethnicity reports from the Surveillance, Epidemiology, and End Results (SEER) cancer registry coordinated by the National cancer Institute (2004) for the period of 1995-1999, noted that per 100,000 people, incidence of melanoma occurred as depicted in the table below:

Table 1: Incidence of Melanoma per 100,000 people (1995-1999)

	Ethnicity				
Sex	Non-Hispanic Whites	Hispanics	Asians	American Indian/ Alaskan Natives	Non-Hispanic blacks
Men	23.5	3.8	1.8	1.5	1.2
Women	15.7	3.7	1.3	0.1	0.9

Most communication campaigns regarding sun exposure have focused on promoting understanding that UV radiation increases the likelihood of skin cancer and premature aging (Jones & Leary, 1994). Multiple leading organizations including the American Academy of Dermatology, the American Cancer Society, the Centers for Disease Control, and the National Council on Skin Cancer Prevention recommend UV radiation reducing behavior to prevent skin cancer. These behaviors can include a variety of activities that help to diminish exposure and severity of UV radiation to one's skin. Most professional organizations recommend a host of protective behaviors. Commonly, these organizations first promote abstinence from UV radiation and recommend that people seek shade during the peak sun hours between 10am and 2pm when UV radiation is strongest. They also recommend wearing long-sleeved shirts, hats, and sunglasses when outdoors. When this isn't possible, they urge the use of sunscreens—protective products applied directly to the surface of the skin designed to block UV radiation and thus diminish skin cancer and premature aging risks.

1.3.4 Sunscreens

Sunscreens have been available since 1928 and there is solid evidence that "when applied correctly, sunscreens are efficacious in preventing acute sunburn and tanning. They have also been successful in reducing some chronic effects of UVR irradiation, including immunosuppression, photocarcinogenesis, and photoaging (Sambadan & Ratner, 2010). Sunscreen ingredients can be found in a variety or skin care products. Originally developed to prevent sunburn, sunscreen products have been enhanced to protect against harmful effects of UV radiation (Sambadan & Ratner, 2010).

Sunscreens are applied to the outermost layer of the dermis, the stratum corneum, which is not living tissue. Sunscreens reduce the risk of developing actinic keratoses and non-melanoma skin cancer, and sunscreens have been demonstrated to be cost effective in their prevention capabilities (Darlington et al., 2003; Gordon, Schuffham, ven der Pols, McBride, Williams, & Green, 2009). However, there has also been some concern that the use of sunscreen could increase the risk of developing melanoma. However, multiple studies have discounted this claim as they failed to find correlations between sunscreen use and melanoma development (Dennis, Beane Freeman, & VanBeek, 2003; Huncharek & Kupelnick, 2002). More likely, predisposed genetic factors may play a role in the development of melanoma (Ivry, Ogle, & Shim, 2006).

Furthermore, there are other concerns that some ingredients used within sunscreens may penetrate through the stratum corneum and into viable tissue where it may cause oxidative stress and other harm. Although there are many sunscreens on the consumer market today, only 17 compounds have been deemed allowable for consumer use in the United States by the FDA, and 28 compounds are cleared for use in Australia (Therapeutic Goods Association (TGA), 2013). These active ingredients range from organic compounds like ozybenzone and avobenzone, to inorganic compounds including zinc oxide and titanium dioxide.

While there has been a great deal of concern and assessment of organic and inorganic compounds with mixed results, organizations like the American Cancer Council (2013) continue to recommend the use of sunscreens as they are known to aid in the prevention of skin cancer and premature aging. Both organic and inorganic compounds are discussed in detail in the following section.

1.3.5 UV Radiation Blocking Sunscreen Ingredients

Organic compounds including ozybenzone and avobenzone have come under controversy as they have been identified as photosensitizers that increase the production of free radicals when illuminated (Hanson, Gratton, & Bardeen, 2006; Knowland, McKenzie, McHugh, P., & Cridland, 1993). This demonstrated mutagenicity of the ingredients when exposed to sunlight is of great concern as studies question if the recommended form of protection from sun exposure may be introducing new risks. However, Hayden, Cross, Anderson, Saunders, & Roberts (2005) investigated the potential for such organic sunscreen compounds to penetrate the skin. Their study sought to determine if such compounds penetrated viable human skin and could then put living tissue at risk of toxicity. They tested the penetration and retention of five sunscreen agents including avobenzone, octinoxate, octocrylene, oxybenzone and padimate O). After 24 hours of exposure to the sunscreen agents, they found detectable amounts of all sunscreens present in the stratum corneum and viable epidermis, and that oxybenzone had penetrated the skin the most. While the study notes that these organic compounds do penetrate the skin, the levels of the sunscreen ingredients were too low to cause any significant toxicity to the underlying human tissue. All of the organic compounds tested in the Hayden et al (2005) study are currently approved for use by the FDA.

Inorganic, mineral-based compounds including zinc oxide and titanium dioxide have been used in sunscreen formulations for decades. Zinc oxide is completely photstable and is a broad spectrum UV radiation reflector approved for over-the-counter use by the FDA (Mitchnick, Fairhurst, & Pinnell, 1999; US FDA, 2012). Titanium dioxide refracts light and is used as a physical sunlight blocker as it scatters light more readily than zinc oxide. These inorganic compounds are believed to cause much less skin irritation than organic compounds that are more likely to produce allergic reactions. Oftentimes these two inorganic compounds are used together to increase protective effects.

Zinc oxide and titanium dioxide have a long history and have been incorporated into a host of applications and consumer products in a variety of compositions, structures, shapes, and sizes. Zinc oxide is speculated to have been used in medicinal salves as early as 500 BCE in India and is more widely reported to have been used by Greek physicians in the 1st century as a preferred treatment for skin conditions (Craddock, 1990; 2008). Titanium dioxide was discovered in 1791 and later refined and mass produced for use as a whitening agent (Encyclopædia Britannica, 2013).

Today, the use of zinc oxide is synthesized with other materials to improve its medicinal qualities. For instance, when zinc oxide is mixed with small amounts of iron oxide, calamine is produced which is used in the popular topical skin treatment calamine lotion. Zinc oxide has also been incorporated in fabrication processes for many products that take advantage of the material's antibacterial and UV-protective properties and its high thermal conductivity (Padmavathy & Vijayaraghavan, 2008). Zinc oxide is often used in the manufacture of rubber, concrete, coatings for metals, paints and pigments, and even as a food additive for breakfast cereals as a source of zinc (Brown, 1957; 1976).

Titanium dioxide has been used through most of the 20th century as a white pigment for many products including paints, paper, plastics, and even dairy products including milk (Phillips & Barbano, 1997; Winkler, 2003). Besides increasing white appearance, titanium dioxide is used as a thickener as well as incorporated into products for its UV resistant properties.

More recently, these inorganic compounds have come under fire from civic groups that are concerned that the size of zinc oxide and titanium dioxide compounds included in sunscreens has contributed to a pernicious toxicological profile (ABC News, 2008). The use of nanoparticle-sized zinc oxide and titanium dioxide has become popular among sunscreen and cosmetic producers in recent years. The smaller particles (10-100 nm) serve dual-functions as highlighted by Dr. Paul Wright, a professor of immunotoxicology at the Royal Melbourne Institute of Technology. He says "[n]ano-sized metal oxides absorb UV light better as particle size gets smaller, and have the added advantage of a transparent appearance" (Norrie, 2012). Many consider the aesthetic property important because if the product applies onto skin more clearly, then consumers are likely to value the product more highly and are more likely to apply, and reapply the skin protection product more readily, thus improving the product's ability to protect from UV radiation (Lawson, 2005).

Some individuals and groups are concerned that the use of these mineral-based compounds at the nano-level may be introducing new risks to human health. The following section details some of the debate regarding the use of nanoparticle-formulated zinc oxide and titanium dioxide.

1.4 Nanoparticle-formulated Zinc Oxide and Titanium Dioxide Risk

Great strides have been made in recent years to characterize and assess nanoparticle-sized zinc oxide and titanium dioxide as they appear in sunscreens. Many toxicological risk assessment studies have been conducted in order to empirically assess the exposure and dosage levels of the compounds to viable tissue. As zinc oxide and titanium dioxide have been reduced to sizes in the nano-range (1-100 nm), there has been increased concern that the particles can more readily penetrate the outermost, non-living layer of skin and reach viable living tissue.

One issue that has emerged given the size of nanoparticle-formulations of zinc oxide and titanium dioxide is whether certain nanoparticles can pass through the skin and gain access to the circulatory and lymphatic systems (Tinkle et al., 2003). Mixed findings have been reported in recent years. Some have claimed that the nanoparticle forms of zinc oxide and titanium dioxide may function differently from their larger counterparts and may penetrate the skin and hold different photoactivation processes that may damage cells (Borm et al., 2006; Nakagawa, Wakuri, Sakamoto, & Tanaka, 1997). One study has also shown that nanoparticle titanium dioxide can pass through cell membranes and impair cellular function in dermal fibroblast cultures (Pan, Lee, Slutsky, Clark, Pernodet, & Rafailovich, 2009).

A review conducted by the Australian Government's Therapeutic Goods Association (2006), concluded that "…TiO2 (titanium dioxide) and ZnO (zinc oxide) nanoparticles do not reach viable skin cells, rather, they remain on the surface of the skin and in the outer layer of the skin…" (TGA, 2006). The conclusion that nanoparticle titanium dioxide and zinc oxide do not readily pass through the skin surface has been corroborated by others including the FDA, the Cancer Council of Australia and other groups abroad (Sadrieh et al., 2010).

Some researchers have noted that although it appears nanoparticles cannot readily pass through the skin, they can lodge in hair follicles, sweat glands and skin folds, which has led to further safe use testing (Lademann, Weigmann, Rickmeyer, Barthelmes, Mueller, & Sterry, 1999, Lademann et al., 2006; Nanoderm, 2007).

A recent experiment using 17 participants complicates the conclusions drawn by some governmental groups by concluding that very small amounts of zinc from zinc oxide nanoparticles in sunscreens were found in blood and urine samples among research subjects who used NFS in the study (Gulson et al, 2010). However, the experimenters note that the "overwhelming majority of applied Zn was not absorbed" and that the amounts that were absorbed "were small when compared with the amounts of natural Zn normally present in the human body" and "are minute when compared with the dietary intake of Zn" (p. 140; p. 147).

The European Union Scientific Committee on Consumer Safety in September 2012 released this statement, "it is concluded on the basis of available evidence that the use of ZnO nanoparticles … at a concentration up to 25% as a UV-filter in sunscreens, can be considered not to pose a risk of adverse effects in humans after dermal application (European Union Scientific Committee on Consumer Safety, 2102, p. 97).

Returning to the structural model of risk, we are reminded that risk is comprised of both the dosage level of a substance, and the exposure level of that substance. For nanoparticles in sunscreens to be considered a health risk they have to not only demonstrate their harmful effects to viable cells but also demonstrate that they can reach those cells after topical application. As studies currently have demonstrated little to no evidence that nanoparticle titanium dioxide and zinc oxide can 1) penetrate the skin to the degree in which viable cells are exposed, and 2) maintain dosage levels significant enough to cause harm to the human body, many agencies and groups including the FDA and the Therapeutic Goods Association continue to recommend the use of these sunscreen ingredients. However, one recent publication notes that findings of nanoparticle dermal penetration and toxicity are still inconclusive and the debate over nanoparticle safety is substantiated by civic advocacy groups, scientists, and governmental officials (Wiesenthal, Hunter, Wang, Wickliffe, & Wilkerson, 2011).

1.4.1 Public Debate of Nanoparticle-formulated Sunscreens

It is generally well known that the frequent use of sunscreen may help to reduce the risk of UV radiation that can increase the likelihood of skin cancer and early aging. However, in some countries, especially Australia where skin cancer rates are highest in the world, there has been an increase in communication urging inexpert audiences to take caution regarding the sun protection methods they use. There have been many voices in the debate ranging including members from civic advocacy groups, media, and government agencies. Many have led campaigns to urge inexpert audiences to protect themselves from the harsh risk of UV radiation. While all of the groups hope to protect inexpert audiences from health risks, their stances on NFS have become a battleground and the discourse has spurred controversy over the potential harm that may be caused by the debate itself—especially considering the rhetorical manipulation of toxicological studies that has colored the issue (Berube, 2008b).

Some civic advocacy groups have gone as far as to urge a moratorium on all uses of nanoparticles in consumer products until there is conclusive evidence that demonstrates that nanoparticles pose no potential harm to human health or the environment (Friends of the Earth- Australia, 2007). One such group, Friends of the Earth- Australia (FOE-A) has taken up the mantle to inform people about the potential risks of NFS.

The group has produced a communication campaign of high production quality reports and briefings available online beginning with 2006's "Nanomaterials, sunscreens and cosmetics: small ingredients big risks," 2007's "Nanotechnology & Sunscreens: a consumer guide for avoiding nano-sunscreens," and more recently with 2012's "Nano-ingredients in sunscreen: The need for regulation."

Berube (2008b) examined the potential that publications by this group as well as media may make use of "risk profile shifts" that take a risk profile from one phenomenon and transfer it to another phenomenon within the same class. The concern with risk profile shifting is that it may be used to "bias the public opinion about the safety of some nanoparticles" (p. 24). He vetted the FOE-A 2007 report by contacting the scientists whose work was referenced to support a variety of claims and concluded that the "the rhetoric to describe the findings was much more totalistic or absolute than the researchers admitted could be drawn from their own research" (p. 25). He also noted that scientists "were genuinely apprehensive about how their findings were used by others" (p. 28). He goes on to note that "companies are overclaiming the effectiveness of their sunscreens" (p. 33) and that the "public debates over the health and safety of nanoparticles are a mess and blame rests nearly everywhere" (p. 23).

Of forefront concern is that health risk communication campaigns urging inexperts to be wary of nanoparticles in sunscreens may adversely alter perceptions, intentions and behaviors and gives reason to believe that condemnation of sunscreens incorporating nanoparticles may produce apathy and reluctance to use sunscreens as all. This is especially relevant given recent report from researchers at multiple institutions including the Australian National Measurement Institute, New Zealand's Industrial Research Limited, USA's Argonne National Laboratory, and the Stanford Synchrotron Lightsource, that some sunscreens that claim to be “nano-free” actually contain nanoparticles (Coleman, Ingham, Collins, Ilavsky, & Toney, 2012).

Thus the question looms, are people putting off using sunscreens for fears of nanoparticles? If so, this is likely to be a far riskier behavior that increases melanoma rates and cancer deaths (Green, Williams, & Logan 2011).

1.4.2 Australian Opinion of Nanoparticle-formulated Sunscreen Safety

At the end of 2011, I assisted the Australian Government’s Department of Industry, Innovation, Science, Research and Tertiary Education (DIISRTE) as an outside consultant. DIISRTE conducted a cross-sectional survey of 1,000 Australians to assess if their exposure to communication campaigns that urged avoidance of NFS influenced their behavioral intentions to use traditional sunscreen and NFS. The agency employed the data collection firm Edentify to populate the data for the short survey and included questions regarding sun exposure history, familiarity with NFS messages, and perceptions of health risks from using NFS (DIISRTE, 2012).

The reported findings of the study became yet another point of contest between stakeholder groups, especially FOE-A, as press releases containing simple summaries of univariate statistics became amplified into formal edicts in public media worldwide, where claims using single items from survey data were transformed into volatile statements like “An online poll of 1,000 people by the Department of Industry, Innovation, Science, Research and Tertiary Education found that one in four people felt it was safer to use no sunscreen at all than nanoparticle-based lotion” and “Some Australians Prefer Skin Cancer to

Sunscreens with Nanoparticles"(Norrie, 2012; Johnson, 2012) Of the survey respondents, 5% strongly agreed with the statement that "Not using sunscreen at all is less risky to my health than using sunscreens that include nanoparticles," while 12% agreed, 11% remained neutral, 19% disagreed, 11% strongly disagreed, and 43% of respondents chose to not report an opinion and instead noted that they "didn't know" (DIISRTE, 2012). The public debates over the safe use of NFS continue in Australia as groups urge inexpert audiences to protect themselves from health risks.

Ultimately the Australia case demonstrates that the communication of risk portrayals of NFS represents a significant locus that may influence public health for better or worse. It is from my experience in following the Australian case and noting that all stakeholders vested in the debate want to improve public health that I chose to focus my dissertation project on experimentally assessing if the communication of differing risk portrayals regarding NFS influence persuasive outcomes like comparative risk perceptions and behavioral intentions. I was concerned that studies like the cross-sectional survey were being used by government agencies, stakeholder groups, and media in a hyperbolic manner to further political agendas rather than keeping the wellbeing of the public in mind.

Through this dissertation I wanted to provide more robust experimental data to clarify some of the accounts of perceptions witnessed in casual reports of research that need stronger analysis before being communicated to broad audiences. I wanted to provide rigorous evaluation and empirically sound answers to questions regarding the veracity of claims about the effects of communicating safety and risk messages concerning the use of NFS. It is with this goal in mind that I focused on differentiating between primary risks involving UV radiation exposure and potential secondary risks posed by NFS being both proposed and condemned as a product to protect oneself from UV radiation. The following section provides discussion of the differences between primary and secondary risks.

1.5 Primary and Secondary Risks

A great deal of risk research concerns the prevention, attenuation, abolishment, and diminishment of a specified human health risk. Risks like skin cancer can be lessened in degree by adopting adaptive recommended responses thought to lessen the risk itself. The use of sunscreen is one example. In delineating primary and secondary risks, primary risks are those assumed by an individual at the hand of some hazard, usually involving some environmental threat. Skin cancer and early aging are both outcomes from exposure to UV radiation. Thus exposure to UV radiation is classified as a primary risk.

Secondary risks, on the other hand, are constructed through the response to a primary risk. Secondary risks involve new hazards posed by interventions taken to reduce a primary risk. One of the few definitions of the difference between primary and secondary risks comes from the Project Management Institute that defines secondary risks "as a risk created by the response to another risk. In other words, the secondary risk is a consequence of dealing with the original risk" (Project Management Institute, 2008). Borrowing from David Hillson, a risk consultant in the field of project management, secondary risks "should be identified for responses to key risks, and secondary risks [to] determine whether the risk position after implementation of a response is better or worse than it was beforehand. For example, suppose that Response R is proposed in order to address a primary risk (Risk A), with the result that the original Risk A is reduced to Risk a. However if Response R introduces a new Secondary Risk S, the project team needs to test whether a+S<A" (Hillson, 1999, p. 4).

As previously discussed, many intervention strategies have been proposed in response to the risk of sun exposure including lessening time outdoors during high UV radiation, wearing protecting clothing, and using sunscreen. The great majority of public health campaigns regarding sun exposure urge the use of traditional sunscreens without reservation and very few portray traditionally-construed sunscreens as holding secondary risks in their use. However, this is not the case with NFS.

As witnessed in Australia, traditionally construed sunscreens containing larger sized inorganic compounds have all but been deemed safe and are a widely-accepted form of sun protection, but newer NFS has been a politicized object of debate and often are accompanied with secondary risk information questioning or cautioning the use of the product (Berube, 2008).

Secondary risks have been expressed in scholastic and popular literature under many other pretenses and titles. Perhaps most prominently, secondary risks illustrate the wide interdisciplinary literature evaluating risks associated with emerging technologies as technological advancements are often made to diminish some other primary risk. Airbags in automobiles are designed to improve safety during car crashes, but prove more dangerous for children and infants (Newgard, & Lewis, 2005).

1.6 Motivation for Protection

Although hereditary factors are important when considering the negative impacts on human health from sun exposure, behavioral factors contribute significantly to the development of skin cancer and early aging. Specific behaviors like the use of sunscreen, as well as avoiding or limiting UV radiation exposure have been identified which, if followed, are likely to prevent or diminish skin cancer and premature aging. Recommendations for these protective behaviors are communicated routinely by physicians, mass media, and in pamphlets provided by the American Cancer Society, Cancer Council Australia, the American Academy of Dermatology, and the Skin Cancer Foundation, among others. Straightforward recommendations like wearing sunscreen have been communicated to inexpert audiences; however there are still many people who engage in maladaptive and potentially harmful behaviors.

A great deal of research has been conducted to improve understanding of why people behave the way they choose when faced with health threats. Besides investigations of skin cancer and premature aging prevention, there have been many studies investigating protective behaviors regarding sexual practices, environmental hazards, military violence, food safety, and many other subjects.

A host of psychological and health communication theories seek to explain and predict how individuals initiate and maintain protective behaviors. Weinstein (1993) reviewed four widely used health communication theories describing protective behaviors, the health belief model (HBM), protection motivation theory (PMT), the theory of reasoned action (TRA), and subjected expected utility theory (SEU). His influential review found more similarities than differences between the four theories. All are predicated on the notion that motivation toward protective behavior results from a perceived threat coupled with motivation to avoid negatives outcomes associated with that threat. Each of the theories also incorporates a cost-benefit analysis component where the individual must assess the expected benefit of engaging in a recommended action against that action's expected costs.

Although Weinstein notes each of the four models to be more similar than different, he also notes that some of the major concepts differ in certain regards between theories. For example, and as will be more explicitly detailed in the following section, some concepts like response-efficacy, the perceived effectiveness of engaging in adaptive precautionary behavior is marked as a crucial variable in PMT and HBM but not in the other models. Also, of the four health-decision theories reviewed by Weinstein, only PMT includes self-efficacy as an autonomous variable, and Schwarzer (1992) suggests that self-efficacy is a vital component of a health behavior theory as it is evidenced to influence cognitive, affective, and motivational processes (Bandura, 1997; Floyd, Prentice-Dunn, and Rogers, 2000).

Another popular theory derived in-part from PMT, is the extended parallel process model (EPPM) that attempts to answer why fear appeals sometimes succeed and sometimes fail (Witte, 1992). Using similar constructs of threat and efficacy, the model proposes that "the greater the fear aroused, the more attention getting the message (through depictions of the significance of severity), and the more involving the message (through depictions of susceptibility). If perceptions of threat are low, then people are not motivated to continue message processing, because the threat is perceived as either irrelevant or trivial" (Witte, 1992, p. 338). While EPPM maintains popular usage in examining a variety of fear messages, it has been criticized for assuming an additive relationship among foundational variables and assuming that audiences are not aware of either the threat or the effective responses prior to fear message exposure (Popova, 2011). Nor does the model specify how pre-existing knowledge or states interact with fear message processing (Popova, 2011).

This dissertation employs granularly assess message-attributes on PMT concepts. PMT has been chosen as the foundational theory from which this research is derived as it has a significant history of use in formative research, is not dependent upon constricting calculi supposed by other models and frameworks. As Floyd, Prentice-Dunn, and Rogers (2000) note, “The PMT model provides an understanding of why attitudes and behavior can change when people are confronted with threats” and “PMT has been shown to be a viable model on which to base individual and community interventions” (Floyd et al 420).

1.7 Protection Motivation Theory

PMT draws upon concepts that identify how people react and behave when confronted with messages that may put them at dis-ease. The term “protection motivation” refers to individuals’ motivations to engage in adaptive protective behaviors when facing potential threats. PMT was developed to explain and predict the effects of fear appeals on health attitudes and behaviors (Rogers, 1975).

Fear appeals amount to a problem-solution messaging format that identifies a potential fear-inducing problem and recommends an advocated solution to that problem (O’Keefe, 2002). Fear arousal has been studies for decades, and Sutton’s (1982) landmark meta-analysis of fear-arousing communication studies between 1953 and 1980 demonstrated that increases in the perceived degree of fear consistently resulted in increases in acceptance of a proposed adaptive intention or behavior. Sutton’s meta-analysis also demonstrated that incremental increase in perceived response-efficacy resulted in incremental increases in behavioral intentions to engage in recommended adaptive response.

PMT's origins lie in earlier work on the persuasive impact of fear appeals. Specifically, the Yale Programme of Research on Communication and Attitude Change focused on explaining the circumstances and determinants from which fear appeals influence attitudes and behaviors (Hovland et al. 1953). The primary inquiry of this program focused on whether fear appeals alone would influence attitudes and behavior or whether the impact of such communication was more indirect. This foundational research program was based on a fear-drive model that fear acts as a driving force motivating trial and error behavior (Norman, Boer, & Seydel, 2005).

The premise of this model supposes that if a message evokes fear in a recipient, then that recipient will be motivated to reduce the unpleasant emotional state, and if the message also contains a recommended behavioral response, following the recommendation is one way to diminish the threat. If following the recommended behavioral response leads to a reduction of feelings of fear, then the behavior will be reinforced and the likelihood for sustained adaptive behavior is enhanced. However, if the message does not contain a recommendation for adaptive behavior, or if following the recommended behavioral response does not lead to a reduction of fear, alternative maladaptive coping responses, especially dismissal and denial are likely to be initiated in order to reduce the level of aroused fear.

PMT notes that individuals first learn of a potential threat from a variety of sources of information (Rogers, 1975). These include environmental sources, verbal persuasion, observational learning, and interpersonal sources. The model also suggests that prior experiences associated with the potential threat, and the targeted adaptive behavior may influence mediating cognitive processes when assessing information sources. Rodgers (1983) revised and extended the theory to encompass more general accounts of persuasive impacts on behavior change with a greater emphasis on the cognitive processes that mediate behavior change.

PMT is organized along two cognitively mediated processes: threat-appraisal, and coping-appraisal (Floyd, Prentice-Dunn, & Rogers, 2000). According to the model, assessment of these two factors forms the mediating variable "protection motivation," that addresses individuals' motivation to engage adaptively when facing a potential threat. Like other forms of motivation, protection motivation initiates, maintains, and directs behavior (Rogers, 1975; O'Keefe, 2002). However, both threat-appraisal, and coping-appraisal are further unpacked into smaller components.

1.7.1 Threat-appraisal

The cognitively mediating process of threat-appraisal evaluates 1) severity of the potential threat as well as 2) vulnerability to the threat. Threat severity refers to the perceived degree that the individual believes they will be harmed if they experience the threat. Threat vulnerability, often referred to as susceptibility, refers to the perceived probability and extent to which the individual believes they might experience the threat. Threat-appraisal is dependent upon both threat severity and threat vulnerability, as individuals perceive the threat to be more severe and as they perceive themselves more vulnerable, they are expected to increase their protection motivation.

1.7.2 Coping-appraisal

The other cognitively mediating process of PMT, coping-appraisal evaluates 1) response-efficacy and 2) self-efficacy. Response-efficacy refers to the degree that the recommended behavior is perceived to be efficacious in diminishing the threat. Self-efficacy refers to the individual's perceived ability to perform or adopt the recommended behavior. Self-efficacy as conceptualized by Bandura (1986) is a primary determinant of behavior whereby "people's judgments of their capabilities to organize and execute courses of action required to attain designated types of performances" (Bandura 1986, p. 391). Like threat-appraisal, coping-appraisal is dependent upon both components to influence protection motivation positively. As perceived efficaciousness of the response increases along with perceived degree of self-efficacy, individuals are expected to increase their protection motivation.

This dissertation provides a granular assessment of SRQ impacts on PMT variables including the mediating states of threat and efficacy perceptions as well on persuasive outcomes including behavioral intentions and comparative risk attitudes. Figure 1 below depicts the proposed conceptual model (also referred to as an elaboration model or Lazarsfeld model) of PMT that aids in visualizing the relationships between theoretical concepts.

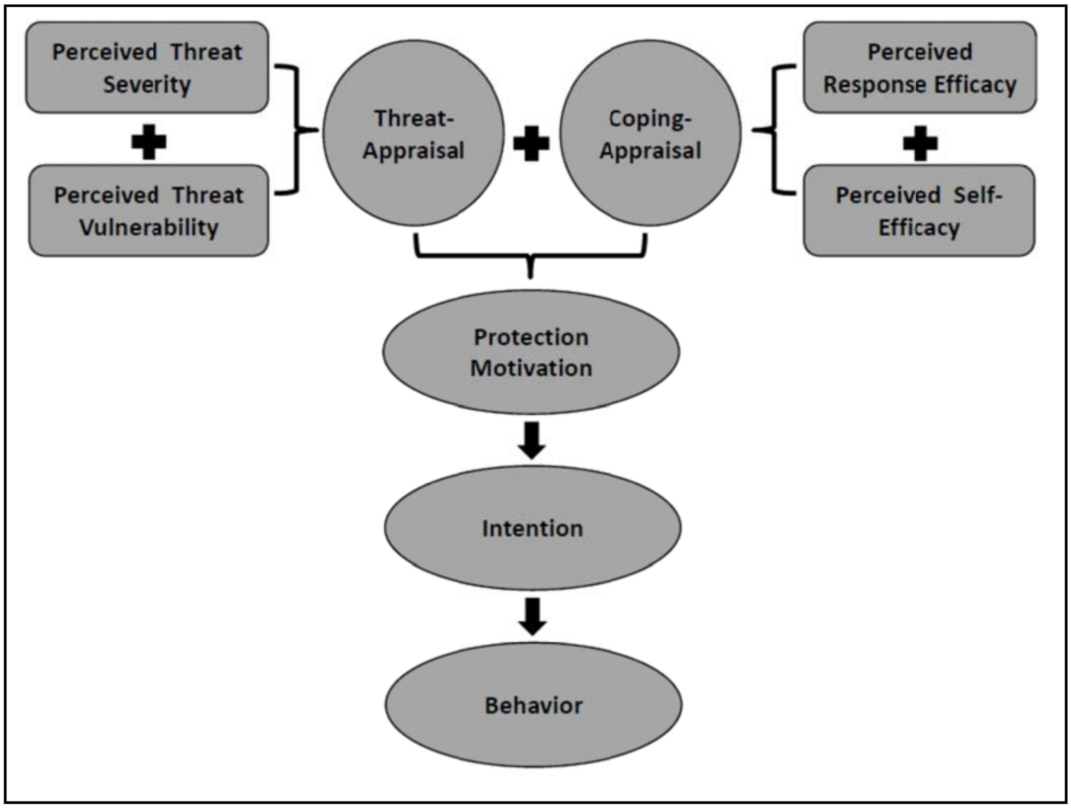

Figure 1: Conceptual Model of Protection Motivation Theory

1.7.3 PMT Criticism and Analysis

Persuasion theory scholar Dan O'Keefe (2003) reviewed and criticized previous PMT research while outlining inroads to improve this dissertation by addressing the vital linkage between theory development and data analysis. Regarding previous PMT studies he notes:

"[r]esearchers collect data about potential mediating states, but then treat such data as providing nothing more than message manipulation checks and hence do not report data analyses in ways that illuminate underlying processes. [PMT] aims at explaining persons' motivations to undertake protective actions (e.g. health-protection actions such as adopting an exercise program). PMT identifies a number of perceptual states (such as perceived threat severity, perceived threat vulnerability, perceived response-efficacy, and perceived self-efficacy) as influences on decisions about adopting protective behaviors. PMT research thus commonly involves the creation of message variations aimed at influencing such perceptual states (e.g., messages that vary in their depiction of the severity of a threat) and the postexposure assessment of both the perceptual state and the persuasive outcomes. Parallel to data-analytic practices common in guilt appeal research, however, the perceptual-state assessment is often treated simply as a message manipulation check." (p. 260).

This dissertation improves upon O'Keefe's criticism of previous PMT research by granularly assessing impacts of message attributes on all major concepts within the theory. The dissertation also assesses the influences of SRQs on both perceptual states and persuasive outcomes in order to characterize SRQ influences on perceptual states and persuasive outcomes including behavioral intentions to use or avoid NFS and comparative risk attitudes between NFS, traditional sunscreens, and not using sunscreen at all.

1.7.4 Review of PMT Studies

Many studies have been conducted using PMT as a guiding framework for inquiry and most of these studies have taken one of two perspectives: first, PMT has been used as a model to develop and evaluate persuasive communication initiatives, and second, PMT has been used as a model to explain social cognitive processes in predicting health behavior (Norman, Boer, & Seydel, 2005). This dissertation employs PMT to assist in formative research on the effects of SRQs on well-established mediating variables like threat-appraisal and coping-appraisal, as well as on persuasive outcomes like behavioral intentions.

A significant amount of empirical research has been conducted to understand how audiences respond when confronting various threats. Studies and communication campaigns using PMT as a theoretical framework come from diverse fields including the promotion of safe-sex activities among adolescent males (Ahia, 1991), HIV prevention among college students (Basen-Engquist, 1994), adherence to medical treatment regimens for muscular dystrophy (Flynn, M., Lyman, R., and Prentice-Dunn, S., 1995), intentions to consume omega-3 fatty acids (Calder, Davidson, & Ho, 2011), and interventions for reducing skin cancer risk (McClendon and Prentice-Dunn, 2001).

1.7.5 Risk Response Recommendations

As noted by communication campaign researchers Witte, Meyer, and Martell (2001), “fear appeals arouse fear by promising negative consequences for not doing a certain behavior. Because you don’t want the negative consequence to occur and you are (presumably) afraid of experiencing the negative consequences, you do what’s suggested in the appeal” (p. 2). Termed a recommended risk response, the communication campaigner urges specific actions to be adopted by the audience that are said to diminish the risk portrayed in the fear message.

Recommended risk responses promote adaptive behaviors that are the crux of any health communication campaign—they are the actions desired of audience members by the communication campaigner to protect themselves from harm. Such recommendations have included the use of condoms to prevent HIV/AIDS, wearing seatbelts in automobiles, and of course, wearing sunscreen to prevent skin cancer and premature aging (Green, & Witte, 2007; Sussex Safer Roads Partnership, 2010; Jorgensen, Wayman, Green, & Gelb, 2000).

While the recommended risk response is considered a vital component of risk communication campaigns, little has been done to assess what impacts occur when the recommended behavior poses some new risk itself. This dissertation provides new territory for discussing the impacts of SRQs, messages included in many risk communication campaigns that assert the existence of new risks about recommended actions intended to reduce preexisting threats to human health. This quandary where risk reducing actions introduce new risks is the locus of this dissertation. While the subject of study is sunscreens, the dissertation assesses a new facet of human communication campaign theory, the impacts of secondary risk qualifications on established health-behavior variables.

2. Scope of the Current Research

The experiment described in section 3 is designed to assess the impacts of message attributes on individual mediating perceptual states and persuasive outcomes. Designs that test message attributes themselves, can be used to create more effective health risk communication initiatives than studies that assess psychological effects alone which may leave communicators and decision-makers wondering how to best elicit a desired psychological states and persuasive outcomes through their messaging with intended audiences (O'Keefe, 2002; Dahlstrom, Dudo, & Brossard, 2012).

Specifically, this dissertation has been designed to investigate three levels of the message attribute SRQs regarding NFS, that are derived from the three major positions taken by stakeholders in the Australian case:

1) Sunscreens that contain nanoparticles do not pose significant health risks,
2) Sunscreens that contain nanoparticle could possibly pose significant health risks, and,
3) Sunscreens that contain nanoparticles do pose significant health risks.

The study was also designed to assess the influence of combined recommendations that include the presence of a statement that traditionally construed sunscreens are safe. It is thought that this isolation of the two independent variables in a 2 x 3 factorial design would elicit ample data to begin unpacking the potential effects that SRQs and comparative risk qualifications hold on perceptual states and persuasive outcomes. Beyond the six conditions in the 2 x 3 factorial design, two control groups were used to assess the experimental manipulations, a traditionally defined control group that did not receive any form of either independent variable, and a second group that had a statement that traditionally construed sunscreens are safe but did not include any SRQ regarding sunscreens containing nanoparticles. The experimental conditions are further detailed in section 3.3.

Table 2 details the basic 2 x 3 factorial design:

Table 2: Factorial Design

Condition 1	*Condition 2*	*Condition 3*
• NFS no-risk • Presence of no-risk qualification for traditional sunscreen	• NFS Uncertainty • Presence of no-risk qualification for traditional sunscreen	• NFS risk • Presence of no-risk qualification for traditional sunscreen
Condition 4	*Condition 5*	*Condition 6*
• NFS no-risk • Absence of no-risk qualification for traditional sunscreen	• NFS Uncertainty • Absence of no-risk qualification for traditional sunscreen	• NFS risk • Absence of no-risk qualification for traditional sunscreen

This dissertation was conceived to answer various questions about how inexpert audiences are influenced by risk messages regarding sunscreens and NFS. Based on historical accounts of risk portrayals regarding sunscreens and NFS as detailed in section 1.4.1, this study investigates how SRQs influence perceptual states like threat and efficacy perceptions regarding sunscreen and NFS and they may impact persuasive outcomes like behavioral intentions and comparative risk attitudes. In other words, the research examines the relationships between message attributes of witnessed risk communication messages and related outcomes, and explores factors that might mediate these relationships.

In this work, the little-studied topic of SRQs was identified as a potential influence on the risk communication process. Driving the concerns of this dissertation are questions including—after viewing a SRQ of a protective product:

1) Do consumers feel differently about the product that was originally intended to protect them?

2) Would they only consider using the product if it was deemed safe?

3) If the product poses new risks, does that decrease perceptions that the product is effective in preventing the primary risk?

4) Do comparative SRQs between two products influence mediating states are perceptual outcomes?

The following section formally delineates research hypotheses of this dissertation.

2.1 Research Hypotheses

This study tests multiple hypotheses concerning mediating perceptual states like threat and efficacy attitudes, as well as persuasive outcomes like comparative attitudes and behavioral intentions as they are influenced by SRQs.

Three hypotheses, each with two components were posed regarding SRQs' impacts on mediating perceptual states concerning NFS. The second message attribute, the presence of a traditional sunscreen safe qualification was also assess as detailed in coming chapters. Table 3 notes the perceptual state hypotheses.

Table 3: Hypotheses—Mediating Perceptual States

H 1: SRQs regarding NFS will increase perceived (i) threat severity to NFS, and (ii) threat vulnerability where risk statements will cause higher levels of perceived threat severity and vulnerability compared to other conditions.
H 2: SRQs will decrease perceived response-efficacy regarding NFS prevention of (i) skin cancer, and (ii) premature aging where secondary risk statements will cause lower levels of perceived response-efficacy than uncertainty statements compared to other conditions.
H 3: SRQs will decrease perceived self-efficacy regarding NFS prevention of (i) skin cancer, and (i) premature aging where secondary risk statements will cause lower levels of perceived self-efficacy compared to other conditions.

A second set of hypotheses were posed to address the impacts of SRQs regarding NFS on persuasive outcomes including behavioral intentions to use, or avoid NFS and comparative risk attitudes. Table 4 notes the persuasive outcome hypotheses.

Table 4: Hypotheses—Persuasive Outcomes

H 4: SRQs will increase behavioral intentions to avoid using NFS, where secondary risk statements will cause higher levels of avoidance intention than other conditions.
H 5: SRQs will decrease behavioral intentions to use NFS, where secondary risk statements will cause lower levels of intention to use NFS than other conditions.
H 6: SRQs will influence comparative attitudes between NFS and non-NFS so that SRQ conditions will view NFS as more risky than other conditions.
H 7: SRQs will influence comparative attitudes between NFS and no sunscreen use so that SRQ conditions will view NFS as more risky than other conditions.

Inspired by a sizable history of experimental study of similar PMT variables, this experiment provides empirical indication that SRQs can greatly impact cognitive mediating states and persuasive outcomes.

3. Formulating an Experimental Design

3.1 Overview

An experiment was conducted to test the veracity of the various hypotheses regarding influences of SRQs and comparative risk qualifications on respondents' risk perceptions, efficacy perceptions, and behavioral intentions to engage in recommended adaptive risk reducing behavior.

3.2 Experimental Stimulus

The experimental design for this study included the use of a color-printed health brochure that served as the experimental stimulus for the project. The stimulus took the form of a health information brochure similar to pamphlets that audiences read at health centers, doctor's offices, and clinics. As noted by Michielutte, Bahnson, Dignan, & Schroeder (1992) in their study of different types of health brochures, "the use of aids such as illustrations and text style can make health education literature more accessible to high-risk populations, while remaining interesting enough to appeal to individuals at all levels of reading ability" (p. 251). These brochures are often the locus of information communicated about health risk issues during information campaigns distributed by government agencies, health promotion groups, or civic advocacy groups. The brochure produced for this dissertation was designed to be informative, appealing to the eye, as well as serve as the experimental stimulus.

The use of a brochure as the stimulus for this dissertation project was desirable for various reasons. First, health pamphlets are commonly circulated to wide audiences and are a simple form of communication that can also be easily tailored to specific experimental conditions desired by the researcher. They are of little financial burden to create and are a form of health communication that is presumed to be familiar with a majority of study participants.

Health brochures blend written and visual forms of communication and allow participants to interact with the medium, letting them read it at their speed, in a more naturalistic setting than holding the audience captive during a health promotion lecture or video. Brochures like the one employed in the experiment provide high reliability in the information they portray and pamphlets are not susceptible to shortcomings of other modes of experimental stimuli delivery like live lecturing, use of confederates, live interviewing, participant observation and the like.

All participants received a bi-fold health brochure that upon simple investigation appeared to be uniform across all experimental conditions. A copy of the brochure can be found in Appendix A. Care was taken to maintain a high level of internal validity with the use of the brochure as the experimental stimulus. As health brochures blend textual and visual messages, I was challenged to create a brochure that was provocative enough to entice the reader but was not overly stimulating to the point of distraction. In the creation of the brochure I emulated styles and layouts of a variety of brochures I obtained from local health clinics and online. To maintain control and adequate manipulation over the primary independent variables of interest, I chose to keep all of the brochure information, textual and visual, static between experimental conditions save for the differences in secondary risk qualifications. In doing so, I minimized potential confounding influences that could arise due to issues of source credibility and persuasive influences of visual messages.

The brochure cover displays a typical day at the beach with sunshine, sand, waves, and beach umbrellas. A large type-faced title reads “Staying Safe in the Sun: Protecting yourself from the risks of sun exposure.” Upon opening the pamphlet the reader notes four quadrants of partitioned information and pictures. The upper-leftmost quadrant bears the title “Know the Risks of Sun Exposure.” Accompanying the title is a short paragraph detailing basic epidemiological and health risk information regarding the current consensus of skin cancer and premature aging risks. The section reads:

“While we often associate a glowing complexion with good health, the truth is that UV radiation from sun exposure and tanning beds accelerates the effects of aging and increases your risk of developing skin cancer. Over 75,000 Americans are diagnosed with skin cancer each year and almost 10,000 Americans die from skin cancer annually. UV radiation from sun exposure and tanning beds is known to lead to:

- Pre-cancerous and cancerous lesions and tumors,
- Premature aging like course wrinkles and discolored, patchy skin,
- Elastosis—the destruction of elastic skin lining resulting in sagging and misshaped skin, and,
- Actinic keratoses—think scaly precancerous bumps and lesions that may become cancerous if left untreated”.

This section of the health pamphlet was designed to provide all participants with similar information regarding the primary risks of sun exposure; skin cancer and premature aging. Care was taken to provide detailed quantitative information in a straightforward and easily understandable manner so that participants first encountered baseline risk information.

The second quadrant located in the lower-left of the pamphlet housed the title "Sunscreen Facts." The aim of the information portrayed in this quadrant was two-fold; 1) to introduce participants to both forms of sunscreen to be assessed in the experimental design i) NFS, and ii) more traditionally construed "sunscreen," and 2) to provide inroads to discuss the role of secondary risks associated with NFS. The section read the same for all conditions as follows:

> *"The best advice to avoid premature aging and skin cancer is to avoid sun exposure. This isn't always possible. Over the past 30 years sunscreens have been offered as a way to reduce premature aging and cancer risks.*
>
> *<u>But how safe are sunscreens?</u>*
>
> *For decades sunscreens have contained zinc and titanium oxide formulations that block Ultra Violet (UV) rays. These traditional sunscreen formulations have been considered by experts to be safe and effective in minimizing sun exposure risks. Sunscreen formulations continue to change in an effort to improve their safety and effectiveness.*
>
> *<u>Sunscreens including nanoparticles</u>*
>
> *Recently, sunscreen containing very small versions of zinc oxide and titanium dioxides, called nanoparticles, have been marketed to consumers in the USA. Sunscreens including nanoparticles are known to be just as effective as other sunscreens in reducing premature aging and cancer risks; however these sunscreens containing nanoparticles are said to be more pleasing in appearance on the skin. While sunscreens including nanoparticles are effective in reducing premature aging*

> *and cancer risks, they are currently being tested to determine if they may cause other significant health risks."*

This section of the pamphlet also provided participants with a statement about the comparative effectiveness of traditional sunscreens to nanoparticle formulated sunscreens, noting that both forms of sunscreen are equal in their ability to reduce premature aging and skin cancer risks.

The upper-rightmost quadrant was filled with a picture of a woman applying sunscreen to her shoulder. The picture was chosen in order to visually reiterate the subject of study for the participants.

Finally, the lower-rightmost quadrant contained the only non-static information presented in the health pamphlet. This section of the pamphlet contains two parts: 1) a static recommended risk response and 2) the message attribute variations that served as the experimental manipulation. For all participants, the quadrant begins with a large-typeface title reading "Experts Say." following the title all participants received the same information reading:

"We feel that it is important to take expert recommendations to protect yourself from the risks of sun exposure. Here's what the experts say: Dermatologists recommend that you frequently use any form of sunscreen to significantly decrease your risks of skin cancer and premature aging."

This statement was designed to follow from PMT and other popular health-decision theories regarding explicit communication of a specific risk reduction recommendation that is thought to improve adaptive behavior among the targeted audience.

Following this uniform risk reduction recommendation is a single sentence that serves as the only manipulation between experimental conditions. The statement qualifies the recommended risk response and contains the two message-level variables under investigation in this project 1) SRQs regarding NFS and 2) presence of a no-risk qualification regarding traditional sunscreen.

3.3 Experimental Conditions

In sum, eight forms of the health brochure were drafted to serve as the stimulus for the eight experimental conditions. Six of the eight experimental conditions followed a traditional 2 x 3 factorial designed experiment of the effects of message attributes[1]. Two experimental conditions were used to assess manipulation checks and were not used in the 2 x 3 factorial design. The first removed condition issued only a no-risk qualification for traditional sunscreen that read "Furthermore dermatologists agree that sunscreens do not have other significant health risks." This condition made use of one of the two variables of interest and thus could not be used in hypothesis testing. The second experimental condition, the Control group did not receive any sort of manipulation of either variable under analysis. This group was exposed to the recommended risk response but did not attend to SRQs.

Of the remaining conditions, the first of the two independent variables included three levels, all regarding different types of SRQs concerning NFS. The second variable was used

[1] This experimental design purposively limits the conditions to assess the primary message attribute regarding NFS, and does not portray more traditionally-construed sunscreens as posing secondary risks. This decision to refrain from portraying uncertain or negative conditions regarding traditional sunscreen is due to the overwhelming dominance of support for the use of sunscreen to reducing sun exposure risks. While scant literature exists that may note sunscreens use to be a health risk, the abundance of public material notes traditional sunscreens to be safe for frequent use. This echoes my desire to maintain a close semblance to health campaign material that is commonly circulated among audiences. A final condition was added as a control that did not contain any SRQ. Rather, for the control, the brochure information ends with the previous expert risk reduction recommendation to frequently use any form of sunscreen as given to all participants.

as a covariate in analysis to assess if the presence or absence of a statement of traditional sunscreen safety would impact dependent measures. This variable had two levels, whether the condition included a "no-risk" statement regarding traditional sunscreens, or if it did contain a "no-risk" statement. Table 5 below depicts the six conditions in the 2 x 3 factorial designed experiment as they appeared in the health brochures:

Table 5:Factorial Design: Stimulus diction

	NFS SRQ: no-risk	*NFS SRQ: Uncertainty*	*NFS SRQ: Risk*
Presence of no-risk qualification for traditional sunscreen	*Condition 1:* "Furthermore dermatologists agree that sunscreens and sunscreens containing nanoparticles do not have other significant health risks."	*Condition 2:* "Furthermore dermatologists agree that sunscreens do not have other significant health risks but are uncertain about if sunscreens containing nanoparticles could possibly have other significant health risks."	*Condition 3:* "Furthermore dermatologists agree that sunscreens do not have other significant health risks but that sunscreens containing nanoparticles do have other significant health risks."
Absence of no-risk qualification for traditional sunscreen	*Condition 4:* "Furthermore dermatologists agree that sunscreens containing nanoparticles do not have other significant health risks."	*Condition 5:* "Furthermore dermatologists are uncertain about if sunscreens containing nanoparticles could possibly have other significant health risks."	*Condition 6:* "Furthermore dermatologists agree that sunscreens containing nanoparticles do have other significant health risks."

3.4 Data and Measurement

Data for this project were measured using a pre-test, post-test experimental design. The pre-test asked respondents about their attitudes and history concerning sun exposure, sunburns, and sun protection. This set of measures asked respondents to report their typical behaviors regarding sun exposure and sunscreen use, types of sun protection they typically use, and purchasing history regarding sunscreens. Respondents were also prompted to report their likelihood to engage in sun protection behaviors during the next week. A battery of semantic differential scales was also incorporated into the pre-test to judge the degree of respondent favorability regarding sun exposure, suntanning, and using sunscreen. Finally, this baseline set of measures also asks for basic individual-level information including age, sex, university class standing, and racial/ethnic identification.[2]

Following the reading of the health brochure that served as the experimental stimulus for the project, respondents were asked to complete the post-test. This set of measures was designed to assess perceptual states and behavioral intentions that may have been influenced by the experimental stimulus. The following section details the measures used to assess these PMT variables.

3.4.1 Measuring PMT variables

Dependent variables were measured post-stimulus exposure to test potential effects of SRQs on PMT variables including mediating perceptual states and persuasive outcomes.

As previously detailed, PMT articulates that individuals assess a given risk through two cognitively mediated processes: threat-appraisal, and coping appraisal (Floyd, Prentice-Dunn, and Rogers, 2000). Each of these processes is unpacked into smaller components including threat severity and threat vulnerability, as well as response-efficacy and self-efficacy of the adaptive response recommended by the communicator. This study granularly assesses these cognitively mediating variables as well as persuasive outcomes.

[2] Many of the pre-test measures will be investigated in future analyses and are not incorporated into this investigation of SRQ impacts on PMT variables.

Some variables were assessed using multiple post-test items and were then computed into single measures for analysis. All post-test measures asked respondents to indicate their level of agreement on a 5-point Likert scaling system (Likert, 1932).

Table 6 below provides overall descriptive statistics for threat severity and threat vulnerability regarding skin cancer, premature aging, and NFS as well as Cronbach's alpha for computed dependent measures (Cronbach, 1951).

Table 6: Post-test measures: Threat severity and threat vulnerability (N=320)

	Skin cancer	*Premature aging*	*Risks of NFS*
Threat Severity	4.39 (.72)	3.95 (.91)	2.64 (.82) α =.82
Threat Vulnerability	2.33 (.92)	2.51 (1.01)	2.77 (.83)

Note. Standard Deviations appear in parentheses below means and alpha scores are reported for computed measures

The next table provides overall descriptive statistics for response-efficacy and self-efficacy regarding the use of traditional sunscreen and NFS to prevent skin cancer and premature aging.

Table 7: Post-test measures: Response-efficacy and self-efficacy(N=320)

	Sunscreen preventing skin cancer	*Sunscreen preventing premature aging*	*NFS preventing skin cancer*	*NFS preventing premature aging*
Response-Efficacy	4.29 (.67)	4.21 (.62)	3.76 (.81) α =.78	3.76 (.79) α =.74
Self-Efficacy	3.95 (.86)	3.95 (.88)	3.35 (.92)	3.38 (.94)

Note. Standard Deviations appear in parentheses below means and alpha scores are reported for computed measures

Beyond the examination of the mediating perceptual states of threat-appraisal and efficacy-appraisal, items were developed to assess persuasive outcomes including behavioral intentions and comparative risk attitudes.

Table 8: Post-test measures: Behavioral intentions and comparative risk attitudes (N=320)

Nanoparticle-sunscreen avoidance	2.56 (.91)
Nanoparticle-sunscreen use	3.24 (.84)
Nanoparticle-sunscreen vs. traditional sunscreen	2.96 (.87)
Nanoparticle-sunscreen vs. no sunscreen	2.40 (1.10)

3.5 Participants and Recruitment

In order to facilitate experimental testing concerning the manipulation of SRQs regarding NFS, a student sample was drawn from the undergraduate population at North Carolina State University. Following a pre-test of the experimental procedures and measures on August 23, 2012, participant recruitment was conducted in two phases beginning in September 2012. Undergraduate students from North Carolina State University enrolled in various introductory courses served as participants in this study (N = 320).

Phase one of data collection accessed students from two required undergraduate courses in the Department of Communication (N= 201). Thanks are due to both Professor Edward Funkhouser and Professor Ryan Hurley for their willingness to host data collection sessions in their courses. Data were collected using class time among this group of participants.

Phase two of data collection accessed undergraduate student participants in the NCSU Political Science Research Subject Pool (PSRSP) run through the Department of Political Science. Thanks are due to Professor Michael Cobb and Professor William Boettcher for allowing me to access this group. Four, hour-long data collection sessions were hosted between October 15 and October 18, 2012 (N= 119). Care was exercised to ensure that all introductions of materials and procedures were similar between data collection sessions. Caution was also exercised to ensure that participants could only participate in one data collection session.

Participants were incentivized in one of two ways. Department of Communication students were each given a five dollar gift card to Amazon.com. They were also entered into a lottery drawing to win one of two Kindle fire tablets, each valued at two hundred dollars. No other compensation was given in any form to the department of Communication students.

PSRSP participants were given research credit by the department of Political Science to sate introductory political science course requirements. Because the students received course credit, a secondary lottery at the request of the PSRSP director Professor Boettecher to randomly select one student from the PSRSP participants to receive a lump sum of gift cards to Amazon.com totaling a value of $595 dollars.

As this study sample was drawn from the undergraduate student population at North Carolina State University, little variance was observed regarding age and educational attainment of the sample. The mean age of the participants was 21.02 (SD = 2.89), and approximately 62% of participants were female. 32.8% of participants were university freshman, 38.2% sophomore, 21.6% junior, and 12.8% of participants were listed as undergraduate seniors. 77.7% of respondents self-reported that they describes themselves as “white,” 9.4% as “Black or African American,” 5.3% as “Asian,” 3.4% as “Hispanic,” 2.2% as “Other,” and 1.9% as “American Indian, Alaska Native.”

3.6 Data Collection Procedure

The data for this study were collected using a human subject experiment involving undergraduate students. During each of the six data collection sessions, the researcher replicated the following procedure.

First, students were informed that they were being asked to participate in doctoral dissertation research and that their participation was voluntary. Students were then read a letter from the research that articulated all required disclosures as demanded by the NCSU Internal Review Board. A copy of this informed consent letter can be found at the beginning of the pre-test in Appendix B. Within the letter, information is disclosed regarding the nature of the study to improve understanding of how citizens feel about risks to health and safety regarding sun exposure and sun protection and the ways in which people respond to information about these issues. Participants were also informed that the results from this study would be used in dissertation research and may also help improve understanding of sun exposure and sun protection methods and their effect on health and safety.

Regarding anonymity and confidentially, participants were informed that responses would be completely confidential and would only be released as summaries in which no individual's answers could be identified. Participation was recorded using researcher-assigned numeric identification and participants were reassured that names would never be connected to responses. Also included in the consent letter was information pertaining to participant incentivization. The consent letter concludes with contact information and a statement of gratitude thanking the students for their participation.

Following the reading of the informed consent letter, the researcher asked if the participants had any questions regarding their rights as study participants. Following any clarifications, the researcher discussed the procedure for the study.

All materials were disseminated in random fashion using a random number generator to students in identical manila envelopes. Each envelope contained three documents and participants were asked to proceed through three phases in their participation as research subjects.

The first phase consisted of the completion of a pre-test entitled Staying Safe in the Sun: Citizens, Science, and Sun Exposure Survey Questionnaire I that can be found in appendix B. This component asked participants to respond to a set of measures regarding sun exposure and sun protection history as previously discussed and preexisting attitudes regarding sun exposure and sun protection.

Following the completion of the pre-test, participants were asked to read the health brochure. A copy of the brochure can be found in appendix A. As previously noted, the brochure was designed to appear identical between all participants in order to not alert participants that they were randomly assigned to experimental conditions.

After reading through the health brochure, participants were asked to proceed to the final task—the completion of the post-test that can be found in appendix C. This component asked participants to respond to a set of measures assessing PMT variables. The survey also included exploratory measures regarding social normative values concerning sun exposure and sun protection from parents, friends, relational partners, doctors that were not used in this dissertation project as the primary focus concerns the impacts of secondary risk information on the major components of PMT. Finally, as will be discussed in the section 5.1, three items were included into the post-test as manipulation checks on the experimental design.

4. Data Analysis

Analysis of covariance (ANCOVA) was used to statistically assess impacts of the two independent variables expressed in the 2 x 3 factorial designed on dependent measures (Fisher, 1932). ANCOVA is a statistical technique based upon the general linear model, and is often referred to as an extension of analysis of variance (ANOVA) and regression analysis (Wildt & Ahtola, 1978). ANCOVA is commonly applied in experimental research.

ANCOVA is useful as a statistical technique when the researcher chooses to examine the relationship between two variables while controlling for a potentially confounding third variable. In this sense ANCOVA allows the researcher to assess the relationship between a quantitative dependent variable and a categorical independent variable, with a second variable being controlled as a nuisance factor. The researcher can then examine the difference on the dependent variable among categories of the independent variable "controlling for" differences on the nuisance variable (Wildt & Ahtola, 1978, p. 5).

ANCOVA increases the precision of randomized experiments due to indirect statistical control that "may be achieved by measuring one or more concomitant variables in addition to the independent variable(s) of interest. By partitioning out the amount of variability in the dependent variable accounted for by the concomitant variables, the experimenter is able to more accurately assess the influence of the independent (experimental) variable(s)" (Wildt & Ahtola, 1978, p. 13).

ANCOVA is often used in factorial designed experiments like this one to simultaneous assess two categorical independent variables in a single analysis. As Wildt & Ahtola (1978) note in cases like this one, "the researcher is simultaneously interested in the effect of all categorical independent variables, and the test subjects are typically randomly assigned to the various combinations of levels of the categorical independent variables by the researcher" (p. 69).

In this study, ANCOVA is used to assess differing SRQs while controlling for the presence of traditional sunscreen safety qualifications in some conditions. When ANCOVA yields a significant *F*-test (alpha $<.05$), then the researcher is confident that some significant difference is observed upon the dependent variable given difference in the independent variable(s). In this case, *post hoc* testing is conducted to isolate which conditions are significantly different from one another.

In this dissertation, *post hoc* analysis was conducted using Fisher's least significant difference (LSD) test to note significant mean score differences between the three levels of the NFS SRQ variable following a significant primary *F*-test. Fisher's LSD is a method for comparing mean scores of experimental conditions after the ANCOVA or ANOVA null hypothesis of equal means has been rejected following a significant F-test. Fisher's LSD conducts a pairwise comparison of mean scores and summarizes which experimental conditions are significantly different from one another.

Chapter 5 reports results that provide empirical support for hypothesis testing. Once again, all dependent variables were measured using 5-point Likert scales.

4.1 ANCOVA independent variables

All research questions and hypotheses were tested using one-way analyses of covariance (ANCOVA). The two variables being manipulated in the 2 x 3 factorial design were isolated in order to test main- and interaction-effects on a variety of dependent measures.

The primary message attribute that assesses differences in the qualifications of secondary risks regarding NFS was aptly termed “NFS SRQ” and was isolated as the fixed factor in the ANCOVA model. As previously noted, this variable contains three where experts note: 1) NFS are safe, 2) uncertainty about if NFS are safe or not, and 3) NFS pose significant health risks.

The second independent variable was used as a binary covariate in the 2 x 3 factorial design. The traditional sunscreen safety qualification was isolated from the manipulated message attributes in the experiment. This two-level variable assesses the potential effects of conditions containing a declaration of the safety of traditionally construed sunscreen as well as one of the three NFS SRQs. This variable was defined through either the presence or absence of the statement “dermatologists agree that sunscreens do not have other significant health risks.”

Also as previously noted, in order to facilitate hypothesis testing, control conditions were removed from the statistical analysis as they did not contain message attributes that included NFS information—the primary message-level variable under investigation in this study. Six conditions were included in final statistical analysis and each contained a uniform number of respondents (N= 240). As will be further witnessed in the next chapter, the binary covariate, the “traditional sunscreen safety qualification” did not have significant impacts on dependent variables and in the analyses, the six experimental conditions were conflated into three comparison groups based in the fixed factor identified by the levels of the NFS SRQ variable.

5. Results

This Chapter reports results from experimental testing of secondary risk qualifications impacts on established concepts from Protection Motivation Theory. What follows is discussion of manipulation checks on the experimental design, and reports from hypothesis testing of perceptual states and persuasive outcomes.

5.1 Manipulation Checks

In the post-test, respondents were asked to answer three preliminary questions that served as manipulation checks. Phrasing of the three items is depicted in table 9 below:

Table 9: Manipulation checks on brochure information and NFS SRQs

Manipulation check question 1	Based on what you just read, how much do dermatologists agree about the effectiveness of sunscreen?
Manipulation check question 2	To what extent did the brochure focus on possible dangers of using sunscreens?
Manipulation check question 3	To what extent did the brochure focus on possible dangers of using sunscreens containing nanoparticles?

Questions 1 and 2 served as a check on the static information contained in all of the health brochures between experimental conditions. All of the brochures contained strong language of agreement regarding the safety and effectiveness of sunscreen formulations. Specifically, the health brochure noted, “For decades sunscreens have contained zinc oxide and titanium dioxide formulations that block Ultra Violet (UV) rays. These traditional sunscreen formulations have been considered by experts to be safe and effective in minimizing sun exposure risks” and that “Dermatologists recommend that you frequently use any form of sunscreen to significantly decrease your risks of skin cancer and premature aging."

Question 3 assessed the perceptual difference of respondents concerning the degree to which the health brochure focused on secondary risks of NFS based upon the experimental conditions. This question was designed to assess the conditional difference of the primary manipulated message attribute—that being the presence and form of SRQs concerning NFS. Independent samples *t*-tests were used to identify if the experimental conditions differed from the control condition on each measure.

6 t-tests were conducted to compare mean scores of each of the 2 x 3 factorial design conditions with the control group on question 1. No significant difference was observed between any of the experimental conditions and the control group for question 1 concerning dermatologists' agreement about the effectiveness of sunscreen.

Question 2 addressed respondents' perceptions regarding the extent to which the brochure focused on possible dangers of using sunscreens. Analysis showed that only one mean score comparison noted marginal difference between Condition 5 (M= 2.93, SD= 1.07) and the control group (M= 3.33, SD= .89) where t (78) = 1.82, p = .07. The remaining tests noted no statistically significant difference between conditions and the Control group. Questions 1 and 2 demonstrate that conditional differences were unlikely to cause respondents to view static material in the brochure differently between groups.

Question 3 addressed if respondents noted the primary manipulation of the study by asking then to respond to what extent the brochure focused on possible dangers of using sunscreens containing nanoparticles. For this manipulation, it was expected that all experimental conditions would differ from the control group as it did not present any SRQ. T-tests demonstrated that all conditions differed significantly from the control at the $p<.05$ level, save for condition 1 ($M = 3.28$, $SD = .96$) that was marginally different from the control group ($M = 3.58$, $SD = .71$) where $t\ (78) = 1.59$, $p=.09$.

Further manipulation checks using ANCOVA were conducted to identify if the experimental manipulation significantly influenced perceptual states including threat and efficacy perceptions not associated with NFS, namely threat perceptions of 1) skin cancer, and 2) premature aging, as well as response-efficacy attitudes, and self-efficacy attitudes regarding traditional sunscreen preventing skin cancer, and premature aging. No confounding evidence was observed that would suggest that the experimental manipulation influenced variables not associated with NFS.

5.2 Reporting Data: Perceptual States of PMT

This section reports findings from the analysis of three hypotheses, each of which contains two components. Table 10 summarizes all statistical findings pertaining to these hypotheses tests.

Hypothesis 1 tested if the levels of NFS SRQ caused (i) threat severity perceptions, and (ii) threat vulnerability perceptions to increase when compared with other conditions.

For hypothesis 1 (i), the potential interaction effect of the presence of the traditional sunscreen safety qualification is assessed as well in the ANCOVA model. The result of the *F*-test of the product term of the factorial design variables failed to support the violation of the regression homogeneity where, $F_{\text{NFS SRQ}*\text{traditional sunscreen safety qualification}}\ (2, 234) = .796$, $p> 0.05$. In other words, no interaction effect occurred between conditions including both NFS

SRQ and a traditional sunscreen safety confirmation. Therefore, a single rule of the covariate-based adjustment of the dependent variable scores can be adequately used to assess the effects of the three levels of the primary variable NFS SRQ on threat severity. Thus, a second test was conducted to assess the conditional impacts of the fixed factor, NFS SRQ, on the dependent measure.

Results demonstrate that NFS SRQ caused increases in threat severity perceptions of sunscreens incorporating nanoparticles. Following a significant *F*-test indicating conditional difference, *post hoc* analysis of the three conditions was conducted using Fisher's LSD test. Pairwise comparison of means using the Fisher LSD test revealed that individuals in the risk condition showed a significantly greater threat severity perception as compared to the uncertain condition as well as to the no-risk condition. The uncertain conditions also held significantly greater threat severity perceptions than the no-risk conditions. Statistical summaries of findings are reported in table 10.

Hypothesis 1 (ii) used a single-measure item to assess threat vulnerability perceptions toward NFS given message attribute manipulation. Again, no interaction effect occurred between the two independent variables, $F_{\text{NFS SRQ}*\text{traditional sunscreen safety qualification}}(2, 234) = 1.04$, $p > 0.05$, so main effects of NFS SRQ where subsequently analyzed. Analysis of threat vulnerability demonstrated that significant differences exist between conditions. *Post hoc* Fisher's LSD testing found that all three conditions were significantly different from one another on the dependent measure as witnessed in table 10.

Hypothesis 2 (i) assessed the effects of differing levels of NFS SRQ on perceptions of response-efficacy for NFS to prevent skin cancer. Like previous tests, no interaction effect was found when controlling for traditional sunscreen safety qualifications where $F_{\text{NFS SRQ}}*_{\text{traditional sunscreen safety qualification}}$ (2, 234)= 1.14, p> 0.05. Main effects testing demonstrated that significant differences occurred between groups and *post hoc* testing revealed that the no-risk condition caused respondents to feel that NFS is more efficacious in preventing skin cancer than the other conditions. *Post hoc* testing also revealed that no that no difference was found between the uncertain and risk conditions regarding the perception that NFS is efficacious in preventing skin cancer.

Hypothesis 2 (ii) assessed the main- and interaction-effects of conditional differences in message attributes on perceptions that NFS is efficacious in preventing premature aging. No significant interaction effect was observed, where $F_{\text{NFS SRQ}}*_{\text{traditional sunscreen safety qualification}}$ (2, 234) = .576, p> 0.05,and final testing of main effects of NFS SRQ demonstrated significant differences between levels of the fixed factor regarding the response-efficacy of NFS to prevent premature aging. *Post hoc* testing revealed that the no-risk condition caused respondents to feel that NFS is more efficacious in preventing premature aging than other conditions, but both the uncertain and risk conditions did not differ significantly from one another.

Hypothesis 3 (i) assessed self-efficacy attitudes regarding the use of NFS to prevent skin cancer. Like other test, No significant interaction effect was observed among respondents, $F_{\text{NFS SRQ}}*_{\text{traditional sunscreen safety qualification}}$ (2, 234)= .511, p> 0.05, but subsequent testing of the main effects of NFS SRQ demonstrated significant conditional difference concerning self-efficacy to use NFS in preventing skin cancer. *Post hoc* testing revealed that the no-risk condition held significantly higher levels of perceived self-efficacy than both uncertain and risk conditions, but that those conditions did not differ from one another regarding their feelings of self-efficacy concerning the use of NFS to prevent skin cancer.

The final hypothesis testing conditional differences on perceptual states assessed self-efficacy to prevent premature aging using NFS. Similar to the other hypotheses in this section, no interaction effect was observed between the fixed factor and covariate, $F_{\text{NFS SRQ}*\text{traditional sunscreen safety qualification}}(2, 234) = .842$, $p > 0.05$,but a significant main-effect was found regarding NFS SRQ on self-efficacy to use NFS to prevent premature aging. *Post hoc* testing again demonstrated that the no-risk condition caused respondents to feel more efficacious in their ability to use NFS to prevent premature aging than the other conditions. Both the uncertain and risk condition did not differ significantly from one another regarding the degree of perceived self-efficacy to use NFS to prevent premature aging. Table 10 below recapitulates findings and provides statistical summarization of the analysis from this first set of hypotheses pertaining to perceptual states of PMT.

Table 10: Hypotheses tests: SRQ on mediating perceptual states

	Experimental group				
	Risk (a)	Uncertain (b)	No-risk (c)	*F*	η^2
H 1 (i)	3.14bc (.62)	2.85ac (.63)	2.22ab (.67)	44.42***	.27
H 1 (ii)	3.34bc (.78)	2.86ac (.63)	2.25ab (.77)	44.50***	.27
H 2 (i)	2.55c (.71)	2.36c (.78)	2.04ab (.68)	9.96*	.08
H 2 (ii)	2.51c (.72)	2.38c (.74)	2.09ab (.68)	7.49 **	.06
H 3 (i)	3.07c (.85)	3.22c (.97)	3.51ab (.91)	4.73**	.04
H 3 (ii)	3.13c (.88)	3.21c (.96)	3.52ab (.94)	4.09*	.03

Note. # = p <.1, * = p < .05, *** = p < .001. Standard Deviations appear in parentheses below means

5.3 Reporting Data: Persuasive outcomes of PMT

A second set of hypotheses was posed to address the impacts of SRQs on persuasive outcomes including behavioral intentions to avoid or use NFS, and comparative risk attitudes between NFS, traditional sunscreens, and not using sunscreen at all.

Hypothesis 4 assessed the effects of the manipulated on selective avoidance of NFS. No interaction-effect was observed given the fixed factor and covariate in the first ANCOVA test $F_{\text{NFS SRQ}^{*}\text{traditional sunscreen safety qualification}}(2, 234) = 1.45$, p> 0.05. Main-effects of the fixed factor NFS SRQ revealed significant differences in respondent intentions to avoid using NFS. *Post hoc* testing revealed that conditional differences resulted in all three levels differing significantly one another and that respondents in the risk condition were significantly more likely to intend to avoid NFS than the other conditions. The no-risk condition was also found to differ significantly from the uncertain condition, where the no-risk group was more likely to not intent to selectively avoid using NFS. Statistical summarization of ANCOVA and *post hoc* testing can be found in table 11.

Hypothesis 5 assessed the counterclaim to selective avoidance for using NFS; behavioral intentions to use NFS in the future. No significant interaction-effect was observed between independent variables, $F_{\text{NFS SRQ}}{*}_{\text{traditional sunscreen safety qualification}}$ (2, 234) = .704, $p > 0.05$, and subsequent main-effects testing of the fixed factor noted significant differences in respondent intentions to use NFS. Fisher's LSD noted that the manipulation caused the no-risk condition to intend to use NFS significantly more so than other conditions. The uncertain condition also reported that they intended to use NFS more than the risk condition.

Hypothesis 6 assessed conditional effects on comparative risk attitudes between NFS and sunscreens that do not contain nanoparticles. Again, no significant interaction-effect was observed among respondents $F_{\text{NFS SRQ}}{*}_{\text{traditional sunscreen safety qualification}}$ (2, 234) = .187, $p > 0.05$, and main effects testing of the three levels of NFS SRQ demonstrated significant differences between conditions. Secondary analysis revealed that all three levels of the fixed factor brought about significant differences and the risk condition held attitudes that NFS were more risky than sunscreens that do not contain nanoparticles when compared to the uncertain condition and the no-risk condition. Significant differences were also found between the no-risk condition and the uncertain condition.

The final hypothesis stemmed from the controversial findings and headlines in Australia that reported many Australians thought that “Not using sunscreens at all is less risky to my health than using sunscreens containing nanoparticles.” This statement was replicated in this experimental examination to determine if SRQs cause comparative risk attitudes to change between NFS use and not using sunscreen at all. Once again, no interaction-effect was observed between the fixed factor and the covariate, $F_{\text{NFS SRQ}}*_{\text{traditional sunscreen safety qualification}}$ (2, 234) = .346, p> 0.05, and only marginally significant difference was noted under main-effects testing of the fixed factor (p=.077). Fisher’s LSD revealed that the risk condition agreed significantly more with the statement that not using sunscreen was less risky than using NFS, than the no-risk condition; however both groups were not significantly different from the uncertain condition. Table 11 below depicts the statistical findings from this set of tests regarding persuasive outcomes.

Table 11: Hypotheses tests: SRQ of NFS on persuasive outcomes

	Experimental group				
	Risk (a)	Uncertain (b)	No-risk (c)	*F*	η^2
H 4	3.11bc (.91)	2.60ac (.87)	2.23ab (.81)	21.22***	.15
H 5	2.81bc (.84)	3.15ac (.75)	3.58ab (.81)	18.15***	.13
H 6	3.51bc (.73)	3.13ac (.70)	2.47ab (.89)	36.84***	.24
H 7	2.56c (1.05)	2.40 (.95)	2.19a (1.16)	2.60#	.02

Note. # = p <.1, * = p < .05, *** = p < .001. Standard Deviations appear in parentheses below means

6. Discussion

6.1 Research Implications

Like many other studies that assess PMT variables (O'Keefe 2002), this study sought to identify if message-attribute manipulations impacted mediating states and persuasive outcomes. This experiment assessed the impacts of two independent variables, 1) SRQs, and 2) comparative risk qualifications concerning recent controversy in Australia surrounding risk response recommendations made to inexpert audiences about types of sunscreens incorporating nanoparticles.

Following analysis, it was demonstrated that the second independent variable, the manipulation of the presence of traditional sunscreen safety messages that was used as a covariate in ANCOVA testing did not have any significant interaction effects on dependent measures in this study. This was an interesting finding as I thought that the combined presence of safety messages for non-nanoparticle sunscreens along with risk, uncertainty, and no-risk manipulations of secondary risks of NFS would dampen differences observed between conditions. As this was not witnessed in the analysis, focus will be placed on discussing the causal impacts of SRQs on mediating states and persuasive outcomes concerning the nanoparticle sunscreen case.

To reiterate, this dissertation focuses on assessing what occurs when audiences are exposed to simply-worded qualifications that a recommended protective product holds or may hold potential harm in its use. Findings from this study demonstrate SRQs significantly influence inexpert perceptions and intentions to protect themselves. This may hold large implications for public health professionals, health campaigners, and industry.

SRQs caused significant differences on comparative risk attitudes between NFS, non-nanoparticle sunscreens, and not using sunscreen at all. As expected, qualifying secondary risk statements caused respondents to increase the likelihood to view the NFS as more risky than sunscreens that do not contain nanoparticles. All three levels of the SRQ variable differed significantly from one another where respondents exposed to the NFS risk condition felt NFS were more risky when compared to the uncertainty condition and the no-risk condition. This finding parallels common assumptions about the portrayal of consumer product health risks—that if two products are in the same class of consumer use, but product A is stated to hold some health risk that product B does not, product A will be deemed as more risky to use than product B.

Perhaps more significant is the potential link between exposure to SRQs and comparative risk attitudes between NFS and not using sunscreen at all. As witnessed in the Australia case, some communication campaigns have urged inexpert audiences to avoid sunscreens that may potentially contain nanoparticles, and others have questioned if these recommendations may go beyond just the use of NFS. Some stakeholders questioned, "if the public was being urged to avoid sunscreens that contain nanoparticle because of fears that they pose unknown health risks, were they also going to go beyond the caution and choose to avoid sunscreens all together?"

Government groups like the Therapeutic Goods Association in Australia responded to such concerns in 2009 with the statement "the risks of excessive sun exposure are welldocumented and outweigh the unproven theoretical risks related to nanoparticles," although the understanding of comparative risk attitudes was yet to be determined (Australian Associated Press, 2009). The comparative risk attitude "NFS versus no sunscreen at all," was previously addressed by researchers in the 2012 Australian cross-sectional survey where respondents were asked to indicate their level of agreement with the statement, "not using sunscreens at all is less risky to my health than using sunscreens containing nanoparticles." From this item sprung controversy, government press releases, and evocative media that read, "Aussies Shun Sunscreen: 1 in 4 people concerned about nanoparticles,"(Sunrise 7 TV, 2012) and "One in four Australians who heard stories about the risks of nanoparticle-based sunscreens felt it was safer to use no sunscreen" (News Limited, 2012). This dissertation clarifies the potential link by assessing the same item in a more robust and rigorous experimental format.

Unlike survey studies, experiments like this one employ the manipulation of a treatment variable followed by observations of its effects on persuasive outcomes among randomized conditions of participants. The use of experimental form allows for more accurate assessment of qualifying statements about secondary risks of protective products, and can assess the impacts of these statements on behavioral intentions, risk attitudes and mediating perceptual states with greater control. The item used in the Australian study was replicated in the experimental post-test to assess the conditional difference of SRQs of NFS on comparative risk attitudes concerning the use of NFS versus not using sunscreen at all. As reported in Chapter 5, this measure demonstrated marginal significant difference between the three levels of the SRQ manipulation ($p=.077$), and following *post hoc* testing, only two of the three levels differed from one another significantly—the risk condition, and the no-risk condition.

The Australian cross-sectional survey study found that 17% of respondents agreed or strongly agreed with the comparative risk statement (DIISRTE, 2012). A similar ratio was found in the sample of respondents in the experimental design, where 17.8% either agreed or strongly agreed with the statement (N=57), and among respondents in the no-risk condition (N=80), 17.6% (N=14), agreed or strongly agreed, while 68.8% (N=55) disagreed or strongly disagreed with the proposition.

In this study, the risk condition demonstrated similar agreement with the no-risk condition where 18.8% (N=15) agreed or somewhat agreed, although disagreement with the proposition was diminished (50%, N=40 who disagreed or strongly disagreed with the statement). Figure 2 below depicts the ratio and frequencies of the risk and no-risk conditions.

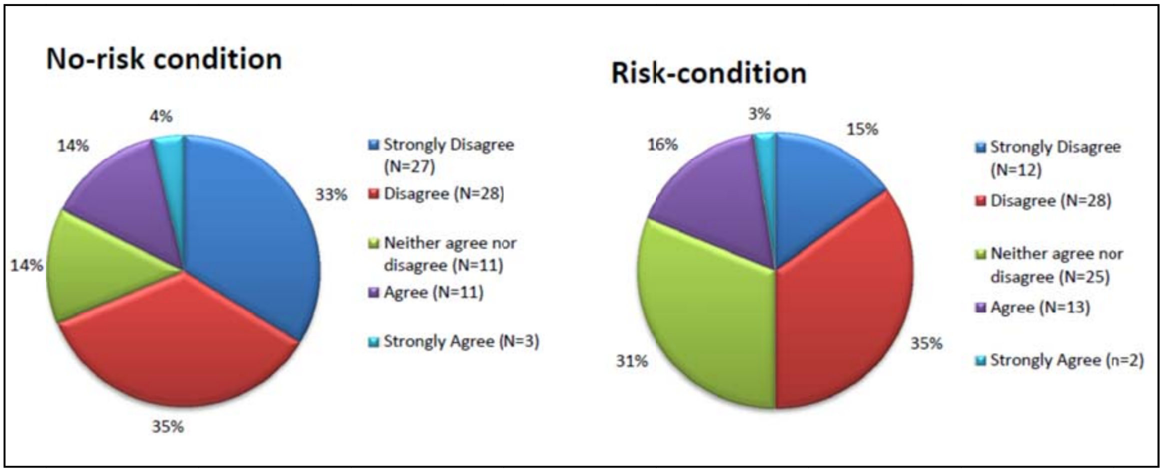

Figure 2: Frequency comparison of SRQ no-risk and risk conditions for comparative risk attitudes

This comparison demonstrates that SRQs are at least marginally influential on comparative risk attitudes concerning the utility of using NFS versus not using sunscreen at all. However, this is not a cut-and-dry scenario.

Current data supports the claim that explicit declarations of secondary risks did not inflate the ratio of respondents who deemed NFS as more risky than no sunscreen at all. However, communicating secondary risks of NFS increased neutral reports where respondents neither agreed nor disagreed with the proposition at a much higher rate than the no-risk condition, and decreased the rate in which respondents reported that they strongly disagreed that not using sunscreen at all is less risky than using NFS.

This finding bodes well for the Australia case where concerns were raised that SRQs of NFS may be turning audiences off using sunscreen use entirely. This experiment notes that among the U.S. sample, the NFS risk-condition did not increase in the amount of respondents who reported that they felt NFS were more risky than not using sunscreens at all. Thus, SRQs of NFS did not have a polarizing effect, but instead shifted participants from strong disagreement to a more ambivalent comparative risk attitude between NFS and not using sunscreen at all. Besides the demonstrated impacts of SRQs on comparative risk attitudes, SRQs also had effects on behavioral intentions.

As expected, respondents in the risk condition demonstrated increased reluctance to intend to use NFS to protect themselves from skin cancer and premature aging. The inverse was true of selective avoidance, where it was found that respondents in the risk condition was significantly more likely to go out of their way to avoid using sunscreens that incorporated nanoparticles.

Besides impacting comparative risk attitudes and behavioral intentions, the differing levels of qualifying statements of secondary risks regarding NFS caused respondents to feel that they were less efficacious in their ability to prevent skin cancer and premature aging and that the product itself had less protective qualities. In order to pinpoint the impacts of SRQs, the experiment investigated mediating variables including threat severity, threat vulnerability, response-efficacy, and self-efficacy that often go understudied in PMT studies of message effects (O'Keefe, 2003).

Secondary risk statements were seen to significantly impact respondents' perceptions that they could use NFS to effectively prevent both skin cancer and premature aging. This impact on self-effect is likely linked to the impact the secondary risk statements had on perceptions of the response-efficacy of the product to protect from the primary risks of UV radiation.

Respondents in the risk condition felt that NFS was less efficacious in its ability to protect from sun exposure dangers. The magnitude of this finding is further articulated after revisiting information present in the health brochure read by all participants that stated, "*Sunscreens including nanoparticles are known to be just as effective as other sunscreens in reducing premature aging and cancer risks."* Interestingly, even when told explicitly that NFS are just as effective as a protective product as other sunscreens, those who then exposed to qualifying statements articulating some secondary risk to NFS, they then reported that they felt the protective product were less effective in preventing skin cancer. This effect was also witnessed between the uncertain condition and the no-risk condition where the respondents exposed to a qualifying statement that experts were uncertain about it NFS could possible pose health risks reported they felt NFS were less effective than the no-risk group.

Of grave concern is the finding that the presence of qualifying statements of secondary risks causes audiences to feel that the protective product is less efficacious in preventing the primary risks for which the product was designed. By portraying that a protective product may pose some new risk, even if that risk is not yet understood, quantified, or disclosed by experts, one can seemingly persuade audiences to dismiss the product or at least be wary of it.

This may have drastic implications on stakeholders who produce or recommend protective products like sunscreens as well as on the consumers who are trying to protect themselves and loved ones from well-established and understood risks like skin cancer. Great care should be taken to assess communication campaigns made by individuals and groups who are motivated to slow or stop the use of emerging technological products like NFS that may take such findings and use them to produce communication campaigns with propagandistic overtones to sway opinion.

While debates involving a variety of stakeholders around the safety of NFS will likely continue, so too will the need for empirical observation of the impacts of the debates themselves. Risk communication campaigns are intended to further the public good, but should be conducted and assessed in ways that diminish potential backlashes on public health.

Mihail Roco, chair of the US National Science and Technology Council subcommittee on Nanoscale Science, Engineering and Technology, and Senior Adviser for nanotechnology at the National Science Foundation emphasizes the role of social scientists in improving public communication of emerging technologies in saying "[t]hey are professionally trained representatives of the public interest and capable of functioning as communicators between nanotechnologists and the public or government officials. Their input may help maximize the societal benefits of the technology while reducing the possibility of debilitating public controversies" (Berube, 2006).

This experimental assessment of the impacts of secondary risk qualifications provides inroads to improve the understanding of persuasive communication theory. Health decision theories and models like Protection Motivation Theory, the Health Belief Model, and the Extended Parallel Process Model focus on the adoption of specified risk response recommendations—highlighting the cognitive appraisal of that response to be efficacious in diminishing a threat. This study challenges previous assumptions concerning risk response recommendations. Secondary risk qualifications of recommended risk responses are highly influential on cognitive processes that govern protection motivation. Secondary risk qualifications may prove to be as important as the recommendation itself. This bears considerable weight for the current state of health decision theories and models that elaborate on cognitive and persuasive outcomes influenced by communication involving risk reduction responses. These models need to move past viewing the recommendation of risk reduction responses as an endpoint in the communication of risk and research should further uncover the influences of post-recommendation communication. As our society continues to both promote and condemn the use of technology to reduce health risks, we too must improve our theories and models to reflect the times.

6.2 Research Limitations

While care has been taken to exercise a high-level of scientific rigor in this experimental method used, as well as in data collection and statistical analysis, there are undoubtedly some limitations to this study.

One limit was the scope of feasible assessment given limited funds. Financial constraints limited the scale of participants included in the experiment. The sample could be improved with greater heterogeneity of subjects based on demographic characteristics, pervious knowledge of subject matter, and geographic location. A parallel sample of Australian respondents would potentially corroborate findings among the population that spurred the direction of this research.

Also, PMT considers behavioral intent to be a persuasive outcome and this experiment did not assess individuals use of sunscreen post-stimulus exposure. Such a focus on behavioral intentions promises that they relate to actions, although this may not be the case in all instances. Many scholars have reported intention-behavior correlations ranging from .41 to .53, indicating reasonably strong relationships between intentions and behaviors, but this has yet to be witnessed considering the impacts of secondary risk qualifications on NFS use (Kim & Hunter, 1993; Sheppard, Hartwick, & Warshaw, 1988). Future studies could longitudinally assess the use of sunscreens post-stimulus in the field, although ethical considerations must be made to protect public health.

6.3 Future Directions for Research

This dissertation is by no means an endpoint in studying the impacts of health risk messaging. Qualifying statements of secondary risks have become commonplace in communication campaigns between experts, media, civic advocacy groups, and inexpert audiences who are trying to navigate complex health issues in order to make decisions that will impact their lives. This study provides a new direction to characterize the impact of secondary risk qualifications used in communication campaigns through experimental assessment.

Future studies can take a variety of directions that can further improve the understanding of how different forms of health risk messages impact how individuals come to assess risks and recommended risk responses in their day-to-day lives. Study of secondary risk qualifications can be conducted in a variety of settings using multiple techniques and addressing issues regarding multiple subjects. Along with secondary risk qualifications, many other message-level variables may play a role in the health-risk decision making. Further inquiry should identify if other textual or visual message attributes common to health risk communication campaigns rhetorically influence protection motivation and behavior.

Some potential foci of study could include examination of credibility issues of the campaigner, influences of visual information, ordering of information, and examination of how the medium of the message may alter persuasive outcomes.

Other arenas may benefit from emulating this study by investigating controversy surrounding the potential risks posed by responses to a host of risks. Whenever an action is recommended to reduce a risk, there exists the possibility that that action will produce new risks, whether they may be physical, social, financial, etc. Assessing the foreseen impacts of secondary risks, and assessing the impacts of communication about the uncertainty of potential secondary risks may play a significant role in furthering the goals of health-belief theories like PMT. Through robust investigation of the influences of SRQs and other message attributes on persuasive outcomes and mediating perceptual states, we may be able to build toward better predictive models of the impacts of risk communication campaigns on real-world health outcomes.

Finally, societies worldwide will continue to cultivate technological fixes to solve for human health risks. Material scientists will continue to improve performance for protective products like sunscreens. Pharmacologists will continue to develop products that better interact with biological systems. Synthetic biologists will continue to redesign and construct biological systems to target health and environmental challenges. Geoengineers will continue to seek out interventions to curb global warming and maintain climactic equilibrium. New and exotic technological solutions to challenging problems come with secondary risk baggage.

Each new technological fix, each new product, each new intervention strategy holds the potential to introduce new secondary risks. Risk assessors, decision-makers, and researchers must be vigilant to the prospect that secondary risks will arise as we continue to solve for health risks through the advent of emerging science and technology. As our world continues to reduce health risks through technological means, we must expand our risk assessment protocols to incorporate magnitude and exposure measures of secondary risks posed by risk reduction responses—whether physical risks or social constructions of risks both of which have behavioral health outcomes.

Issues of science and technology will be increasingly complicated as debates between risk assessors, risk communicators, governing bodies, industry, and civic advocacy groups become more contentious and parties engage members of the public to adopt certain behaviors that align with their desires. Collectively, we must move to a mode of public health engagement that maintains the audience's wellbeing as the highest priority. Only through rigorous assessment of the risk profiles of emerging technologies and their associated secondary risks, and careful and ethical communication about risks and safety issues can we be entrusted as true protectors of public wellbeing—our families, friends, and neighbors deserve nothing less.

REFERENCES

ABC News. (2008, December 18). Nano-tech sunscreen presents potential health risk. Retrieved from http://www.abc.net.au/news/2008-12-18/nano-tech-sunscreen-presents-potential-health-risk/244014.

Ahia, R. (1991). Compliance with safer-sex guidelines among adolescent males: Application of the health belief model and protection motivation theory. *Journal of Health Education*, 22, 49-52.

American Cancer Council. (2013). Skin cancer facts. Retrieved From http://www.cancer.org/cancer/cancercauses/sunanduvexposure/skin-cancer-facts.

Armstrong, B., & Kricker A. (1993). How much melanoma is caused by sun exposure? *Melanoma Research, 3*,395– 401.

Armstrong B. (1997). Melanoma: childhood or lifelong sun exposure. In Grob, J., Stern, R., Mackie R., & Weinstock, W., (eds.) *Epidemiology, causes, and prevention of skin diseases* (63-66). London: Blackwell Science.

Armstrong, B., & Kricker, A. (2001). The epidemiology of UV induced skin cancer. *Journal of Photochemistry and Photobiology B, 63*(1–3), 8 –18.

Auffan, M., Rose, J., Bottero, J., Lowry, G., Jolivet, J., & Wiesner, M. (2009). Toward a definition of inorganic nanoparticles from an environmental health and safety perspective. *Nature Nanotechnology, 4,* 634-641.

Australian Associated Press. (2009, January 11). Not using sunscreen 'a bigger risk'. The Sydney Morning Herald online. Retrieved from http://news.smh.com.au/national/not-using-sunscreen-a-bigger-risk-20090111-7e4n.html.

Australian Institute of Health and Welfare and the Australasian Association of Cancer Registries.(2004). *Cancer in Australia 2001.* AIHW cat. No. CAN 23. Canberra: Australian Institute of Health and Welfare.

Australian Institute of Health and Welfare and the Australasian Association of Cancer Registries. (2005). *Health system expenditures on cancer and other neoplasms in Australia, 2000-01*. AIHW cat. No. CAN 22. Canberra: Australian Institute of Health and Welfare.

Australian Institute of Health and Welfare and the Australasian Association of Cancer Registries. (2008a). *Cancer in Australia: an overview, 2008.* AIHW cat. No. CAN 32. Canberra: Australian Institute of Health and Welfare.

Australian Institute of Health and Welfare and the Australasian Association of Cancer Registries. (2008b). *Non-melanoma skin cancer: general practice consultations, hospitalisation and mortality*. AIHW cat. No. CAN 39. Canberra: Australian Institute of Health and Welfare.

Australian Institute of Health and Welfare and the Australasian Association of Cancer Registries. (2012). *Cancer in Australia: an overview, 2012.* AIHW cat. No. CAN 70. Canberra: Australian Institute of Health and Welfare.

Autier, P., Doré, J., Cattaruzza, M., Renard, F., Luther, H., Gentiloni-Silverj, F., Zantedeschi, E., Mezzetti, M., Monjaud, I., & Andry, M. (1998). Sunscreen use, wearing clothes, and number of nevi in 6- to 7-year-old European children. *Journal of the National Cancer Institute, 90* (24), 1873-1880.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory.* Englewood Cliffs, NJ: Prentice Hall.

Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York: Freeman.

Basen-Engquisgt, K. (1994). Evaluation of theory-based HIV prevention intervention for college students. *AIDS Education and Prevention, 6*, 412-424.

Beck, U. (1992). *Risk Society: Towards a New Modernity*. Sage: New Delhi.

Berube, D. (2006). *Nano-Hype: the truth behind the nanotechnology buzz*. New York: Prometheus.

Berube, D. (2008a). Stakeholder Participation in Nanotechnology Policy Debates, in Bennett, D. *Nanotechnology: Ethics and Society* (225-229), London: Taylor & Francis.

Berube, D. (2008b). Rhetorical Gamesmanship in the Nano Debates Over Sunscreens and Nanoparticles. *Journal of Nanoparticle Research, 10*, 23-37**.**

Berube, D., Faber, B., Scheufele, D., Cummings, C., Gardner, G., Martin, K., Martin, M., & Temple, N. (2010). *Communicating risk in the 21st century: The case of nanotechnology.* National Nanotechnology Coordination Office, Arlington, VA.

Berube, D., Cummings, C., Cacciatore, M., Scheufele, D., and Kalin, J. (2011). Characteristics and classification of nanoparticles: Expert Delphi survey. *Nanotoxicology, 5* (2), 236-243.

Borm, P., Robbins, S., Haubold, T., Kuhlbusch, H., Fissan, K., Donaldson, R., Schins, V., Stone, W., Kreyling, J., Lademann, J., Krutmann, D., B. Warheit, D., & Oberdorster, E. (2006). The potential risks of nanomaterials: A review carried out for ECETOC, *Particle and Fibre Toxicology, 3*, 11.

Brown, H. E. (1957). *Zinc Oxide Rediscovered*. New York: The New Jersey Zinc Company.

Brown, H. E. (1976). *Zinc Oxide Properties and Applications*. New York: International Lead Zinc Research Organization.

Calder, S., Davidson, G., & Ho, R. (2011). Intentions to Consume Omega-3 Fatty Acids: A Comparison of Protection Motivation Theory and Ordered Protection Motivation Theory. *Journal of Dietary Supplements, 8* (2), 115-134.

Coleman, V. Ingham, B., Collins, K., Ilavsky, J & Toney, M. (2012). *Ultra small angle X-Ray Scattering Study of the Aggregation State of Nanoparticles in Commercially Available Sunscreens*. International Conference on Nanoscience and Nanotechnology: Perth, Australia. Retrieved from http://libcloud.s3.amazonaws.com /93/16/5/2292/Coleman_ICONN_NMI_2012.pdf.

Craddock, P. (1990). *2000 years of zinc and brass*. London: British Museum Press.

Craddock, P. (2008). Mining and metallurgy. In J. Oleson, *The Oxford Handbook of Engineering and Technology in the Classical World* (111–112). Oxford University Press.

Cronbach, L. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika*, *16* (3), 297–334.

Dahlstrom, M., Dudo, A., & Brossard, D. (2012). Precision of information, sensational information, and self-efficacy information as message-level variables affecting risk perceptions. *Risk Analysis, 32*(1), 155-166.

Darlington, S., Williams, G., Neale, R., Frost, C., & Green, A. (2003). A randomized controlled trial to assess sunscreen application and beta carotene supplementation in the prevention of solar keratoses. *Archives of Dermatology, 139*, 451–455.

Dennis, L., Beane Freeman, L, & VanBeek, M. (2003). Sunscreen use and the risk of melanoma: a quantitative review. *Annals of Internal Medicine, 139*, 684-703.

Department of the Environment (1995). *A guide to risk assessment and risk management for environmental protection*. London: HMSO.

Department of Industry, Innovation, Science, Research and Tertiary Education (2012). *Study* *of public attitudes towards sunscreens with nano particles*. Retrieved from: http://www.innovation.gov.au/Industry/Nanotechnology/ PublicAwarenessandEngagement/Documents/SunscreenStudy.pdf

Douglas, M. (1992). *Risk and Blame: Essays in Cultural Theory*. London: New York: Routledge.

El Ghissassi, F., Baan, R., Straif, K., Grosse, Y., Secretan, B., Bouvard, V., Benbrahim-Tallaa, L., Guha, N., Freeman, C., Galichet, L., Cogliano, V. (2009). A review of human carcinogens – Part D: radiation. *The Lancet Oncology, 10*, 751-752.

Encyclopædia Britannica. (2013). *Titanium (Ti).* Retrieved from http://www.britannica.com/ EBchecked/topic/597135/titanium-Ti.

European Union Scientific Committee on Consumer Safety (2012). *Opinion on zinc oxide (nano form)*. Retrieved from http://ec.europa.eu/health/ scientific_committees/consumer_safety/docs/sccs_o_103.pdf

Fisher R. (1932) *Statistical methods for research workers (4th ed.).* Oliver & Boyd: Edinburgh, Scotland.

Floyd, D., Prentice-Dunn, S., & Rogers, R. (2000). A meta-analysis of research on protection motivation theory. *Journal of Applied Social Psychology, 30* (2), 407-429.

Flynn, M., Lyman, R., and Prentice-Dunn, S., (1995). Protection motivation theory and adherence to medical treatment regimens for muscular dystrophy. *Journal of Social and Clinical Psychology, 14*, 61-75.

Fox, N. (1999). Postmodern reflections on 'risk', 'hazards,' and life choices in D. Lupton, *Risk and sociocultural theory: new directions and perspectives.* Cambridge University Press: UK.

Friends of the Earth- Australia (2007) *Nanotechnology & sunscreens: a consumer guide for avoiding nano-sunscreens.* Retrieved from http://www.foe.org/nano_sunscreens_guide/Nano_Sunscreens.pdf.

Gilchrest, B., Eller, M., Geller, A., & Yaar, M. (1999). The pathogenesis of melanoma induced by ultraviolet radiation. *New England Journal of Medicine, 340*, 1341–1348.

Godar, D., Urbach, F., Gasparro, F., & Van Der Leun, J. (2004). UV doses of young adults. *Photochemistry and Photobiology, 77*, 453–457.

Gordon, L., Schuffham, P., ven der Pols, J., McBride, P., Williams, G., & Green, A. (2009). Regular sunscreen use is a cost-effective approach to skin cancer prevention in subtropical settings. *Journal of Investigative Dermatology, 129*, 2745-2746.

Green, E., & Witte, K. (2006). Can fear arousal in public health campaigns contribute to the decline of HIV prevalence? *Journal of Health Communication*, *11*(3), 245-259.

Gulson, B., McCall, M., Korsch, M., Gomez, L., Casey, P., Oytam, Y …Greenoak, G. (2010). Small amounts of zinc from zinc oxide particles in sunscreens applied outdoors are absorbed through human skin. *Toxicological Sciences, 118* (1), 140-149.

Hall, H., Miller, D., Rogers, J., & Bewerse, B. (1999). Update on the incidence and mortality from melanoma in the United States. *Journal of the American Academy of Dermatology, 40*, 35–42.

Hanson, K., Gratton, E., & Bardeen, C. (2006). Sunscreen enhancement of UV-induced reactive oxygen species in the skin. *Free Radical Biology and Medicine,* 41 (8), 1205–1212.

Hayden, C., Cross, S., Anderson, C., Saunders, N., Roberts, M., (2005). Sunscreen penetration of human skin and related keratinocyte toxicity after topical application. *Skin Pharmacology and Physiology, 18* (4), 170-174.

Hillson, D. (1999). *Developing effective risk responses.* Conference Proceedings of the 30th Annual Project Management Institute, Philadelphia, PA. Retrieved from: http://www.risk-doctor.com/pdf-files/rsp1099.pdf

Hirst, N., Gordon, L., Scuffham, P., & Green, A. (2012). Lifetime cost effectiveness of skin cancer prevention through promotion of daily sunscreen use. *Value Health, 15*(2), 261–268.

Holmes, C., Foley, P., Freeman, M., & Chong, A. (2007). Solar keratosis: epidemiology, pathogenesis, presentation and treatment. *Australasian Journal of Dermatology, 48*, 67–74.

Hovland, C., Janis, I., & Kelley, H. (1953). *Communication and Persuasion*. New Haven CT: Yale University Press.

Huncharek, M., & Kupelnick, B. (2002). Use of topical sunscreens and the risk of malignant melanoma: a meta-analysis of 9067 patients from 11 case-control studies. *American Journal of Public Health, 92*, 1173-1177.

International Medical News Group. (2011). *AAD President Commends FDA on Sunscreen Regulations*. Retrieved from http://www.skinandallergynews.com /index.php?id=1059&type=98&tx_ttnews%5Btt_news%5D=59148&cHash=da03e20 e36.

International Organization for Standardization. (2009). *Risk Management—Vocabulary.* Retrieved from http://www.iso.org/iso/iso_catalogue/ catalogue_ics/catalogue_detail_ics.htm?csnumber=44651.

Ivry, G., Ogle, C, & Shim, E. (2006). The end of the sunscreen and melanoma controversy? *Archives of Dermatology, 32*, 874-887.

Jemal, A., Devesa, S., Hartge, P., & Tucker, M.(2001). Recent trends in cutaneous melanoma incidence among whites in the United States. *Journal of the National Cancer Institute, 93*, 678–683.

Jemal, A., Bray, F., Center, M. Ferlay, J., Ward, E., & Forman, D. (2011). Global cancer statistics. *CA—A Cancer Journal for Clinicians,* 61, 69–90.

Johnson, D. (2012). *Some Australians prefer skin cancer to sunscreens with nanoparticles*. IEEE Spectrum, February 10. Retrieved from http://m.spectrum.ieee.org/nanoclast/ semiconductors/nanotechnology/some-australians-prefer-skin-cancer-to-sunscreens-with-nanoparticles.

Jones, J., & Leary, M. (1994). Effects of appearance-based admonitions against sun exposure of tanning intentions in young adults. *Health Psychology, 13*, 86-90.

Jorgensen, C., Wayman, J., Green, C., & Gelb, C. (2000). Using health communications for primary prevention of skin cancer: CDC's Choose Your Cover campaign. *Journal of Women's Health and Gender-Based Medicine* , *9*(5), 471–475.

Kasperson, R., & Stallen, P. (1991). *Communicating risks to the public: International Perspectives.* Boston: Kluwer Academic Publishers.

Kim, M., & Hunter, J. (1993). Relationships among attitudes, behavioral intentions, and behavior: A meta-analysis of past research, part 2. *Communication Research, 20*, 331-364.

Knowland, J., McKenzie, E., McHugh, P., & Cridland, N. (1993). Sunlight-induced mutagenicity of a common sunscreen ingredient. *Federation of European Biochemical Societies Letters, 324* (3), 309–313.

Kricker, A., Armstrong, B., English, D., Heenan, P. (1995). Does intermittent sun exposure cause basal cell carcinoma? A case-control study in Western Australia. *International Journal of Cancer*, 60, 489 –94.

Krimsky, S. & Plough, A. (1988). *Environmental hazards: Communicating risks as a social process.* Dover: Auburn House.

Lademann, J., Weigmann, H., Rickmeyer, C., Barthelmes, H., Mueller, G., and Sterry, W. (1999). Penetration of titanium dioxide microparticles in a sunscreen formulation into the horny layer and the follicular orifice. *Skin Pharmacology and Applied Skin Physiology, 12*, 247-256.

Lademann, J., Schanzer, S., Richter, H., Pelchrzim, R., Zastrom, L., Golz, K., & Sterry, W. (2004). Sunscreen application at the beach. *Journal of Cosmetic Dermatology, 3*, 62-68.

Lawson, A. (2005, December 18). The Therapeutic Goods Administration will investigate the safety of a new sunscreen technology due to concerns it could damage skin cells. *The Sydney Morning Herald*.

Likert, R. (1932). A Technique for the Measurement of Attitudes. *Archives of Psychology, 140*, 1–55.

McClendon, B., & Prentice-Dunn, S. (2001). Reducing skin cancer risk: An intervention based on protection motivation theory. *Journal of Health Psychology, 6*, 313–320.

Michielutte, R., Bahnson, J., Dignan, M., & Schroeder, E. (1992). The use of illustrations and narrative text style to improve readability of a health education brochure. *Journal of Cancer Education, 7* (3), 251-260.

Mitchnick, M., Fairhurst, D., & Pinnell, S. (1999). Microfine zinc oxide (Z-cote) as a photostable UVA/UVB sunblock agent. *Journal of the American Academy of Dermatology, 40* (1), 85–90.

Morgan, M., Fischhoff, B., Bostrom, A., & Atman, C. (2002). *Risk communication: A mental models approach*. Cambridge: Cambridge University Press.

Mu, L., & Sprando, R. (2010). Application of nanotechnology in cosmetics. *Pharmaceutical Research, 27*, 1746-1749.

Nakagawa, Y., Wakuri, S., Sakamoto, K., & Tanaka, N. (1997). The photogenotoxicity of titanium dioxide particles, *Mutation Research—Genetic Toxicology and Environmental Mutagenesis,* 394, 125–132.

Nanoderm. (2007). *Quality of skin as a barrier to ultra-fine particles: QLK4-CT-2002–02678.* Retrieved from http://www.uni-leipzig.de/~nanoderm/Downloads/ Nanoderm_Final_Report.pdf.

National Cancer Institute. (2004). *Surveillance Epidemiology and End Results (SEER) Cancer Statistics Review 1973-1999.* Retrieved from http://seer.cancer.gov/csr/1973_1999/melanoma.pdf.

Neidecker, M., Davis-Ajami, M., Balkrishnan, R., & Feldman, S. (2009). Pharmacoeconomic considerations in treating actinic keratosis. *Pharmacoeconomics, 27*(6):451–64.

Newgard, C., & Lewis, R. (2005). Effects of child age and body size on serious injury from passenger air-bag presence in motor vehicle crashes. *Pediatrics, 115* (6), 1579-1585.

News Limited. (2012, February 9). *Sun lovers avoid sunscreen over fear of nanoparticles.* Retrieved from http://www.news.com.au/travel/news/sun-lovers-avoid-sunscreen-over-fears-of-nanoparticles/story-e6frfq80-1226266321745.

Norman, P., Boer, H., & Seydel, E.R. (2005). Protection Motivation Theory. In M. Conner and P. Norman (eds.), *Predicting Health Behaviour: Research and Practice with Social Cognition Models* (81-126). Maidenhead: Open University Press.

Norrie, J. (2012). *Keep slapping it on: fears over sunscreen nanoparticles unfounded.* The Conversation. Retrieved from http://theconversation.edu.au/keep-slapping-it-on-fears-over-sunscreen-nanoparticles-unfounded-5321.

O'Keefe, D. (2002). *Persuasion: theory and research*. Thousand Oaks, CA: Sage Publications Inc.

O'Keefe, D. (2003). Message properties, mediating state, and manipulation checks: Claims, evidence, and data analysis in experimental persuasive effects research. C*ommunication Theory, 13* (3), 251-274.

Project Management Institute (2008). *A guide to the project management body of knowledge.* Project Management Institute: Newton Square: Pennsylvania.

Padmavathy, N., & Vijayaraghavan, R. (2008). Enhanced bioactivity of ZnO nanoparticles—an antimicrobial study. *Science and Technology of Advanced Materials, 9*, 1-8.

Pan, Z., Lee, W., Slutsky, L., Clark, R., Pernodet, N., & Rafailovich, M. (2009). Adverse effects of titanium dioxide nanoparticles on human dermal fibroblasts and how to protect cells. *Small, 5*, 511-520.

Phillips, L., & Barbano, D. (1997). The Influence of Fat Substitutes Based on Protein and Titanium Dioxide on the Sensory Properties of Lowfat Milks. *Journal of Dairy Science, 80* (11): 2726-2731.

Robinson, J. (2005). Sun Exposure, Sun Protection, and Vitamin D. *The Journal of the American Medical Association, 294*, 1541-1543.

Popova, L. (2011). The extended parallel process model: illuminating the gaps in research. *Health Education & Behavior early online edition,* 1-19. Retrieved from: http://heb.sagepub.com/content/early/2011/10/13/1090198111418108.full.pdf.

Ries, L., Wingo, P., Miller, D., Howe, H., Weir, H., Rosenberg, H… Edwards, B. (2000). The annual report to the nation on the status of cancer, 1973–1997, with a special section on colorectal cancer. *Cancer, 88,* 2398–2424.

Rogers, R. (1975). A protection motivation theory of fear appeals and attitude change. *Journal of Psychology, 91*, 93-114.

Rogers, R. (1983). Cognitive and physiological processes in fear appeals and attitude change: a revised theory of protection motivation. In Cacioppo, J., & Petty, R. (eds.) *Social Psychophysiology: A Source Book,* (153-176) .New York: Guilford Press.

Rogers, H., Weinstock, M., Harris, A., Hinckley, M., Feldman, S., Fleischer, A., & Coldiron, B. (2010). Incidence estimate of nonmelanoma skin cancer in the United States, 2006. *Archive of Dermatology, 146*(3), 283-287.

Sadrieh, N., Wokovich, A., Gopee, N., Zheng, J., Haines, D., Parmiter, D… Buhse, L. (2010). Lack of Significant Dermal Penetration of Titanium Dioxide from Sunscreen Formulations Containing Nano- and Submicron-Size TiO2 Particles. *Toxicological Sciences, 115*, 156-166.

Sambadan, D., & Ratner, D. (2010). Sunscreens: An overview and update. *Journal of American Academic Dermatology, 64*(4), 748-758.

Sandman, P. (1993). *Responding to community outrage: Strategies for effective risk communication.* Fairfax, VA: American Industrial Hygiene Association.

Saraiya, M., Glantz, K., Briss, P., Nichols, P., White, C., Das, D., … Rochester, P. (2004). Interventions to prevent skin cancer by reducing exposure to ultraviolet radiation. *American Journal of Preventative Medicine, 27*(5), 422-466.

Schwarzer, R. (1992). Self-efficacy in the adoption and maintenance of health behaviors: Theoretical approaches and a new model. In R. Schwarzer (Ed.), *Self-efficacy: Thought control of action,* (217-243). Washington, DC: Hemisphere.

Sheppard, B., Hartwick, J., & Warshaw, P. (1988). The theory of reasoned action: A meta-analysis of past research with recommendations for modifications and future research. *Journal of Consumer Research, 15*, 325-343.

Slovic, P., Fischoff, B., & Lichtenstein, S. (1981). Facts and fears: Societal perception of risk. *Advances in Consumer Research, 8*, 497-502.

Sjöberg, L. (2001b). Political decisions and public risk perception. *Reliability Engineering and System Safety, 72*, 115-123.

Staples, M., Elwood, M., Burton, R., Williams, J., Marks, R., & Giles, G. (2006). Non-melanoma skin cancer in Australia: the 2002 national survey and trends since 1985. *Medical Journal of Australia, 184*, 6–10.

Sunrise 7 TV. (2012, February 10). *Aussies Shun Sunscreen: 1 in 4 people concerned about nanoparticles.* Retrieved from http://au.tv.yahoo.com/sunrise/video/-/watch/da66463f_2709_389f_899b_7377f3fbf6f0/.

Sussex Safer Roads Partnership. (2010). *Embrace Life.* Retrieved from http://www.sussexsaferroads.gov.uk/safer-for-all-drivers/embrace-life-seatbelt-campaign.html.

Sutton, S. (1982). Fear-arousing communications: a critical examination of theory and research. In J.R. Eiser *Social Psychology and Behavioural Medicine.* (303-337). London: Wiley.

Taylor, C., Stern, R., Leyden, J., & Gilchrest, B. (1990). Photoaging/photodamage and photoprotection. *Journal of the American Academy of Dermatology,* 22, 1–15.

The Project on Emerging Nanotechnologies. (2013). *Consumer Products Inventory*. Retrieved from http://www.nanotechproject.org/inventories/consumer/.

The United States National Nanotechnology Initiative (2012). *What is Nanotechnology?* Retrieved from http://www.nano.gov/nanotech-101/what/definition.

Therapeutic Goods Association (2006). *A review of the scientific literature on the safety of nanoparticulate titanium dioxide or zinc oxide in sunscreens.* Retrieved from: http://www.tga.gov.au/npmeds/sunscreen-zotd.pdf.

Therapeutic Goods Association (2013). *Australian regulatory guidelines for OTC medicines (ARGOM)*. Retrieved from http://www.tga.gov.au/industry/otc-argom-00.htm.

Tinkle, S., Antonini, J., Rich, B., Roberts, J., Salmen, R., DePree, K., & Adkins, E. (2003). Skin as a Route of Exposure and Sensitization in Chronic Beryllium Disease. *Environmental Health Perspectives, 111* (9), 1202–1218.

United States Food and Drug Administration. (2012). *Radiation-emitting products.* Retrieved from http://www.fda.gov/RadiationEmittingProducts/ RadiationEmittingProductsandProcedures/Tanning/ucm116445.htm

Wesson, K., & Silverburg, N. (2003). Sun protection education in the United States: What we know and what needs to be taught. *Cutis, 71*, 71-77.

Westerdahl, J., Olsson, H., Ingvar, C. (1994). At what age do sunburn episodes play a crucial role for the development of malignant melanoma? *European Journal of Cancer, 30A*, 1647–1654.

Whiteman, D., Whiteman, C., & Green, A. (2001). Childhood sun exposure as a risk factor for melanoma: a systematic review of epidemiologic studies. *Cancer Causes and Control, 12*, 69 – 82.

Williams, M., & Pennella, R., (1994). Melanoma, melanocytic nevi, and other melanoma risk factors in children. *Journal of Pediatrics, 124*, 833– 845.

Weinstein, N. (1993). Testing four competing theories of health-protective behavior. *Health Psychology, 12*(4), 324-333.

Wiesenthal, A., Hunter, L., Wang, S., Wickliffe, J., & Wilkerson, M. (2011). Nanoparticles: small and mighty. *International Journal of Dermatology*, *50*, 247-254.

Witte, K. (1992). Putting the fear back into fear appeals: The extended parallel process model. *Communication Monographs, 59*, 329-349.

Witte, K., Meyer, G., & Martell, D. (2001) *Effective health risk messages: A step-by-step guide.* Sage Publications: Thousand Oaks, CA.

Wildt, A., & Ahtola, O. (1978). *Analysis of Covariance*. Newbury park, CA: Sage Publications Inc.

Winkler, J. (2003). *Titanium Dioxide*. Hannover: Vincentz Network.

World Health Organization. (2013). *Risk communication*. Retrieved from http://www.who.int/foodsafety/micro/riskcommunication/en/index.html

APPENDICES

APPENDIX A

Staying Safe in the Sun

Protecting yourself from the risks of sun exposure

Know the Risks of Sun Exposure

While we often associate a glowing complexion with good health, the truth is that UV radiation from sun exposure and tanning beds accelerates the effects of aging and increases your risk of developing skin cancer. Over 75,000 Americans are diagnosed with skin cancer each year and almost 10,000 Americans die from skin cancer annually.
UV radiation from sun exposure and tanning beds is known to lead to:

- Pre-cancerous and cancerous skin lesions and tumors,
- Premature aging like course wrinkles, discolored patchy skin,
- Elastosis— the destruction of elastic skin lining resulting in sagging and misshaped skin, and,
- Actinic keratosis— thick, scaly precancerous bumps and lesions that may become cancerous if left untreated.

Sunscreen Facts

The best advice to avoid premature skin aging and skin cancer is to avoid sun exposure. This isn't always possible. Over the past 30 years sunscreens have been offered as a way to reduce premature aging and cancer risks.

But, how safe are sunscreens?

For decades sunscreens have contained zinc oxide and titanium dioxide formulations that block Ultra Violet (UV) rays. These traditional sunscreen formulations have been considered by experts to be safe and effective in minimizing sun exposure risks. Sunscreen formulations continue to change in an effort to improve their safety and effectiveness.

Sunscreens including nanoparticles

Recently, sunscreens containing very small versions of zinc oxide and titanium dioxide, called nanoparticles, have been marketed to consumers in the USA. Sunscreens including nanoparticles are known to be just as effective as other sunscreens in reducing reduce premature aging and cancer risks, however these sunscreens containing nanoparticles are said to be more pleasing in appearance on the skin. While sunscreens including nanoparticles are effective in reducing premature aging and cancer risks, they are currently being tested to determine if they may cause other significant health risks.

Experts Say:

We feel that it is important to take expert recommendations to protect yourself from the risks of sun exposure. Here's what the experts say:

Dermatologists recommend that you frequently use any form of sunscreen to significantly decrease your risks of skin cancer and premature aging.

Furthermore dermatologists are uncertain about if sunscreens containing nanoparticles could possibly have other significant health risks.

APPENDIX B

RESPONDENT #: ______________

Staying Safe in the Sun:

Citizens, Science, and Sun Exposure Survey Questionnaire I

This survey questionnaire is designed to study how citizens feel about risks to health and safety regarding sun exposure and sun protection and the ways in which people respond to information about these issues. The results from this study will be used to help improve public understanding of sun exposure and sun protection methods and their effect on health and safety.

Your answers are completely confidential and will be released only as summaries in which no individual's answers can be identified. The researcher will assign you a numeric identifier and your name will never be connected to your responses. This survey is voluntary. However, if you complete the study you will receive a $5.00 Amazon gift card as a small token of appreciation for your help with this study. Should you decide to participate in the study, you will also be entered into a random drawing to win one of two Amazon Kindle Fire Tablets valued at $200.00 each. A random drawing will be held at the conclusion of the study and winning participants will be notified via email to claim their prize.

If you have any comments or questions about this study, I would be happy to talk with you.

Thank you very much for helping with this important study.

Sincerely,

Christopher L. Cummings
Doctoral Candidate
Communication, Rhetoric & Digital Media, PhD Program
North Carolina State University
clcummin@ncsu.edu

Check the box to indicate your answer. This first set of questions is about your experience with sun exposure and sun protection.

1. Have you been sunburned in the last year?

☐ Yes ☐ No ☐ Unsure

2. In a typical week, how often do you…

	Never	Rarely	Sometimes	Quite often	Very often
a. Get two hours of continuous sun exposure?	☐	☐	☐	☐	☐
b. Go suntanning outdoors?	☐	☐	☐	☐	☐
c. Go suntanning in a tanning booth?	☐	☐	☐	☐	☐
c. Use sunscreen when outside in the sun for two hours or more?	☐	☐	☐	☐	☐

3. What types of sun protection do you typically use when outside (check all that apply)?

☐ None

☐ Sunscreens (lotions, oils, sprays, sticks)

☐ Suntanning agents (lotions, oils)

☐ Long clothing and hat

☐ Keep out of the sun

4. Have you purchased sunscreen in the past year?

☐ Yes → Please answer items #5 and #6

☐ No

☐ Unsure } → Skip to item #7

5. What forms of sunscreen have you purchased in the past year (check all that apply)?

☐ Rub-in cream

☐ Spray-on lotion

☐ Sunbathing lotion

☐ Sunbathing oil

☐ Sunscreen stick applicator

6. What factors influenced the type of sunscreen you purchased (check all that apply)?

☐ Price

☐ SPF factor

☐ UVA and UVB blocking (broad spectrum)

☐ Limited options available at time of purchase

☐ Ease of purchase

☐ Familiar brand

7. How much do you agree with the following statements?

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
a. Sun exposure is risky to my health.	☐	☐	☐	☐	☐
b. Not using sunscreen is risky to my health.	☐	☐	☐	☐	☐
c. I am at risk of developing skin cancer at some point in my life.	☐	☐	☐	☐	☐
d. I am at risk of premature aging from sun exposure.	☐	☐	☐	☐	☐
e. Skin cancer is a severe threat.	☐	☐	☐	☐	☐
f. Premature aging is a severe threat.	☐	☐	☐	☐	☐

8. How likely are you to engage in the following activities <u>during the next week</u>?

	Not at all	Not likely	Somewhat possible	Likely	Very Likely
a. Wear sunscreen.	☐	☐	☐	☐	☐
b. Suntan outdoors.	☐	☐	☐	☐	☐
c. Get two hours of continuous sun exposure.	☐	☐	☐	☐	☐
d. Use a tanning booth.	☐	☐	☐	☐	☐
e. Purchase sunscreen.	☐	☐	☐	☐	☐

For this next set of questions, check the box that best corresponds to your answer.

9. How would you rate *your views* about these activities according to the each of the following characteristics?

a. Using sunscreen whenever outside						
	Very	Somewhat	Neither	Somewhat	Very	
Good	☐	☐	☐	☐	☐	Bad
Relaxing	☐	☐	☐	☐	☐	Not Relaxing
Advantageous	☐	☐	☐	☐	☐	Disadvantageous
Healthy	☐	☐	☐	☐	☐	Unhealthy
Pleasant	☐	☐	☐	☐	☐	Unpleasant
Convenient	☐	☐	☐	☐	☐	Inconvenient
Valuable	☐	☐	☐	☐	☐	Worthless

b. Suntanning outdoors						
	Very	Somewhat	Neither	Somewhat	Very	
Good	☐	☐	☐	☐	☐	Bad
Relaxing	☐	☐	☐	☐	☐	Not Relaxing
Advantageous	☐	☐	☐	☐	☐	Disadvantageous
Healthy	☐	☐	☐	☐	☐	Unhealthy
Pleasant	☐	☐	☐	☐	☐	Unpleasant
Convenient	☐	☐	☐	☐	☐	Inconvenient
Valuable	☐	☐	☐	☐	☐	Worthless

c. Not using sunscreen at all						
	Very	Somewhat	Neither	Somewhat	Very	
Good	☐	☐	☐	☐	☐	Bad
Relaxing	☐	☐	☐	☐	☐	Not Relaxing
Advantageous	☐	☐	☐	☐	☐	Disadvantageous
Healthy	☐	☐	☐	☐	☐	Unhealthy
Pleasant	☐	☐	☐	☐	☐	Unpleasant
Convenient	☐	☐	☐	☐	☐	Inconvenient
Valuable	☐	☐	☐	☐	☐	Worthless

d. Exposing yourself to the sun						
	Very	Somewhat	Neither	Somewhat	Very	
Good	☐	☐	☐	☐	☐	Bad
Relaxing	☐	☐	☐	☐	☐	Not Relaxing
Advantageous	☐	☐	☐	☐	☐	Disadvantageous
Healthy	☐	☐	☐	☐	☐	Unhealthy
Pleasant	☐	☐	☐	☐	☐	Unpleasant
Convenient	☐	☐	☐	☐	☐	Inconvenient
Valuable	☐	☐	☐	☐	☐	Worthless

e. Suntanning in a tanning booth						
	Very	Somewhat	Neither	Somewhat	Very	
Good	☐	☐	☐	☐	☐	Bad
Relaxing	☐	☐	☐	☐	☐	Not Relaxing
Advantageous	☐	☐	☐	☐	☐	Disadvantageous
Healthy	☐	☐	☐	☐	☐	Unhealthy
Pleasant	☐	☐	☐	☐	☐	Unpleasant
Convenient	☐	☐	☐	☐	☐	Inconvenient
Valuable	☐	☐	☐	☐	☐	Worthless

These final questions are about your background so that we can learn how different types of people feel about the topics that are included in this study.

10. What year were you born? ____________

11. Are you:

☐ Female

☐ Male

12. What is your current university class standing?

☐ Freshman

☐ Sophomore

☐ Junior

☐ Senior

☐ Graduate Student

☐ Other

13. How would you describe yourself (choose one or more of the following racial groups)?

☐ Hispanic

☐ American Indian, Alaska Native

☐ Asian

☐ Black or African American

☐ Native Hawaiian, Pacific Islander

☐ White

☐ Other

APPENDIX C

RESPONDENT #: ______________

Staying Safe in the Sun:

Citizens, Science, and Sun Exposure Survey Questionnaire II

First, we'd like to know what you thought of the brochure itself.

1. Based on what you just read, how much do dermatologists agree about the effectiveness of sunscreen?

Completely agree	Mostly agree	Somewhat agree	Mostly disagree	Completely disagree
☐	☐	☐	☐	☐

2. To what extent did the brochure focus on possible dangers of using sunscreens?

A great deal	Very much	Somewhat	Very little	Not at all
☐	☐	☐	☐	☐

3. To what extent did the brochure focus on possible dangers of using sunscreens containing nanoparticles?

A great deal	Very much	Somewhat	Very little	Not at all
☐	☐	☐	☐	☐

Next, please answer the following questions:

4. How much do you agree with the following statements?

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
a. Sunscreens containing nanoparticles are safe to use.	☐	☐	☐	☐	☐
b. All forms of sunscreens are safe to use.	☐	☐	☐	☐	☐
c. I will consider using sunscreens containing nanoparticles in the future.	☐	☐	☐	☐	☐

5. In general, how much do you agree or disagree with the following statements?

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
a. Sunscreens containing nanoparticles are safe to use.	☐	☐	☐	☐	☐
b. All forms of sunscreens are safe to use.	☐	☐	☐	☐	☐
c. I will consider using sunscreens containing nanoparticles in the future.	☐	☐	☐	☐	☐
d. Sunscreens containing nanoparticles are better than other sunscreens.	☐	☐	☐	☐	☐
e. Skin cancer is a severe threat.	☐	☐	☐	☐	☐
f. Premature aging is a severe threat.	☐	☐	☐	☐	☐
g. Health effects from using sunscreens containing nanoparticles are severe.	☐	☐	☐	☐	☐
h. Skin cancer has serious negative consequences.	☐	☐	☐	☐	☐
i. Premature aging has serious negative consequences.	☐	☐	☐	☐	☐
j. Using sunscreens containing nanoparticles has serious negative consequences.	☐	☐	☐	☐	☐

6. In general, how much do you agree or disagree with the following statements about <u>different types of sunscreens</u>?

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
a. Using sunscreen is effective in preventing skin cancer.	☐	☐	☐	☐	☐
b. Using sunscreen containing nanoparticles is effective in preventing skin cancer.	☐	☐	☐	☐	☐
c. Using sunscreen is effective in preventing premature aging.	☐	☐	☐	☐	☐
d. Using sunscreen containing nanoparticles is effective in preventing premature aging.	☐	☐	☐	☐	☐

7. And what about the effectiveness of different types of sunscreen? How much do you agree or disagree with these statements?

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
a. If I frequently use sunscreen, I am less likely to get skin cancer.	☐	☐	☐	☐	☐
b. If I frequently use sunscreens containing nanoparticles, I am less likely to get skin cancer.	☐	☐	☐	☐	☐
c. If I frequently use sunscreen, I am less likely to age prematurely.	☐	☐	☐	☐	☐
d. If I frequently use sunscreens containing nanoparticles, I am less likely to age prematurely.	☐	☐	☐	☐	☐
e. I am able to frequently use sunscreen to prevent skin cancer.	☐	☐	☐	☐	☐
f. I am able to frequently use sunscreens containing nanoparticles to prevent skin cancer.	☐	☐	☐	☐	☐
g. I am able to frequently use sunscreen to prevent premature aging.	☐	☐	☐	☐	☐
h. I am able to frequently use sunscreens containing nanoparticles to prevent premature aging.	☐	☐	☐	☐	☐

8. And how much do you agree or disagree with these statements about your own ability to use sunscreen effectively?

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
a. It is easy to frequently use sunscreen to prevent skin cancer.	☐	☐	☐	☐	☐
b. It is easy to frequently use sunscreens containing nanoparticles to prevent skin cancer.	☐	☐	☐	☐	☐
c. It is easy to frequently use sunscreen to prevent premature aging.	☐	☐	☐	☐	☐
d. It is easy to frequently use sunscreens containing nanoparticles to prevent premature aging.	☐	☐	☐	☐	☐

9. How strongly do you agree with the following statements?

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
a. I feel pressure from my parents to use sunscreen.	☐	☐	☐	☐	☐
b. I feel pressure from my parents to use sunscreens containing nanoparticles.	☐	☐	☐	☐	☐
c. I feel pressure from my parents to go suntanning outdoors.	☐	☐	☐	☐	☐
d. I feel pressure from my parents to go suntanning in a tanning booth.	☐	☐	☐	☐	☐

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
e. I feel pressure from my friends to use sunscreen.	☐	☐	☐	☐	☐
f. I feel pressure from my friends to use sunscreens containing nanoparticles.	☐	☐	☐	☐	☐
g. I feel pressure from my friends to go suntanning outdoors.	☐	☐	☐	☐	☐
h. I feel pressure from my friends to go suntanning in a tanning booth.	☐	☐	☐	☐	☐

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
i. I feel pressure from my boyfriend/girlfriend to use sunscreen.	☐	☐	☐	☐	☐
j. I feel pressure from my boyfriend/girlfriend to use sunscreens containing nanoparticles.	☐	☐	☐	☐	☐
k. I feel pressure from my boyfriend/girlfriend to go suntanning outdoors.	☐	☐	☐	☐	☐
l. I feel pressure from my boyfriend/girlfriend to go suntanning in a tanning booth.	☐	☐	☐	☐	☐

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
m. I feel pressure from my doctor to use sunscreen.	☐	☐	☐	☐	☐
n. I feel pressure from my doctor to use sunscreens containing nanoparticles.	☐	☐	☐	☐	☐
o. I feel pressure from my doctor to go suntanning outdoors.	☐	☐	☐	☐	☐
p. I feel pressure from my doctor to go suntanning in a tanning booth.	☐	☐	☐	☐	☐

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
q. The views of my parents on sunscreen use are important to me.	☐	☐	☐	☐	☐
r. The views of my friends on sunscreen use are important to me.	☐	☐	☐	☐	☐
s. The views of my boyfriend/girlfriend on sunscreen use are important to me.	☐	☐	☐	☐	☐
t. The views of my doctor on sunscreen use are important to me.	☐	☐	☐	☐	☐

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
u. The views of my parents on suntanning are important to me.	☐	☐	☐	☐	☐
v. The views of my friends on suntanning are important to me.	☐	☐	☐	☐	☐
w. The views of my boyfriend/girlfriend on suntanning are important to me.	☐	☐	☐	☐	☐
x. The views of my doctor on suntanning are important to me.	☐	☐	☐	☐	☐

10. How much do you agree or disagree with the following statements?

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
a. I would go out of my way to avoid using sunscreens with nanoparticles.	☐	☐	☐	☐	☐
b. Sunscreens with nanoparticles pose a risk to my health and safety.	☐	☐	☐	☐	☐

11. And how much do you agree or disagree with these statements?

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
a. Using sunscreens containing nanoparticles is risky to my health.	☐	☐	☐	☐	☐
b. sunscreens containing nanoparticles are more risky to my health than sunscreens that do not contain nanoparticles.	☐	☐	☐	☐	☐
c. Not using sunscreens at all is less risky to my health than using sunscreens containing nanoparticles.	☐	☐	☐	☐	☐
d. I would feel comfortable using sunscreens containing nanoparticles.	☐	☐	☐	☐	☐

12. In order to be eligible to win one of two Kindle Fire Tablets please complete the following identification questions. Your email address will only be used to notify winners from the drawing:

a. NCSU Student ID#:______________________

b. NCSU email address: ______________________@ncsu.edu

Thank you very much for your participation in this study.
Please provide any comments you would like to share with the researcher below:
