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The Biobehavioral Model of Persuasion: The Role of Cognitive Processing in Challenge and Threat Message Framing

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THE BIOBEHAVIORAL MODEL OF PERSUASION: THE ROLE OF COGNITIVE PROCESSING IN CHALLENGE AND THREAT MESSAGE FRAMING

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ABSTRACT

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Persuasive messages are meant to influence people towards endorsing attitudes, intentions, and behaviors suggested in the message. However, describing the kinds of messages that are persuasive is not as helpful as understanding *why* certain messages are persuasive, yet others are not. The biobehavioral model of persuasion suggests that challenge-framed messages (messages that evoke low/moderate concern and high efficacy) are persuasive because they facilitate greater message elaboration leading to outcomes aligned with message suggestions. The following paragraphs outline the BMP and describe two experiments that tested the postulate that challenge-framed messages evoke greater message elaboration. In the first experiment (N = 160), messages framed to evoke different amounts of concern and efficacy were examined with an argument strength manipulation. It was hypothesized that the challenge-framed message would persuade people to adopt the suggestions in the message, and these effects would be strongest when the challenge-framed message was coupled with strong arguments. Although there was no evidence that challenge-framed messages were particularly effective when paired with strong arguments, the challenge-framed message did lead to

greater interest in and perceived relevance of the message information and behaviors suggested in the message. A second experiment (N = 136) tested whether messages framed to evoke different levels of concern and efficacy lead to different peak pupil dilation, a measure of resource allocation. It was hypothesized that the challenge-framed message would lead to greater peak pupil dilation compared to other concern by efficacy frames. This hypothesis was not supported, likely because the messaging task lacked comparable methods with those from past research and imposed high cognitive demands across message conditions. Collectively, these results have implications for both basic and applied research. The findings from experiment 1 extend the BMP, showing that challenge-framed messages evoke responses characteristic of greater message elaboration. Persuasive campaigns should consider using challenge-framed messages, as these messages lead to components of greater message elaboration and behavioral engagement. Moreover, the findings from this dissertation highlight the need for comparable manipulation strength in factorial messaging designs. In addition, persuasion researchers who wish to incorporate pupillometry into their methodological repertoire must consider what procedural demands they impose on participants when testing message manipulations.

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It is not enough to know what kinds of messages are more effective at changing attitudes and behaviors. Rather, when there is a good understanding of *why* messages are effective – the mechanisms that drive their effectiveness, then we can design messages with maximum impact. Regardless of the specific domain, determining why messages lead to behavior change is critical for really understanding how best to communicate with, and ultimately persuade, target populations.

The present research investigated *why* certain messages are more persuasive than others, based on how people appraise and process information. This research was guided by the biobehavioral model of persuasion (BMP; Schneider, Rivers, & Lyons, 2009), a model which suggests cognitive mechanisms drive persuasion outcomes. In early BMP research, some persuasive messages led to issue-relevant thoughts about message content. This preliminary finding suggested that some messages evoke greater message elaboration, or motivation and ability to process message content (Petty & Cacioppo, 1986). The present research expanded on the suggestions of the BMP and tested if message elaboration is the mechanism which leads some messages derived from the BMP to be persuasive. Specifically, this research more fully tested a postulate of the BMP – that different messages evoke different levels of cognitive processing. Further, the present research expands the discussion of how messages facilitate routes to persuasion.

Challenge and Threat Messages

Communicators aim to deliver information in a way that persuades action. For those who research effective communication and persuasion, the goal is to draw meaningful conclusions on *why* people are persuaded by a message and uncover mechanisms that lead to attitude and behavior change (e.g., Janis, 1967; Petty & Cacioppo, 1986; Rothman & Salovey, 1997; Schneider et al., 2009). An overarching goal of the BMP was to understand how to develop persuasive health messages, based on how people appraise and process message information (Schneider et al., 2009). Combining persuasion and arousal regulation literatures, the BMP proposed that messages which evoke low to moderate concern and high efficacy about message issues are relatively more effective in promoting challenge states, which facilitate an approach orientation towards the suggestions in the message. In contrast, messages that evoke high concern and low efficacy promote threat states and an avoidance orientation away from message suggestions. Messages derived from the BMP aim to evoke challenge and threat states through message frames that convey different levels of concern and efficacy. Perceived concern and efficacy are key components in the BMP and are crucial for understanding how different messages evoke different amounts of message elaboration.

Challenge and threat states have been linked to affective, physiological, and behavioral outcomes characteristic of approach and avoidance orientations, respectively. For instance, challenge states are associated with lower negative and higher positive affect, whereas threat states are related to higher negative and lower positive affect (Baumgartner, Schneider, & Capiola, 2018; Schneider, 2004, 2008). Challenge and threat

psychological states have also been shown to facilitate unique physiological patterns associated with different motivational orientations (Schneider, 2004, 2008; Tomaka et al., 1993). In terms of behavior, challenge states predict better performance in lab math subtraction tasks (Baumgartner et al., 2018; Schneider, 2004, 2008; Tomaka, Blascovich, Kelsey, & Leitten, 1993), upcoming athletic competitions (Blascovich, Seery, Mugridge, Norris, & Weisbuch, 2004), and computer training tasks (Gildea, Schneider, & Shebilske, 2007) compared to threat states. Also, there is evidence that some BMP derived messages facilitate different levels of cognitive processing. Specifically, messages framed to evoke challenge led to more thoughts about message content, indicative of greater message elaboration (Schneider et al., 2009).

The BMP is innovative in merging several theoretically distinct bodies of research. These bodies of work include research and theorizing on fear appeals (Janis, 1967) and the transactional theory of stress (Lazarus, 1999; Lazarus & Folkman, 1984), along with persuasion (Petty & Cacioppo, 1986; Petty & Wegener, 1998). The transactional theory of stress was used as a guide for experimental investigation by Tomaka and colleagues (Tomaka & Blascovich, 1994; Tomaka et al., 1993). From these literatures, the BMP proposes that different levels of worry or concern about an issue, coupled with different levels of perceived efficacy to engage in action, are relevant in driving the effectiveness of persuasive messages.

The BMP extends Janis' theorizing, outlining the importance of how messages evoke different levels of worry/concern (Hovland, Janis, & Kelly, 1953; Janis, 1967;

Janis & Feshbach, 1953; see Schneider et al., 2009). Based on the Yerkes-Dodson inverted-U curve, Janis (1967) proposed that there is an optimal level of emotional arousal (fear) that is related to persuasion outcomes. When message content evokes too much emotional arousal, such as strong fear responses, people will become overly vigilant and defensive. Such a defensive orientation restricts cognitive processing of message content, preventing people from adopting the recommendations put forth in the message. Put simply, messages that evoke strong fear and worry interfere with message processing. Similarly, when message content evokes little to no emotional arousal, people will not be compelled to engage with the message. They will regard the message as irrelevant to them personally and will be unmotivated to attend to it. Either of the extremes, whether too much or too little arousal, will result in no meaningful attitude or behavior change. Instead, messages that evoke some moderate level of arousal or fear will help people to attend to the message content, which in turn will influence attitudes and behavior. Messages designed to evoke some fear lead to beliefs that the fear can be overcome through personal action.

The BMP (Schneider et al., 2009) integrated these ideas about the optimal effects of moderate levels of arousal on attitude and behavior change with psychophysiological research guided by Lazarus' transactional theory of stress. Lazarus proposed that upon encountering a potentially stressful situation, people make two appraisals (Lazarus, 1999; Lazarus & Folkman, 1984; see also Baumgartner et al., 2018 and Schneider, 2008). Specifically, people evaluate the personal relevance of the stressor (i.e., primary

appraisal) and whether they have the resources to cope with the stressor (i.e., secondary appraisal). These two types of appraisal combine to determine whether people are challenged or threatened in response to a stressful situation. People are challenged when they believe they have the coping resources that are equal to or exceed the personal relevance or importance of the stressor. In contrast, people are threatened when their personal concern about the stressor outweighs their perceived resources to cope (Schneider, 2008; Tomaka et al., 1993). The BMP suggests that messages which evoke different appraisals will influence persuasion, and the model offers new mechanisms that drive message effectiveness (Schneider et al., 2009).

Guided by Lazarus' transactional theory of stress (Lazarus & Folkman, 1984), Tomaka and colleagues investigated how primary and secondary appraisals interact to influence subjective stress, physiology, and performance outcomes (Tomaka et al., 1993). Participants were subjected to an active coping stressor (i.e., verbal backward subtraction task from an arbitrary number by intervals of 7), and appraisals, subjective stress, physiological responses, and performance were measured. Primary appraisals were measured by asking participants how stressful they thought the upcoming task would be, and secondary appraisals were measured by asking participants how able they are to cope with the task. Tomaka et al. found that when people appraised the task as a challenge (i.e., the stressfulness of the task was deemed relatively equal to or less than their ability to cope) relative to a threat (i.e., task stressfulness outweighed coping ability), they reported less subjective stress about the upcoming subtraction task. Physiologically,

challenged participants had an increased heart rate (HR; heart beats per minute) and cardiac output (CO; a measure of blood volume pumped out of the heart over time), along with decreased pre-ejection period (PEP; the time course (ms) of ventricular contraction) and lower total peripheral resistance (TPR; a measure of vascular resistance). That is, challenged participants had more blood flowing into a more receptive vasculature. Challenged participants also gave more total and correct responses during the subtraction task. In contrast, when participants appraised the task as a threat (i.e., their level of stress exceeded their coping perceptions), they reported more subjective stress, had relatively less blood flowing into a more constricted vasculature, and performed worse on the subtraction task. These different psychological, physiological, and behavioral outcomes associated with challenge and threat states expanded Lazarus' transactional theory of stress and established the biopsychosocial model of challenge and threat (Blascovich & Tomaka, 1996).

The findings from Tomaka and colleagues are robust, having been found across multiple studies and in other laboratories. Compared to threat appraisals, challenge appraisals are related to higher levels of optimism (Baumgartner et al., 2018) and lower levels of neuroticism (Schneider, 2004). Compared to threatened individuals, those in a state of challenge have increased positive affect and lower negative affect (Baumgartner et al., 2018; Schneider, 2004, 2008). In addition, challenge and threat physiological patterns have been shown across laboratories (Baumgartner et al., 2018; Blascovich et al., 2004; Schneider, 2004, 2008; Schneider et al., 2009; Tomaka et al., 1993, 1994; Tomaka,

Blascovich, Kibler, & Ernst, 1997). Behaviorally, those in a state of challenge outperform their threatened peers in athletic competition (Blascovich et al., 2004), computer learning tasks (Gildea et al., 2007), and have better end-of-semester academic standing (Capiola, Baumgartner, & Schneider, 2017). Challenged individuals also engage in more adaptive behaviors such as scheduling an illness detection screening (Schneider et al., 2009) and endorsing preparatory behaviors in response to extreme weather-related messages (Schneider, Capiola, Fox, Houpt, & Simmons, under review).

Combining Janis' (1967) fear and arousal framework with Lazarus' (Lazarus, 1999; Lazarus & Folkman, 1984) transactional theory and the biopsychosocial model of stress (Blascovich & Tomaka, 1996), the BMP (Schneider et al., 2009) postulated that challenge-framed messages, those which evoke low to moderate levels of concern and high levels of efficacy, should lead to approach-oriented outcomes suggested in the message. On the other hand, threat-framed messages, which evoke high levels of concern and low levels of efficacy, should lead to avoidance-oriented responses away from the suggestions in the message. The BMP also suggests that different physiological patterns would drive different attitudes and behaviors resulting from challenge and threat states. In two studies, Schneider et al. tested the postulates of the BMP. Participants received brochures containing information about an ostensible illness. The brochures varied in their emphasis of concern and efficacy. Challenge frames comprised low/moderate concern and high efficacy, while threat frames comprised high concern and low efficacy. Schneider and colleagues expected challenge frames would evoke content-relevant

thoughts about the illness, indicating greater message elaboration (Petty, Schumann, Richman, & Strathman, 1993). They also expected challenge frames would facilitate challenge physiology, intentions to get a screening, and pro-screening behaviors such as calling to schedule an actual screening. Threat frames were expected to evoke fewer content-relevant thoughts, threat physiology, fewer screening intentions, and less behavioral engagement.

In the first study, participants were run individually and asked to read a health message about the ostensible illness. In the first reading session, messages contained the concern manipulation only (low/moderate vs. high). To further differentiate low/moderate versus high concern, participants completed a writing task after their first reading session in which they were either instructed to write about their day (control) or the effects of contracting the ostensible illness. A brief manipulation check was administered, followed by a second and final reading session, only this time the efficacy (low vs. high) manipulation was included at the end of the message. Finally, participants were given an opportunity to schedule a screening before leaving the lab. Schneider et al. found that the challenge-framed message led to lower concern over, and higher perceived efficacy to cope with, the ostensible illness. In contrast, the threat-framed message evoked higher concern and lower perceived efficacy to cope with the illness. These findings showed that the message framing was effective. Further, those who received the challenge-framed message had lower systolic blood pressure compared to those who received the threat-framed message, suggesting relatively lower stress arousal in the

challenge group. Compared to the threat-framed message, those who received the challenge-framed message appeared more likely to schedule an illness screening, though this difference was not reliable potentially due to low power.

In the second study, Schneider et al. (2009) manipulated the time participants could think about the messages (brief vs. prolonged exposure) and collected more precise physiological indices (Schneider, 2004, 2008; Sherwood, et al., 1990; Tomaka et al., 1993). To measure behavior, participants were given the opportunity to take business cards containing information on how to schedule a screening for the ostensible illness over the phone. Schneider and colleagues hypothesized prolonged message exposure would enhance the ability to process message information leading to more issue-relevant thinking and more persuasion. The results showed that those who had prolonged exposure to the challenge-framed message wrote more issue-relevant thoughts, had more intentions to get tested for the illness, and took more business cards. Those who received the challenge-framed messages also experienced challenge physiology (higher CO, less TPR). In contrast, those who received the brief threat-framed message appeared to write fewer issue-relevant thoughts, had fewer intentions to schedule a screening, and took fewer business cards. Those who received the threat-framed messages also experienced threat physiology (lower CO, more TPR).

These studies demonstrated that challenge-framed messages facilitate deeper, more effortful message processing (Schneider et al., 2009). This postulate is based on the finding that those who received challenge-framed messages had more issue-relevant

thoughts indicating greater message elaboration. This finding illustrates one cognitive mechanism that influences better persuasion in response to challenge-framed messages. However, there are limitations to the thought-listing procedure which cautions using this method to infer that different messages lead to different cognitive processing. Memories of past events are reconstructive and are not error free (e.g., Loftus, 1979, Loftus & Palmer, 1974; Neisser, 1981; Redelmeier & Kahneman, 1996). The thought-listing procedure relies on participants to reconstruct the thoughts they had while they read a message. This limitation was recognized by those who use the thought-listing task as a proxy for message processing (Cacioppo, von Hippel, & Ernst, 1997). Nevertheless, challenge frames have been shown to be more persuasive than threat frames, and there is some evidence that this may be due to deeper processing of message content because they result in more issue-relevant thoughts, along with more attitudes, intentions, and behaviors suggested in the message. The BMP proposed that challenge frames would enhance deeper elaboration based on the elaboration likelihood model of persuasion (Petty & Cacioppo, 1986), and Schneider et al. interpreted their findings along those lines. The present research builds on this by testing whether challenge-framed messages evoke greater message elaboration across two experiments.

Message Processing and the Elaboration Likelihood Model of Persuasion

The elaboration likelihood model (ELM; Petty & Cacioppo, 1986; Petty & Wegener, 1998) is a dual-process model of persuasion which proposes different avenues by which people process and are persuaded by information. People process information

differently based on where they fall on the elaboration likelihood continuum, a key construct in the ELM. The elaboration continuum is based upon how able and motivated people are to process a message. The more able and motivated people are, the more likely they are to expend effort to think deeply about and process message content.

Processing ability has been operationalized as the *capability* for issue-relevant thinking (O'Keefe, 2013; Petty & Cacioppo, 1986). Ability can be determined by general intelligence (Laczniak, Muehling, & Carlson, 1991) and prior knowledge of a topic (Wood, 1982; Wood, Kallgren, & Preisler, 1985). Ability can also be manipulated in the laboratory. In a classic experiment (Petty, Wells, & Brock, 1976), participants were instructed to listen to a message and simultaneously monitor the number of Xs that flashed on a screen at different intervals (every 15, 5, or 3 seconds for low, medium, or high distraction, respectively) or do nothing (control condition). Those monitoring the Xs that flashed more often had less cognitive capacity – or ability – to scrutinize and encode information due to distraction, compared to those in the control condition.

Motivation, the other processing moderator in the ELM, has been operationalized as the *desire* to engage in issue-relevant thinking (O'Keefe, 2013; Petty & Cacioppo, 1986). Individual differences can moderate levels of motivation. For example, need for cognition is a trait that characterizes a preference and enjoyment for engaging in deep, systematic thinking (Cacioppo & Petty, 1982). Motivation has also been manipulated in the laboratory by assigning participants to messages that vary in personal relevance. For example, participants may be assigned to conditions where the content they receive

directly affects them ("your school is raising tuition this year") or does not directly affect them ("in the next 10 years, the tuition is raising") (Petty & Cacioppo, 1984).

People with greater message elaboration – those with more ability and motivation, are more likely to engage in deeper message processing (Petty & Wegener, 1998). They are more likely to systematically process the messages they receive, think deeply about message content, and incorporate that content into their attitudes towards the topic (Petty, Brinol, & Priester, 2009). According to the ELM, higher message elaboration leads to information processing along the central route. In contrast, low ability and/or motivation to process message content evokes less message elaboration. Low ability and/or motivation leads to information processing along the peripheral route. Central route processing leads to more attitude change and lasting persuasion relative to the peripheral route (e.g., Haugtvedt & Petty, 1992; Petty, Haugtvedt, & Smith, 1995; also see Chaiken, 1980). Those processing along the central route are more persuaded by issue-relevant evidence (Albarracin & Kumkale, 2003) and high-quality arguments (Petty & Cacioppo, 1984; Updegraff, Sherman, Luyster, & Mann, 2007), which require more effort and resources to process yet are more pertinent to the issues in the message (Petty & Wegener, 1998). Because attitudes formed via central route processing are more carefully formulated and assimilated into cognitive associations surrounding a topic (see Petty et al., 2009, p. 134), central route processing leads to more lasting attitude and behavior change (e.g., Haugtvedt & Petty, 1992; Petty et al., 1995). However, just because someone processes information along the peripheral route does not mean that they are not

persuaded. Those processing along the peripheral route can be persuaded by less personally relevant cues, such as message content delivered by an attractive person (Chaiken, 1987) or a domain expert (Petty, Cacioppo, & Goldman, 1981). However, these peripheral cues are processed more superficially, less effortfully, and evoke less engagement with message content, leading to weaker persuasion outcomes (Petty & Wegener, 1998). However, when someone does not have the ability and/or motivation to process a message, peripheral cues can act as simple acceptance rules, or heuristics, which serve to support the suggestions in a message (Petty & Cacioppo, 1986; see also Chaiken, 1980). Taken together, there are different routes, central and peripheral, to persuasion.

According to the ELM, when people process information along the central route, they are more deeply persuaded by the message content (Petty & Cacioppo, 1984, 1986). Adopting this notion, the BMP suggests that challenge frames enhance personal relevance of message content and perceived efficacy, facilitating greater message elaboration which leads to the adoption of message recommendations (Schneider et al., 2009). There are ways to test whether or not a person has ample message elaboration and is processing along the central route. Argument strength, the degree to which arguments in a message support the main points of that message, is a variable that is differentially persuasive for those with different amounts of message elaboration (Petty & Cacioppo, 1984, 1986). The first study in the present research examined the influence of argument

strength as a way to investigate message processing and whether or not challenge frames are effective because they evoke greater message elaboration.

Using Argument Strength to Investigate Message Processing

Argument strength describes the degree to which an argument reflects the central merits of a persuasive appeal (Petty & Cacioppo, 1986). Strong arguments emphasize issue-relevant evidence and provide evidence-based reasons to support the suggestions in a message. Strong arguments may present meaningful data and/or logically founded conclusions that support the claims in a message (Petty & Cacioppo, 1984). In contrast, weak arguments emphasize less stringent evidence such as personal opinions or anecdotal experiences as reasons to support the suggestions in a message (Petty et al., 1981).

Researchers have manipulated argument strength to investigate its effects on message processing. In one study, participants were told that their university would implement comprehensive exams 10 years later (low personal relevance) or the following year (high personal relevance) (Petty & Cacioppo, 1984). By manipulating personal relevance, the researchers were evoking lower or higher motivation to process the message. Participants received messages that varied in personal relevance, argument strength, and number of arguments (three vs. nine). After reading the message, participants completed questionnaires assessing their attitudes towards implementing comprehensive exams and listed the thoughts they had while reading the message. When participants were in the high personal relevance condition, strong arguments led to more favorable attitudes supporting introducing comprehensive exams as well as more issue-

relevant thoughts about the message content. Those assigned to the low relevance condition were more likely to support introducing comprehensive exams when they received nine arguments compared to three, regardless of the strength of those arguments. Petty and Cacioppo (1984) concluded that strong arguments were more persuasive when participants had more message elaboration and processed information along the central route. In contrast, a high number of arguments, regardless of their strength, were more persuasive for those with less message elaboration who processed information along the peripheral route. This and other studies have shown that when people have more message elaboration, they are more persuaded by strong arguments which take more effort to process. In contrast, when people have less message elaboration, they are more persuaded by simple cues that take less effort to process (Petty & Cacioppo, 1986; see also Petty, Kasmer, Haugtvedt, & Cacioppo, 1987).

More recently, Updegraff et al. (2007) examined the effects of matched messages – message frames aligned with motivational orientation – and argument strength on dental flossing attitudes and behaviors. Matched appeals have been shown to be persuasive, and research suggests this is because they evoke greater messages elaboration leading to central route processing (Kreuter, Bull, Clark, & Oswald, 1999; Sherman, Mann & Updegraff, 2006). Updegraff et al. (2007) presented messages that were either gain- or loss-framed. Gain frames emphasized the benefits of engaging in flossing and the ways that undesirable outcomes from not flossing could be prevented. Loss frames emphasized the costs of not flossing and the benefits lost from not flossing. The BIS/BAS

(Carver & White, 1994) questionnaire was used to measure approach versus avoidance motivational orientation. Motivation towards approaching positive occurrences in the environment was measured with the approach (BAS) items, whereas concern about the possibility of and sensitivity to negative occurrences was measured with the avoidance (BIS) items. Matched conditions were those in which gain frames were paired with approach-orientated participants, and loss frames were paired with avoidance-orientated participants. In comparison, mismatched conditions were those in which gain frames were paired with avoidance-orientated participants, and loss frames were paired with approach-orientated participants. Argument strength was also manipulated, such that participants received messages that were either weak (e.g., "People report that flossing helps them develop dexterity and coordination in their fingers") or strong (e.g., "Flossing eliminates bacteria that can damage the gums"). Participants completed the BIS/BAS questionnaire and received one of four messages (gain or loss frame) containing weak or strong arguments. After reading the message, participants responded to questionnaires measuring their attitudes and intentions towards flossing. Participants assigned to matched messages who also received strong arguments had more positive flossing-related perceptions and attitudes towards flossing compared to those who received weak arguments. Those assigned to mismatched conditions were not influenced by the strength of arguments. Updegraff et al. (2007) interpreted these effects as evidence that matched messages facilitate more central route processing. Those assigned to matched conditions, which evoked greater message elaboration, were more sensitive to the argument strength

manipulations and were thus more persuaded by strong arguments.

In summary, research shows that people are more sensitive to argument strength when they are processing information along the central route (Petty & Cacioppo, 1984; Updegraff et al., 2007). In other words, strong arguments are more persuasive for those with greater message elaboration. In past research, challenge-framed messages led to more issue-relevant thoughts, an indication of greater message elaboration (Schneider et al., 2009). In addition, challenge-framed messages have been shown to evoke more attitudes, intentions, and behaviors that are aligned with suggestions in the message. Based on this rationale, the present study hypothesized that challenge-framed messages would be more persuasive than other concern × efficacy framing combinations. Challenge-framed messages should increase message elaboration, leading to effortful engagement with message content and greater sensitivity to argument strength manipulations. When paired with strong arguments, challenge-framed messages were hypothesized to be most effective in getting people to offer more issue-relevant thoughts as well as engage in approach-oriented attitudes, intentions, and behaviors suggested in the message.

Pilot Study

The purpose of experiment 1 was to test the hypothesis that challenge-framed messages (which evoke low/moderate concern and high efficacy) lead people to adopt suggestions in the message, and that these effects are more robust when challenge frames are paired with strong arguments. Independent variables included concern (low/moderate vs. high), efficacy (low vs. high), and argument strength (weak vs. strong) in messages, and dependent variables included issue-relevant thoughts, attitudes, intentions, and behaviors. The independent variables required pilot testing before engaging fully with experiment 1, to ensure experiment 1 manipulations were effective. Message frames were piloted to ensure they evoked different levels of concern (low/moderate, high) and efficacy (low, high) about an ostensible illness. Argument strength was piloted to determine which statements were weakest versus strongest for making people aware of an ostensible illness and convincing them to get tested. To investigate argument strength, various statements about an ostensible illness were created, adapted from past research (Updegraff et al., 2007), and additional items were added to create parallel weak versus strong arguments.

Method

Participants

40 undergraduate participants (34 females; 85%) with a mean age of 23 years (*SD* = 6) participated in the pilot study for partial course credit.

Materials

Messages. Four different message combinations were constructed: a) low/moderate concern paired with low efficacy, b) low/moderate concern paired with high efficacy (challenge), c) high concern paired with low efficacy (threat), and d) high concern paired with high efficacy. Message frames and content from prior research materials were used in the pilot study (Schneider et al., 2009). The message content described information about an ostensible illness (Letrolisus), but the information was framed differently in terms of concern and efficacy across message conditions. Messages intended to evoke low/moderate concern used phrases such as, "the Letrolisus virus is contagious and can be deadly" and "…you *just need to* set up an appointment for your test." In comparison, messages intended to evoke high concern used phrases such as, "the Letrolisus virus is *highly* contagious and can *often* be deadly" and "…you *should* set up an appointment for your test." Messages intended to evoke low efficacy used phrases such as, "the screening test … has proven to be *somewhat* reliable" and "*do your best* to prevent yourself from contracting Letrolisus." In comparison, messages intended to evoke high efficacy used phrases such as, "the screening test … has proven to be *very* reliable" and "prevent yourself from contracting Letrolisus."

Manipulation checks. To ensure concern was manipulated across messages, participants responded to the item, "How threatened do you feel about the possibility of getting the Letrolisus virus?" To ensure efficacy was manipulated across messages, participants responded to the item, "How reliable do you think a Letrolisus screening is?" Both items were assessed on a 5-point scale (1 = *not at all* to 5 = *extremely*).

Argument strength rating survey. To discern weak and strong arguments for experiment 1, twenty-four parallel statements of varying strength were piloted (12 weak, 12 strong). Statements were as similar in grammatical structure as possible but varied in terms of the strength and quality of the content. Weak statements emphasized personal opinions and anecdotal experiences (Petty et al., 1981). A sample weak statement is, "By disinfecting surfaces you and other's frequently touch, the surfaces will be shiny and clean." In comparison, strong statements emphasized issue-relevant evidence and provided meaningful reasons to support the suggestions in the message (Petty & Cacioppo, 1984). A sample strong statement is, "By disinfecting surfaces you and other's frequently touch, you help to prevent contracting Letrolisus." The sequence of these statements was randomized for every participant. Participants rated the strength of each argument on a 9-point scale (1 = *extremely weak* to 9 = *extremely strong*) as in past research (Updegraff et al., 2007).

Procedure

Participants were randomly assigned to one of four message conditions. They were told, "This study today is about evaluating messages about health. Specifically, we're working with the Health Communications Project to inform college students about a new virus, called Letrolisus. Before going public, we're evaluating the effects of our messages. We ask that you attend to the information in the message thoughtfully and carefully." After reading the message aloud, participants completed the manipulation checks. Participants then completed the argument strength rating survey. To avoid

ordering effects, the presentation of framed messages and the argument strength rating survey was counterbalanced. Upon completing the final survey, participants were debriefed. No participants left the laboratory thinking that the ostensible virus was real.

Results

Manipulation checks

Given the low power in the pilot study, no significant differences were anticipated, but it was expected that means on manipulation check items would be in the anticipated directions. It was expected that participants who read a high concern message would feel more threatened about the possibility of getting Letrolisus compared to those who received the low/moderate concern message. It was also expected those who received a high efficacy message would rate the Letrolisus screening as having higher reliability compared to those who received a low efficacy message. Table 1 shows that concern (low/moderate: M = 2.30, SD = .86; high: M = 2.45, SD = 1.45) and efficacy (low: M = 2.75, SD = .91; high: M = 3.45, SD = .94) message manipulations led to mean responses in the anticipated directions.

Argument strength ratings

Table 2 presents the strength ratings of all 24 arguments (12 weak, 12 strong). Based on participant ratings, a subsection of statements that conveyed similar content but differed in strength were selected to compose the argument strength manipulation for experiment 1. The five weak statements selected were, “By disinfecting surfaces you and other’s frequently touch, the surfaces will be shiny and clean,” “Those living with

advanced Letrolisus often struggle with scheduling appointments to get their hair cut," "Students say that getting tested for Letrolisus with friends is a good group activity," "Those living with advanced Letrolisus often struggle financially and can't afford fast food," and "Recently, some students thought that the Letrolisus test might be a good idea." The five strong statements selected were, "By disinfecting hard surfaces you and other's frequently touch, you help to prevent contracting Letrolisus," "Advanced Letrolisus affects your respiratory system's everyday functioning and ability to heal," "Medical doctors agree that getting tested for Letrolisus is a fast and effective path towards healthy living," "Those living with advanced Letrolisus often struggle financially due to the cost of Letrolisus treatments," and "The Letrolisus vaccination has lowered the number of reported health issues related to the Letrolisus virus."

Discussion

The purpose of the pilot experiment was to examine the effectiveness of message manipulations. Concern and efficacy message manipulations led to responses in the anticipated directions, and parallel weak and strong argument statements were identified to compose that manipulation.

Experiment 1

As noted previously, people with greater message elaboration are more influenced by strong arguments (Petty & Cacioppo, 1986). There is evidence that challenge-framed messages evoke greater message elaboration, leading to persuasion (Schneider et al., 2009). Experiment 1 tested the hypothesis that challenge-framed messages evoke greater message elaboration, leading to more issue-relevant thinking, attitudes, intentions, and behaviors put forth in the message, and that these effects are strongest when challenge-framed messages are coupled with strong arguments.

Method

Design

The study was a 2 (concern: low/moderate, high) × 2 (efficacy: low, high) × 2 (argument strength: weak, strong) between-subjects design. Participants received messages about an ostensible illness. Each message contained the same substantive content, but concern, efficacy, and argument strength were manipulated between subjects. The dependent variables were self-reported thoughts, attitudes, and intentions towards getting a screening for the illness, as well as behaviors related to message suggestions.

Participants

An initial sample of 160 undergraduates was collected, with each of the eight message conditions comprising an equal number of participants (n = 20). Of that original sample, a portion of participants stated that the message content was not legitimate or guessed the purpose of the study (n = 26). Subsequent analyses indicated that this

subsample was not randomly assigned across message conditions. That is, those assigned to the weak messages were more likely to question the legitimacy of the message content or guess the study purpose, $\chi^2(1) = 6.61$, $p = .01$. To obtain the desired sample size with an equal number of participants per group, additional data were collected. Of the final sample ($N = 160$), 110 identified as female (70%) with a mean age of 21 years ($SD = 3$).

Materials

Messages. Messages used in experiment 1 were developed from insights gleaned from the pilot study. The substantive content of each message described information about an ostensible illness (Letrolisus), but the information was framed differently in terms of concern and efficacy across message conditions. A sample low/moderate concern statement included, "The Letrolisus virus is contagious and is transmitted in much the same way as the common flu, but it has *other* consequences." Comparatively, a sample high concern statement included, "The Letrolisus virus is *highly* contagious and is transmitted in much the same way as the common flu, but it has *far more damaging* consequences." A sample low efficacy statement included, "There are *some* steps you can take to *try and* avoid getting Letrolisus." Comparatively, a sample high efficacy statement included, "There are *many* steps you can take to avoid getting Letrolisus."

Parallel weak versus strong argument statements were taken from the pilot study to create the argument strength manipulation. A sample weak statement included, "By disinfecting surfaces you and other's frequently touch, the surfaces will be shiny and

clean." The parallel strong statement was, "By disinfecting surfaces you and other's frequently touch, you help to prevent contracting Letrolisus."

To fully test the 2 (concern: low/moderate, high) × 2 (efficacy: low, high) × 2 (argument strength: low, high), eight different message combinations were constructed. For the full message used in experiment 1, see Appendix A.

Baseline questionnaire. Trait worry (Borkovec, Robinson, Pruzinsky, & DePree, 1983) was measured with the item, "How much do you worry in a typical day?" Participants responded by circling one of four options, *0-10%*, *25%*, *50%*, and *more than 50%*. State anxiety was assessed with the State Trait Anxiety Inventory (Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983). Participants rated 10 items on how they feel in the present moment (e.g., "I feel anxious") on a 4-point scale (1 = *not at all*, 4 = *very much so*). The items assessing state anxiety composed a reliable scale, $\alpha = .84$.

Need for cognition. The need for cognition scale was used to measure trait levels of the desire to engage in effortful thinking (Cacioppo, Petty, & Kao, 1984). The scale consists of 18 items, 9 of which are reversed scored. Two sample items are, "I would prefer complex to simple problems" and "Thinking is not my idea of fun (R)." All items are rated on a 5-point agreement scale (1 = *strongly disagree*, 5 = *strongly agree*). Higher average scores denote higher need for cognition. The items composed a reliable scale, $\alpha = .86$.

Thought-listing. After participants read the message, they completed a thought-listing task. Participants were instructed to write down five thoughts they had while they

read the message, with more issue-relevant thoughts indicating greater message elaboration (Petty & Cacioppo, 1984; Schneider et al., 2009). Thoughts about the causes of Letrolisus and thoughts supporting getting a screening for Letrolisus were summed.

Manipulation checks. To assess the concern manipulation, participants responded to the item, "How threated do you feel about the possibility of getting the Letrolisus virus?" To assess the efficacy manipulation, participants responded to the item, "How reliable do you think a Letrolisus screening is?" To test the argument strength manipulation, participants responded to the item, "How strong were the arguments in the message?" All manipulation checks were assessed on a 5-point scale (1 = *not at all* to 5 = *extremely*).

Attitudes. Attitudes about getting tested for Letrolisus were assessed with the items, "I think that getting a screening for Letrolisus is a smart thing to do," "I believe getting a screening for Letrolisus is a proactive way to promote good health" "I think that getting a screening for Letrolisus is a waste of time," and "Detecting Letrolisus, before symptoms develop, is a good idea."

Beliefs about the information presented in the message were assessed with the following four items: "The information in the message was believable," "The information in the message was interesting," "The information in the message helped me learn a lot about Letrolisus," and "The information in the message was irrelevant to me." Items were assessed on a 5-point scale (1 = *strongly disagree* to 5 = *strongly agree*).

Intentions. Intentions to get tested for Letrolisus were assessed with three items from a past experiment (Schneider et al., 2009): "If over the next few months the Letrolisus virus became of greater public and personal concern, I would get tested," "I plan to get tested for Letrolisus within the next 3 months," and "If I could set up an appointment right now to get a test to see if I have Letrolisus, I would." In addition, participants were asked to respond to the following items: "If I thought I had Letrolisus, I would get tested" and "I would trust the results of a Letrolisus test." Items were assessed on a 5-point scale (1 = *definitely not* to 5 = *definitely yes*).

Behaviors. Screening-related behaviors were measured by counting alcohol pads taken to wipe surfaces clean from the virus and the number of business cards taken before leaving the laboratory. These business cards contained contact information for scheduling a screening for Letrolisus. In addition, participants were given the opportunity to leave a phone number to receive mouthwash samples at a later date. Alcohol pads, business cards, and mouthwash samples requested were treated as continuous variables.

Procedure

Participants were run individually. Informed consent was obtained, then participants completed a baseline questionnaire containing demographic, trait worry, state anxiety items, and need for cognition measures. Then, participants received one of the eight messages and were given the instructions, "This study today is about evaluating messages about health. Specifically, we're working with the Health Communications Project to inform college students about a new virus, called Letrolisus. Before going

public, we're evaluating the effects of our messages. We ask that you attend to the information in the message thoughtfully and carefully." After reading the message aloud, participants completed the thought-listing task, manipulation checks, and post-message questionnaires assessing their attitudes and intentions about message content. Before leaving the laboratory, participants were given the option to take alcohol pads and business cards, and to leave their phone number to receive mouthwash samples at a later time. Upon leaving, participants were called back into the laboratory, debriefed, and assured the illness discussed in the message was fictitious.

Results

Preliminary Analyses

To assess randomization across conditions, 2 (concern: low/moderate, high) × 2 (efficacy: low, high) × 2 (argument strength: weak, strong) ANOVAs were conducted, with trait worry, state anxiety, and need for cognition as outcomes. Participants assigned to the low efficacy message had higher state anxiety at baseline (low efficacy: $M = 3.29$, $SD = .45$; high efficacy: $M = 3.11$, $SD = .61$; $F(1, 142) = 3.97$, $p = .05$, $\eta_p^2 = .03$) and lower need for cognition (low efficacy: $M = 3.28$, $SD = .55$; high efficacy: $M = 3.46$, $SD = .49$; $F(1, 152) = 4.78$, $p = .03$, $\eta_p^2 = .03$).[1] In addition, age was significantly correlated

[1] When factorial designs contain 2 or more independent variables and/or covariates, partial eta-squared (η_p^2) should be used as an estimate of effect size because it accounts for the sum of squares of each manipulation and covariate, along with error variance attributed to each. (Cohen, 1973; Levine & Hullett, 2002). η_p^2 values of .02, .13, and .26 are small, medium, and large effect sizes, respectively.

with two manipulation check items, all attitude outcomes, four intention outcomes, and one behavioral outcome, *p*s < .05. Consequently, all analyses in experiment 1 controlled for state anxiety, need for cognition, and age. Significant interactions were subjected to follow-up simple effects tests.

Manipulation checks

Table 3 displays the means (*SD*s) of all manipulation checks. There was a significant concern × efficacy interaction on how threatened participants felt about getting the Letrolisus virus, $F(1, 138) = 3.79$, $p = .05$, $\eta_p^2 = .03$. Those assigned to the threat-framed message (high concern, low efficacy) were more threatened about potentially getting Letrolisus. Simple effects tests revealed participants assigned to the threat-framed message rated the possibility of getting Letrolisus as significantly more threatening ($M = 2.33$, $SD = 1.15$) compared to those who received the low/moderate concern, low efficacy message ($M = 1.81$, $SD = .91$). However, there was no reliable difference between those who received the threat-framed message and those who received the challenge-framed message ($M = 2.11$, $SD = 1.13$). As in a past experiment (Schneider et al., 2009, experiment 2), there was no significant main effect of concern on how threatened participants felt about getting Letrolisus. However, the findings from the present research suggest that the threat-framed message seemed to evoke more threat about potentially getting Letrolisus.

There was a significant main effect of efficacy on how reliable participants thought the Letrolisus screening was, $F(1, 137) = 6.55$, $p = .01$, $\eta_p^2 = .05$. Those assigned

to the high efficacy message perceived the Letrolisus screening to be more reliable (M = 3.20, SD = .90) compared to those who received the low efficacy message (M = 2.77, SD = 1.09). This effect was qualified by a significant efficacy × argument strength interaction, $F(1, 137) = 4.88$, $p = .03$, $\eta_p^2 = .03$. Simple effects tests revealed those who received the high efficacy, strong argument message rated the Letrolisus screening as significantly more reliable (M = 3.45, SD = .65) compared to those who received all other efficacy × argument strength combinations (low efficacy, low argument strength: M = 2.84, SD = 1.24; low efficacy, strong arguments: M = 2.69, SD = .92; high efficacy, low argument strength: M = 2.95, SD = 1.05). Based on these findings, perceived efficacy was reliably manipulated, and those assigned to the high efficacy message thought the Letrolisus screening was even more reliable when that message was paired with strong arguments supporting the message suggestions.

There was a significant main effect of argument strength on how strong participants rated the arguments in the message, $F(1, 138) = 15.00$, $p < .001$, $\eta_p^2 = .10$. Those who received strong arguments rated the message arguments as stronger (M = 3.17, SD = .86) compared to those who received weak arguments (M = 2.57, SD = 1.14). No other main effects or significant interactions emerged.

Thought-listing

Table 4 displays the mean (SDs) thoughts listed across message conditions. The were no significant main effects of concern, efficacy, or argument strength manipulations on the number of thoughts about causes of Letrolisus or thoughts supporting getting a

screening for Letrolisus, nor did any significant interactions emerge, *F*s ≤ 3.52, *ns*, η_p^2s ≤ .03. Regarding the hypotheses of experiment 1, there was no evidence that challenge-framed messages coupled with strong arguments evoked more issue-relevant thinking as measure by the thought-listing task.

Post-message attitudes

Table 5 displays the means (*SD*s) from all post-message attitude analyses. There were no significant main effects or interactions of concern, efficacy, and argument strength manipulations on agreement ratings to the items "I think that getting a screening for Letrolisus is a smart thing to do," "I believe getting a screening for Letrolisus is a proactive way to promote good health," and "I think that getting a screening for Letrolisus is a waste of time," *F*s ≤ 2.62, *ns*, η_p^2s ≤ .02.

Those who received strong arguments had higher agreement (*M* = 4.27, *SD* = .70) that detecting Letrolisus before symptoms develop is a good idea compared to those who received weak arguments (*M* = 3.97, *SD* = .84), *F*(1, 138) = 5.78, *p* = .02, η_p^2 = .04. Moreover, participants who received strong arguments rated the information in the message as more believable (*M* = 3.47, *SD* = .95) compared to those who received weak arguments (*M* = 2.97, *SD* = 1.24), *F*(1, 137) = 7.74, *p* < .01, η_p^2 = .05, and agreed more so that the message information helped them learn more about Letrolisus (weak argument: *M* = 3.23, *SD* = .99; strong argument: *M* = 3.67, *SD* = .98), *F*(1, 137) = 6.45, *p* = .01, η_p^2 = .05. Across these outcomes, no other main effects or interactions were significant, *F*s ≤ 3.74, *ns*, η_p^2s ≤ .03.

There was a main effect of argument strength on how interesting participants rated the message information, $F(1, 137) = 3.77$, $p = .05$, $\eta_p^2 = .03$. Participants who received strong arguments rated the message information as more interesting ($M = 3.84$, $SD = .87$) compared to those who received weak arguments ($M = 3.56$, $SD = .91$). In addition, there was a significant concern × efficacy interaction, $F(1, 137) = 8.56$, $p < .01$, $\eta_p^2 = .06$, such that the challenge-framed message appeared to evoke the greatest interest in the message information. Simple effects tests revealed that those assigned to the challenge-framed message rated the message as significantly more interesting ($M = 3.97$, $SD = .65$) compared to those who received the low/moderate concern, low efficacy ($M = 3.51$, $SD = 1.07$) and the high concern, high efficacy ($M = 3.59$, $SD = .91$) messages. However, there was no reliable difference between those who received the challenge-framed message and those who received the threat-framed message ($M = 3.75$, $SD = .87$).

There was a significant main effect of argument strength on how irrelevant the information in the message was rated, $F(1, 137) = 10.24$, $p < .01$, $\eta_p^2 = .07$. Participants who received weak arguments rated the message information as more irrelevant ($M = 2.73$, $SD = 1.11$) compared to those who received the strong arguments ($M = 2.25$, $SD = 1.00$). In addition, there was a significant concern × efficacy interaction, $F(1, 137) = 7.65$, $p < .01$, $\eta_p^2 = .05$. Though simple effects tests revealed cell means were not statistically different from one another in the 2-way interaction, those who received the challenge-framed message appeared to rate the message information as most relevant compared to

those who received other concern by efficacy messages, including the threat-framed message.

Intentions

Table 6 displays the means (*SD*s) from all intention analyses. There were no significant main effects or interactions of concern, efficacy, and argument strength manipulations on agreement ratings to the items "If I could set up an appointment right now to get a test for Letrolisus, I would," "If I thought I had Letrolisus, I would get tested," and "I would trust the results of a Letrolisus test," *F*s ≤ 3.56, *ns*, η_p^2s ≤ .03.

There was a significant concern × efficacy interaction on ratings to the item, "If over the next few months the Letrolisus virus became of greater public and personal concern, I would get tested," $F(1, 138) = 7.95$, $p = .01$, $\eta_p^2 = .05$. Surprisingly, simple effects tests revealed those assigned to the threat-framed message had significantly higher intentions ($M = 4.33$, $SD = .68$) compared to those who received the low/moderate concern, low efficacy message ($M = 3.84$, $SD = .99$). However, there was no reliable difference between those who received the threat-framed message and those who received the challenge-framed message ($M = 4.11$, $SD = .81$).

There were no main effects of concern, efficacy, or argument strength on plans to get tested for Letrolisus within 3 months, *F*s ≤ 1.78, *ns*, η_p^2s ≤ .01. However, there was a significant concern × efficacy × argument strength interaction, $F(1, 138) = 7.13$, $p = .01$, $\eta_p^2 = .05$. Simple effects tests revealed those assigned to the low/moderate concern, low efficacy, weak argument message had significantly lower intentions ($M = 2.11$, $SD = .74$)

compared to those who received the low/moderate concern, low efficacy, strong argument message (*M* = 2.83, *SD* = .99), the threat-framed message coupled with weak arguments (*M* = 2.89, *SD* = 1.13), and the high concern, high efficacy, strong argument message (*M* = 2.79, *SD* = .92). However, there was no evidence that those who received the challenge-framed message coupled with strong arguments (*M* = 2.40, *SD* = 1.05) had particularly higher intentions compared to any other message combination, including the threat-framed message coupled with either weak or strong arguments (*M* = 2.61, *SD* = 1.09).

Behaviors

Table 7 displays the means (*SD*s) from all behavior analyses. There was a significant main effect of efficacy on the number of alcohol pads participants took before leaving the lab, $F(1, 138) = 5.30$, $p = .02$, $\eta_p^2 = .04$. Those assigned to the high efficacy message took more pads (*M* = 1.11, *SD* = 1.01) compared to those assigned to the low efficacy message (*M* = .93, *SD* = 1.10). This main effect was qualified by a significant concern × efficacy interaction, $F(1, 138) = 4.58$, $p = .03$, $\eta_p^2 = .03$. Simple effects tests revealed that those assigned to the challenge-framed message were significantly more likely to take alcohol pads (*M* = 1.35, *SD* = 1.21) compared to those assigned to the low concern, low efficacy message (*M* = .70, *SD* = .88). However, there was no reliable difference between those who received the challenge-framed message and those who received the threat-framed message (*M* = 1.03, *SD* = 1.08). In addition, there was a significant efficacy × argument strength interaction, $F(1, 138) = 4.58$, $p = .03$, $\eta_p^2 = .03$.

Simple effects tests revealed that those who received the low efficacy message coupled with weak arguments took significantly fewer alcohol pads (M = .59, SD = .80) compared to those who received the low efficacy, strong argument (M = 1.14, SD = 1.10), the high efficacy, weak argument (M = 1.27, SD = 1.26), and the high efficacy, strong argument messages (M = 1.08, SD = .93).

There were no main effects of concern, efficacy, or argument strength on the number of contact cards participants took before leaving the laboratory, Fs ≤ 1.15, *ns*, η_p^2s ≤ .01. However, a significant concern × efficacy interaction did emerge, $F(1, 138) = 5.28$, $p = .02$, $\eta_p^2 = .04$. Participants assigned to the challenge-framed message appeared to take the most contact cards compared to those who received other message combinations. However, simple effects tests revealed no significant differences in condition means. In addition, a significant concern × efficacy × argument strength interaction emerged, $F(1, 138) = 11.73$, $p = .001$, $\eta_p^2 = .08$. Simple effects tests revealed those assigned to the challenge-framed message paired with weak arguments took significantly more contact cards (M = .94, SD = .66) compared to those who received the challenge-framed message coupled with strong arguments (M = .45, SD = .51), the threat-framed message coupled with strong arguments (M = .50, SD = .51), the high concern and high efficacy message paired with weak arguments (M = .40, SD = .50), and the low/moderate concern, low efficacy message paired with weak arguments (M = .32, SD = .48). In addition, those assigned to the low/moderate concern, low efficacy message paired with weak arguments took significantly fewer cards compared to those who

received the threat message coupled with weak arguments (M = .67, SD = .49) and the high concern, high efficacy message paired with strong arguments (M = .68, SD = .48).

Lastly, there were no significant main effects of concern, efficacy, or argument strength on the number of mouthwash samples participants signed up to receive, Fs ≤ 2.17, *ns*, $\eta_p^2 \leq .02$. However, there was a significant concern × efficacy interaction on the number of mouthwash samples participants signed up for before leaving the laboratory, $F(1, 138) = 4.14$, $p = .04$, $\eta_p^2 = .03$. Participants who received the challenge-framed message appeared to sign up for more mouthwash samples compared to other messages. Simple effects tests revealed those assigned to the challenge message signed up to receive significantly more samples (M = .73, SD = 1.95) compared to those assigned to the high concern, high efficacy message (M = .08, SD = .35). However, there was no reliable difference between those who received the challenge-framed message and those who received the threat-framed message (M = .31, SD = .92).

Discussion

The purpose of experiment 1 was to examine message processing with an argument strength manipulation, thereby extending prior research which found that challenge-framed messages evoke greater message elaboration, leading to more thoughts, attitudes, intentions, and behaviors aligned with message suggestions (Schneider et al., 2009). The hypothesis of experiment 1 was that the challenge-framed message (low/moderate concern, high efficacy) would lead to more persuasion, and these effects would be most pronounced when challenge frames were paired with strong arguments.

Although there was no evidence that the challenge-framed message was particularly effective when paired with strong arguments, some support was found for the postulate that challenge-framed messages evoked greater message elaboration.

In many instances, the challenge-framed message led to favorable attitudes and behaviors suggested in the message. Participants who received the challenge-framed message rated the information in the message as more interesting and relevant. Increasing involvement in and perceived relevance of a topic and has been shown to evoke greater message elaboration (Petty & Cacioppo, 1986). In addition, those who received the challenge-framed message took more alcohol pads and signed up to receive more mouthwash samples before leaving the laboratory. These results replicate those from past research and demonstrate that the challenge-framed message led to approach-oriented behaviors aligned with message suggestions (Schneider et al., 2009). Collectively, these findings support tenets of both the ELM (Petty & Cacioppo, 1986) and the BMP (Schneider et al., 2009) – that greater interest and perceived relevance of message content leads to behavioral engagement aligned with suggestions in the message.

There was no evidence that the challenge-framed message led to more issue-relevant thoughts. In a past experiment, Schneider et al. (2009) found that prolonged exposure to challenge-framed messages led participants to write more issue-relevant thoughts in a thought-listing task. However, Schneider et al. found very small differences in mean thoughts listed across message conditions (*M*s = .00 - .79). Moreover, Schneider and colleagues found no evidence that prolonged exposure to the challenge-framed

message evoked more issue-relevant thinking compared to brief or prolonged exposure to the threat-framed message. Taken together, the findings from both Schneider and colleagues and the present experiment may call the thought-listing technique into question as to whether it can be used to effectively measure message elaboration. Some researchers have placed constraints on the time participants have to write their thoughts about persuasive messages. This is done to extract only those thoughts participants had while reading the message while preventing them from generating new thoughts (Petty & Cacioppo, 1986; Wood, 1982). In experiment 1, the time participants had to write was not constrained. With unlimited time to respond, participants may have generated new ideas which may or may not have been related to the message content. This may have further weakened the utility of the thought-listing technique as an index of message elaboration. Future research should determine in what contexts (if any) thought-listings are useful for assessing relevant (and irrelevant) thoughts about a message.

In experiment 1, participants who received the threat-framed message had higher intentions to get tested for Letrolisus if the virus became of greater public and personal concern over the next few months. This finding contrasts with those from past research (Schneider et al., 2009) and the hypotheses of experiment 1. One possible explanation for this finding is that the post-message item itself conveyed greater concern about (i.e., assuming the virus becomes of greater concern in the "next few months") and lower efficacy to avoid Letrolisus (i.e., intentions to get tested only *after* the virus had become a public issue). Thus, it is possible some post-message items led to increased concern and

low efficacy based on how they were written, matching the state of those participants who received the threat-framed message. Matching effects have been shown in past literature investigating whether messages matched to locus of control persuaded behaviors (i.e., scheduling a mammogram; Williams-Piehota, Schneider, Pizzaro, Mowad, & Salovey, 2004). In that study, women completed a questionnaire assessing their locus of control (internal vs external) and received messages that reflected an internal (e.g., "The responsibility for maintaining your good health belongs to you") or external focus (e.g., "The responsibility for maintaining your good health resides in your partnership with your health care provider"). Women who received messages that matched their locus of control were more likely to get a mammography. In experiment 1 of the present research, participants showed greater intention in response to the item which conveyed a sense of high concern and low efficacy when they received the threat-framed message. Future research should investigate the effects of matching challenge and threat frames to participant characteristics, as tailoring messages to recipient characteristics has been shown to increase personal relevance and message elaboration (Updegraff et al., 2007). This research would help determine when (and for whom) threat frames are persuasive based on the state people are in, as well as their experiences in/with particular contexts (Capiola, Schneider, & Hillard, in preparation).

There was no evidence that the challenge-framed message was particularly effective when coupled with strong arguments. Challenge frames alone persuaded participants to take alcohol pads and mouthwash samples, while strong arguments

persuaded many responses to self-report items. Interestingly, participants who received the challenge-framed message coupled with weak arguments took significantly more contact cards before leaving the laboratory. It should be noted that not all behavioral engagement is equivalent, and the effects of challenge-framed messages on participants taking alcohol pads and mouthwash samples align with research from Schneider and colleagues (2009). Nevertheless, the finding that challenge-framed messages persuaded people to take more contact cards when coupled with weak arguments does not align with the hypotheses of experiment 1 or past research (Schneider et al., 2009). It may be that challenge frames are effective in promoting behavioral engagement, regardless of whether they were paired with strong arguments, while strong arguments are more effective at persuading responses to self-report items. Clearly, more research is needed before such conclusions can be drawn.

In another instance, participants who received the low/moderate concern, low efficacy messages coupled with weak arguments had the least intention to get tested for Letrolisus within the next 3 months. This finding supports empirical research demonstrating that the low/moderate concern, low efficacy message leads to a lack of engagement and ultimately no persuasion (Schneider et al., 2009). Indeed, messages that evoke little personal concern about the message content or efficacy to act on the

suggestions in the message will result in abandoned interest and reduced processing effort. In this instance, the weak arguments seemed to enhance this effect.[2]

Though the original emphasis of the BMP was to suggest that challenge- and threat-framed messages promote different health attitudes and behaviors (Schneider et al., 2009), other research has applied challenge and threat framing to other contexts (Capiola et al., in preparation; Schneider et al., under review). In testing this model, challenge messages have been shown to promote more hospitable attitudes towards female STEM faculty (Capiola et al., in preparation) and lead people to endorse more preparatory behaviors in response to extreme weather (Schneider et al., under review) compared to threat frames. The findings from experiment 1 do not compliment these results from past research. In several instances, the challenge-framed message was significantly more persuasive than the low/moderate concern, low efficacy message and the high concern, high efficacy message. However, there was no evidence that those who received the

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[2] It cannot be ignored that participants who received the threat-framed message had greater intentions to get tested for Letrolisus in the next 3 months when they received weak arguments. Threat-framed messages, which evoke high concern that restricts cognitive processing of the message content and low efficacy perceptions to act on the message suggestions, may have led to low message elaboration (Schneider et al., 2009). Those who have low message elaboration do not have the ability or motivation to process message information deeply, but they can still be persuaded by simple cues that have little merit yet require fewer resources to process (Chaiken, 1980; Petty & Cacioppo, 1986). Based on this rationale, the data suggest that with respect to this particular intention item, threat frames evoked lower message elaboration and were more persuasive when they were paired with weak arguments.

challenge-framed message had significantly more issue-relevant thoughts, attitudes, intentions, or behaviors aligned with message suggestions compared to those who received the threat-framed message.

The results from experiment 1 differ somewhat, though not entirely, from the findings of Schneider et al. (2009). Schneider and colleagues investigated the interaction between BMP derived messages and duration of message exposure on persuasion outcomes. They found several significant interactions which suggested prolonged exposure to challenge-framed messages were more persuasive than other messages. Follow-up simple effects tests showed that prolonged exposure to challenge-framed messages evoked significantly greater intentions and behavioral engagement compared to brief exposure to threat-framed messages. However, Schneider and colleagues found no evidence that prolonged exposure to the challenge-framed message evoked significantly different stressor appraisals, issue-relevant thoughts, intentions, or behavioral engagement compared to those assigned to the prolonged threat-framed messages. Taken together, Schneider and colleagues found many instances where challenge-framed messages were persuasive and often evoked significantly different outcomes compared to threat-framed messages, but they also found instances where challenge- and threat-framed messages did not lead to reliably different outcomes.

In the present experiment, it seems challenge-framed messages evoked greater interest in and perceived relevance of message information along with behavioral engagement, but not significantly more so than the threat-framed message. One limitation

of experiment 1 in this dissertation, as well as experiment 2 from Schneider and colleagues (2009), is that the concern manipulation was not very strong. Indeed, message manipulations reliably influenced perceived efficacy across messages, but this was not the case regarding the concern manipulation. Future research should attempt to bolster the concern manipulation when creating challenge and threat message frames. Increasing the BMP derived message manipulations should lead to stronger message effects, such that more differentiation can be investigated between challenge- versus threat-framed messages rather than just challenge-framed messages compared to the other concern by efficacy framing combinations.

Experiment 1 was the first study to examine argument strength in conjunction with concern and efficacy message manipulations to investigate the effects of challenge and threat framing on persuasion outcomes. In the present study, great care was taken to ensure the argument strength manipulation was robust (see pilot experiment). Based on a comparison of the manipulation check effect sizes, the argument strength manipulation may have masked the subtleties of the concern and efficacy manipulations. Additionally, there were instances where strong arguments led people to support the suggestions in the message, yet the challenge-framed message showed no effect.[3] Future research should

[3] Petty and Cacioppo explained that weak versus strong arguments should evoke differential strength ratings, negative and positive thoughts, and/or "persuasiveness" to serve as an effective manipulation (Petty & Cacioppo, 1986). However, they noted that weak versus strong arguments should not differ in their rated believability because the "…goal is to develop arguments that are weak and strong, but that do not strain credulity" (p. 134). In experiment 1, weak arguments evoked significantly lower believability

determine how participants weigh the importance of argument strength statements compared to concern and efficacy manipulations when evaluating a message. This could be done in a post-message interview or by implementing a recall procedure. A study such as this would help determine whether argument strength manipulations are too overpowering when paired with subtler concern and efficacy manipulations, such that the former masks the effects of the latter two.

In summary, the challenge-framed message led to greater relevance of and interest in message content. Greater perceived relevance of and interest in a topic are indicative of greater message elaboration (Petty & Cacioppo, 1986). However, there was no evidence that the challenge-framed message was particularly persuasive when paired with strong arguments. One reason for this may be that the argument strength manipulation was stronger compared to the concern and efficacy manipulations. However, the challenge-framed message led to behavioral engagement in the direction of message suggestions, while strong arguments did not. Clearly, future research should investigate whether the strength of arguments and appraisals of concern and efficacy differently influence self-reported versus behavioral responses.

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ratings compared to the strong arguments. This, along with the high exclusion rate of those participants who received weak arguments and the relatively stronger effect size attributed to the argument strength manipulation, lends support to the inference that the argument strength manipulation was more robust than the concern and efficacy manipulations and may have masked their effects to some degree.

Based on these findings, challenge messages may have evoked greater message elaboration compared to other concern and efficacy message frame combinations. However, the results of experiment 1 were not as strong as anticipated, and there was no evidence supporting the hypothesis that challenge frames coupled with strong arguments are particularly persuasive. Therefore, an additional experiment was run using a psychophysiological index of resource allocation to further investigate whether challenge-framed messages evoke greater message elaboration. Prior to describing this psychophysiological index in detail, the limitations of the thought-listing method are revisited. Then, literature that has utilized pupil diameter as an index of cognitive resource allocation is described, followed by the hypotheses of experiment 2.

Limitations of the thought-listing method

The thought-listing method asks participants to write about what they were thinking while they were reading a message, where more issue-relevant thoughts indicate greater message elaboration. A noted limitation of the thought-listing method is that it is administered after participants read a message, thus relying on participants to recall their past thoughts (Cacioppo et al., 1997, p. 932). There are examples in the literature where reports of past thoughts and experiences are biased (Loftus & Palmer, 1974; Neisser, 1981). For example, one study found that reports of pain experienced during a laboratory stressor showed systematic biases (Kahneman et al., 1993). Researchers manipulated the duration participants experienced pain across two sessions. Participants immersed one of their hands in 54 degrees Fahrenheit water for 60 seconds. Then, they repeated the same

procedure extended for an additional 30 seconds, at which time the water temperature was raised to 56 degrees Fahrenheit. Afterwards, participants were asked to recall which session they preferred. Results showed that the majority of participants preferred the extended (60 seconds) session over the shortened (30 seconds) session. These findings show that people remember pain experienced towards the end of a procedure more vividly while neglecting to consider its duration (Varey & Kahneman, 1992). Another study found similar results (Redelmeier & Kahneman, 1996). People were asked to report their pain every 60 seconds during a minimally invasive medical procedure. Afterwards, they were asked to report the pain they experienced during the procedure. The retrospective reports were biased, such that they were correlated with peak pain ratings and pain ratings at the very end of the procedure. More recent studies have found similar biases and errors when patients report past ailments to their doctors (Van den Bergh & Walentynowicz, 2016) and when they report pain during exercise (Babel, 2016). Clearly, self-reports of past events are subject to bias. Such findings suggest the thought-listing technique has limitations, as thought-listings are based only on self-reports of past thoughts.

To avoid the shortcomings of the thought-listing method, experiment 2 investigated processing differences in those exposed to messages derived from the BMP *while* they read a message. By assessing cognitive processing during reading, experiment 2 investigated whether different message frames lead to different message elaboration. Experiment 1 aimed to address the limitations of thought-listings by investigating

message elaboration using the argument strength manipulation. Experiment 2 aimed to address the limitations of thought-listings by using a psychophysiological measure of resource allocation which does not rely on reconstructive memory.

Pupil diameter: A psychophysiological measure of resource allocation

Pupil diameter is a reliable psychophysiological metric that has been used to assess resource allocation and mental effort (Beatty & Lucero-Wagoner, 2000; Kahneman, 1973). Pupil dilation increases as task-demands increase (i.e., task-evoked pupillary response). In a classic experiment (Hess & Polt, 1964), researchers photographically monitored change in pupil dilation as participants attempted to solve math problems. As participants calculated the product of two numbers, their pupil dilation increased monotonically as the problem difficulty increased from relatively low (7×8) to high (16×23). This task-evoked pupillary response has since been replicated in other laboratories (e.g., Ahern & Beatty, 1979, 1981).

Pupil diameter also increases in relation to short term memory load (Kahneman & Beatty, 1966). In an experiment, participants were asked to listen and recall strings of numbers ranging from 3 to 7 digits while their pupil dilation was monitored. As the number of digits to be remembered increased, pupil diameter increased. Then, in the recall phase, their pupil diameter constricted as they vocalized each digit. Similar findings were shown when participants were asked to transform 4-digit numbers mentally and verbally report their transformation (Kahneman, Beatty, & Pollack, 1967). Participants were presented a 4-digit number and asked to add 1 to each digit in the string

(e.g., *4531* transforms to *5642*). Pupil dilation increased as each number in the 4-digit string was presented. Maximum dilation was recorded as participants verbalized the first transformed number, and dilation gradually reduced as participants reported transformed digits with a return to baseline after they finished reporting the final digit. Kahneman and Beatty interpreted these findings as evidence that the pupil dilates as mental effort increases in short-term memory tasks and constricts back towards baseline diameter as effort decreases.

Pupil dilation has also been used to measure cognitive processing in more recent research (Laeng, Orbo, Holmlund, & Miozzo, 2011). Laeng and colleagues investigated changes in pupil dilation as an index of resource allocation while participants completed a Stroop task. During the Stroop task, participants are presented with words and asked to name the color in which the word is presented. Because of the tendency to read the word, naming the color of a word when the word presented ("blue") does not match the color of the font (printed in red) becomes difficult. Consequently, incongruent Stroop trials ("red" printed in blue) are more difficult and require greater resource allocation to verbally identify than congruent trials ("red" printed in red; Siegle, Ichikawa, Steinhauer, 2008). Laeng et al. (2011) found that when participants received incongruent trials, their pupil dilation significantly increased from baseline compared to their pupil dilation during congruent trials. The authors suggested that the incongruent trials led to greater cognitive interference and required more effortful cognitive processing and control to perform the incongruent task, evoking greater pupil dilation.

In another study, people who transformed sentences and read them as reflecting a verb orientation, compared to an object orientation, had an increase in pupil dilation (Schluroff et al., 1986). According to formal grammar, sentences that are verb oriented (e.g., “The boy was kicked by Zared on the swing”) are syntactically more complex compared to sentences that are object oriented (e.g., “The boy on the swing was kicked by Zared”). Participants were exposed to sentences, five of which were biased towards an object or verb oriented syntactic transformation, respectively, and 10 which were ambiguous based on pretest results. Participants were instructed to transform the sentences into passive voice and vocalize the transformed sentence. Results indicated that compared to object-oriented transforms, pupil diameter increased when participants were to transform sentences to be verb-oriented. Regardless of whether the sentences were biased to be transformed to verb orientations or classified as ambiguous during the pretest, verb-oriented transforms led to significantly increased pupil dilation from baseline, compared to object-oriented transforms. Schluroff et al. (1986) concluded that transforming sentences to verb orientations led to greater pupil dilation because these stimuli were syntactically more complex, requiring more cognitive effort to interpret.

Researchers have encouraged the use of pupillometry to measure cognitive effort in future cognitive neurophysiological research (Beatty & Lucero-Wagoner, 2000; Laeng, Sirois, & Gredeback, 2012). Moreover, in tasks that require substantive cognitive engagement, pupil dilation indicates fluctuations in mental effort and not variation in arousal (Stanners, Coulter, Sweet, & Murphy, 1979; Vo et al, 2008). Pupillometry may

help researchers understand one mechanism, cognitive effort, that may influence message processing. For the purposes of the present study, cognitive effort indexes message elaboration. If challenge-framed messages lead to different amounts of cognitive effort towards processing the message information, then a corresponding change in pupil dilation should emerge.

Experiment 2

Experiment 2 examined whether messages containing different levels of concern (low/moderate, high) and efficacy (low, high) lead to different issue-relevant thoughts, attitudes, intentions, and behaviors toward scheduling a screening procedure for an ostensible illness, and pupil dilation. It was hypothesized that challenge-framed messages (low/moderate concern, high efficacy) would evoke more issue-relevant thoughts, attitudes, intentions, and behaviors towards scheduling a screening procedure, as well as increased pupil dilation, compared to other message combinations.

Method

Design

The study was a 2 (concern: low/moderate, high) × 2 (efficacy: low, high) between-subjects design. Participants received messages about the same ostensible illness as in experiment 1. Each message presented the same substantive content, but concern and efficacy were varied between subjects. The dependent variables were self-reported issue-relevant thoughts, attitudes, intentions, and behaviors related to getting a screening for the illness, as well as pupil dilation in response to message content.

Participants

An initial sample of 136 undergraduates was collected. There was an equal number of participants randomized across four message conditions (n = 34). Of that original sample, a portion of participants had unusable pupil data (n = 11) or were

suspicious of the message content (n = 8).[4] To obtain the desired sample size and an equal number of participants per group, additional data were collected. Of the final sample (N = 136), 88 identified as female (64.7%) with a mean age of 20 years (SD = 5).

Materials

Messages. Messages used in experiment 2 were the same as those used in experiment 1, with the exception of the argument strength manipulation. The substantive content of each message described information about an ostensible illness (Letrolisus), but the information was framed differently in terms of concern and efficacy across message conditions. A sample low/moderate concern statement included, "The Letrolisus virus is contagious and is transmitted in much the same way as the common flu, but it has *other* consequences." Comparatively, a sample high concern statement included, "The Letrolisus virus is *highly* contagious and is transmitted in much the same way as the common flu, but it has *far more damaging* consequences." A sample low efficacy statement included, "There are *some* steps you can take to *try and* avoid getting Letrolisus." Comparatively, a sample high efficacy statement included, "There are *many* steps you can take to avoid getting Letrolisus."

[4] Of the initial participants sampled who were suspicious of the message content, four received the threat-framed message, three received the high concern, high efficacy message, and one received the low/moderate concern, low efficacy message. No participants who were suspicious in the initial sample received the challenge-framed message.

Baseline questionnaire. Trait worry (Borkovec et al., 1983) was measured with the item, "How much do you worry in a typical day?" Participants responded by circling one of four options, *0-10%, 25%, 50%,* and *more than 50%.* State anxiety was assessed with the State Trait Anxiety Inventory (Spielberger et al., 1983). Participants rated 10 items on how they feel in the present moment (e.g., "I feel anxious") on a 4-point scale (1 = *not at all*, 4 = *very much so*). The items assessing state anxiety composed a reliable scale, $\alpha = .81$.

Need for Cognition. The need for cognition scale was used to measure trait levels of the desire to engage in effortful thinking (Cacioppo et al., 1984). The scale consists of 18 items, 9 of which are reversed scored. Two sample items are "I would prefer complex to simple problems" and "Thinking is not my idea of fun (R)." All items are rated on a 5-point agreement scale (1 = *strongly disagree*, 5 = *strongly agree*). The items composed a reliable scale, $\alpha = .82$.

Thought-listing. After participants read the message, they completed a thought-listing task. Participants were instructed to write down five thoughts they had while they read the message, with more issue-relevant thoughts indicating greater message elaboration (Petty & Cacioppo, 1984; Schneider, et al., 2009). In experiment 2, thoughts about the causes of Letrolisus and thoughts supporting getting a screening for Letrolisus were summed.

Manipulation checks. To ensure personal concern was manipulated across messages, participants responded to the item, "How threatened do you feel about the

possibility of getting the Letrolisus virus?" To ensure efficacy was manipulated across messages, participants responded to the item, "How reliable do you think a Letrolisus screening is?" All manipulation checks were assessed on a 5-point scale (1 = *not at all* to 5 = *extremely*).

Attitudes. Attitudes towards message content were measured with four items: "I think that getting a screening for Letrolisus is a smart thing to do," "I believe getting a screening for Letrolisus is a proactive way to promote good health," "I think that getting a screening for Letrolisus is a waste of time," and "Detecting Letrolisus, before symptoms develop, is a good idea."

In addition, beliefs about the message information were assessed with the following items: "The information in the message was believable," "The information in the message was interesting," "The information in the message helped me learn a lot about Letrolisus," and "The information in the message was irrelevant to me." Items were assessed on a 5-point scale (1 = *strongly disagree* to 5 = *strongly agree*).

Intentions. Intentions to get tested for Letrolisus were assessed with three items from a past experiment (Schneider et al., 2009): "If over the next few months the Letrolisus virus became of greater public and personal concern, I would get tested," "I plan to get tested for Letrolisus within the next 3 months," and "If I could set up an appointment right now to get a test to see if you have Letrolisus, I would." In addition, participants were asked to respond to the following items: "I would trust the results of a

Letrolisus test" and "If I thought I had Letrolisus, I would get tested." Items were assessed on a 5-point scale (1 = *definitely not* to 5 = *definitely yes*).

Behaviors. Behaviors related to getting a screening for Letrolisus were measured by counting the number of alcohol pads to wipe surfaces clean from the virus and business cards taken before participants left the laboratory. These business cards contained contact information for scheduling a screening for Letrolisus. In addition, participants could leave a phone number to receive mouthwash samples at a later date. Alcohol pads, business cards, and the number of mouthwash samples requested were treated as continuous variables.

Stimuli Presentation and Apparatus

Messages were presented to participants in single sentence segments and displayed on a 20-inch computer monitor (Sony Trinitron) placed 90 cm (35.43 in) away from the headrest holding their head. The trial began once participants pressed the space bar. A 2-sec rolling baseline with the monitor displaying "+" occurred before sentence presentation (Bradley, Miccoli, Escrig, & Lang, 2008). Then, a sentence was displayed, and participants were instructed to read the sentence aloud. After participants read the sentence aloud, they pressed the spacebar and the sentence disappeared. Then, a 2-sec pupil relaxation phase commenced, followed by a blinking phase where the monitor displayed "********" and participants could blink their eyes until they were ready to proceed (Nuthmann & Meer, 2005; Raisig, Welke, Hagendorf, & Meer, 2007). For the full messaging procedure, see Figure 1.

Research has shown reliable differences in pupil dilation between message manipulations within single sentences (12 and 17 words in length; Just & Carpenter, 1993) and entire paragraphs (Metalis, Rhoades, Hess, & Petrovich, 1980) of varying complexity. However, recent research has suggested that pupillometry should not be used if messages are excessively long (mean words > 340; Iqbal, Zheng, & Bailey, 2004; see also Schultheis & Jameson, 2004). In experiment 2, each message segment was less than 30 words. Content was displayed in black, 30-point, Arial font on a gray background.

As participants read messages, an infra-red eye tracker (EyeLink 1000), with a focal point error of .25° to .5°, sampled pupil dilation continuously (250 Hz). Raw data from the eye tracker was converted to .asc files containing pupil dilation over time and time stamps for each sample. Data were then aggregated into a single .csv file. Further cleaning of the pupil data (e.g., smoothing anomalies resulting from eye blinks, removing trials in which artifacts could not be corrected) was completed in post-processing.

Procedure

As in experiment 1, participants were run individually and completed baseline questionnaires. Participants were then given a brief description of the eye-tracker, the calibration process, and were trained on the message presentation procedure. The first trial of the training session displayed a gray screen only; participants were instructed to look at the screen and refrain from blinking (10 sec physiological baseline). Afterwards, participants received five trials displaying benign message content (e.g., “The weather is

supposed to be mild for the remainder of the week"). Participants were instructed to read the sentences aloud at their normal reading pace.

After training, participants were given reading instructions which read, "This study today is about evaluating messages about health. Specifically, we're working with the Health Communications Project to inform college students about a new virus, called Letrolisus. Before going public, we're evaluating the effects of our messages. We ask that you attend to the information about the virus thoughtfully and carefully." Participants were told that the monitor would display message content related to Letrolisus. Participants were randomly assigned to one of the four message conditions.

After the messaging procedure, participants completed manipulation checks and post-message questionnaires. Before leaving the laboratory, participants were given the chance to take alcohol pads, business cards, and leave their phone number to be contacted to receive mouthwash samples at a later time. Participants were then debriefed and assured the illness discussed in the message was fictitious.

Pupillometry Data Selection and Artifact Detection

Pupil dilation during baseline and message presentation were calculated for each trial. This allowed for relative change scores to be calculated for each participant (i.e., max dilation during message presentation – mean dilation during baseline; Beatty & Lucero-Wagoner, 2000; Raisig et al., 2007). The baseline period comprised the average dilation during the last 200-ms before message onset. The message presentation period began immediately following the baseline and lasted until participants read the message

aloud and pressed the space bar after the blink phase.[5] Therefore, peak dilation was calculated for each trial, as this index is independent of the number of samples that occur within the message presentation interval (Beatty & Lucero-Wagoner, 2000; Raisig et al., 2007). As the average time participants spent on each trial was ~7-sec, the time window from 2-sec to 7-sec composed the message presentation region of interest.

For each participant, mean dilations per trial that were 2 ± *SD*s beyond their overall grand mean baseline dilation were excluded. To account for artifacts during the message presentation period, a LOWESS smoother was applied allowing for interpolation of the signal (see Figure 2). This technique uses a locally-weighted polynomial regression algorithm to smooth sampled values (Cleveland, 1979, 1981). Values are smoothed based on the frequency by which the span parameter (f) is set in the LOWESS function, with greater values indicating more smoothing (R Core Team, 2018). For each participant, trials in which artifacts (e.g., blinks, sampling anomalies) created a peak dilation value that could not be interpolated by the LOWESS (f = .1) were excluded; for a similar approach, see Raisig et al. (2007). For each participant, peak dilations per trial that were 2 ± *SD*s beyond their grand mean peak dilation were excluded. For each trial, difference scores were calculated (mean peak dilation – mean baseline). Difference

[5] Sentences were advanced by participants pressing the space bar. As such, trial duration between and within participants was variable. Therefore, latency to peak dilation and mean dilation during the region of interest were not calculated for subsequent analyses (Beatty & Lucero-Wagoner, 2000; see also Nuthmann & Meer, 2005).

scores were then averaged for each participant, yielding a final peak dilation per participant for further analysis.

Results

Preliminary Analyses

To assess randomization across conditions, 2 (concern: low/moderate, high) × 2 (efficacy: low, high) ANOVAs were conducted, with trait worry, state anxiety, and need for cognition as outcomes. Analyses revealed that participants were randomly assigned across levels of trait worry, state anxiety, and need for cognition, Fs ≤ 2.70, *ns*, $\eta_p^2 \leq .02$, and these variables were not used as covariates in subsequent analyses. All subsequent analyses for experiment 2 are 2 (concern: low/moderate, high) × 2 (efficacy: low, high) ANOVAs. Significant interactions were subjected to simple effects tests.

Manipulation checks

Table 8 presents the means (*SD*s) of all manipulation checks. There was a significant main effect of concern on how threatened participants felt about getting Letrolisus, $F(1, 132) = 4.33$, $p = .04$, $\eta_p^2 = .03$. Those assigned to the high concern message appeared to be more threatened about potentially getting Letrolisus ($M = 2.31$, $SD = 1.12$) compared to those who received the low/moderate concern message ($M = 1.94$, $SD = .91$). Based on these findings, the concern manipulation was effective at evoking different levels of threat about potentially getting Letrolisus.

The efficacy manipulation did not lead to significantly different perceptions about how reliable the Letrolisus screening was, $F(1, 132) = 2.70$, $p = .10$, $\eta_p^2 = .02$. Those

assigned to the high efficacy message perceived the Letrolisus screening to be marginally more reliable (M = 3.31, SD = .85) compared to those who received the low efficacy message (M = 3.06, SD = .91). Based on these findings, the efficacy manipulation did not evoke statistically different perceptions about the reliability of the Letrolisus screening. This is surprising, as past research investigating challenge and threat messaging has shown that efficacy is more easily manipulated than personal concern (Schneider et al., 2009; Capiola et al., in preparation). However, other findings from experiment 2 do show that the efficacy manipulation still influenced intentions when coupled with the concern manipulation.

Thought-listing

Table 9 displays the means (SDs) for thought-listings. There was a main effect of concern on the number of thoughts participants wrote about causes of Letrolisus, $F(1, 132) = 4.85$, $p = .03$, $\eta_p^2 = .04$. Participants assigned to the low/moderate concern message provided more thoughts about the causes of Letrolisus (M = .28, SD = .51) compared to those assigned to the high concern message (M = .12, SD = .33). No other main effects or interactions emerged. There were no significant main effects of concern or efficacy on the number of thoughts participants wrote supporting getting a screening for Letrolisus, nor did a significant interaction emerge, Fs ≤ 3.26, ns, η_p^2s ≤ .02. Regarding the hypotheses of experiment 2, there was no evidence that the challenge-framed message led to more issue-relevant thoughts in the thought-listing task.

Post-message attitudes

Table 10 displays the means (*SD*s) from all post-message attitude analyses. There were no main effects of, or interactions between, concern and efficacy on agreement ratings to the items "I think that getting a screening for Letrolisus is a smart thing to do," "I believe getting a screening for Letrolisus is a proactive way to promote good health," "I think that getting a screening for Letrolisus is a waste of time," and "Detecting Letrolisus, before symptoms develop, is a good idea," nor ratings of how much participants felt they learned from the message. In addition, there were no main effects of, or interactions between, concern and efficacy on ratings of message believability, interest, and relevance, Fs ≤ 2.12, *ns*, η_p^2s ≤ .02. Collectively, there was no evidence that the challenge-framed message led to more attitudes or beliefs aligned with the suggestions in the message.

Intentions

Table 11 displays the means (*SD*s) from all intention analyses. There were no main effects of, or interactions between, concern and efficacy on agreement ratings to the items "If over the next few months the Letrolisus virus became of greater public and personal concern, I would get tested," "If I could set up an appointment right now to get a test for Letrolisus, I would," and "I would trust the results of a Letrolisus test," Fs ≤ 1.97, *ns*, η_p^2s ≤ .02.

There were no main effects of concern or efficacy on agreement to the item, "I plan to get tested for Letrolisus within the next 3 months," Fs ≤ .33, *ns*, η_p^2s ≤ .01. However, there was a significant concern × efficacy interaction such that those assigned

to the high concern, high efficacy message appeared to offer more agreement to this item, $F(1, 132) = 5.31$, $p = .02$, $\eta_p^2 = .04$. Simple effects tests revealed those who received the high concern, high efficacy message ($M = 2.76$, $SD = .92$) had significantly greater intention compared to those who received the threat-framed message ($M = 2.32$, $SD = .77$). However, there was no reliable difference in intentions between those who received the threat-framed message and those who received the challenge-framed message ($M = 2.38$, $SD = .99$).

There were no main effects of concern or efficacy on agreement ratings to the item, "If I thought I had Letrolisus, I would get tested," Fs ≤ 2.17, *ns*, $\eta_p^2 \leq .02$. However, there was a significant concern × efficacy interaction such that those who received the high concern, high efficacy message appeared to offer more agreement to this item, $F(1, 131) = 4.03$, $p = .05$, $\eta_p^2 = .03$. Simple effects tests revealed those who received the high concern, high efficacy message ($M = 4.38$, $SD = .60$) had significantly greater intentions compared to those assigned to the threat-framed message ($M = 3.94$, $SD = .89$). However, there was no statistically significant difference between those who received the threat-framed message and those who received the challenge-framed message ($M = 4.24$, $SD = .61$).

Behaviors

Table 12 displays the means (*SD*s) from all behavior analyses. There were no main effects of, or interactions between, concern and efficacy on the number of alcohol pads participants took, the number of mouthwash samples they requested, or the number

of contact cards participants took before leaving the lab, *F*s ≤ 3.48, *ns*, η_p^2s ≤ .03. Relevant to the hypotheses of experiment 2, there was no evidence that the challenge-framed message led to more behavioral engagement aligned with the suggestions in the message.

Pupillometry Analyses

Table 13 displays the means (*SD*s) of all pupillometry analyses. There were no main effects of concern or efficacy on peak dilation from baseline, nor was there a significant interaction, *F*s ≤ .08, *ns*, η_p^2s ≤ .01. These results show that the challenge-framed messages did not evoke significantly different pupil dilation compared to the other concern by efficacy messages.

Discussion

The purpose of experiment 2 was to test whether challenge-framed messages evoke greater message elaboration, leading to more thoughts, attitudes, intentions, and behaviors aligned with message suggestions, replicating past research. Experiment 2 also tested whether challenge-framed messages led to greater message elaboration as indexed by a continuous physiological measure of resource allocation (pupil dilation).

In experiment 2, participants assigned to the low/moderate concern message provided significantly more thoughts about the causes of Letrolisus compared to those assigned to the high concern message. This finding supports the suggestions of Schneider et al. (2009), such that messages which evoke a moderate level of concern about the message content promote cognitive engagement while messages that evoke too much

concern restrict cognitive processing. Though there was no evidence that the challenge-framed message evoked more issue-relevant thoughts in the thought-listing task, experiment 2 shows an appropriate level of concern may at least evoke issue-relevant thoughts about the causes of Letrolisus.

Those assigned to the high concern, high efficacy message had greater intentions to get tested for Letrolisus in the next 3 months, as well as intentions to get tested if they thought they had Letrolisus. The high concern, high efficacy message has components from both challenge- and threat-framed messages, in that it evokes high personal concern about the message information coupled with high resource efficacy to act based on suggestions in the message. Messages that evoke too much fear have been shown to overwhelm people and restrict their message processing, while messages that evoke high efficacy have been shown to motivate people to engage and act in agreement with the suggestions in the message (Schneider et al., 2009). Though there was no evidence that the challenge-framed message led to intentions suggested in the message, it may be that messages which evoke high resource efficacy can keep people engaged with the message content even when that same message evokes high personal concern. Put another way, messages which evoke high concern can still persuade intentions as long as they also evoke greater efficacy perceptions to act on the suggestions in the message. If, however, a message evokes too much concern but does not evoke perceived efficacy to cope, then the message will restrict cognitive processing and result in no persuasion. This interpretation is supported by the data, which showed that the threat-framed message –

high concern coupled with low efficacy – was particularly ineffective at evoking intentions towards the message suggestions.

In experiment 2, the challenge-framed message did not lead to more issue-relevant thoughts, attitudes, intentions, and behaviors aligned with suggestions in the message, compared to the other concern by efficacy message frames. These results contrast with those of Schneider and colleagues (Schneider et al., 2009; see also Capiola et al., in preparation and Schneider et al., under review). Moreover, the challenge-framed message did not lead to greater peak pupil dilation compared to the other messages. One reason for these null findings may be that experiment 2 implemented a different message presentation procedure compared to past research on challenge and threat messaging and emphasized high procedural demands across message conditions. For instance, past research on challenge and threat message framing presented participants with entire concern and efficacy message segments (Capiola et al., in preparation; Schneider et al., 2009) or the entire message at once (Schneider et al., under review). These studies presented messages in colorful pamphlets that one might see in a doctor's office (Schneider et al., 2009) or academic department (Capiola et al., in preparation). Other studies presented entire messages on a piece of paper (experiment 1 of this dissertation; see also Schneider et al., under review). In each of these past experiments, the messaging procedures closely resembled the way people read messages on a day-to-day basis and

were very different from the messaging procedure in experiment 2.[6] Because pupil dilation can vary depending on many artifacts (e.g., light changes, head movement, blinking; see Beatty & Lucero-Wagoner, 2000), participants in experiment 2 were asked to read messages following a strict procedure. Specifically, they were given instructions on when to speak aloud, press the spacebar, and blink. They were told to keep their head still and directed towards the monitor throughout the procedure, and to keep their eyes open until they received the cue to blink. Additionally, messages were displayed in single sentence segments one at a time. These procedural constraints were implemented in order to sample clean pupil data. However, these constraints may have simultaneously dampened the concern and efficacy message effects shown in past laboratory studies that implemented message presentation procedures which closely resembled how people read messages on a daily basis (e.g., Capiola et al., in preparation; Schneider et al., under review; Schneider et al., 2009) and masked their influence on the outcomes measured in experiment 2.

The messaging procedure in experiment 2 may have also required too much effort to complete and was too cognitively demanding across message conditions. Indeed, several participants commented that their eyes were tired and that it was difficult to read some sentences while keeping their eyes open. Though participants were trained for the

[6] It should be noted that experiment 2 had reduced ecological validity compared to other messaging studies carried out in applied contexts such as markets and fairs (e.g., Van't Reit, Ruiter, Marieke, & Vries, 2008) and university restaurant halls (e.g., Van't Reit, Ruiter, Werrij, Candel, & Vries, 2010).

message presentation procedure, they commented they had trouble remembering when to push the spacebar and blink, indicating the procedure itself may have taxed short-term memory (see Kahneman & Beatty, 1966). Based on the non-significant differences in pupil dilation between message conditions, it seems the reading procedure itself required high effort and was cognitively demanding across conditions. This in turn may have restricted message elaboration to some extent, resulting in null findings not only with respect to the pupil dilation analyses but also in the majority of the self-report and behavioral outcomes.

In summary, messages that evoked low/moderate concern did lead to more thoughts about the causes of Letrolisus compared to messages that evoked high concern. This supports past findings, such that that messages which evoke too much personal concern overwhelm and reduce message processing (Schneider et al., 2009). However, messages that evoke high concern may still be persuasive as long as they also evoke high resource efficacy to act on the suggestions in the message. In contrast to past research (Schneider et al., 2009), there was no evidence that the challenge-framed message led to thoughts, attitudes, intentions, and behaviors aligned with message suggestions, nor greater peak pupil dilation in experiment 2. These null findings may be due to the messaging procedure differing with those from past research, and the cognitive demands this procedure placed on participants, which dampened the messaging effects on the majority of post-message self-reports, behaviors, and pupil dilation.

General Discussion

People receive messages each day that aim to persuade them towards some kind of attitude or behavior change. What is key to understanding persuasion is not simply identifying *what* messages are persuasive, but *why* they are persuasive. The present research investigated whether challenge-framed messages – messages framed to evoke low/moderate concern and high efficacy – facilitate greater messages elaboration, leading to persuasion. Across two experiments, challenge-framed messages were investigated to determine whether they lead to more issue-relevant thoughts, attitudes, intentions, and behaviors aligned with message suggestions (experiments 1 and 2), as well as greater peak pupil dilation (experiment 2), compared to other messages. In experiment 1, messages framed to evoke different levels of concern and efficacy were crossed with weak and strong arguments. In experiment 2, a continuous physiological measure (pupil dilation) was used to index resource allocation and test whether this index differed across message conditions.

In experiment 1, the challenge-framed message led to interest in and perceived relevance of message content, as well as behaviors suggested in the message. This pattern of results provides some support that challenge-framed messages led to greater message elaboration and behavioral engagement. However, there was no evidence that challenge-framed messages were particularly persuasive when paired with strong arguments. In past research, messages that evoked greater message elaboration were more persuasive when paired with strong arguments (Petty & Cacioppo, 1984; Updegraff et al., 2007).

Specifically, when people receive messages that evoke greater message elaboration, they have more ability and motivation to process the message information more deeply and are thus more sensitive to the strength of the arguments in the message. In experiment 1, challenge-framed messages were found to evoke components of messages elaboration (interest in and perceived relevance of message content), but they were not particularly persuasive when paired with strong arguments. One potential limitation discussed earlier was that the argument strength manipulation may have been too effective and potentially dampened the effects of the concern and efficacy manipulations. In experiment 1, the results from the manipulation checks showed that argument strength was a stronger manipulation compared to the concern and efficacy manipulations. In addition, there were many instances where strong arguments were persuasive at getting people to endorse the suggestions in the message when challenge-framed messages showed no effect.

Alternatively, the effects of strong arguments and challenge-framed messages may be orthogonal, as there were instances where both strong arguments and challenge-framed messages had independent effects on the same outcome variable. For example, participants who received strong arguments agreed that the information in the message was more relevant compared to those who received weak arguments. In addition, challenge-framed messages also evoked greater perceived relevance of the message information. This pattern of results suggests that strong arguments and challenge-frames may be independently persuasive. Future research should investigate how participants

weigh the importance of argument strength compared to concern and efficacy manipulations in persuasive messages by conducting post-message interviews or a recall procedure. These studies would help to clarify how robust concern and efficacy manipulations ought to be when paired with argument strength manipulations in order to investigate message elaboration as in past research (e.g., Petty & Cacioppo, 1984, 1986; Petty et al., 1981; Updegraff et al., 2007). These studies would also help to determine if BMP derived message manipulations and argument strength manipulations independently influence persuasion outcomes. Each of these suggestions provide a way forward for designing robust BMP derived message manipulations and more thoroughly testing core tenets of the BMP (Schneider et al., 2009).

In experiment 1, it seems challenge-framed messages evoked greater interest in message information along with behavioral engagement, but not significantly more so than the threat-framed message. One limitation of the present experiment is that the concern manipulation was not very strong. Future research should attempt to bolster the concern manipulation when creating challenge and threat message frames. It may be that increasing the BMP derived message manipulations will lead to stronger effects, such that more differentiation can be found between challenge- versus threat-framed messages rather than just challenge-framed messages compared to the other concern by efficacy framing combinations.

In experiment 2, messages that evoked low/moderate concern led to more thoughts about the causes of Letrolisus compared to messages that evoked high concern.

Though there was no effect of challenge-framed messages on issue-relevant thoughts, these findings provide support for past research showing that messages which evoke too much personal concern interfere with and restrict message processing (Schneider et al., 2009). In addition, messages that evoked high concern coupled with high efficacy led to greater intentions to get tested for Letrolisus. These results show that messages which evoke high concern can still be persuasive as long as they simultaneously evoke high resource efficacy to act on the suggestions in the message.

Unexpectedly, there was no evidence that the challenge-framed message evoked greater resource allocation compared to other messages in experiment 2. Specifically, the challenge-framed message did not evoke greater peak pupil dilation compared to other concern by efficacy frames, nor more issue-relevant thoughts, attitudes, intentions, or behaviors suggested in the message. The presence of mostly null findings may be due to the reading procedure differing from past research (Capiola et al., in preparation; Schneider et al., under review; Schneider et al., 2009) and requiring too much cognitive effort across message conditions. Based on comments participants made, the reading procedure may have prevented them from fully engaging with the message content. These procedural constraints were implemented to sample clean pupil data, but the additional task demands of reading aloud, while simultaneously keeping eyes open and remembering when (and how often) to press the spacebar to progress messages, required too much effort. However, this should not lead future researchers to abandon using pupillometry to index message elaboration in persuasion studies. Future researchers may

wish to present messages to participants aurally and progress the messages automatically, rather than having participants read aloud and tasking them with remembering when to progress sentences and blink. Research has shown that resource allocation towards aurally presented stimuli (e.g., spoken sentences) can be reliably indexed via pupil dilation (Koelewijn, Zekveld, Festen, & Kramer, 2012). If participants could simply listen to the messages while looking at a fixation cross, then the cognitive demands of the procedure would be reduced. This would allow for a clear physiological index of cognitive effort based on concern and efficacy message manipulations, rather than the demands of the messaging procedure (e.g., reading aloud without blinking eyes, remembering when to push space bar).

In addition, experiment 1 should be replicated to investigate the interaction between challenge-framed messages and strong arguments. The literature is replete with studies showing that people with greater message elaboration are sensitive to argument strength manipulations, and are thus persuaded by strong arguments (e.g., Petty & Cacioppo, 1984, 1986; Petty et al., 1981; Updegraff et al., 2007). As mentioned, the effect sizes of concern and efficacy, which compose challenge and threat messages, were smaller than those of argument strength in experiment 1. This may indicate the argument strength manipulation overshadowed the effects of concern and efficacy. In a similar way, experiment 2 implemented a different messaging procedure that tasked cognitive resources across conditions, and this procedure may have masked the effects of concern and efficacy on message elaboration, leading to little difference across message

conditions on outcomes of interest. As such, experiment 2 should also be replicated, incorporating the procedural suggestions mentioned above to investigate how pupil dilation varies based on the effects of message manipulations derived from the BMP (Schneider et al., 2009).

Implications

The findings from the present experiments have implications for basic and applied social psychological research. Challenge-framed messages led to more interest in and perceived-relevance of message content, and this is evidence that challenge frames evoke greater message elaboration (Petty & Cacioppo, 1986). These findings add to those of Schneider and colleagues, who found that challenge-framed messages led to issue-relevant thinking in a thought-listing task (Schneider et al., 2009). Moreover, the findings from experiment 1 bolster the suggestions made previously from Schneider and colleagues – that challenge-framed messages evoke appropriate levels of personal concern and resource efficacy, which leads to greater message elaboration and behavioral engagement. Additionally, research has shown challenge-framed messages are effective for persuading attitudes and intentions towards extreme-weather preparedness (Schneider et al., under review) and reducing gender bias in STEM contexts (Capiola et al., in preparation). Other researchers may wish to incorporate challenge-framed messages into their existing persuasive campaigns. Presenting information in a way that evokes challenge should encourage people to be more interested in the message content and perceive the content as more relevant to them, leading people to actually do the actions

suggested in the message. It may be that other persuasion methods are enhanced when combined with challenge-framed messages. The literature has shown that persuasive messages matched to recipient locus of control and motivational orientation were viewed as more relevant and were more persuasive (Williams-Piehota et al., 2004; Updegraff et al., 2007). Challenge-framed messages may interact with certain recipient characteristics and evoke greater message elaboration, leading people to adopt even more suggestions in the message when challenge frames are matched to those characteristics (Capiola et al., in preparation). Alternatively, challenge-framed messages may interact with other message manipulations or show a main effect on persuasion that is orthogonal to other messaging manipulations. Investigating these suggestions would help to uncover other framing methodologies to consider alongside challenge-framed messages and spawn new research questions.

To the author's knowledge, experiment 2 is the first study to investigate message elaboration with pupillometry. Though experiment 2 did not find differences in pupil dilation across message conditions, limitations were noted that may help future persuasion researchers to effectively incorporate pupillometry into their repertoire of metrics for investigating message elaboration. Hopefully, researchers can learn from the methodological considerations of the present research and guide their future investigations of message processing by measuring pupil dilation, a continuous measure of resource allocation and cognitive effort.

Conclusion

The present research investigated the role of message elaboration in the biobehavioral model of persuasion, by examining how different messages interact with different levels of argument strength, as well as by measuring pupil dilation as a way to index cognitive resource allocation. Challenge-framed messages were effective in generating more interest in and perceived relevance of the message content and led to behavioral engagement, showing evidence that challenge-framed messages evoke greater message elaboration and persuasion towards behaviors suggested in the message. Strong arguments were also found to be persuasive, though challenge-framed messages paired with strong arguments were not particularly persuasive. The influence of BMP derived message manipulations on cognitive processing as measured by pupil dilation is still unclear.

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Appendix A: Full message, containing all manipulations, used in Experiment 1

Over the past decade, doctors have heard some/ [intense] complaints from patients with flu-like symptoms. For some, the illness became more/ [very] serious [and debilitating], sometimes/ [often] causing death. Recently, this illness has been identified as the Letrolisus virus. The Letrolisus virus is [highly] contagious and is transmitted in much the same way as the common flu, but it has other/ [far more damaging] consequences. It can [easily] be transmitted from infected surfaces or infected people. Initial symptoms can include [severe] congestion in the nose, throat, and lungs causing difficulty breathing. In later stages, {advanced Letrolisus affects your respiratory system's everyday functioning and ability to heal}/ *people with advanced Letrolisus often struggle with scheduling appointments to get their hair cut*. As the condition gets worse, [permanent] lung and heart problems can result, causing death in some/ [many] cases. People {with advanced Letrolisus often struggle financially due to the cost of Letrolisus treatments}/ *People with advanced Letrolisus often struggle financially and cannot afford fast food*.

There are **some**/ MANY steps you can take to *try and* avoid getting Letrolisus. On surfaces, the virus can **sometimes** be killed EFFECTIVELY by alcohol-based liquids, and the virus in your mouth can **sometimes** be killed EFFECTIVELY by using alcohol-based mouthwashes. By disinfecting surfaces that people frequently touch, {you can better avoid getting Letrolisus}/ *the surfaces will be shiny and clean*. Early detection and treatment can **sometimes**/ OFTEN TIMES prevent the worst outcomes. {Medical doctors agree that getting tested for Letrolisus is a fast and effective path to healthy living}/ *Students say that getting tested for Letrolisus with friends is a good group activity*. **Try to**/ YOU SHOULD find out if you have Letrolisus by scheduling a screening test, which has proven to be **somewhat**/ VERY reliable. {The Letrolisus vaccination has also lowered the number of reported health issues related to the Letrolisus virus}/ *Recently, some students also thought that the Letrolisus test might be a good idea*.

We know that college students can/ [are very likely to] get Letrolisus, and some/ [many] already have it./ [!] You **might**/SHOULD consider steps to **try to** prevent contracting Letrolisus and schedule a screening appointment. If you do have Letrolisus, **try to**/ YOU SHOULD start treatment when you get a chance/ [right away] for the best results.

Concern: Low/moderate, [High]

Efficacy: **Low efficacy**, HIGH EFFICACY

Argument strength: *Weak*, {Strong}

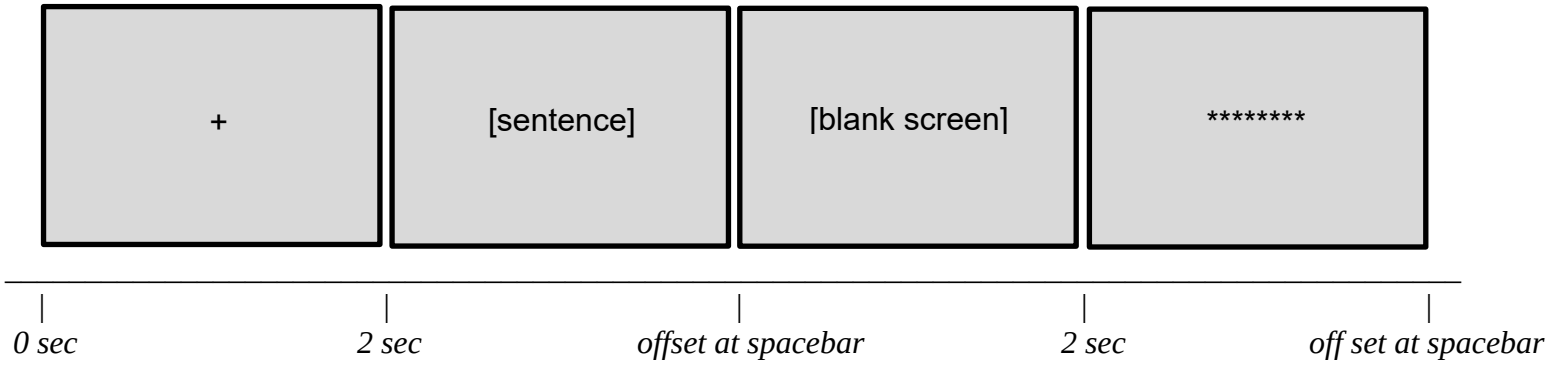

Figure 1. Full message procedure, Experiment 2.

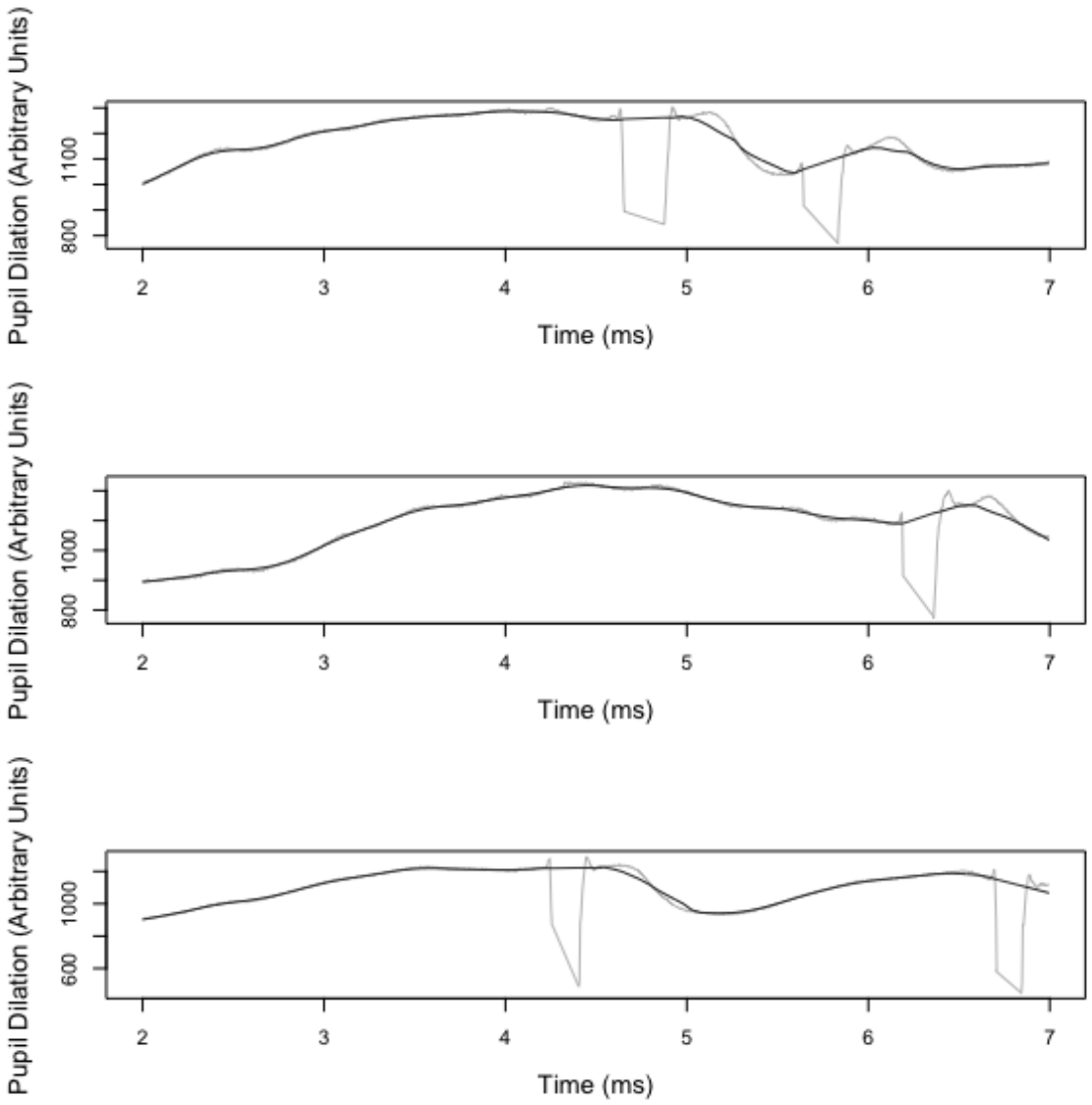

Figure 2. Participant 80, trials 5 – 7, pupil area; raw data (light gray) and smoothed with LOWESS function (dark gray).

Table 1

Mean (SD) Concern and Efficacy Manipulation Checks, Pilot Experiment

	Low/Moderate Concern		High Concern	
	High Efficacy (Challenge)	Low Efficacy	High Efficacy	Low Efficacy (Threat)
How threatened do you feel about the possibility of getting the Letrolisus virus?	2.20 (0.92)	2.40 (0.84)	2.50 (1.08)	2.40 (1.26)
How reliable do you think the Letrolisus screening is?	3.50 (0.85)	2.80 (1.03)	3.40 (1.07)	2.70 (0.82)

Table 2

Mean (SDs) Ratings of Argument Strength, Pilot Experiment

Items	*M*	*SD*
"Advanced Letrolisus affects your respiratory system's everyday functioning and ability to heal."	7.35	1.46
"Clinical research shows that the negative effects of Letrolisus on your physical health are lowered when detected early."	7.03	1.54
"By getting a Letrolisus screening, you are doing the best you can to protect your immunity and overall health."	6.98	1.76
"By disinfecting hard surfaces you and other's frequently touch, you help to prevent contracting Letrolisus."	6.88	1.88
"Medical doctors agree that getting tested for Letrolisus is a fast and effective path towards healthy living."	6.75	1.53
"The Letrolisus vaccination has lowered the number of reported health issues related to the Letrolisus virus."	6.68	1.76
"Getting a Letrolisus screening early lowers your chances of developing bad symptoms and poor health."	6.55	1.72
"Advanced Letrolisus affects you going about your day normally."	6.50	2.01
"On average, those who get seasonal screenings for Letrolisus have fewer health-related problems caused by Letrolisus."	6.48	1.50
"Those living with advanced Letrolisus often struggle financially due to the cost of Letrolisus treatments."	6.10	2.31
"Letrolisus is the third most common seasonal illness, second only to the common cold and seasonal flu.	5.93	2.25

Table 2 (continued)

Mean (SDs) Ratings of Argument Strength, Pilot Experiment

Item	*M*	*SD*
"Recently, the American Medical Association (AMA) supported the Letrolisus test in a publication."	5.80	2.08
"Getting a Letrolisus screening early lowers your chances of being stressed and moody about getting sick."	5.20	1.80
"Some people who get seasonal screenings for Letrolisus are less stressed about being sick."	5.03	2.14
"By getting a Letrolisus screening, you are on your way to doing your part."	4.88	2.44
"Letrolisus is a common seasonal illness next to a few other seasonal illnesses."	4.45	1.88
"Those living with advanced Letrolisus often struggle with scheduling their doctors' appointments."	4.25	2.08
"The Letrolisus vaccination has lowered people's complaining about seasonal illness."	4.20	2.13
"Recently, some students thought that the Letrolisus test might be a good idea."	4.05	2.15
"Those living with advanced Letrolisus often struggle financially and can't afford fast food."	3.55	2.02
"Some people say that Letrolisus symptoms will not make you look as bad when detected early."	3.53	2.00
"Students say that getting tested for Letrolisus with friends is a good group activity."	3.20	1.98
"Those living with advanced Letrolisus often struggle with scheduling appointments to get their hair cut."	2.55	1.77

Table 2 (continued)

Mean (SDs) Ratings of Argument Strength, Pilot Experiment

Item	*M*	*SD*
"By disinfecting hard surfaces you and other's frequently touch, the surfaces will be shiny and clean."	2.28	1.74

Note. Means (*SD*) correspond to average ratings of argument strength.

Table 3

Mean (SD) Concern, Efficacy, and Argument Strength Manipulation Checks, Experiment 1

		Low/Moderate Concern		High Concern	
		High Efficacy (Challenge)	Low Efficacy	High Efficacy	Low Efficacy (Threat)
How threatened do you feel about the possibility of getting the Letrolisus virus?	Weak Argument	2.29_{ab} (1.21)	1.63a (1.07)	1.90_{ab} (1.12)	2.39_{b} (1.09)
	Strong Argument	1.95_{ab} (1.05)	2.00_{ab} (0.69)	2.16_{ab} (0.90)	2.28_{ab} (1.23)
How reliable do you think the Letrolisus screening is?*efficacy	Weak Argument	2.88_{ab} (1.11)	2.63_{a} (1.17)	3.00_{ab} (1.03)	3.06_{ab} (1.31)
	Strong Argument	3.42_{b} (0.69)	2.72_{a} (1.02)	3.47_{b} (0.61)	2.67_{a} (0.84)
How strong were the arguments in the message?*argument strength	Weak Argument	2.88_{ab} (1.11)	2.32_{a} (1.16)	2.60_{ab} (1.14)	2.50_{a} (1.15)
	Strong Argument	3.20_{b} (0.70)	3.17_{b} (0.99)	3.32_{b} (0.67)	3.00_{b} (1.09)

Note. $^{*}p < .05$ denote main effects; different subscripts denote a significant difference.

Table 4

Mean (SD) Issue-relevant Thoughts Listed, Experiment 1

		Low/Moderate Concern		High Concern	
		High Efficacy (Challenge)	Low Efficacy	High Efficacy	Low Efficacy (Threat)
# of thoughts about the causes of Letrolisus	Weak Argument	.06 (0.24)	.11 (0.32)	.10 (0.31)	.11 (0.32)
	Strong Argument	.05 (0.22)	.11 (0.32)	.00 (0.00)	.06 (0.24)
# of thoughts supporting getting a screening for Letrolisus	Weak Argument	$.59_{b}$ (1.06)	$.26_{ab}$ (0.73)	$.15_{ab}$ (0.37)	$.17_{ab}$ (0.38)
	Strong Argument	$.25_{ab}$ (0.55)	$.06_{a}$ (0.24)	$.37_{b}$ (0.60)	$.11_{ab}$ (0.32)

Note. $^{*}p < .05$ denote main effects; different subscripts denote a significant difference.

Table 5

Mean (SD) Attitudes and Beliefs, Experiment 1

		Low/Moderate Concern		High Concern	
		High Efficacy (Challenge)	Low Efficacy	High Efficacy	Low Efficacy (Threat)
I think that getting a screening for Letrolisus is a smart thing to do.	Weak Argument	3.88 (0.93)	3.53 (1.02)	3.50 (0.95)	3.83 (0.79)
	Strong Argument	3.75 (0.85)	3.78 (0.81)	4.10 (0.85)	3.83 (0.86)
I believe getting a screening for Letrolisus is a proactive way to promote good health.	Weak Argument	4.00 (0.71)	3.63 (1.12)	3.75 (0.85)	4.00 (0.77)
	Strong Argument	3.75 (0.85)	3.72 (0.83)	4.21 (0.92)	4.00 (0.69)
I think that getting a screening for Letrolisus is a waste of time.	Weak Argument	1.94 (0.97)	2.47 (1.17)	2.50 (1.43)	2.17 (1.15)
	Strong Argument	2.05 (0.83)	2.11 (1.13)	1.89 (1.08)	2.28 (0.96)
Detecting Letrolisus, before symptoms develop, is a good idea.*argument strength	Weak Argument	4.24_{ab} (0.56)	3.89_{a} (0.88)	3.85_{b} (0.93)	3.94_{ab} (0.94)
	Strong Argument	4.25_{ab} (0.79)	4.00_{ab} (0.69)	4.42_{a} (0.69)	4.39_{a} (0.61)
The information is the message was believable.*argument strength	Weak Argument	3.00_{ab} (1.21)	2.58_{b} (1.22)	3.10_{ab} (1.25)	3.22_{ab} (1.26)
	Strong Argument	3.60_{a} (0.88)	3.33_{a} (1.03)	3.53_{a} (0.96)	3.39_{a} (0.98)

Note. $^{*}p < .05$ denote main effects; different subscripts denote a significant difference.

Table 5 (continued)

Means (SD) Attitudes and Beliefs, Experiment 1

		Low/Moderate Concern		High Concern	
		High Efficacy (Challenge)	Low Efficacy	High Efficacy	Low Efficacy (Threat)
The information in the message was interesting.	Weak Argument	4.00_{a} (0.52)	3.26_{b} (1.24)	3.45_{b} (0.83)	3.61_{ab} (0.78)
	Strong Argument	3.95_{a} (0.76)	3.78_{ab} (0.81)	3.74_{ab} (0.99)	3.89_{ab} (0.96)
The information in the messages helped me learn a lot about Letrolisus.*argument strength	Weak Argument	3.44_{ab} (0.96)	3.26_{b} (1.24)	3.00_{b} (0.92)	3.28_{b} (0.83)
	Strong Argument	3.95_{a} (0.89)	3.61_{ab} (1.09)	3.42_{ab} (1.07)	3.67_{a} (0.84)
The information in the message was irrelevant to me.*argument strength	Weak Argument	2.63_{ab} (0.89)	2.74_{b} (1.15)	2.95_{b} (1.15)	2.56_{ab} (1.25)
	Strong Argument	2.00_{a} (1.03)	2.56_{ab} (1.10)	2.21_{a} (0.86)	2.28_{ab} (1.02)

Note. $^{*}p < .05$ denote main effects; different subscripts denote a significant difference.

Table 6

Mean (SD) Intentions, Experiment 1

		Low/Moderate Concern		High Concern	
		High Efficacy (Challenge)	Low Efficacy	High Efficacy	Low Efficacy (Threat)
If over the next few months the Letrolisus virus became of greater public and personal concern, I would get tested.	Weak Argument	4.29_{ab} (0.77)	3.84_{ab} (1.07)	3.85_{ab} (1.09)	4.28_{ab} (0.67)
	Strong Argument	3.95_{ab} (0.83)	3.83_{a} (0.92)	4.32_{ab} (0.58)	4.39_{b} (0.70)
I plan to get tested for Letrolisus within the next 3 months.	Weak Argument	2.59_{ab} (1.12)	2.11_{a} (0.74)	2.20_{ab} (1.11)	2.89_{b} (1.13)
	Strong Argument	2.40_{ab} (1.05)	2.83_{b} (0.99)	2.79_{b} (0.92)	2.61_{ab} (1.09)
If I could set up an appointment right now to get a test to see if I have Letrolisus, I would.	Weak Argument	3.12_{a} (1.41)	2.21_{b} (1.08)	2.45_{ab} (1.19)	2.72_{ab} (1.07)
	Strong Argument	2.25_{b} (1.21)	2.50_{ab} (0.86)	2.68_{ab} (0.95)	2.78_{ab} (1.11)
If I thought I had Letrolisus, I would get tested.	Weak Argument	4.00_{ab} (0.94)	4.11_{ab} (1.05)	3.74_{b} (0.87)	4.17_{ab} (0.86)
	Strong Argument	4.30_{a} (0.66)	4.06_{ab} (0.87)	4.37_{a} (0.60)	4.22_{ab} (0.65)
I would trust the results of a Letrolisus test.	Weak Argument	3.76_{ab} (0.97)	3.21_{b} (1.08)	3.50_{ab} (1.24)	3.56_{ab} (0.86)
	Strong Argument	4.00_{a} (0.65)	3.72_{ab} (0.90)	3.79_{a} (0.53)	3.50_{ab} (0.92)

Note. Different subscripts denote a significant difference.

Table 7

Mean (SD) Behaviors, Experiment 1

		Low/Moderate Concern		High Concern	
		High Efficacy (Challenge)	Low Efficacy	High Efficacy	Low Efficacy (Threat)
# of alcohol pads taken^{*efficacy}	Weak Argument	1.59_{a} (1.28)	$.53_{b}$ (1.02)	1.00_{abc} (1.21)	0.67_{b} (0.49)
	Strong Argument	1.15_{abc} (1.14)	0.89_{bc} (0.68)	1.00_{abc} (0.67)	1.39_{ac} (1.38)
# of contact cards taken	Weak Argument	0.94_{a} (0.66)	0.32_{d} (0.48)	0.40_{bd} (0.50)	0.67_{ac} (0.49)
	Strong Argument	0.45_{bd} (0.51)	0.56_{acd} (0.51)	0.68_{abc} (0.48)	0.50_{bd} (0.51)
# mouthwash samples requested	Weak Argument	0.82_{a} (1.51)	0.11_{ab} (0.46)	0.10_{b} (0.45)	0.22_{ab} (0.55)
	Strong Argument	0.65_{ab} (2.30)	0.22_{ab} (0.55)	0.05_{b} (0.23)	0.39_{ab} (1.20)

Note. $^{*}p < .05$ denote main effects; different subscripts denote a significant difference.

Table 8

Mean (SD) Concern and Efficacy Manipulation Checks, Experiment 2

	Low/Moderate Concern		High Concern	
	High Efficacy (Challenge)	Low Efficacy	High Efficacy	Low Efficacy (Threat)
How threatened do you feel about the possibility of getting the Letrolisus virus?[*concern]	1.94 (.89)	1.94 (.95)	2.35 (1.13)	2.26 (1.14)
How reliable do you think the Letrolisus screening is?	3.26 (.93)	3.12 (1.04)	3.35 (.77)	3.00 (.78)

Note. $^{*}p < .05$ denote main effects.

Table 9

Mean (SD) Issue-relevant Thoughts Listed, Experiment 2

	Low/Moderate Concern		High Concern	
	High Efficacy (Challenge)	Low Efficacy	High Efficacy	Low Efficacy (Threat)
# of thoughts about the causes of Letrolisus^{*concern}	$.26_{a}$ (.51)	$.29_{a}$ (.52)	$.21_{ab}$ (.41)	$.03_{b}$ (.17)
# of thoughts supporting getting a screening for Letrolisus	.18 (.39)	.35 (.73)	.12 (.33)	.12 (.33)

Note. $^{*}p < .05$ denote main effects; different subscripts denote a significant difference.

Table 10

Mean (SD) Attitudes and Beliefs, Experiment 2

	Low/Moderate Concern		High Concern	
	High Efficacy (Challenge)	Low Efficacy	High Efficacy	Low Efficacy (Threat)
I think that getting a screening for Letrolisus is a smart thing to do.	4.03 (.72)	3.97 (.87)	4.00 (.60)	3.88 (.64)
I believe getting a screening for Letrolisus is a proactive way to promote good health.	4.06 (.65)	4.09 (.90)	4.00 (.60)	3.97 (.67)
I think that getting a screening for Letrolisus is a waste of time.	4.03 (.87)	4.12 (.88)	4.12 (.73)	3.79 (.81)
Detecting Letrolisus, before symptoms develop, is a good idea.	4.24 (.65)	4.06 (.85)	4.24 (.70)	4.21 (.59)
The information is the message was believable.	3.68 (.95)	3.62 (.92)	3.91 (.67)	3.62 (.60)
The information in the message was interesting.	3.71 (1.00)	3.76 (.74)	3.94 (.69)	3.74 (.79)
The information in the messages helped me learn a lot about Letrolisus.	3.65 (.95)	3.59 (.86)	3.62 (.89)	3.82 (.76)

Table 10 (continued)

Mean (SD) Attitudes and Beliefs, Experiment 2

	Low/Moderate Concern		High Concern	
	High Efficacy (Challenge)	Low Efficacy	High Efficacy	Low Efficacy (Threat)
The information in the message was irrelevant to me.	2.12 (1.04)	2.18 (.90)	2.26 (1.02)	2.41 (.82)

Table 11

Mean (SD) Intentions, Experiment 2

	Low/Moderate Concern		High Concern	
	High Efficacy (Challenge)	Low Efficacy	High Efficacy	Low Efficacy (Threat)
If over the next few months the Letrolisus virus became of greater public and personal concern, I would get tested.	3.97 (.80)	4.26 (.90)	4.06 (.81)	3.97 (1.00)
I plan to get tested for Letrolisus within the next 3 months.	2.38_{ab} (.99)	2.65_{ab} (.88)	2.76_{a} (.92)	2.32_{b} (.77)
If I could set up an appointment right now to get a test to see if I have Letrolisus, I would.	2.67_{ab} (1.11)	2.62_{ab} (1.05)	2.97_{a} (.90)	2.53_{b} (.99)
If I thought I had Letrolisus, I would get tested.	4.24_{ab} (.61)	4.30_{ab} (.81)	4.38_{a} (.60)	3.94_{b} (.89)
I would trust the results of a Letrolisus test.	3.76 (.65)	3.88 (.88)	3.88 (.73)	3.74 (.75)

Note. Different subscripts denote a significant difference.

Table 12

Mean (SD) Behaviors, Experiment 2

	Low/Moderate Concern		High Concern	
	High Efficacy (Challenge)	Low Efficacy	High Efficacy	Low Efficacy (Threat)
# of alcohol pads taken	$.76_{ab}$ (.86)	$.56_{a}$ (.89)	1.06_{b} (1.07)	$.74_{ab}$ (1.02)
# of contact cards taken	$.38_{ab}$ (.55)	$.41_{ab}$ (.50)	$.62_{a}$ (.49)	$.32_{b}$ (.48)
# mouthwash samples requested	1.24 (5.34)	.32 (.91)	.38 (1.23)	.62 (1.46)

Note. Different subscripts denote a significant difference.

Table 13

Mean (SD) Peak Dilations, Experiment 2

	Low/Moderate Concern		High Concern	
	High Efficacy (Challenge)	Low Efficacy	High Efficacy	Low Efficacy (Threat)
Peak Dilation	287.98 (148.48)	283.76 (114.78)	280.36 (116.11)	288.79 (135.91)