MEASURING RESPONSES TO THREATENING ANTI-ELECTRONIC CIGARETTE MESSAGES, SUBSEQUENT MESSAGE RECALL, AND VAPING INTENTIONS

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ABSTRACT

Prescriptive health messages frequently have limited success in changing minds, especially when perceived as threatening to a target audiences' autonomy or sense of self. To understand the gaps of when health messages have adverse effects, this study uses reactance theory and limited capacity model for motivated mediated message processing framework to identify how message language directs resource allocation during encoding and how such language affects perceived message effectiveness, message recall, and behavioral intentions over time. Results across two studies, a lab experiment collecting electroencephalography (EEG) data (*n* = 30) and a national online survey using MTurk (*n* = 111) demonstrated that participants exposed to experimentally controlled anti e-cigarette messages with freedom threatening language experienced more reactance, increases in e-cig use intention and decreases in health information recall, despite no differences in ERP responses and self-reporting that freedom threatening messages were more effective relative to non-freedom threatening messages. Updates to these bodies of literature reactance permanence and language effects on resource allocation were discussed, as well as practical implications for better persuasive health message strategies.

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To my comrades, thank you for fighting for a better world that feels worth living in. I feel small yet powerful because I am able to show up with you to take action in the world we envision. Whether engaging in mutual aid, reclaiming spaces, taking over the streets, and showing what radical solidarity looks like, I am grateful to your work. This dissertation is possible because of the radical ways marginalized elders have showed up in the fight for equity of all people.

Lastly, I want to acknowledge myself and all that I have overcome to complete this dissertation. When I applied for graduate school, I remember that 3% of undergraduates had been in the foster care system. I can only imagine how small that percent must be for those of us who have completed a dissertation. When I spent time in a shelter for youth without homes, I became acutely aware of the barriers for abused teens and especially teens that were Black or LGBTQIA+. Over both times I stayed in shelters, I was among one of the few cishetero and or White youths. After being placed in another home, it took a long time to find my self-worth and find people who could see my worth. I've come far in being able to accept myself and advocate for myself. I've been able to find better ways to treat those I love and hold myself accountable. Of course, my growth was also made possible by all those I previously mentioned. However, this dissertation is a testament to the ability to overcome adversity and continue growing yourself.

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LIST OF ABBREVIATIONS

EEG electroencephalogram

ERP Event related potential

LC4MP Limited capacity model for motivated mediated message processing

LPP Late positive potential

Introduction

The use of electronic cigarettes (e-cigs) is so common that one out of 60 Americans under 35 reports daily use, and this is especially problematic for adolescents (ages 10-19), who are now much more likely than previous generations to use tobacco (Mirbolouk et al., 2019). In Michigan, rates of e-cig use increased 118% from 2015 to 2018 among adolescents (Glasser et al., 2019). Nationwide, 2.5 million adolescents use e-cigs, with 27.6% of users vaping daily (Cooper et al., 2022). Although a complete understanding of the long-term effects of e-cigarette use is currently unknown, evidence to date associates e-cig use with significant negative health outcomes such as impaired respiratory functioning (Larcombe et al., 2017), and cardiovascular disease (Alzahrani et al., 2018).

As e-cigarette use is becoming an increasing health concern, health campaigns are leveraging the potential of social networking sites (SNSs) to influence young adults to become their own health campaign creators and discuss the emerging risks of e-cig use (Cavallo et al., 2019; Lazard, 2021). However, messages attempting to discourage e-cigarette use, either in online or interpersonal contexts, frequently rely on young adult's intuitive theories of message generation that proselytize behaviors or provide ineffective advice (Cugelman et al., 2011; Feng & Magen, 2016; Tian et al., 2020). As a result, health messages with such proselytizing or demanding language may not be optimally successful and, instead, evoke reactance (Worchel & Brehm, 1970).

Reactance refers to "the psychological, emotional, or motivational state aroused when a perceived behavioral freedom is threatened, reduced, or eliminated" (p. 1, Zhang & Sapp, 2013). Reactance results from perceived threats to the self or autonomy, such as health advice aimed at limiting a person's smoking or eating behaviors. While previous research has frequently explored the antecedents and outcomes of reactance, limited work has explored how message receivers process messages while exposed to threatening language (Clayton, 2022).

This work across two studies aims to i) examine how specific features of messages evoke reactance and ii) examine differences in neural responses *and* free recall to threatening language. Figure 1 provides a conceptual overview outlining the study 1 design and key measures/hypotheses across both studies. In the following sections, an overview of why reactance is detrimental to effective health communication and e-cigarette messaging is provided. Then, how threatening language affects immediate brain responses to health messages is discussed, message recall, and hinders health communication goals. The implications of better understanding these differences are that scholars can more accurately explain and predict message effects processes related to message processing and practitioners can develop anti e-cigarette messages that minimize negative health intentions. Furthermore, understanding the effects of threatening language (e.g., "don't smoke anymore") is especially pertinent because reactance and poor memory of health information is associated with higher intentions for negative health behaviors following health messages (Dorrance Hall et al., 2023; Otto et al., 2016; Wang et al., 2015).

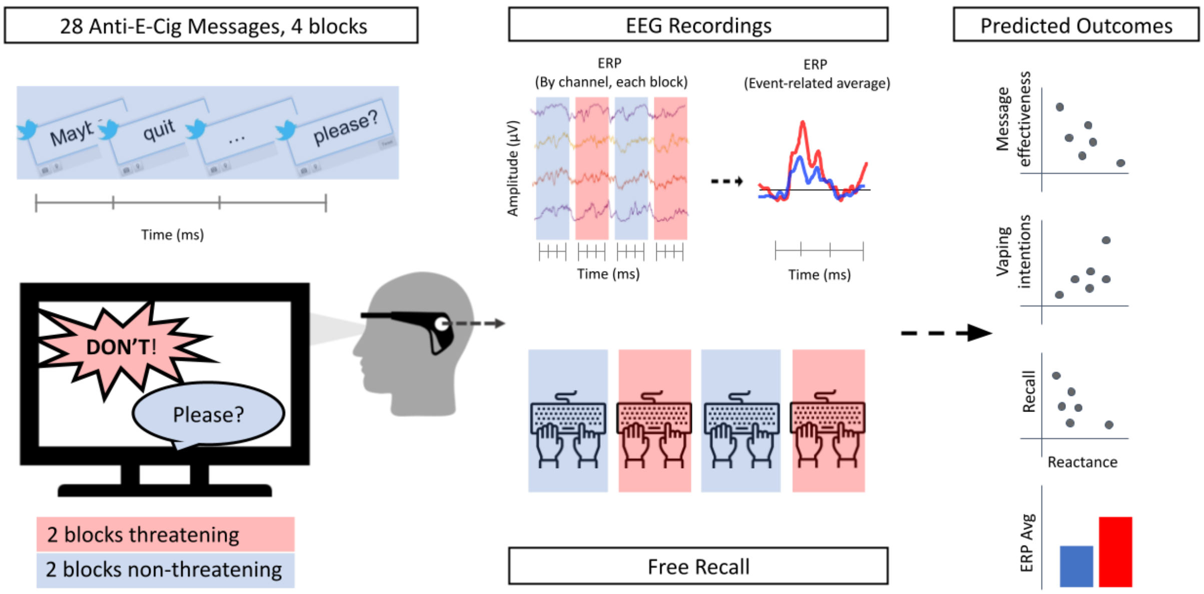

Figure 1. Conceptual overview outlining the causal logic and the parallel analysis streams of the study. Left panel: Messages were of two kinds: threatening language and non-threatening language. Middle panel (top): Mobile EEG (Muse, as depicted on the human head) were used to capture message-concurrent and word specific neural responses (i.e. brain responses to each word of the messages as they appear). EEG responses were collected in person only. Middle panel (bottom): After each block of messages, a free recall prompt asked people to report the messages that they remember from the preceding message block, providing rich verbal data for linguistic analysis. Right panel: After the study, participants reported their perceived message effectiveness of and reactance to each message, their general use intentions regarding e-cig, and compared textual similarity between free recall and average ERP between threatening and non-threatening messages: The dashed arrows represent procedural flow of study and not statistical model or hypothesized relationships.

The Nature of Reactance and the Impact of Threatening Language

Within health communication in general, reactance because of threats to self, autonomy, and freedom, is a critical factor that affects how messages are received and whether they will be accepted (Miller et al., 2007). Because autonomy is an idea that is universal and valued by all people alike, including current e-cigarette users, phenomena like reactance, and other negative message responses are a frequent problem in the context of e-cigarette use prevention (see politeness theory, Goldsmith, 2008). Even tobacco advertisers are aware of people's love for freedom considering advertisements frequently associate e-cigarette use with free choice, (i.e. adventure, risk-taking, being care-free; Duan et al., 2024). People's desire for free choice and avoidance of "feeling controlled" or judged makes it more difficult for health communication to avoid arousing reactance in individual message recipients, or the target audience at large such as current- or at-risk e-cigarette users (Clayton et al., 2018).

Psychological reactance theory outlines how attacking a person's behaviors or attitudes results in perceived threats to their choices and personhood, and how threats affect motivation (Brehm, 1966). The four components of reactance theory are (i) a person must have a behavior or attitude towards a certain behavior they perceive as a freedom, (ii) messages that attempt to restrict or minimize that freedom are perceived by the person as a threat, (iii) perceived freedom threats result in reactance, (iv) reactance then motivates a person to restore the freedom. A person may try to restore freedom or their sense of self directly by engaging in the restricted behavior, or indirectly by adopting a positive attitude towards the restricted behavior (Brehm & Brehm, 1981).

Dillard and Shen (2005) argue that reactance acts as a mediator between threatening messages and outcomes, such as message rejection or defiant behavior towards whatever the message advocates for ('You absolutely must not think of a red elephant'). In addition, they conceptualized reactance as both an affective and cognitive response, mostly associated with negative emotions (i.e., anger) and cognitions (i.e., counterarguing) (Quick & Considine, 2008). Indeed, research suggests that some threats elicit immediate arousal whereas other threats prompt reflection about the threatened behavior before arousal (Sittenthaler et al., 2015). Therefore, different types of threats affect whether messages are processed via a more automatic, impulsive affect-driven route or a more cognitive dominated reflective route (Strack & Deutsch, 2004).

Researchers have investigated a variety of antecedents of reactance with an important antecedent being language (Dorrance Hall et al., 2023). Messages that use controlling and forceful language increase perceived threat and increase reactance compared to messages without controlling and forceful language (Miller, et al., 2007; Quick & Stephenson, 2008; Clayton, 2022). For example, framing a message to workout with the phrase "consider it" is perceived as less threatening and words like "consider" gives choice which allows the person more autonomy (Quick & Considine, 2008). Previous research also indicates that various tactics can be used to reduce reactance when making requests such as the use of nonverbal behavior (e.g., smiling, voice tone) (Witt & Kerssen-Griep, 2011), incorporating more perspective taking and empathy language (Shen, 2010), and avoiding limiting a person's choices (Bessarabova et al., 2013). These findings suggest that there exist objective (linguistic) message features that create nuances in messages that make reactance more or less likely to occur.

H1: Participants will report greater reactance following freedom threatening messages compared to non-freedom threatening messages

The Relationship Between Threatening Language and Brain Responses

Negative outcomes following reactance suggest that reactance is a state with behavior-directing properties (Brehm & Brehm, 1981). In parallel, motivation to process a message has been important in determining the persuasiveness of health messages, and predicting long-term health behaviors (Lang, 2009; Petty & Cacioppo, 1986). Specifically, research on the persuasiveness of mass media health messages has broadly focused on resource allocation as an indicator of message processing motivation.

The limited capacity model for motivated mediated message processing (LC4MP) posits that motivation shapes how messages are encoded (processed), stored (remembered), and retrieved (recalled), and messages that are motivationally relevant are associated with greater resource allocation (Lang, 2009). According to the LC4MP literature, resource allocation is mediated by threat intensity (Leshner et al., 2017). Some examples of messages with higher threat intensity include more vivid, graphic images (Quick & Stephenson, 2008), graphic labels (LaVoie et al., 2017), and dogmatic language (Clayton et al., 2020). Messages with greater, more immediate threats result in reduced resource allocation to encoding and storing of message content, and increased resource allocation towards a rejection response. Whereas messages with small, less immediate threats result in increased resource allocation to encoding and storing of message content, and reduced resource allocation to a rejection response. Rejection responses may include discounting of information via counterarguing or attempting to disengage with the threatening stimuli by moving away, closing one's eyes, or turning off the message if possible. These rejection responses are referred to as a fight or flight response (Clayton et al., 2017).

According to the LC4MP, people are capacity limited with a finite amount of resources used to cognitively and affectively process messages (Lang, 2009). Specifically, resources are devoted across cognitive and perceptual resource pools. People then use their resources during encoding, retrieval, and storage of information like health messages. Undergirding how resources are allocated are two independent, evolutionary-based motivational systems, the appetitive (approach) or the aversive (avoid) (Cacioppo & Berntson, 1994; Cacioppo & Gardner, 1999). The appetitive motivational system responds to positive stimuli in an environment (e.g., social belonging, sex) whereas the aversive motivational system responds to negative stimuli in an environment (e.g., threats, pain). When a threat is perceived in the environment, the aversive system is quick to activate and vigorous in motivating a person to engage in protective behaviors (Cacioppo & Bernston, 1994; Cacioppo & Gardner, 1999).

Preliminary evidence from behavioral and psychophysiological studies suggest that reactance diverts cognitive resources from processing health messages and results in decreased recall accuracy of health information (Clayton et al., 2019; Clayton, 2022). In Clayton and colleagues (2020), participants were assigned to one of four conditions (threatening x non-threatening and smoking cue x no smoking cue). Those in the non-threatening and smoking cue condition were most accurate in their message recall and those in the threatening x smoking cue were the least accurate. In line with LC4MP, these results suggest that smoking cues activate the appetitive or approach motivation system and increases cognitive resources either to the message when no threat is present or to retrieval when threat is present (Lang, 2009).

Moreover, reactance has been shown to be an automatic affect-driven response (Strack & Deutsch, 2004). For instance, consider your own reflexive reaction when hearing the word “you must” or “how dare you …” in a social interaction. These responses occur within a fraction of a second and are akin to a jolt of lightning. The enormous speed, affective, and largely non- or at least pre-verbal nature of the underlying neurocognitive reactions to incoming messages is clearly incommensurate with the speed and reflective nature of currently used methods to study reactance. The unobtrusive brain measures linked to messages allows for an understanding of the earliest moments resource allocation may be directed away from encoding but also what downstream processes or intentions may be impacted by neural differences.

Measuring brain responses

A novel method useful to examining resource allocation to threatening anti-e-cigarette messages is measuring neural responses (Falk et al., 2012). Neural responses provide important insights into how people process messages. Using neural measures to examine message processing is particularly useful because neural measures are taken in real-time as participants view health messages (Berkman & Falk, 2013). For example, researchers can examine changes in brain activity with temporal precision by presenting health messages word by word to look at how neural responses to threatening language (e.g., do not, cannot, forbid) occur. Additionally, when combined with self-report, neural measures can predict behavioral outcomes more accurately than self-report measures alone (Falk et al., 2012). Recent advances in neuroscience also demonstrate the utility of neural measures in examining social phenomena (Wilcox et al., 2020). These neural responses make important theoretical contributions by grounding latent concepts like message encoding in observable biological and physical properties (Huskey, Bue, et al., 2020). These neural responses make important practical contributions by connecting content to millisecond changes in the brain to better identify language that evokes negative responses in target audiences.

Electroencephalography (EEG) measurement during message exposure is promising for studying resource allocation following threatening language because the measurements may help to capture the allocation changes (Luck et al., 2000). Resource allocation changes have previously been difficult to capture because these changes are fleeting and transitory in nature, and are easily interrupted when changing the cognitive demand (e.g., asking participants a question) (Fisher, Keene, et al., 2018). Furthermore, compared to other types of neuroimaging methodologies, EEG has many considerable advantages. Widely accepted by researchers and clinicians, EEG is a non-invasive, portable, safe, and inexpensive method that requires minimal acquisition time. Additional rationale for using EEG is that the data can be analyzed through event-related potentials (ERP), which look at changes in electrical neural activity, specifically changes in a brain waveform’s amplitude polarity, latency, and topography in millisecond time-frame after presentation of a stimulus (Luck, 2005). ERP research has been used to see differences in processing for tasks, receiving images, and receiving written messages, making perfect for this word-by-word message presentation in the current study (Jahn et al., 2022).

Using EEG to study neural responses to health messages about e-cigarettes can be approached in another way beyond ERP analyses, although such an approach has not been attempted with the Muse device. Muse™ by Interaxon is an EEG neurofeedback device that provides an easy-to-mount and relatively inexpensive option for data collection. The Muse uses Bluetooth-connection to collect and transmit data from four sensors AF7, AF8, TP9, and TP10, and the Fpz electrode as a reference for baseline.

In a clinical trial by Ratti and colleagues (2017), the Muse device was compared to another consumer EEG system (Mindwave) and two other medical-grade devices (B-Alert, Enobio). No significant differences were observed between the Muse and the medical-devices. An additional study conducted comparing the utility of the Muse to a 64-channel EEG device found that the Muse required less set-up time but was demonstrated to have similar capabilities and efficacy (Krigolson et al., 2017, 2021). As with all EEG devices, several limitations exist.

Data from EEG can be greatly affected by minor movements in the head or body, making data rather noisy with erroneous artifacts (Luck, 2005). Given the noisy artifacts, one-third to half of the epochs in EEG data are thrown out because of eye-blinking, signal loss, or implausible voltage measures. This is especially true for lower-channel EEG devices like the Muse (Jahn et al., 2022).

In sum, keeping in mind these drawbacks of the Muse-EEG system, we can formulate specific expectations about likely results. Specifically, a shift in resource allocation during encoding evoked by a message that contains threatening language, should be reflected in immediate EEG responses to threatening words. These measures should be observable whether engagement to the message increases, or an increase of focus on the self (e.g., counterarguing) occurs. Previous ERP research focuses on neural signatures that elicit changes in electrical activity during specific times, and one that is of primary interest to examine face threatening effects is the late positive potential (LPP).

The LPP has been studied extensively as a differential response to affective stimuli that are motivationally relevant (Cacioppo et al., 1993; Cacioppo et al., 1994; Lang et al., 1997; Schupp et al., 2004; Van Berkum et al., 2009). In particular, the LPP is quantified as a differential ERP response to motivationally relevant stimuli compared to neutral ones. The LPP appears between 400-600 ms post stimulus and is most strongly expressed over centro-parietal sensor sites (Schupp et al., 2004; Van Berkum et al., 2009). The LPP is hypothesized as initializing responses in cell assemblies related to conscious access and relevance evaluation of visual stimuli (Schupp et al., 2006). Importantly, it has been shown that negatively valenced stimuli are associated with a stronger LPP component (Cacioppo et al., 1994; Schupp et al., 2004; Van Berkum et al., 2009). Previous studies investigating the effectiveness of anti-e-cigarette messages have demonstrated that messages with dogmatic language increase activation of the aversive motivation system and are associated with psychophysiological responses like increased heart rate and skin conductance responses (Clayton, et al., 2020). Moreover, a study by van Berkum et al. (2009) showed that EEG responses increase to clashing moral statements (e.g. *euthanasia is an [acceptable vs. unacceptable] course of action*), and this finding seems compatible with the current reasoning that reactance-evoking language should prompt enhanced LPP-like responses. While the LPP component has not been previously used to test the LC4MP and whether people are allocating resources to encoding and storage or retrieval, the LPP component is closely related with neuromodulatory transmitter release (e.g., norepinephrine), and thus, closely associated with arousal responses (see Aston-Jones & Cohen, 2005). Since reactance is elicited through threatening messages, which are theorized as arousing and negatively valanced, there should be a strong LPP component.

> **H2**: ERP responses to messages following threatening messages will differ from ERP responses to messages following non-threatening messages in the LPP range at 300-500 ms

Study 1 Methods

Message Development and Pretesting

Participants. For the message pretesting, a total of 126 participants were recruited as a convenience sample from an undergraduate communication course at a large midwestern university. Although, 8 participants were removed for responding that *they did not take part seriously* when asked ‘It would be very helpful if you could tell us whether you have taken part in this survey seriously, so that we can use your answers for scientific analysis, or whether you were just clicking through to take a look at the survey.’ An additional 8 participants were removed for failing to complete the survey, resulting in a total of 110 participants. Regardless of their response to whether they took the survey seriously, all participants who completed the survey received 0.25 course credits. Participant demographics data related to race, ethnicity, and gender were not collected due to time constraints. Participants' ages ranged from 18-63 years old (M = 20.25, SD = 4.36).

Message pre-testing procedure. Participants completed a 10-minute Qualtrics survey that included demographic questions, e-cig use behavior, and finally, message pre-testing evaluations. Health message stimuli were generated based on text collected and adapted from The Real Cost campaign ads used on social media (e.g., X, Instagram, etc). Message stimuli can be found in table 1. The texts were edited to be similar in length and reading ease (see table 2 for more details). Messages were matched on the negative emotion and amount of health information conveyed to control for qualitative differences that could potentially impact message effectiveness. Following the collection and generation period, students at a large midwestern university viewed each message and rated them for their perceived threat and perceived argument strength. Students rated a message before viewing the next message.

E-cig Use Measures. *Daily vaping behavior* was assessed with the item "How many days in the past week did you use an e-cigarette?" which participants responded to with options 0-7 (M = 2.02, SD =2.23).

Vaping intention was assessed with the item "Do you plan on using e-cigarettes in the foreseeable future?" with response options 1 (definitely not) to 5 (definitely yes) (M = 1.62, SD = 0.95).

Message Pre-Testing Measures. *Perceived face threat* was assessed using a 9-item instrument developed by Cupach and Carson (2002) with the stem "This message" and a 7-point Likert-type scale. Four items (e.g., constrained my choices, invaded my privacy) assessed negative face threat (M = 2.53, SD = 0.16). Negative face threats are typically associated with freedom and autonomy threats. Five items (e.g., was hostile, showed disrespect) assessed positive face threat (M = 2.77, SD = 0.35). Positive face threats are typically associated with threats to a person's sense of self.

Perceived argument strength was assessed with an adapted item from Zhao and colleagues (2011) perceived argument strength scale "Is the reason the message gave for not vaping a strong or weak reason?" with response options 1 (very weak) to 5 (very strong) (M =4.56, SD = 0.98).

Negative emotions and health content in the messages were assessed using Linguistic Inquiry and Word Count (LIWC) dictionary analyses (Cohn et al., 2004; Monzani et al., 2021). Messages did not differ in their word counts ($t(13) = 0.96$, $p = .35$) or their readability scores ($t(13) = 1.65$, $p = .11$). LIWC is a model able to evaluate "various emotional, cognitive, and structural components [of text]" (Pennebaker, 2022) and has successfully analyzed sentiment (e.g., anger, anxiety, positive emotions) and topical discussion (e.g., health) in social media contexts (Thorpe Huerta et al., 2021). Using LIWC, results indicated that freedom threatening and non freedom threatening messages did not significantly differ in their negative emotions ($t(13) = 0.97$, $p = .34$) or health content ($t(13) = -0.14$, $p = .89$).

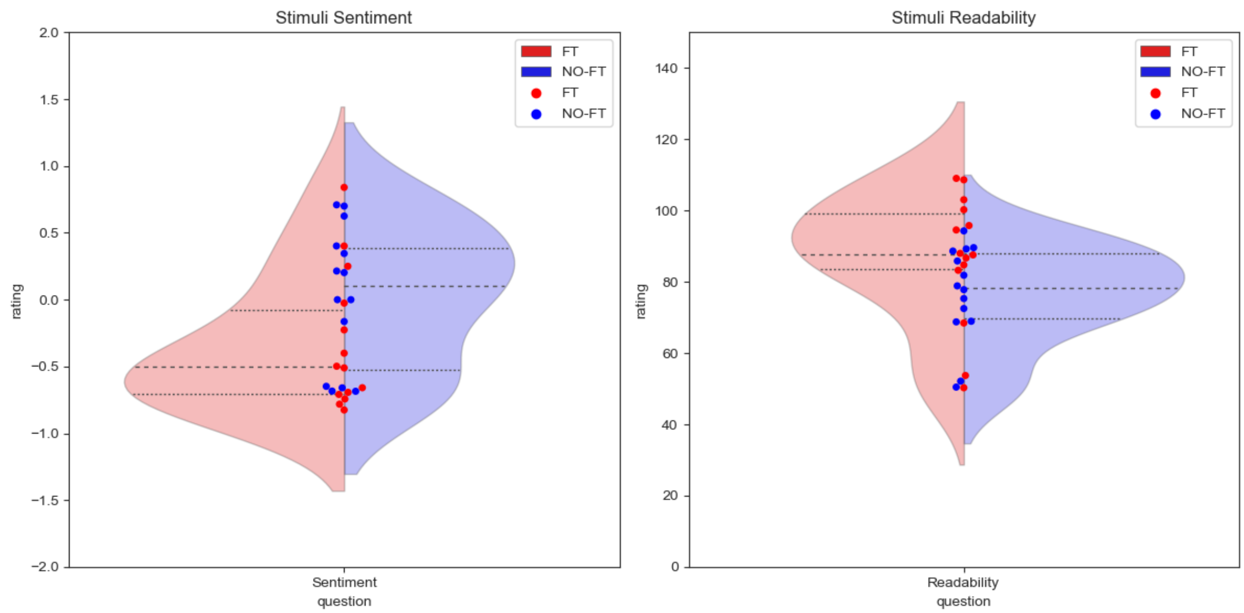

Figure 2. 14 non-freedom threatening (blue) and 14 freedom threatening messages (red) were evaluated in terms of sentiment and readability by the LIWC dictionary. The results revealed similar evaluations and nonsignificant minor differences, with a considerable spread within each category.

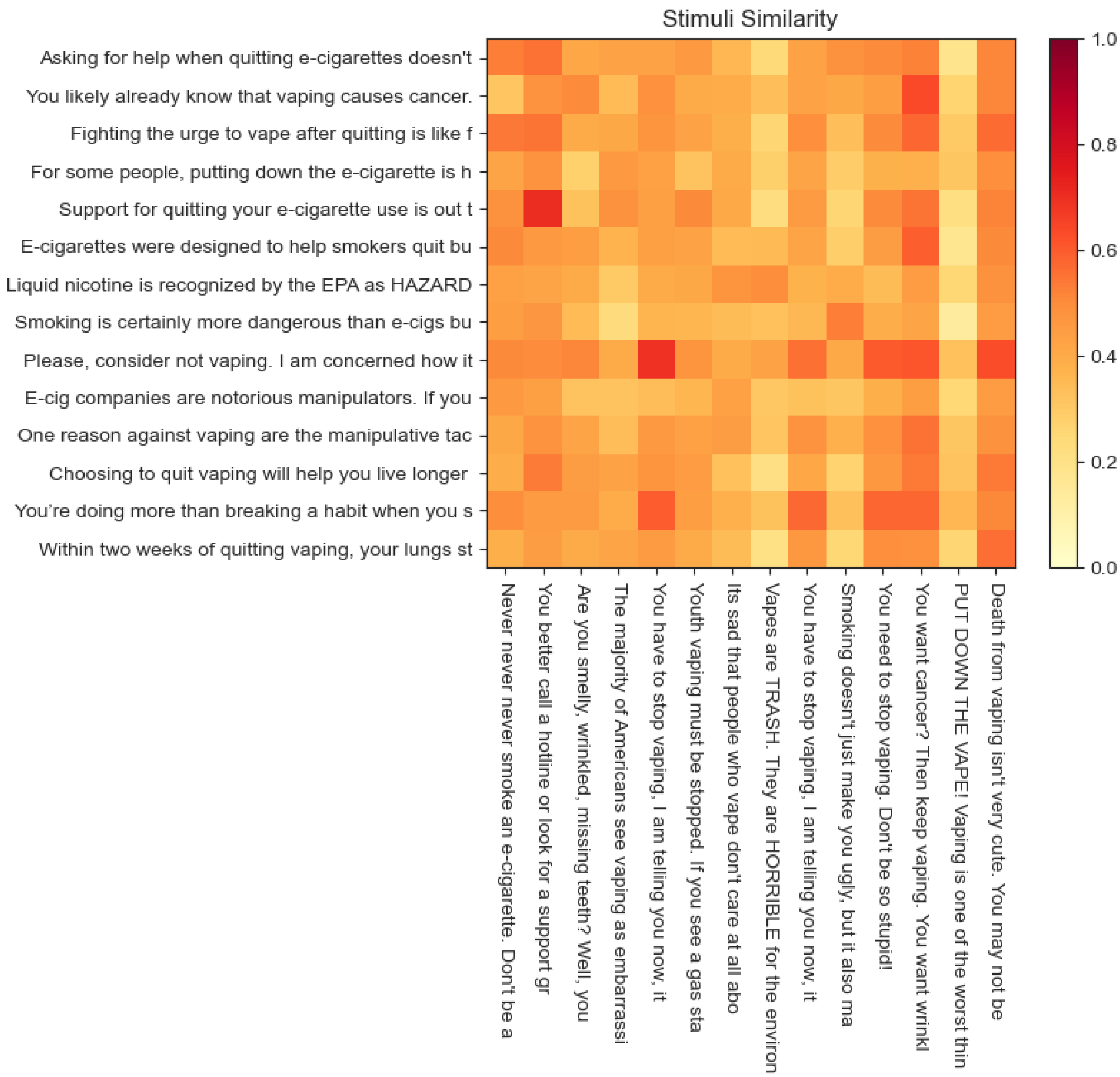

Figure 3. Semantic similarity analysis. A heatmap depicting the correlational matrix between the 14 non-freedom threatening messages (Y-axis) and the freedom threatening messages (X-axis). Correlations were calculated using sentence Bidirectional Encoder Representations from Transformers (BERT), a modification of the pretrained bidirectional encoder representations from transformers model, to derive semantic sentence embeddings, which we then compared using cosine-similarity (Reimers & Gurevych, 2019).

Main Study Methods

EEG Participants. Participants (*N* = 74) were recruited from an online SONA at a large midwestern university. The number of participants recruited reflects the amount needed to reach good reliability with neuroimaging data (Schupp, 2012). Using a large effect size (Cohen's *f* = .25) and G*Power analysis also indicated that recruiting >=22 participants allowed for sufficient power to test for effects of reactance on free recall (Clayton, 2022). Participants were over 18 and provided informed consent approved by the university's IRB. One day prior to the in-person study, participants completed a pre-survey and indicated if they use e-cigarettes and how many times a day on average they use them. Only those who reported e-cig use were included in the study to ensure issue involvement with the messages content. Due to errors in the software used for data collection and artifacts in EEG data, only 30 of the participants' results were usable.

Participants were on average 19.96 years of age (*SD* = 1.46). Most identified as a woman (*n* = 18) compared to a man (*n* = 12) or other genders (0%). The majority of participants identified as White (*n* = 24), followed by Hispanic/Latinx (*n* = 3), then 2 participants identified as mixed race, and 1 identified as Black.

EEG Procedure. Interested participants were sent a pre-survey one day prior to their in-person lab session and were asked if they used e-cigs and how many times a day. If they indicated they used e-cigs once a day or more, they were allowed to attend the in-person session. After consenting to participate, a member of the study team sat participants at a computer and set up the participant with a low-cost minimally invasive mobile electroencephalography (EEG) device. While wearing the EEG device, we recorded about 20 minutes of EEG data while participants viewed 2 blocks of threatening and 2 blocks of non-threatening anti-vaping messages. The order of the blocks was randomly assigned across participants. Each block contains 7 messages so participants viewed 28 messages in total. Messages were presented one word at a time to participants. The messages were matched on their perceived argument strength and threat, reading difficulty, and sentiment.

After viewing all of the messages in one block, participants completed a free recall task for 1-minute with the prompt, “For the next minute, please write about everything you remember about the anti-vaping messages.” EEG was not collected during the free recall. Following the message viewing and free recall, participants reported their attitudes toward e-cig use and their current e-cig behaviors. Finally, participants viewed each message again and reported their reactance and the perceived message effectiveness.

Neurophysiological Measures

EEG data was recorded using a Muse S device from Interaxon Inc., Toronto, Canada (SCR_014418). The Muse is worn like a headband and has four electrodes at locations corresponding to AF7, AF8, TP9, and TP10, and a reference at FPZ. EEG data was sampled at 250 Hz and streamed data via a Bluetooth connection (Kowaleski, 2022) to a Python program (Griffiths et al., 2020) to store the data. Compared to other EEG devices, the Muse S can be easily set-up, requires minimal preparation and additional equipment, and is not attached by wires to equipment. Thus, the Muse S offers more range and mobility than other EEG devices such as traditional 64 channel or 32 channel devices.

Self-Report Measures

E-cigarette Use Behavior. Following procedures from a previous study measuring vaping behaviors and brain activity (Pei et al., 2019), participants reported the average number of times they used an e-cigarette a day in the past 30 days. The data were then winsorized (i.e., setting extreme values to equal three SD’s from the mean, rather than discarding the values) to handle outliers (M = 25.00, SD = 35.12).

Attitudes Toward the Behavior. Attitudes toward quitting or abstaining from e-cigarettes were measured by averaging six items on 7-point semantic differential scales with the stem "My quitting smoking e-cigarettes in the next three months would be ..." Comparisons included: "bad/good," "unenjoyable/enjoyable," "unpleasant/pleasant," "foolish/ wise," "difficult/easy," and "harmful/beneficial" (see Maloney & Capella, 2016) Higher scores indicate more positive attitudes toward smoking cigarettes (*M* = 4.57, *SD* = 0.78).

Reactance. Per Dillard and Shen (2005), anger and negative cognitions in response to each message were assessed. Reactance emotions were operationalized as feelings of anger following the memorable conversation. For anger, participants responded to four items (e.g., "angry", "irritated", "annoyed", "aggravated") with the stem "Did you feel __ while viewing the message?". For negative cognitions, participants responded to two items "Did you feel skeptical while viewing this message?" and "Did you feel argumentative while viewing this message?." Items were rated on a 5-point scale ranging from 'none of this feeling' to 'a great deal of this feeling'. The assessments were then combined and averaged based on non-threatening messages (*M* = 1.87, *SD* = 0.82) and threatening messages (*M* = 2.79, *SD* = 1.20).

EEG-ERP Data Analysis. EEG analysis was performed on MNE-Python (Gramfort et al., 2014) and EEGLAB software (Delorme & Makeig, 2004). The recorded data was loaded and filtered with a bandpass filter from 0.1 Hz to 20 Hz, epoched from 100 milliseconds before the stimulus to 800 milliseconds after the presentation of each individual word comprising a message, and artifact-laden epochs were rejected. Then, event-related averages were formed to yield message-level ERPs, which were aggregated based on message type to yield one ERP datapoint for threatening messages and another ERP for words that are parts of non-threatening messages. In other words, ERP waveforms were subsequently computed by averaging together clean epochs for non-threatening and threatening messages, respectively. The difference between two averages for every subject was then computed, winsorized to handle outliers, and used as the

EEG measure of neural responses to all messages for every subject.

To statistically test for differences between the ERPs toward non-freedom threatening and freedom threatening messages, we compared the mean ERP amplitude (M = -0.61, SD = 3.40) in the time window of interest (300–500 ms) to the mean difference (M = 0.66, SD = 0.70) between message conditions.

Open Science Practices

Study design, hypotheses, and analysis plan were pre-registered in accordance with Open Science Practices. This study was pre-registered on AsPredicted. All data, materials, and code used for this study were made available on GitHub.

Study 1 Results

Participants self-reported significantly greater reactance following freedom threatening messages (*M* = 2.63, *SD* = 1.19) compared to non-freedom threatening messages (*M* = 1.87, *SD* = 0.81, using a dependent sample t-test $t(74) = 7.69$, $p < .001$). Therefore, H1 was supported.

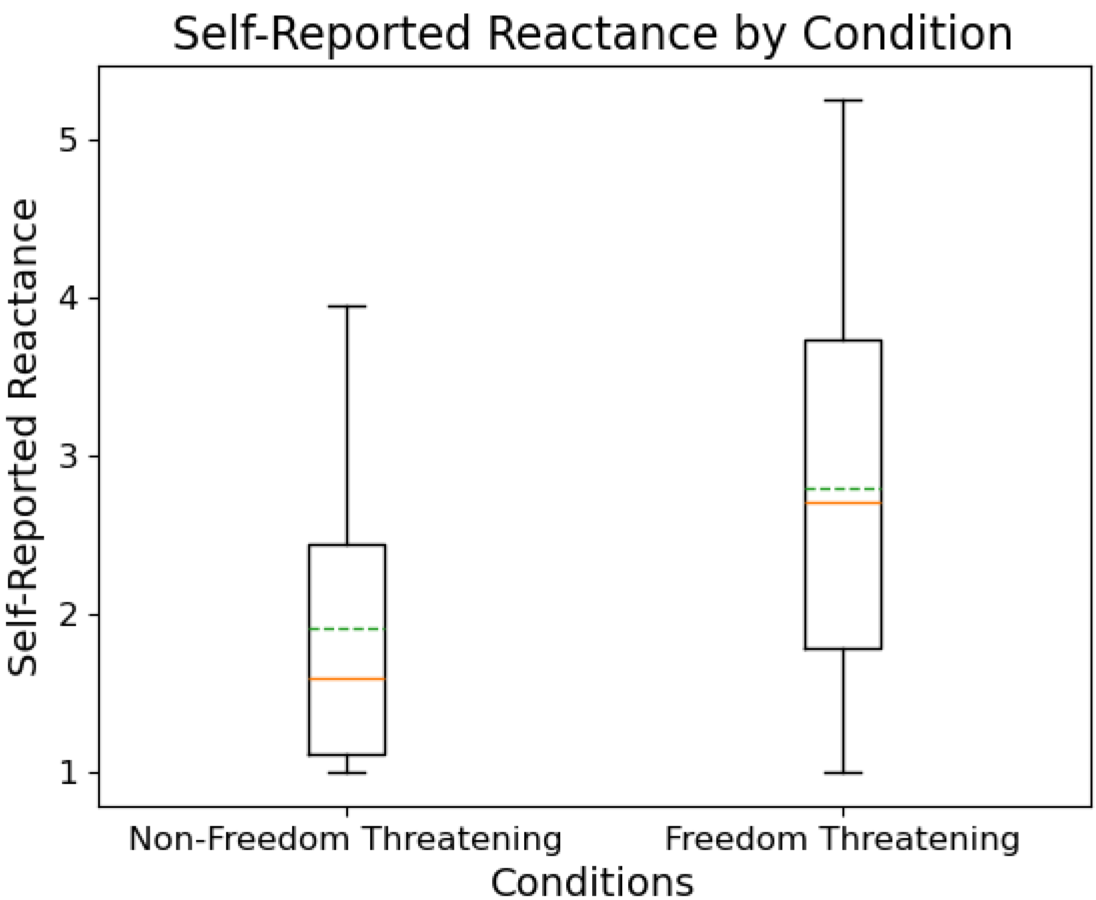

Figure 4. The boxplot illustrates the distribution of reactance within participants in response to non-freedom threatening vs freedom threatening messages. Reactance was measured on a Likert-scale from 1 to 5, with higher scores indicating greater reactance. Reactance significantly differed by messages $t(74) = 7.69$, $p < .001$), with greater variance in reactance to freedom threatening messages.

Results of the paired sample t-test examining whether the EEG responses to threatening messages compared to non-threatening messages differed in amplitude were not significant ($t(27) = -1.30$, $p = .12$). Therefore, H2 was not supported. For additional investigation, see figure

5 depicting the relationship between reactance and ERP responses.

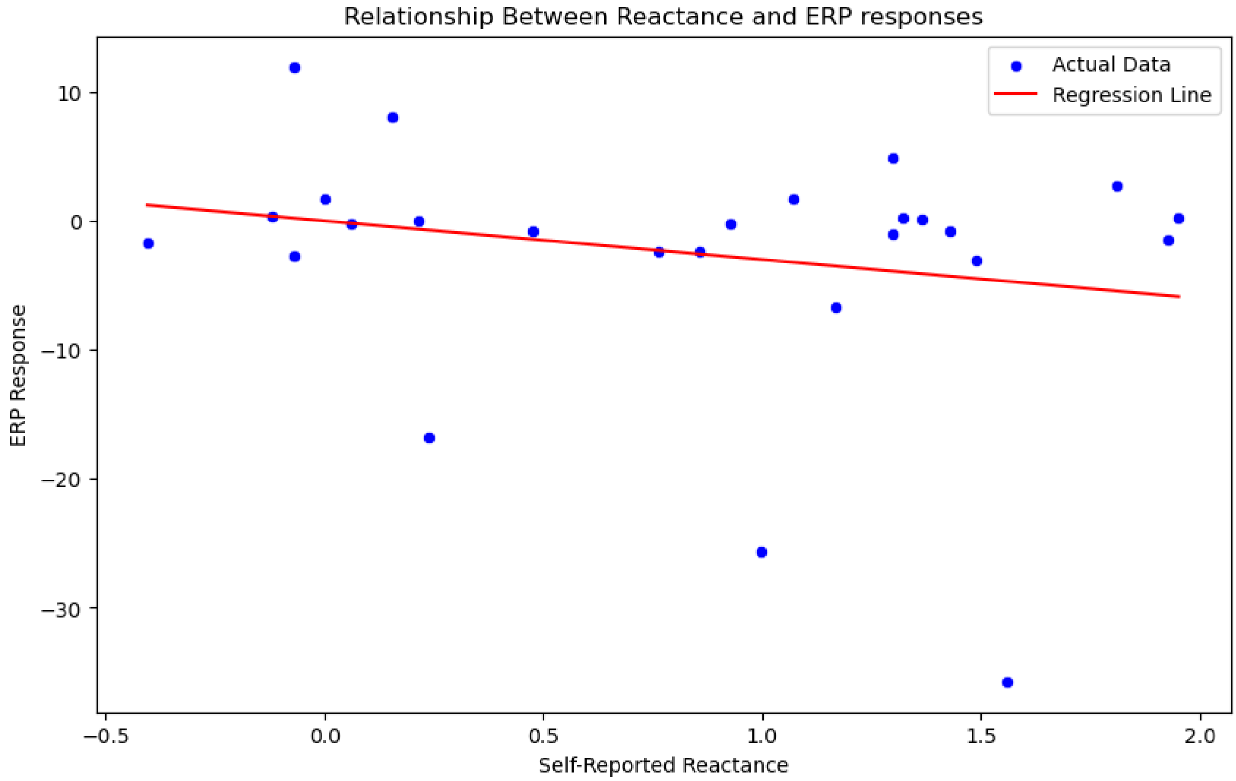

Figure 5. Graphical representation of the non-significant linear relationship (red regression line) between self-reported reactance (X-axis) and ERP responses in the LPP range (Y-axis). Reactance for this comparison was calculated by taking the difference between reactance to freedom threatening and non-freedom threatening messages. The blue dots indicate participants' self-reported reactance and their corresponding ERP response.

Study 1 Discussion

Health message effects are still difficult to ascertain despite the numerous theories across several fields dedicated to identifying message characteristics and their effects. This shortcoming is especially noticeable looking at the rise of e-cigarette use in high school and college students. Despite years of focus on anti-e-cigarette messaging, younger generations are picking up vaping at record numbers (Birdsey et al., 2023). Marketing firms and organizations such as Truth Initiative have spent substantial financial resources attempting to deter e-cigarette use (Donohue, 2020; Hair et al., 2024). The study here aimed to aid in addressing the problem by identifying underlying mechanisms (i.e., inner thoughts and feelings/brain responses) that occur when people are exposed and engage with anti-e-cigarette messages.

Although largely debunked for their effectiveness, aggressive and crude health messages that rely on fear, intimidation, or insult are frequently used. Such messages that limit a person's perceived freedom and diminish their sense of self are more likely to invoke reactance (Dorrance Hall et al., 2023). Despite these findings, continued debate of the usefulness in fear appeals exists (Esrick et al., 2019; Struckman-Johnson et al. 1994; Sun et al., 2021). A recent systematic literature review combining results from advertising appeals points to widespread use of fear appeals, mixed results of their effectiveness, yet calls for continued use of negative emotional appeals (Yousef et al., 2021). Here, we replicate prior findings demonstrating that messages more associated with restrictive (e.g., don't, stop), and insulting (e.g., EW, ugly, stupid) language invoked greater reactance among participants than messages with suggestive (e.g., try, please) and positive (e.g., believe, great job) language. Reactance is associated with lower compliance, and over time, increases in negative behaviors. These findings are in line with results from prior studies that demonstrate fear appeals evoke defensive processing (Witte &

Allan, 2000), and that such negative appeals result in mixed effectiveness in perceived effectiveness and intentions (Esrick et al., 2019). For example, several studies demonstrate that appeals emphasizing negative emotion result in greater fear, self-reported message effectiveness and perceived severity, yet these increases are not associated with decreases in negative health intentions or behaviors (e.g., e-cig use; Byrne et al., 2015; Schmitt & Blass, 2008; Zimmerman et al., 2014). Thus, here we demonstrate a potential detriment to some current approaches in the anti e-cigarette communication environment. Messages should focus on language with more polite requests and avoid targeted language towards e-cigarette users.

A benefit of Study 1 was the within-subjects design, where participants were exposed to both freedom-threatening and non-threatening messages, allowing for comparisons within individuals. This approach offers several benefits, such as controlling for individual differences and reducing error variance, thereby increasing the internal validity of the study. Additionally, within-subject designs are often more statistically efficient, requiring fewer participants to detect effects. This is especially important for ERP studies that typically have more minimally detectable brain responses (but do result in significant differences). Another contribution of study 1 was the novel methodology. For one, the ERP collection co-occurred with the appearance of words on the screen. This meant differences in neural responses could be related to the stimuli with extremely high confidence. Additionally, ERP measures have long been used to examine visual processing, working memory, and attention. This allows for the measures collected here to be compared to LC4MP literature as well literature involved with understanding the neural substrates of key information processing mechanisms. In essence, this study provides a neural basis to examine how stimuli directs the use of cognitive resources across capacity-limited resource pools and a measure to predict behavioral (vaping) and cognitive (memory) outcomes.

Unfortunately, the study here failed to identify differences in neural responses between freedom threatening and non-freedom threatening messages. Although the differences between messages were identifiable in self-reported reactance, the Muse EEG collected ERP responses did not differ. Likely, this may be because of the novel methodology used here, which comes with a number of inherent uncertainties at this point. Few studies collecting ERP data present stimuli in a controlled way similar to the way done here. The word-by-word presentation allowed us to get ERP responses to each word but the small differences that were then averaged at the message level in order to compare across conditions were likely minimized. Therefore, connecting the hypothesized LC4MP processes related to reactance following message exposure in this study is difficult.

To address these limitations, a follow-up study where participants are randomly assigned to either the freedom-threatening or non-threatening message condition is needed, This would allow for direct comparisons between groups. By isolating participants into distinct groups exposed to either freedom-threatening or non-threatening messages, a follow-up study with between-group design could assess the differential impact of message language across groups, potentially elucidating nuanced effects that may be masked in within-subject comparisons. Moreover, a between-groups design reduces the potential for carryover effects and order effects, which may confound results in within-subject designs, especially when examining sensitive constructs such as reactance. In the context of studying the effects of freedom-threatening versus non-threatening messages on behavior and memory, a between-groups design holds particular significance. It allows for a clearer delineation of the immediate and lasting effects of message language on participants' responses, without the potential influence of prior exposure to alternate message types.

Additionally, a larger sample would be beneficial and a sample that is more diverse would also be beneficial to understanding message effects. For example, it may be possible that the age most represented in the in-person study is particularly sensitive to restrictive or self-relevant language. This could be reasonable given that high school and college students are at ages associated with more self-discovery and emotional development (Willoughby et al., 2021). Therefore, a follow-up study to examine reactance effects across multiple age groups is needed. Moreover, addressing the limitations of the current study, such as sample size and diversity, is crucial for generalizing the findings to broader populations and contexts. Therefore, to address these gaps and further elucidate the dynamics of message processing and reactance, a follow-up study is warranted.

Study 2

Study 1 provided insights into the relationship between threatening language and reactance, and brain response differences during message processing. Specifically, that freedom threatening messages regarding health topics that college aged students care about does result in greater reactance. Although, unlike previous studies using other psychophysiological measures that did find differences in resource allocation during message encoding, no difference in encoding were observed as measured by ERP responses in study 1. Thus, an expansion of study 1 is needed to examine the effects of freedom threatening messages on more diverse participants resource allocation beyond encoding (i.e., recall), and subsequent behavioral intentions and behaviors. Previous research suggests the importance of message recall in understanding reactance and resource allocation, there arises a need for a complementary study to delve deeper into this aspect. Investigating how freedom threatening language influences the allocation of cognitive resources through message recall could offer a more comprehensive understanding of the underlying mechanisms when people experience reactance.

Prior studies examining LC4MP and reactance following freedom threatening messages used multiple measures of resource allocation, such as skin conductance responses and message recall tasks employing signal detection theory (Clayton et al., 2019; Clayton et al., 2020). To expand on these findings, verbal recall messages would be beneficial. Rather than recall accuracy, verbal recall offers the potential for deeper linguistic analyses and connections to be made between what types of cognitive processes might be impacted following threatening health messages. For example, the message semantics and similarity to message stimuli can be compared.

Reactance and Memory

Processing visual stimuli is intimately connected to attention to those stimuli (Weber et al., 2018), and attention and memory are strongly, positively linked within neuroscience literature (Cohen & Parra, 2016; Murdock, 1965). Recent neuroscience work on attention and memory suggest a resource trade-off that when memory retrieval occurs, attention is directed inward and away from processing stimuli (Craik et al., 2018; Dai, 2022; Giesbrecht et al., 2006). The retrieved memory is then strengthened and associated with the visual cue (i.e., stimuli) that prompted retrieval (Logan et al., 2022). Attention can be compared to a spotlight; the brighter the light, the more luminous the object under the light becomes while the surrounding objects become darker, less observable. In the context of the research here, this updated understanding of the attention and memory relationship suggests that attention may be increased as a result of reactance, but because of counterarguing, that attention is then turned inward, and the message content receives less attention becoming less memorable.

These recent neuroscience findings are bolstered by key LC4MP assumptions that the appetitive motivational system following message exposure drives automatic allocation of cognitive resources to encoding and storage (Lang, 2009). Whereas messages that activate the aversive motivation system result in cognitive and perceptual resources allocation to retrieval (Clayton, 2019). Moreover, these assumptions are in line with what psychological reactance theory predicts - that messages perceived as highly threatening to a person's freedom and identity elicit strong counterarguing, and refusal to listen to a message (Brehm & Brehm, 1981; Dillard & Shen, 2005).

Unfortunately, the role of counterarguing, which is a component of reactance, has produced mixed effects in message recall research. Previous studies demonstrated that counterarguing following health message exposure increased attention to and memory of message content (Myrick, 2015; Nabi, 1999). These results, therefore, suggest that reactance directs resource allocation to encoding and storage. To explain these contradictory findings, Clayton and colleagues (2019) demonstrated that threatening messages with smoking cues resulted in greater anger and counterarguing, and as a result, these messages were associated with greater physiological arousal but less recall of message content. In other words, in that study resource allocation increased as a response to the threat but these resources were diverted to encoding and storing the content of the *threat*, rather than the *health content.*

Therefore, if threatening messages about health behaviors reduce resources allocation when processing the health content, then health content of threatening messages should be less likely to be remembered, therefore I predict:

> **H3**: The amount of health information a participant recalls from health messages perceived as threatening will be less than the amount of health information a participant recalls from non-threatening health messages.

This study helps us to understand how messages elicit changes in resource allocation, and subsequent information retention following exposure to e-cigarette prevention messages. From a practical sense, understanding how these factors influence e-cig use intentions is paramount for campaign designers and practitioners interested in developing messages meant to encourage e-cigarette users to adopt healthier behaviors.

Reactance as a Deterrent of Message Efficacy and Positive Health Behaviors

Language that threatens a person's self-image or threatens a person's ability to freely make decisions is more likely to result in reactance, and more likely to be associated with lower motivation for changing positive health behaviors (Dorrance Hall et al., 2023). For example, by having participants focus on self-enhancements (e.g., focusing on success in life) and then presenting highly threatening messages (e.g., including ‘Stop the denial.’), participants' reactance increased and reported lower intentions to be physically active (Han & Kim, 2019). Findings also suggest that eliciting reactance leads to reduced behavior compliance, and even increased noncompliance (Dillard & Shen, 2005; Miller et al., 2007; Pavey & Sparks, 2009; Wilcox et al., 2020). In situations of escalating conflict in child-parent relationships higher self-reported reactance following the conflict is correlated to decreased compliance (Missotten et al., 2018). Smith and colleagues (2016) found that perceived threats to autonomy or personhood from a parole officer to parolee predict parolee noncompliance to parole conditions like drinking abstention (i.e., stricter enforcements increase likelihood of drinking). Even more alarmingly, in a study of adolescents receiving HIV treatments, experiencing reactance after seeing reminders to take anti-viral medication made them less likely to do so (Lowenthal et al., 2021).

To be effective, a message must achieve its intended goal. For health communication, message effectiveness is typically measured in how much mediators of behaviors, or better yet, health behaviors change after message exposure (Bigsby et al., 2013; Dillard, Weber, et al., 2007). While message effectiveness refers to actual changes in outcomes, perceived message effectiveness is concerned only with *perceptions* of the likely message effectiveness. Even if a message is perceived as relevant or believable, these perceptions do not necessarily imply that the message will influence behavior. Unfortunately, reactance is associated with several negative outcomes that can render campaigns ineffective such as unfavorable attitudes (Dillard & Shen, 2005; Quick, 2012) and intentions (Rains & Turner, 2007) toward the advocated behaviors. For example, throughout the Covid-19 pandemic, people with higher psychological reactance were less likely to comply with government mandates like wearing a mask (Young et al., 2022), and people high in reactance reported less belief in messages espousing the effectiveness of mask mandates (Taylor & Asmundson, 2021). Thus,

H4: Reactance will be negatively associated with reports of perceived message effectiveness.

Despite research that indicates increasing reactance decreases motivation and compliance towards behaviors, prior studies examining e-cig use intentions following threatening messages have found no differences in e-cig use intentions following messages with dogmatic language compared to non-dogmatic language (Clayton et al., 2020). To date, there has been limited investigation into the reasons behind the lack of increase in e-cigarette use intentions following exposure to threatening anti-e-cigarette messages. In their study, Clayton and colleagues (2020) had participants only view one video message. Here, we have participants view multiple text-only messages. In a follow-up study only differing dogmatic language versus suggestive language in anti-e-cig public service announcements, Clayton (2022) found increased e-cig use intentions for those in the dogmatic language condition. This study extends this literature by focusing on the language in these messages and limiting other visual or auditory input. Therefore, I predict:

H5: Reactance will be positively associated with e-cig use intentions.

Here, we are interested in how long these unfavorable appraisals and freedom restoring behaviors occur after the freedom threatening messages were received. In a 10-day diary study, Dorrance-Hall and colleagues (2021) found that freedom threats affect behavior on the same day and can have a lagged effect on behaviors the next day but freedom threats on one day do not have a significant effect on reactance or behaviors past the next day (for exception, see Rhodes et al., 2016). This suggests the persistence of freedom threatening messages is minimal. Therefore,

H6: E-cig use intentions should be higher following immediate exposure to anti-e-cig messages compared to self-reported e-cigarette use in the following one-week period.

Addressing these hypotheses sheds light on several important phenomena and opens new avenues for interdisciplinary research. Reactance is a complicated psychological state that is assumed to have motivational importance and this study should shed light on the importance of reactance during message processing and subsequent memory. In their updated proposal of the LC4MP, Fisher, Huskey, and colleagues (2018) claimed that a more formalized understanding of memory is needed. This study contributes to that aim by offering substantial insights into how different types of memory (e.g., working memory, semantic memory) may be impacted by reactance. Understanding more about message characteristics and processing should result in greater explanatory power when predicting message recall and effectiveness related to behavior change. The results of this study should be useful by providing ways for campaign designers and health practitioners to avoid ineffective methods or prevent increases in negative behaviors.

To examine this hypothesis, an online survey via Amazon's Mechanical Turk (MTurk) was conducted where participants follow the same procedures as the in-person EEG experiment. Except in the online survey, participants viewed one type of message. Substantial reviews of MTurk data reveal diverse and large participant pools, and that challenges (e.g., participant inattention, study selection bias, higher attrition, etc.) can be mitigated by following recommended best practices (Aguinus et al., 2021; Smith et al., 2015).

Study 2 Methods

Online Participants. Participants (*n* = 261) were recruited from an online recruiting platform, Amazon's Mechanical Turk. Of those 261 participants, 155 participants completed the follow-up study. Inclusion criteria included that participants report using an e-cigarette at least once in the previous 24 hours. A final total of 111 participants were included for analysis following removal of participant responses flagged as bots (*n* = 28), duplicates (*n* = 2), or indicating they quit using e-cigarettes before viewing the messages (*n* = 14). Qualtrics features were used to determine if participants were bots or used bot software. If bot software was detected, participants were notified and not compensated. Notice of these conditions for payment were disclosed to participants before they participated. G*Power analysis (alpha = .10) and previous effect sizes (Cohen's *f* = .30) related to determining reactance effects on vaping intention determined that a sample size of >=100 was sufficient to test for effects in this study with power = .80 (Clayton, 2022). Part 1 of this study took 12-15 minutes and participants were paid $1.25 and part 2 took 3-5 minutes and participants were paid $2.00. Payment was distributed through the MTurk system to compensate participants for their time. Funds ($1,000) were provided by the Sandi Smith Research Fellowship for Health and Risk Communication.

Participants' age ranged from 21 - 75 years old (*M* = 41.20, *SD* = 12.77). Most identified as a man (*n* = 62) compared to a woman (*n* = 49) or other genders (0%). Participants could select multiple racial identities and identified as White (*n* = 95), Black or African/American (*n* = 9), Hispanic or Latinx (*n* = 11), Black or African/American (*n* = 8), Native American or Alaskan Native (*n* = 4), and Asian or Pacific Islander (*n* = 1).

Online procedure. *Part 1.* Participants provided consent and were randomly assigned to view either threatening messages or non-threatening messages. Participants viewed 2 blocks (7 messages each) and completed a 1-minute free recall task after each block. Participants then reported their attitudes toward e-cig use, and their current e-cig behaviors and intentions. Finally, each message was individually presented to participants and under each message they completed measures on their reactance to each message, perceived message effectiveness, and the personal relevance. Thus, participants saw each message twice, once in a block with other messages before recall, and again individually with the measures of interest.

Part 2. A week following the date they completed part 1, participants were asked to complete a short follow-up survey. Participants reported their attitudes toward e-cig use, and their current e-cig behaviors and intentions.

Free recall analysis. To measure participants memories of message information, they completed a task with the following instructions, “For the next minute, please write about everything you remember about the about the message(s) you saw previously.” The Qualtrics Survey page the task appeared on was automatically timed to move on after 63 seconds. Participants completed two free recall tasks which were combined into one text block for analysis. Multiple participants failed to complete the recall task resulting in a final 44 participant recall responses for each condition (i.e., 88 total participants who completed the task). Whether the participants could not remember anything or did not engage with the task is unknown. A study by Uittenhove and colleagues (2023) demonstrated that data loss to memory tasks in online web-based recruitment platforms, especially MTurk, was more common than lab-based memory tasks data loss, but quality in responses did not differ. Therefore, the participants’ failure to complete the memory tasks seemed reasonable in this study. Word count for participant’s recall did not significantly differ by condition (non-freedom threatening, M = 38.48, SD = 18.02; freedom threatening, M = 43.68, SD = 19.82; $t(86)$ = 1.27 , p = .21). However, readability was higher in the freedom threatening condition (*M* = 83.71, *SD* = 11.08) compared to the non-freedom threatening condition (*M* = 75.09, *SD* = 15.17; $t(86) = 3.01$, $p = .003$). Conversely, sentiment was lower (i.e., more negativity) in the freedom threatening condition (*M* = -0.61, *SD* = 0.47) compared to the non-freedom threatening condition (*M* = 0.05, *SD* = 0.57; $t(86) = -5.86$, $p < .001$).

Text responses were converted to vectors using a word frequency matrix derived from the large LIWC dictionary (i.e., each word in the response received a number given the likelihood words follow each other based on the database used to develop LIWC). From these vectors, using the health dimension from the LIWC dictionary, participants' text responses were assessed by counting health-related words and semantic similarity to such words (e.g., inclusion of words like "hospital", "cancer", "health", "depressed", "sick"; Boyd et al., 2022).When analyzing a text, the LIWC software counts the occurrences of words belonging to each category and calculates the percentage of words in the text that fall into that category. The score used for analysis indicates the proportion of words in a participant's recall response related to health topics according to the LIWC dictionary. Higher scores indicate more health-related words relative to other dimensions. Participants' text responses' health semantic similarity scores were then compared by condition (freedom threatening vs non-threatening). This enabled similarity comparisons across participants free recall responses regardless of response length, and it served as a quantifiable measure to assess if participants recalled information that was similar to the messages they viewed. In essence, this approach takes words in a sentence in a given message, and then using previously trained computational models, gives each word a score and then averages all of the scores for each word into a message score which says how semantically similar the message is to the dimension/content of interest (i.e., health). This particular analysis is helpful because the scores are not affected by the length of the messages but the word-for-word content similarity (Reimers & Gurevych, 2019).

E-cigarette Use Intentions. Following procedures from a previous study measuring vaping behaviors and brain activity (Pei et al., 2019), participants responded to the prompt '*Do you plan to keep on using e-cigarettes in the next week?*' with response options "definitely not," "probably not," "might or might not," "probably yes," "definitely yes." The data were then winsorized to handle outliers (M = 3.86, SD = 1.04).

E-cigarette Use Behavior. Following procedures from a previous study measuring vaping behaviors and brain activity (Pei et al., 2019), participants reported the average number of times they used an e-cigarette a day in the week following message exposure. The data were then winsorized to handle outliers (M = 12.82, SD = 15.05).

Attitudes Toward the Behavior. Attitudes toward quitting or abstaining from tobacco cigarettes were measured by averaging six items on 7-point semantic differential scales with the stem "My quitting smoking e-cigarettes in the next three months would be ..." Comparisons included: "bad/good," "unenjoyable/enjoyable," "unpleasant/pleasant," "foolish/ wise," "difficult/easy," and "harmful/beneficial" (Maloney & Capella, 2016). Higher scores indicate more positive attitudes toward smoking cigarettes. Attitudes were measured immediately after message exposure (M = 4.13, SD = 1.30) and one week after (M = 3.91, SD = 1.26).

Perceived Message Effectiveness. Following procedures from (Noar et al., 2018; Pechmen et al., 2003), participants responded to the item "Please rate how effective you think this message is" with options not effective at all, slightly effective, moderately effective, very effective, and extremely effective (M = 2.88, SD = 1.08).

Reactance. Per Dillard and Shen (2005), anger and negative cognitions in response to each message were assessed. Reactance emotions were operationalized as feelings of anger following the memorable conversation. For anger, participants responded to four items (e.g., “angry”, “irritated”, “annoyed”, “aggravated”) with the stem “Did you feel __ while viewing the message?”. For negative cognitions, participants responded to two items “Did you feel skeptical while viewing this message?” and “Did you feel argumentative while viewing this message?”. Items were rated on a 5-point scale ranging from ‘none of this feeling’ to ‘a great deal of this feeling’. The items were then combined and averaged based on non-threatening messages (*M* = 1.95, *SD* = 1.09) and threatening messages (*M* = 3.25, *SD* = 1.42).

Study 2 Results

H3. The amount of health information a participant recalls from health messages perceived as threatening will be less than the amount of health information a participant recalls from non-threatening health messages (see figure 6). Results of an independent t-test demonstrated a significant difference ($t(86) = -2.19$, $p = .03$) in the health-dimension score calculated by LIWC between the freedom-threatening messages ($M = 2.14$, $SD = 2.45$) and the non-freedom threatening messages ($M = 3.49$, $SD = 2.70$) (for more, see figures 7 and 8).

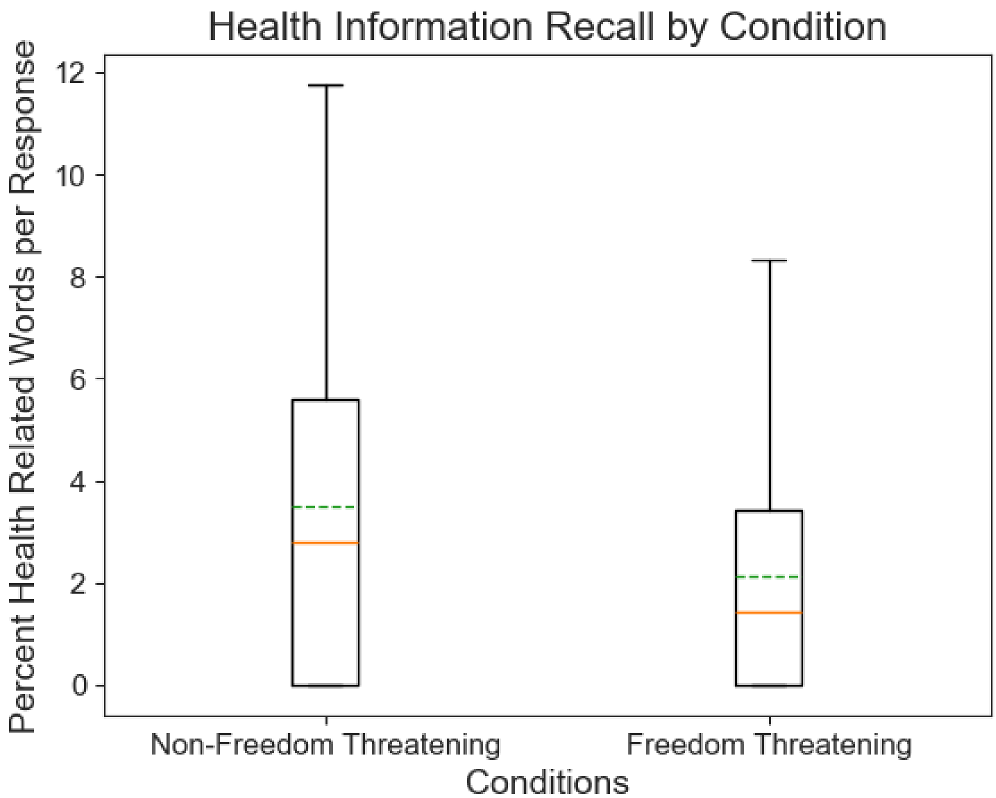

Figure 6. The boxplot illustrates the amount of health-related words in participants recall measure responses relative to non-health related words between conditions. Non-freedom threatening recall responses had significantly more health related words as calculated by LIWC dictionary and determined by t-test ($t(86) = -2.19$, $p = .03$).

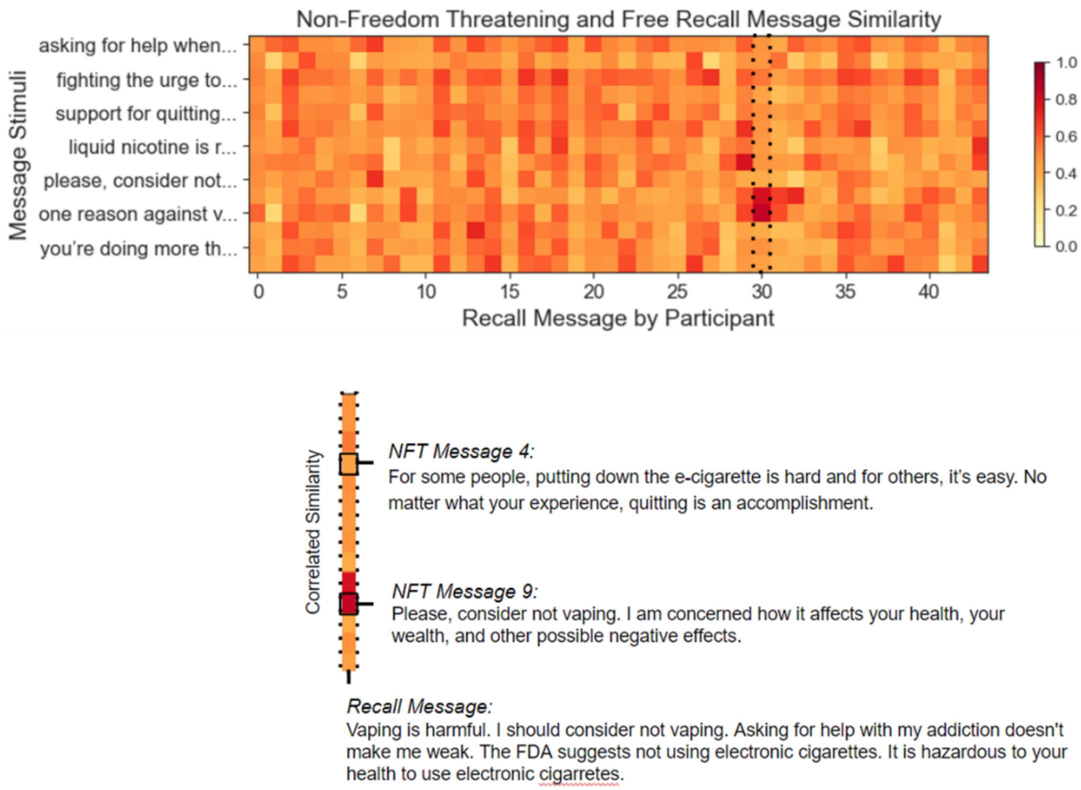

Figure 7. Semantic similarity analysis. Top panel: 20 characters from the message stimuli are presented as example language to show the similarity in meaning of the stimuli to each participants combined verbal recall measure. Each colored box represents one correlation calculated from BERT model cosine similarity between a stimuli and a participant recall measure. Darker colors indicate that the messages were more similar while lighter squares indicate less similarity between stimuli and recall. Bottom panel: One example participant and shows their full recall measure and the similarity to the messages. In this example, non-freedom threatening message 9 is more similar to the recall than non-freedom threatening message 4.

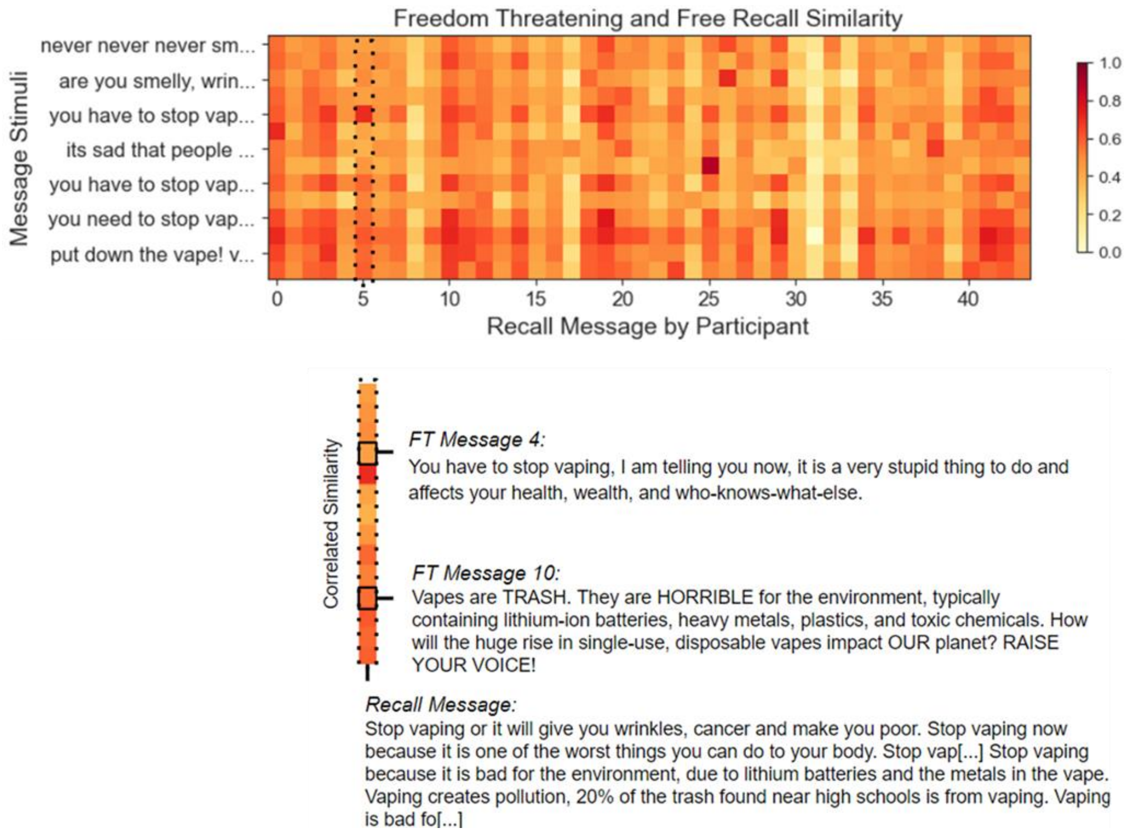

Figure 8. Semantic similarity analysis. Top panel: 20 characters from the message stimuli are presented as example language to show the similarity in meaning of the stimuli to each participants combined verbal recall measure. Each colored box represents one correlation calculated from BERT model cosine similarity between a stimuli and a participant recall measure. Darker colors indicate that the messages were more similar while lighter squares indicate less similarity between stimuli and recall. Bottom panel: One example participant and shows their full recall measure and the similarity to the messages. In this example, freedom threatening message 10 is more similar to the recall than freedom threatening message 4.

To examine whether increased reactance was associated with decreased perceived message efficacy, self-reported reactance following non-freedom threatening and freedom threatening messages were combined into one reactance measure (M = 2.96, SD = 1.50). That reactance measure was then used in an ordinary least squares regression with participants perceived message efficacy as the dependent variable. Results demonstrated a significant positive relationship between reactance and perceived message effectiveness (b(110) = 0.76, SE = 0.50 , 95% CI [0.67, 0.87]). In other words, as reactance increased, perceived message effectiveness increased (see figure 9). Therefore, H4 was not supported.

Figure 9. Graphical representation of the significant linear relationship (red regression line) between self-reported reactance (X-axis) and perceived message effectiveness. Participants reported the effectiveness of each message which was combined in to one measure of PME. Similarly, self-reported reactance was measured in response to each message and then combined across messages so each participant had one averaged measure of reactance. The results in the graph include both the non-freedom threatening and freedom threatening conditions. Increased reactance corresponded to greater perceived message efficacy ($b(110) = 0.76$, $SE = 0.50$, 95% CI [0.67, 0.87]).

H5. To examine whether reactance was positively associated with e-cig use intentions, the combined reactance measure was used in an ordinary least squares regression with participants' e-cigarette use intentions as the dependent variable. Results demonstrated a significant positive relationship between reactance and e-cig use intentions ($b(110) = 1.04$, $SE = 0.06$, 95% CI [0.93, 1.16]; see figure 10). Additionally, self-reported reactance following exposure predicted increased e-cig use intentions one week later ($b(110) = 1.07$, $SE = 0.06$, 95% CI [0.96, 1.81]) Therefore, H5 was supported.

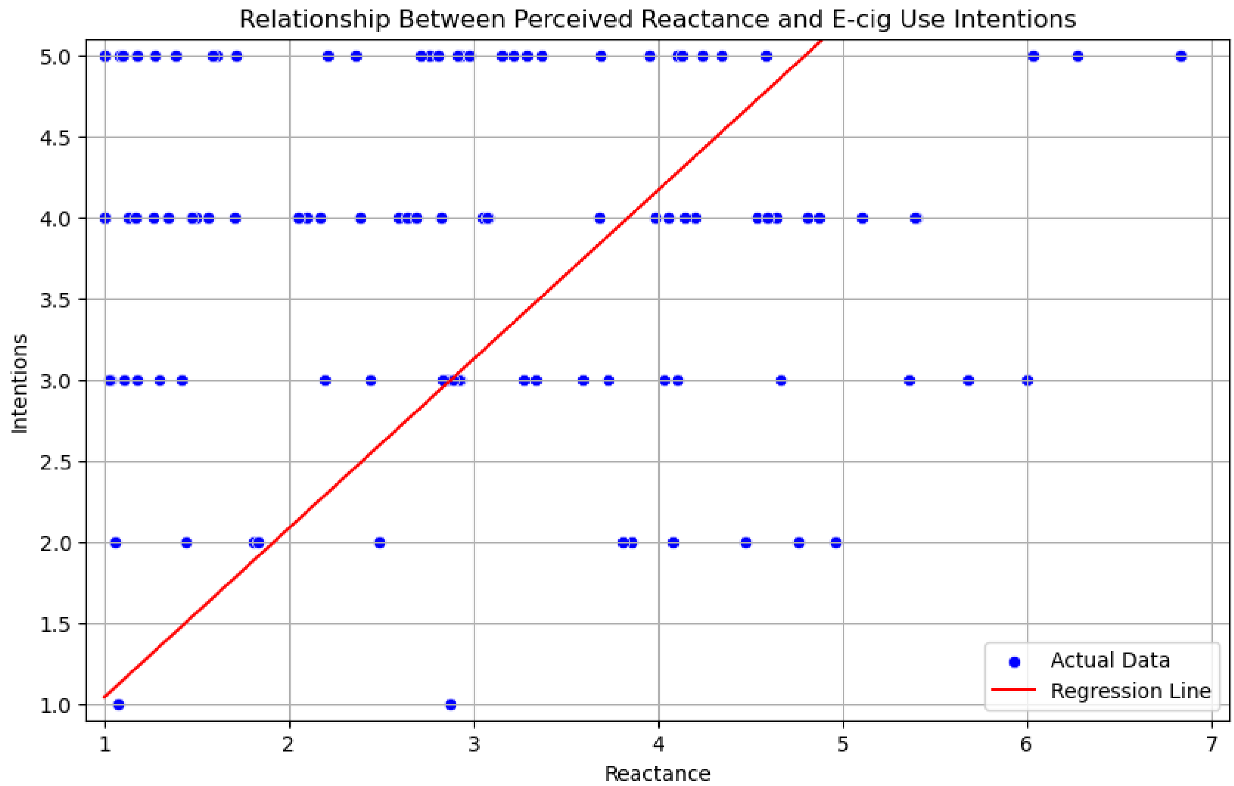

Figure 10. Graphical representation of the significant linear relationship (red regression line) between self-reported reactance (X-axis) and intentions to use e-cigarettes immediately following message exposure. Participants responded to the item 'Do you plan to keep on using e-cigarettes in the next week?' with response options 1- definitely not to 5-definitely will. Therefore, higher scores represent greater intentions to use e-cigarettes. Similarly, self-reported reactance was measured in response to each message and then combined across messages so each participant had one averaged measure of reactance. The results in the graph include both the non-freedom threatening and freedom threatening conditions. Increased reactance corresponded to significantly greater intentions to use e-cigarettes ($b(110) = 1.07$, $SE = 0.06$, 95% CI [0.96, 1.81]).

H6. To examine whether heightened e-cig intentions spiked initially only after following exposure to threatening messages, e-cig use intentions were measured at two time points. Participants intentions did not change between the time following immediate message exposure ($M = 3.86$, $SD = 1.03$) and the one-week follow-up ($M = 3.91$, $SD = 1.02$, $t(220) = -0.39$, p =.70). Therefore, H6 was not supported.

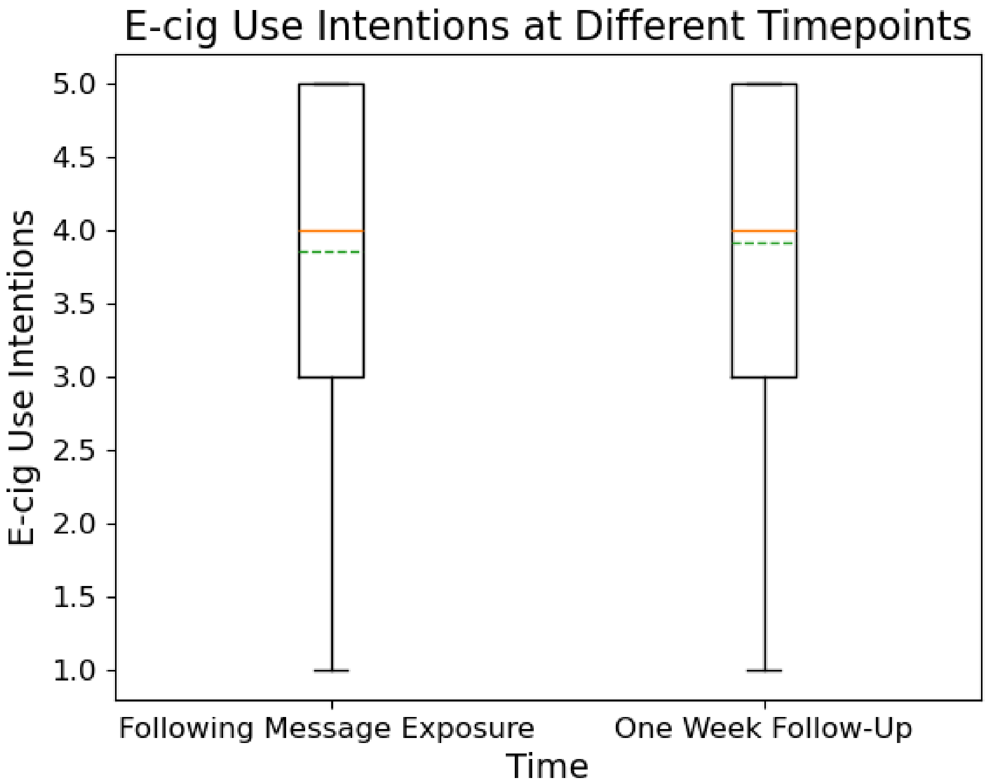

Figure 11. The boxplot illustrates the distribution of e-cig use intentions within participants across time, specifically immediately following exposure and one week later. To measure intentions, participants responded to the item ‘Do you plan to keep on using e-cigarettes in the next week?’ with response options 1- definitely not to 5- definitely will. In general, participants reported relatively high intentions to continue using e-cigarettes at both time points, although participant intentions varied.

General Discussion

The goal of anti-e-cigarette campaigns is to attract the attention of audiences and attempt to inform or persuade them about better health choices than vaping. Unfortunately, effectively changing their mind is often met with resistance. The aim of the studies here was to investigate mechanisms of message effectiveness, reactance and memory, and predict outcomes using LC4MP and reactance theory. The results of an in-person study indicated that the more people perceive messages that impede their freedoms or sense of self, the more reactance they experience. Interestingly, differences between freedom threatening and non-freedom threatening messages were not observed via ERP measurement. In the online follow-up study, results demonstrated that participants perceived freedom threatening messages as more effective, despite no changes to their intentions to use e-cig immediately following exposure or one week following exposure. Lastly, we found that freedom threatening language also diminishes health information recall from health messages.

While previous studies have applied LC4MP and reactance theory to anti e-cigarette messaging, this study offers a novel contribution to the literature by examining the neural mechanisms and the subsequent effects over time. These contributions to both theories are below, followed by limitations and future directions.

Why It's Best to Avoid Freedom Threatening Language If You Want to Positive Outcomes

Reactance theory posits that individuals may experience psychological reactance when they perceive a threat to their freedom of choice or autonomy. Recent findings also extend reactance to include threats to one's sense of self or values (Dorrance Hall et al., 2023; Holmstrom et al., 2023). Our findings here contribute and extend the findings that language is a crucial factor influencing reactance to messages. Even when messages are broken up word-by-word or appear alongside non-freedom threatening messages, controlling and insulting language significantly increases reactance. These findings align with existing literature suggesting that linguistic message features play a critical role in determining the likelihood of reactance occurrence.

In study 2, with a more diverse population, we found that reactance corresponds to greater e-cigarette use intentions immediately after message exposure and that these intentions remain elevated at a one-week follow-up. Potentially, the finding that intentions did not differ is due to participants having associated this study with negative feelings. For example, XX () found that surveying attitudes multiple times can impact how participants self-report attitudes and behaviors (Rogelberg et al., 2001). More likely, is that behavioral intentions remain consistent over time and health messages effects may also be consistent. Understanding this prolonged influence is crucial for designing interventions aimed at reducing e-cigarette use and underscores the need for ongoing monitoring and adaptation of health communication strategies to effectively address reactance and its implications for behavior change. Moreover, the findings imply that interventions targeting reactance should not only focus on immediate responses but also consider long-term effects (Lennon et al., 2010).

With these findings in mind, important implications for communicating prescriptive health messages should be considered. Most obviously, using controlling or insulting language can trigger reactance in target audiences, which may lead them to reject the health advice being communicated (Kim & So, 2018). Therefore, health messages should be crafted using language to emphasize choice and support. Using positive frames, social norms, and positive emotions consistently results in positive outcomes and should be strongly considered for prescriptive health messages (Esrick et al., 2019; Rhodes, 2017). Not only can adverse behaviors result from freedom threatening language, but such language can also damage the relationship between the communicator and the audience (Hockenberry & Billingham, 1993; Seidler et al., 2021). Thus, avoiding freedom threatening language may also be important for interpersonal relationships or credibility. In interpersonal conversations attempting to discourage e-cigarette use, participants should engage in a dialogue that emphasizes choice and respects the other's perspectives. Doing so is more likely to foster a sense of partnership and mutual respect, which is more conducive to behavior change.

Freedom Threatening Message Effects on Cognitive Resources

LC4MP outlines that people have cognitive and perceptual resource pools that are limited. When freedom threatening information occurs, LC4MP predicts that a fight mode is activated and message receivers will disengage with the ad and instead begin counterarguing the information. Looking at the reduced health information recall in the freedom threatening condition, our study supports this hypothesis. Participants were less engaged following freedom threatening messages, although the current study does not elucidate whether counterarguing or avoidance is the likely cause. The study offers support in LC4MP that memory storage may be impeded when threatening cues are in the environment.

The fast pace of this disengagement and redirection of resources should be evident in the brain. However, the study here failed to observe any differences in the ERPs following ad exposures. This differs from psychophysiological studies investigating LC4MP and reactance that demonstrate differences in responses to anti e-cigarette ads with vaping cues and threats compared to messages with vaping cues and no threats. In that study, the messages were audiovisual and not artificially manipulated to present in segregated chunks like the stimuli here. Breaking up the message word-by-word offers significant advantages and insights but can be trickier to analyze at the ERP level, especially with the Muse EEG device (Delorme & Martin, 2021). The more naturalistic audiovisual messages may induce a stronger effect that psychophysiological measures are more adept at detecting.

Moreover, within the LC4MP literature, physiological measures of information processing rely on eye tracking for visual stimuli and heart rate for audiovisual stimuli. Firstly, this study relies on a novel EEG device. Thus, the quality of the data collected compared to the psychophysiological instruments may be to blame. Both methods undergo significant data cleaning procedures and averaging. Due to these data cleaning procedures, potential errors and variance in participant responses may be deflated or inflated because of the forked-path choices (Delorne, 2022). Likely, the data cleaning in this study related to the ERP analyses may have reduced important variance at the word level by comparing message conditions. In other words, the current analyses are better equipped to understand if messages used in the freedom threatening conditions produce more difference than words within the messages (e.g., don't, stop, ew compared to try, believe, choose).

Messages that increase the likelihood of other cognitive processes (e.g., social comparisons, counterarguing) reduce cognitive resources for encoding (Bailey et al., 2018; Clayton et al., 2019). Unfortunately, here, we did not find evidence via LPP measures that demonstrated a significant difference in neural responses between non-threatening and threatening messages. These results suggest several potential outcomes: 1) freedom threatening content is not significantly likely to affect allocation of cognitive resources (e.g., attention), or 2) LPP responds to personally relevant information as well as emotional significance and e-cigarette cues evoke similar LPP responses regardless of threatening language.

The non-significant difference challenges the notion that freedom-threatening content significantly influences the allocation of cognitive resources, such as attention or emotional arousal (Clayton et al., 2020). This discrepancy prompts further evaluation of message characteristics that contribute to the changes of cognitive resources during message processing according to LC4MP. For example, resources may not be limited but simply redirected in different ways following threatening yet relevant messages (Cochran et al., 2018). A meta-analysis investigating the use of LPP to measure drug-users responses to drug cues and emotional cues found significant differences in LPP to drug vs non-drug cues but not emotional vs non-emotional cues (Webber et al., 2022). This assumption may be one interpretation of why LPP differences were not observed. Additionally, the similarity in LPP responses to personally relevant information and emotional significance suggests a complex interplay between cognitive processes and emotional arousal (McFarland et al., 2016). This interpretation supports the link between cognitive and emotional components of reactance. Therefore, personal relevance and reactance may both be important drivers of behaviors. However, the differences in long-term behaviors are still relatively unknown. Further research exploring several downstream outcomes of freedom threatening messages like willingness to engage in e-cigarette conversations or engage with anti-e-cig messages is needed to best understand today's complex health communication environment.

Critics of LC4MP often argue that differences in how people draw from these different cognitive and perceptual pools is difficult to observe and measure. Specifically, the connection between when information is being processed versus stored in memory. This argument is not specific to the LC4MP though. Information processing literature, whether examining attention, engagement, or involvement as the key mechanism of transmitting messages to the brain, mentions the difficulty measuring and defining the conceptual information processing mechanisms (Chun et al., 2011). By likening LC4MP assumptions related to how people take in, store, and retrieve information to hypothesized neural substrates (i.e., brain pathways), the study here provided and tests a promising measure of message processing (ERP). Conducting more studies with EEG to test LC4MP can address some of these critiques by measuring differences across stages of message processing and determining when (e.g., what processing stage) and where (e.g., EEG measure) resource differences may occur.

Freedom Threatening Messages and Downstream Effects on Reactance, Memory, and Intentions

The counterintuitive finding that participants exhibited greater reactance to freedom-threatening messages while simultaneously perceiving them as more effective than non-freedom-threatening messages has significant implications for message effectiveness in health communication. However, this discrepancy underscores the complex nature of message processing and underscores the need for a nuanced understanding of what constitutes effectiveness in persuasive communication. One interpretation of this finding is that while freedom-threatening messages may initially evoke resistance or reactance due to their perceived coerciveness or imposition on personal autonomy and/or identity, they may nonetheless resonate more deeply with individuals and provoke a stronger response. Some responses may include increased counterarguing, increased negative emotions, but rarely are these outcomes channeled into productive long-term changes (Dorrance Hall et al., 2023).

Some studies demonstrate increased cognitive processing of *select* message content following this heightened level of emotional arousal elicited by the threat to freedom (Clayton et al., 2020). For example, content pertaining to e-cigarette use (e.g., vapor) or the self (e.g., increased focus of how people feel about the message). Consequently, participants may perceive freedom-threatening messages as more impactful or persuasive, despite experiencing reactance. In this study, participants reported more health information from non-freedom threatening messages. This suggests that participants retained more information from messages when they did not feel their autonomy or self was threatened. From an LC4MP perspective, this makes sense because people should turn more resources inward to focus on themselves when under threat. McGuire (1968) proposed a model of persuasion involving sequential stages, emphasizing the importance of audience attention and comprehension of the message content during the initial stages of persuasion. According to McGuire, strong message recall indicates better comprehension and, consequently, a greater likelihood of message effectiveness. Thus, here, we can assume participants may have had greater comprehension of message in the non-threatening condition. Although, whether that is due to increased cognitive resources to message engagement or increased resources for recall, is unclear. Despite that ambiguity, those interested in conveying anti-e-cig messages should avoid including threatening languages if they want their target audience to remember the factual health information. Greater recall of health information has several benefits like decreasing the likelihood of spreading misinformation (Cameron et al., 2013; van der Meer & Jin, 2019), persuasion (Carpenter & Boster, 2013), and positive interpersonal conversations related to the health topic (Dunlop et al., 2010).

This finding underscores the importance of considering not only individuals' immediate reactions (e.g., reactance) to messages but also their broader perceptions of message effectiveness and persuasiveness. Effective health messages should strive to balance the need for clarity, requests, and persuasion with respect for target audiences’ freedom of choice and sense of self. Moreover, besides message effectiveness, those who want to convey effective health messages should be aware of the message effects beyond perceived effectiveness of singular messages. For example, non-freedom threatening messages result in more health message memory and potentially more resources and willingness to engage with message content again. Understanding the interplay between reactance and perceived message effectiveness can inform the development of more nuanced and impactful communication interventions that engage audiences and promote behavior change.

Limitations

The results here offer important insights into anti e-cigarette use messaging, but several limitations must be addressed. The messages here were meant to emphasize the difference in freedom threatening stimuli to examine reactance responses. While many messages in the current anti e-cigarette environment deter e-cig users choices and rely on scare tactics, there is a push by practitioners to emphasize positive outcomes and social norms in their messages (Gallagher & Updegraff, 2012). Our results suggest that such moves may be beneficial, and that e-cig users are less likely to be exposed to the more freedom threatening messages used in this study.

Much of the work here is novel and extends LC4MP and reactance theory by investigating neural responses. Measuring the stimuli responses using the MUSE EEG devices added a layer of difficulty in extending these findings. The benefit of the Muse's mobility and affordability resulted in decreased quality and quantity in data collected. Of the total 72 participants, only 42 included usable EEG data. Some issues were related to the packages that started up the Muse device such that the device did not collect data. Additionally, the Bluetooth connection between the computer and device frequently disconnected, a common problem (Schmoigl-Tonis et al., 2023). Other participants' data were compromised by artifacts in the EEG responses such as impossible value reads. These artifacts could be due to the four dry sensors on the device and the fact that the device is only loosely mounted – much like glasses. The loose mounting results in more movement of the brain regions the device collects from or may pull too far away. Devices with more channels or those that specifically use conductive gels or liquid solutions amplify the signal and are more adept at measuring response signals (Brown et al., 2010; Chen et al., 2014). Future research using the Muse EEG device may benefit from using the same conductive gels or saline-based liquids that can be obtained at little cost (Williams et al., 2020).

Another issue related to the neural response measurement is the methodological limitation of EEG responses, and specifically the event-related potential technique. In short, when messages arrive at the brain, they evoke a response akin to a small drop of water hitting the surface in a larger sea. The event-related potential technique works via averaging in order to isolate the small message-evoked brain response from the larger background of message-unrelated brain activity. However, this requires repeated measurements from each participant and then aggregating measures over conditions and multiple participants. This can obviously lead to challenges of response habituation or large artifacts that may easily overshadow the small changes (much like it is difficult to detect the small ripples a small drop creates when hitting the sea's surface during a storm). In summary, the signal response differences detectable by the EEG are incredibly subtle. Increasing the number of participants would improve the confidence around the signal responses and allow for a more detectable response difference (i.e., increase power) within participants by condition. Once EEG measures are deployed at a larger scale (e.g. like the millions of individuals on social media using virtual reality headsets), then it will be possible to make more robust conclusion, but for the time being, we are still confined to fairly small laboratory samples.

Data collection on MTurk presented difficulties related to response collection and completion. Nearly 18% of participants were flagged as bots by Qualtrics Survey software. Further investigation of these flagged participants demonstrated nonsensical responses to open-ended responses. For example, one flagged participant responded to the question 'tell us a conversation about e-cigarettes you recently had' with tips for improving interview performance. Such responses were extremely common. These responses frequently originated from the same geographic location or IP address. Fortunately, Qualtrics Survey offers several indicators of likely ‘bot’ software that can be active during survey responses that then flags responses. Unfortunately, this resulted in the removal of most responses. Removing the participants may have inadvertently removed responses from real people. Although unlikely, there may be something across such participants that went undetected in the current study. The other limiting factor of MTurk data collection was completion rate. The study required participants to complete 2-parts one initial survey and a one-week follow-up. Several (n = 96) participants failed to complete the follow-up survey. Inability to follow-up with these participants may have a systematic issue, such as the reactance participants experienced putting them off from participating in a follow-up or an inability to reach participants via email. Random issues may also play a role in the poor follow-up response rate. Both systematic and random issues can contribute to missing important responses differences among participants.

Future Directions

Considerable research across health-related fields has emphasized the importance of studying health behaviors of not only communities of interest or message receivers, but also their social network (Berkman & Glass, 2000; Godin & Kok, 1996; Smith & Christakis, 2008). The interaction effects between media campaigns and social influence have been theorized and shown to occur at large scales (Jeong & Bae, 2017). By examining the network attitude and behaviors, we can examine if social influence can account for additional variance in e-cigarette use and attitudes following message exposure.

Recently, an increasing amount of research suggests that how we process messages may have more to do with our social networks than previously assumed (Hyon et al., 2020; Smith et al., 2020). For example, friendship predicts neural encoding (Parkinson et al., 2018), closeness between ties increases neural receptivity (Scholz, Doré, Cooper, & Falk, 2019), and similarity between ties predicts message engagement (Song et al., 2018). Unfortunately, what is less known is how interactions with ties and whether those network members use e-cigarette affect message processing. Pandey and colleagues (2021) demonstrate that individuals that report having close social ties that are more physically active increases brain activity in areas associated with motivation and social reward when presented persuasive messages about physical activity, even when individuals themselves are not particularly motivated to increase their physical activity. Similarly, Scholz and colleagues (2019) demonstrated that regardless of positive drinking conversations with friends, neural activity in reward-related networks when viewing safe drinking messages predicted susceptibility to risky peer influence. These findings suggest that individuals' receptiveness and susceptibility to anti-e-cigarette messages may be more or less affected depending on their awareness of their friends, family, and peers e-cigarette use. These differences should be detectable using EEG and asking participants about their social network and interactions with ties. Social influence on message processing and reactance should be examined to better understanding how social influence affects resource allocation during processing anti-e-cigarette messages.

Health-related change messages from intimate partners are critical communicative levers that can influence health behavior change decisions and treatment adherence. When people suggest changes to their partners' health behaviors, a potentially impactful window of opportunity is created; however, many of these messages fail if they trigger psychological reactance and thus, resistance to healthy behavior change (Holmstrom et al., 2023). Including self-reported conversations following anti-e-cigarette message exposure may also help better understand between freedom threats, language, and health outcomes.

Extending this study to include network data and even qualitative data such as transcribed conversations would add another dimension to understanding reactance effects on behaviors over time. Adding these components would also help to triangulate markers of effective and supportive communication related to health behavior change. Given the stigmatization and health disparities associated with certain health behaviors (e.g., smoking) and subsequent diagnoses, this work could minimize deterrents (e.g., reactance) of behavior change from health campaigns and interpersonal interventions.

Conclusion

This work investigated the effectiveness of anti-e-cigarette messages, particularly the ineffectiveness and nuances of messages that include threatening language. By integrating LC4MP and reactance theory with neural mechanisms and multiple timepoints, this study advances our understanding of how messages are processed and their subsequent effects. These findings help to better understand the nature of reactance and how reactance shapes cognitive resources. Specifically, although no significant differences were observed in ERP responses typically associated with increased emotional arousal and perceived message relevance, message recall did not significantly differ. This suggests that the resource allocation hypothesized by LC4MP may be more affected by reactance following message exposure. A key practical finding is that despite initially evoking resistance, messages associated with more reactance were perceived as more effective. Even though e-cig use intentions increased with reactance, suggesting threatening messages were not actually more effective. Study limitations include issues with data collection and methodological constraints. Given the potential benefits of more mobile and less cost intensive EEG devices, these limitations should be examined in future research. Moving forward, incorporating social network analyses and qualitative data could offer deeper insights into the interplay between message processing, social influence, and behavior change. Additionally, investigating interpersonal interventions and the role of intimate partners in health communication may provide valuable strategies for mitigating reactance and promoting positive health outcomes. By leveraging insights from communication science, neuroscience, and interpersonal relationships, future interventions can better engage audiences, foster behavior change, and address the complex challenges that prevent effective persuasive health messaging.

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APPENDIX

Table 1

Depicts messages used in the study that will be pre-tested to ensure significant differences between perceived threats.

Stimuli
Freedom threatening
1. Never never never smoke an e-cigarette. Don't be a fool! Don't let Tobacco control you
2. You better call a hotline or look for a support group to quit e-cigs. Everybody who is in a clear state of mind will know that vaping is the silliest thing to do.
3. Are you smelly, wrinkled, missing teeth? Well, you will be if you keep vaping.
4. The majority of Americans see vaping as embarrassing, and report that they would never date an e-cigarette user. Stop immediately to improve your dating life.
5. You have to stop vaping, I am telling you now, it is a very stupid thing to do and affects your health, wealth, and who-knows-what-else.
6. Youth vaping must be stopped. If you see a gas station or store selling e-cigarettes to youth, you better report them.
7. It's sad that people who vape don't care at all about the environment, considering that an average of 20% of litter collected from high schools are from materials related to e-cigs.
8. Vapes are TRASH. They are HORRIBLE for the environment, typically containing lithium-ion batteries, heavy metals, plastics, and toxic chemicals. How will the huge rise in single-use, disposable vapes impact OUR planet? RAISE YOUR VOICE!
9. You have to stop vaping, I am telling you now, it is a very stupid thing to do
10. Smoking doesn't just make you ugly, but it also makes you poor.
11. You need to stop vaping. Don't be so stupid!
12. You want cancer? Then keep vaping. You want wrinkles? Then keep vaping. Preventable health outcomes all start with the bad decision to use e-cigarettes.
13. PUT DOWN THE VAPE! Vaping is one of the worst things you can do to your body.
14. Death from vaping isn't very cute. You may not be thinking about the health of your future self now, but you should be. Put down the e-cigarette before it is too late.

Table 1 (cont'd)

Stimuli
Non-freedom threatening
1. Asking for help when quitting e-cigarettes doesn't make you weak.
2. You likely already know that vaping causes cancer. What you might not know is how many different kinds.
3. Fighting the urge to vape after quitting is like fighting a former version of you. When you quit, you have to leave behind the smoker identity. You have the power to fight e-cigarette cravings.
4. For some people, putting down the e-cigarette is hard and for others, it's easy. No matter what your experience, quitting is an accomplishment.
5. Support for quitting your e-cigarette use is out there. Consider calling hotlines or finding social groups that don't vape.
6. E-cigarettes were designed to help smokers quit but have since become their own health epidemic. What would it take for you to quit nicotine?
7. Liquid nicotine is recognized by the EPA as HAZARDOUS WASTE. With that and other residual substances, e-cigarette litter can pose a biohazard risk to the environment.
8. Smoking is certainly more dangerous than e-cigs but e-cigs are still dangerous.
9. Please, consider not vaping. I am concerned how it affects your health, your wealth, and other possible negative effects.
10. E-cig companies are notorious manipulators. If you feel targeted by big tobacco and unable to quit, it's not your fault.
11. One reason against vaping are the manipulative tactics used by the tobacco industry.
12. Choosing to quit vaping will help you live longer so that you can spend time with your family and friends.
13. You're doing more than breaking a habit when you stop vaping. You're reclaiming wellness. You're reclaiming your freedom.
14. Within two weeks of quitting vaping, your lungs start to recover. It's not too late to choose.