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Original Article

Attitude-Consistent Health Messages About Electronic Cigarettes Increase Processing Time

Perceiving Message Senders as Socially Close Increases Message Recall

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Abstract: Online contexts are becoming a widely available space to disseminate health information and target specific populations for health campaigns. Limited evidence for health message engagement in these contexts exists. This study draws on the elaboration likelihood model and construal-level theory to predict processing time and recall when individuals are presented with messages for or against electronic cigarette use from socially close or distant sources. Participants (N = 159) were shown messages about electronic cigarettes, designed to look like tweets, from socially close and socially distant message senders. Processing times were highest for pro-attitudinal messages while messages from socially close sources were more likely to be recalled, and furthering social distance increased the difference in processing times for pro- and counter-attitudinal messages. We demonstrate the applicability of behavioral measures in online studies, while finding that attitudes, social distance, and their interaction affect measures of message processing. These findings suggest further exploration may be needed to differentiate between processing time and counterarguing. From our findings, we offer applied practitioners guidance on how to develop messages that target audiences will spend more time considering and are more likely to remember.

Keywords: elaboration likelihood model, construal level theory, e-cigarette use, health message processing, social media

Exposure to health messages occurs frequently within our everyday information environment, with 82% of young adults from a nationally representative sample reporting exposure to e-cigarette related messages (Truth Initiative, 2019). Considering that cognitive resources are required to process each message, and that cognitive resources are capacity limited (Fisher, Huskey, et al., 2018; Fisher, Keene, et al., 2018; Lang, 2009), not every message can be processed with the same amount of time and effort. Motivation and ability to process messages are of key importance as to how messages are selected for further processing and therefore what types of health messages we are likely to engage with (Cappella et al., 2015).

While there are several message characteristics and individual differences that shape message processing, attitudes about message content and message sources are pertinent characteristics that explain how exposure to a message from varying sources will affect the way a message receiver processes information (Petty & Cacioppo, 1986). Determining these effects is important in understanding which messages are more likely to engage an audience while also motivating positive health behaviors (Cappella et al., 2015). Understanding source effects is particularly important for messages shared online given how greatly sources can vary (e.g., health organization, peer, company) within a given platform (e.g., Twitter, Facebook), and that health campaigns are increasingly utilizing online contexts to target the public (Cugelman et al., 2011).

This study explores how characteristics of health messages as well as preexisting attitudes about e-cigarettes (a topic of mounting concern and increased research) affect an individual's processing time of and recall for health messages. We first describe the effects of attitudes, and then source effects on measures of message processing, operationalized as processing time, and memory, operationalized

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as message recall. Notably, we clarify how the social distance of a message source can interact with existing attitudes of message receivers to affect message processing in a novel way that provides greater nuance to explanations offered by existing frameworks on message processing.

Motivational Influences on Message Processing

According to the elaboration likelihood model (ELM), how we process information determines the degree to which a persuasive message is likely to be influential, and which messages are more likely to result in lasting attitude and behavior change (Petty & Cacioppo, 1986). The likelihood that an individual will elaborate on message content depends on their motivation and ability to do so. Motivation to process depends on a number of cues; specifically, we focus on attitudes toward message content and message source cues.

Attitude Effects on Message Processing

Attitudes guide message processing as a function of both message content and one's held beliefs. Fazio and colleagues (1989) demonstrated that evaluation of a message occurs when message content activates vivid memories of attitude-related content. Importantly, individuals can hold strong or weak attitudes about issues (Krosnick & Petty, 1995; Levitan & Visser, 2008). Strong attitudes are those that are considered important and reflect high personal attachment, care, and concern, while also being more psychologically and motivationally relevant (Boninger et al., 1995). Stronger attitudes are less likely to change, while weaker attitudes are less resistant to change (Krosnick & Petty, 1995). How impactful and likely to encourage behavior change a message is depends on how strongly it relates to individuals' held attitudes (Fazio et al., 1989; Trumbo & Kim, 2015). For example, accessible attitudes strongly predict smoking and drinking intentions in college students (Rhodes et al., 2019), and attitudes are stronger behavioral predictors than other predictors such as norms (DiBello et al., 2018).

Messages inconsistent with one's attitudes (counter-attitudinal) result in unfavorable thoughts and message resistance, therefore increasing the likelihood that individuals defensively process the message (Clark et al., 2008). Defensive processing takes many forms, such as limiting available cognitive resources to highly aversive stimuli, or by generating counterarguments against the message (Huskey et al., 2017). As a result of the motivation to defend preexisting attitudes when presented with counter-attitudinal information, individuals are more likely to process counter-attitudinal messages compared to pro-attitudinal messages (Clark et al., 2008). For instance, Edwards and Smith (1996) found participants spent more time processing counter-attitudinal messages rather than pro-attitudinal messages. Taken together, these results provide evidence that individuals are motivated to defend their attitudes against counter-attitudinal messages by processing available information (Edwards & Smith, 1996). And, as demonstrated above, being presented with counter-attitudinal information increases the motivation to process a message. If being presented with counter-attitudinal messages leads to counterarguing, and counterarguing is associated with increased message processing time, we would expect to replicate this effect. Therefore:

Hypothesis 1 (H1): Participants will spend more time processing information in counter-attitudinal messages compared to pro-attitudinal messages.

Processing time is an important measure to understand how people are engaging with messages in an information-rich environment. However, it is important to also understand what information people are taking away from the messages with which they engage. When individuals are more motivated to process a message, like being presented counter-attitudinal information, message content is made more salient and accessible (Newby-Clark et al., 2002). Furthermore, counterarguing leads to improved recall of message content (Cacioppo & Petty, 1979). Eagly and colleagues (2000) conducted a series of studies finding that counterarguing enhanced memories of message content even 2 weeks after message exposure. In other words, conditions in which individuals are highly motivated to process a message suggest individuals will be able to recall more information from a message (Krosnick, 1989). If being presented with counter-attitudinal messages leads to counterarguing, and counterarguing is associated with increased memory for a message, we would expect to replicate this effect. Therefore:

Hypothesis 2 (H2): Participants will recall more information from counter-attitudinal messages compared to pro-attitudinal messages.

Social Distance Motivates Message Processing

Sources are highly influential in affecting how we process message content (see Petty & Cacioppo, 1986) and a substantial body of literature addresses source-characteristic effects on message processing. Atkin and Rice (2013) state that characteristics of a message source can change how people view the similarity, credibility, and relevancy of the source, and thus can affect how people engage with a message. For example, for individuals that have low motivation to scrutinize a message, increasing source credibility

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increases message-relevant thinking (Heesacker et al., 1983). Furthermore, limited cognitive effort is required to evaluate a message source, suggesting that source evaluations are made easily and nearly automatically (Petty et al., 1998). When evaluating messages in a noncritical, low-elaborative manner, people are more likely to accept messages from likable sources and reject messages from unlikable sources (Chaiken, 1980; Lim, 2016). In a social media context, we select and engage with messages from sources we evaluate to be most like us despite being exposed to a variety of sources and opinions (Song et al., 2018).

Researchers have operationalized source effects by measuring dimensions such as group affiliations (Buchan et al., 2006), felt closeness and familiarity with others (Aron et al., 1992), and perceived differences between one's self and someone else (Eveland et al., 1999; Fiedler, 1953; Liviatan et al., 2008; Meirick, 2005; Stephan et al., 2011). As pointed out in the previous paragraph, despite the differences in how source is operationalized, findings suggest that the more positively a message receiver evaluates a message sender, the higher the message acceptance is. Perceived *social distance* may be an underlying factor that explains why findings from the ELM demonstrate that source likability, credibility, and similarity all influence a message receiver's health message processing. However, social distance has not been extensively considered, but may be useful in explaining source effects (for an exception, see Nan, 2007).

Here, social distance is defined as, "a subjective perception or experience of difference of the self to another person or other persons" (Magee & Smith, 2013, p. 2). One way of conceptualizing social distance is through construal-level theory (CLT; Trope & Liberman, 2003). CLT suggests that we evaluate the world through mental construals, which are the frames we look out at the world with, that are formed from our memories, beliefs, and past experiences. Thus, a construal that is clear, detailed, and highly accessible is close, while an abstract, speculative, and inaccessible construal is distal. The reference point for evaluating psychological distance starts at ourselves, and moves outward from there (Trope & Liberman, 2010). Therefore, social distance differs from other source characteristics because evaluating distance prompts the use of mental construals, and affects how we mentally represent information. Specifically, greater distance results in high-level, abstract evaluations of a source while lesser psychological distance is associated with low-level, concrete evaluations that are associated with greater personal relevancy of a source (see Fujita et al., 2008). If socially close others are more motivationally relevant than socially distant others, then message receivers will be more likely to process messages centrally and critically, therefore:

Hypothesis 3 (H3): Participants will spend more time processing messages from socially close message senders compared to socially distant message senders.

Decreased social distance between two people increases the likelihood of each person behaving, and holding attitudes, more similar to the other (Liviatan et al., 2008). This is supported by evidence showing that individuals who are socially closer tend to process messages more similarly than those who are socially distant (Parkinson et al., 2018). Importantly, the more receivers perceive a source to be socially distant, the number of positive traits they tend to attribute to the source decreases (Machunsky et al., 2014). One implication is that, as social closeness increases, the extent to which people project their own attitudes on that person increases, and in line with CLT, the mental representations we form of, and use to evaluate, socially close others have higher personal relevance (Nan, 2007; Park & Morton, 2015), which means that information from socially close sources should be more accessible compared to socially distant others. Therefore:

Hypothesis 4 (H4): Participants will recall more information from socially close message senders compared to socially distant message senders.

Effects of Both Social Distance and Attitudes on Message Processing

To date, little is known about how pro- or counter-attitudinal messages from a target source interact with social distance and the resulting effects on message processing. In some cases, individuals may be more biased to centrally process messages from socially distant sources. For example, Ziegler and Diehl (2001) demonstrated that individuals are more likely to process dislikable expert sources when those sources share messages similar to our own attitudes. Furthermore, previous research shows when people are presented with information that results in conflicting mental representations, such as a strong argument from a less credible source, people are motivated to process the message (Lim, 2016; Ziegler & Diehl, 2001; Ziegler et al., 2002).

However, when a message prompts two conflicting mental representations (e.g., a strong argument from an unlikable source), the perceived importance of the conflicting information decreases as social distance increases (Maglio et al., 2013). Such findings suggest that counter-attitudinal messages from distant sources are more likely to be discounted than if the same message came from a close source. For example, individuals spend more time processing counter-attitudinal messages from liked sources compared to disliked sources (Fujita et al., 2008). Social distance, which is distinct from but covaries with likability may similarly affect message processing (see Liviatan et al., 2008).

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In sum, previous findings suggest that less motivationally relevant sources sharing counter-attitudinal information results in limited message processing, while more motivationally relevant sources (e.g., closer sources) sharing counter-attitudinal information increases message processing. Using the Holbert and Park (2020) interaction typology, we propose a cleaved convergent interaction effect. Specifically, as social closeness increases, the motivation to process counter-attitudinal messages increases while motivation to process pro-attitudinal messages decreases. In addition, the largest difference in the effect of preexisting attitude consistency on message processing will occur when social distance is low and the difference in effects will decrease as social distance increases. Therefore:

Hypothesis 5 (H5): Processing time will be longest for counter-attitudinal messages from socially close senders and shortest for pro-attitudinal messages from socially close senders.

Previous research further suggests that social cues bias how attitudes are retrieved from memory (Bohner & Dickel, 2011), such that cues about the social distance of a sender should enhance the effects of attitudes on recall, therefore:

Hypothesis 6 (H6): Recall will be highest for counter-attitudinal messages from socially close senders and lowest for pro-attitudinal messages from socially close senders.

Method

Open Science Practices

Study design, hypotheses, and analysis plan were pre-registered in accordance with Open Science Practices (Dienlin et al., 2021). There were no deviations from the pre-registration. All data, materials, and code used for this study are on an Open Science Framework project page (https://osf.io/84dhx/).

Pretest

Participants

For the pretest, a total of 265 participants were recruited from Amazon Mechanical Turk (MTurk). Responses were removed if they were indicated to be spam or a duplicate response, failed the CAPTCHA, or did not complete the study, resulting in a final total of 196 responses.

Design

The pretest was conducted via MTurk. After consenting to the study, participants reported their demographic information. Participants then evaluated the perceived argument strength (Zhao et al., 2011) of 10 randomly selected pro (n = 5) and counter (n = 5) electronic cigarette (e-cigarette) messages (from a total of 20 possible messages). Participants then rated the likability (Roskos-Ewoldsen et al., 2002) and credibility (Chaiken & Maheswaran, 1994) of 10 randomly selected fictitious Twitter users (from a total of 20 possible sources). Each stimulus was viewed by between 42 and 54 participants.

Text-based messages were adapted from an online health campaign, Know the Risks (https://e-cigarettes.surgeongeneral.gov) and online advertising messages from JUUL, an e-cigarette company. The Know the Risks campaign features messages about the risks of e-cigarette use and are written for sharing on various social media platforms. Messages underwent minimal editing to provide clarification and to ensure messages were matched on word count and Flesch reading scores (see OSF for examples). Messages were evaluated on perceived argument strength and sources were evaluated on their credibility and likability for selection in the main study (see next section for specific details about the measures). Following these evaluations, participants answered a questionnaire about their smoking and e-cigarette habits. E-cigarette users were participants who used e-cigarettes in the past 30 days as defined in similar previous research (see Pei et al., 2019). The study took 15 min to complete and participants were paid US $2.08 for their time.

Dependent Measures

Argument Strength

Previous research shows that other factors like argument strength shape message processing (Petty & Cacioppo, 1986; Zhao et al., 2011). The perceived argument strength of each message was evaluated using a 10-item perceived argument strength scale ranging from 1 (= *strongly disagree*) to 5 (= *strongly agree*; Zhao et al., 2011). Cronbach's α for the perceived argument strength of each message was $\geq$ .79.

Source Characteristics

To control for source effects other than social distance and to ensure that social distance is a distinct source characteristic, the credibility and likability of the message source stimuli were measured. Credibility was measured with items from Chaiken and Maheswaran (1994) asking participants to rate trustworthiness, credibility, reliability, and expertise of sources. Response options scaled from 1 (= *very low*) to 5 (= *very high*). Cronbach's α for the credibility measure of each source was $\geq$ .90. Likability was measured with items from Roskos-Ewoldsen and colleagues (2002), which asks participants to rate a source's likability, appeal, perceived positivity, and goodness with a scale from 1 at the lowest to 7 at the highest. Cronbach's α for the likability measure of each source was $\geq$ .89.

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Message Selection

The dataset was split by e-cigarette use (users/non-users) and the mean and 95% confidence intervals of perceived argument strength for each message and perceived likability and credibility for each source were calculated. Messages and sources selected for the final stimuli creation did not differ (as indicated by overlapping confidence intervals) on perceived argument strength, credibility, or likability both within and between e-cigarette users and non-users. A total of eight messages (four pro- and four counter-attitudinal) and eight sources (four socially close and four socially distant) were selected for the main study.

Main Study

Participants

For the main study, a total of 260 undergraduate students at The Ohio State University participated with a final sample of $N = 159$ for the analyses. Participants were recruited using a university subject pool rather than MTurk to ensure participants in the main study were familiar with the social distance manipulation (discussed later). Participants were excluded for two reasons; 50 participant responses were excluded due to an error in the survey resulting in a failure to capture baseline processing times, and another 51 responses were excluded due to being incomplete, being an outlier in the total survey completion time, or being flagged as a spam response.[1] The number of participants ($n = 150$) was calculated using G*Power software (Faul et al., 2007, 2009) with a 2×2 repeated measures ANOVA in which $\alpha = .05$, power = 0.9, and a priori effect size of $r = .10$. The necessary effect size was obtained from Stiff's (1986) meta-analysis finding that messages from higher credibility sources were found to have an effect size of $r = .10$. Participants were over 18 and provided informed consent approved by the university IRB.

Design and Materials

Design

The main data-collection experiment was a 2 (pro- vs. counter-attitudinal) × 2 (low vs. high distance) within-subjects design. Multiple messages that varied in their pro- vs. counter-attitudinal content and the social distance of the message sender were used, thus making the design a repeated measure.

Participants completed the study online through a university subject pool using a personal laptop or desktop. Mobile phones and tablets were excluded. Participants first consented to the study and reported their demographic information. To familiarize participants with the experimental procedure, they completed a training task where they were shown non-health-related tweets about being a student and local community member. From there, participants were informed that they would be shown a series of tweets one at a time. Participants were randomly assigned to one of four counterbalanced orders that fully crossed low and high social distance sources with pro- or counter-attitudinal content. Stimuli determined from the pretest to be similar on perceived argument strength, credibility, and likability were used. Participants viewed each stimulus one at a time through a Qualtrics Survey and had the ability to advance to the next screen by pressing the spacebar key. The time spent on each page was recorded in milliseconds (see Edwards & Smith, 1996). As a manipulation check, participants completed a counterarguing questionnaire after each tweet. After viewing all tweets, participants reported perceived social distance of the message sharer as another manipulation check. Participants were then asked a series of questions about their behaviors regarding e-cigarette and cigarette use. The final part of the study involved a signal detection task (described later) to measure participants' message recall. Finally, participants reported any last questions and guessed at the study's purpose. Participants received course credit for their time.

Pro- and Counter-Attitudinal Messages

Messages were classified as pro- or counter-attitudinal based on the participant's self-reported e-cigarette use. Messages containing anti e-cigarette content were classified as counter-attitudinal for self-reported e-cigarette users and pro-attitudinal for self-reported non-e-cigarette users. Messages containing pro e-cigarette content were classified as counter-attitudinal for non-e-cigarette users and pro-attitudinal for e-cigarette users.

Message Source

The social distance of the message sender was manipulated for the main study. Message sender was indicated by an image of a building and affiliated name in the form of a twitter profile. Low social distance message senders were indicated as either, The Ohio State University students, local community members, or state residents via their twitter handle. Profile photos were buildings near The Ohio State University campus. The Ohio State University participants should evaluate sources with these characteristics as more socially close considering that people who are physically closer to a city report the city as more important and emotionally significant (Ekman & Bratfisch, 1965). For high social distance, message sender was manipulated by showing buildings outside of the state with twitter handles

[1] All participants were excluded prior to conducting any analyses on the data.

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indicating affiliations to distant locations (e.g., Bahamas). To make the social distance manipulation more salient, The Ohio State University affiliation was primed using messages with non-health content about local news and student life during the training task.

Manipulation Checks and Independent Variables

Attitude Consistency and Counterarguing

Measures of agreement and counterarguing served as manipulation checks that were used to assess attitudes toward messages. Participants reported agreement with messages on a 7-point Likert scale from 1 (= *disagree completely*) to 7 (= *agree completely*) to assess attitude directionality (Visser & Mirabile, 2004). Additionally, a 3-item questionnaire from Silvia (2006) was used to assess each participant's critical and counterarguing responses. Items include, "Did you criticize the message you just saw while you were viewing it?"; "Did you think of points that went against what was being said while you were viewing the message?"; and "While viewing the message, were you skeptical of what was being said?" Response options range from 1 (= *no, not at all*) to 5 (= *yes, very much*). Cronbach's α for each counterarguing scale was $\geq$ .81.

Social Distance

Social distance was measured using a two-item scale meant to capture similarity and closeness to each message source. Participants indicated how similar the message sender was to themselves, and how close they felt to the message sender with response options being 1 (= *not at all*) to 9 (= *very much*; see Liviatan et al., 2008). Cronbach's α for each social distance scale for each stimulus was $\geq$ .88.

Electronic Cigarette Use and Smoking Behavior

E-cigarette usage was used to classify participants attitudes toward e-cigarette messages, with users being for e-cigarette use and non-users being against e-cigarette use. As in the pretest, to obtain a profile of the participant's smoking behaviors, participants reported how many times in the last 30 days they used an e-cigarette. E-cigarette users (n = 38) were participants who used e-cigarettes in the past 30 days. To account for the possibility that combustible cigarette users may also be sensitive to anti-vaping messages, participants also reported how many times in the last 30 days they smoked a combustible cigarette. A total of 12 participants reported smoking combustible cigarettes, only two of which did not also use an e-cigarette.

Dependent Measures

Processing Time

Processing time was operationalized as the duration between page load for a message and when participants pressed the spacebar key to advance to the next message. This was recorded, in milliseconds, using Qualtrics. Considerable work has explored issues in collecting online reaction times (i.e., differences in web browsers, computer processing systems, and Internet speed; for a review, see Calcagnotto et al., 2021) and shown that despite possible differences resulting in slightly prolonged (typically 30 ms) reaction times, these differences did not significantly affect the power of online studies measuring reaction times (Reimers & Stewart, 2015; Woods et al., 2015). These findings offer support for our ability to use Qualtrics to accurately detect processing time differences between experimental conditions.

Means and standard errors for dependent measures by condition are reported in Table 1 (see the supplementary materials, Wilcox et al., 2021, for a breakdown by e-cigarette and combustible cigarette use). Following guidelines from Ratcliff (1993), processing times were cleaned by replacing outliers above the 95% confidence interval for each message with a value 2 standard deviations above the mean of each message. Baseline processing time was mean centered.

Signal Detection Task

A signal detection task was administered to measure message recall. The task involved showing participants 32 messages, 16 messages clipped from health messages shown to participants in the study (target messages), and 16 messages clipped from health messages not shown to participants (foil messages). Both were 10-word fragments with the target messages adopted from the eight stimuli messages and the foil messages adopted from the unused messages from the pretesting. Participants randomly viewed one message at a time on the screen for 8 s and selected "yes" or "no" to indicate if they had previously seen the fragment or not.

Following procedures by Stanislaw and Todorov (1999), sensitivity (A') and criterion bias (B") were calculated. A' measures how well participants distinguish between targets and foils, with larger values suggesting higher sensitivity (better memory; Shapiro, 1994). B" represents a threshold measure wherein larger positive values indicate a higher, more conservative threshold for participants to indicate they remember the information, and larger negative values represent a lower, more liberal threshold for participants to indicate they remember the information.

Data Analysis

Missing values for responses to counterarguing and social distance measures underwent Hotdeck imputation (see Myers, 2011). Hypotheses related to message-processing time were evaluated using repeated measures ANCOVA with attitude (pro or counter) and social distance (low or high) as within-subject factors, and average processing time for non-health messages as a baseline measure and

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Table 1. Means and standard errors (in parentheses) for dependent variables by condition

Measures	Socially close, pro-attitudinal	Socially close, counter-attitudinal	Socially distant, pro-attitudinal	Socially distant, counter-attitudinal
Response time (s)	9.51 (0.20)	9.27 (0.20)	9.77 (0.26)	8.85 (0.25)
A' (sensitivity)	0.78 (0.01)	0.78 (0.01)	0.75 (0.01)	0.72 (0.01)
B" (criterion bias)	−0.37 (0.62)	−0.35 (0.62)	−0.22 (0.58)	−0.18 (0.57)

covariate. Hypotheses related to message recall were evaluated using repeated measures ANOVA with attitude (pro or counter) and social distance (low or high) as within-subject factors. Signal detection theory (Shapiro, 1994) was applied to determine response accuracy in a recall test. All pairwise comparisons were Bonferroni corrected to control for family-wise error rates. For ANOVA and ANCOVA models, results from the multivariate tests are reported as they are more robust against violations of normality and sphericity. For additional analyses such as correlations between agreement, counterarguing, and e-cigarette use, and whether these results generalize to smokers, please see the supplementary materials (Wilcox et al., 2021).

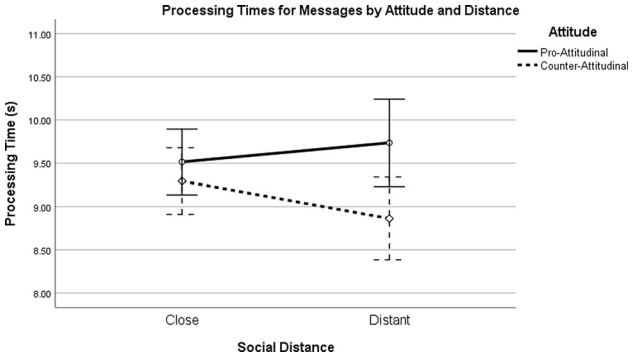

Figure 1. Interaction between attitude and social distance on processing time in seconds. Error bars: ±2 *SE*.

Results

Main Study

Manipulation Checks

Results of a paired-samples *t* test demonstrated that participants, on average, agreed significantly less with counter-attitudinal messages (M = 3.29, SD = 0.11) compared to pro-attitudinal messages (M = 4.88, SD = 0.09), $t(158) = -28.86$, $p < .001$, Cohen's d = .61. Results of a paired-samples *t* test demonstrated that participants, on average, counterargued significantly more when presented with counter-attitudinal messages (M = 3.32, SD = 0.84) than pro-attitudinal messages (M = 2.50, SD = 0.85), $t(158) = 8.74$, $p < .001$, Cohen's d = .98. In addition, the results of a paired-samples *t* test demonstrated that participants, on average, significantly felt closer to sources categorized as socially close (M = 4.01, SD = 2.00) compared to sources categorized as socially distant (M = 2.78, SD = 1.64), $t(158) = 8.62$, $p < .001$, Cohen's d = .67. Taken together, these results indicate successful manipulations.

Hypothesis Testing

Hypotheses 1 and 3 were tested using a 2 (attitude) × 2 (distance) repeated measures ANCOVA with baseline processing time as a covariate (see Figure 1). We expected that processing times would be longest for counter-attitudinal messages (H1) and socially close sources (H3). Results showed that attitude significantly affects processing time, $F(1, 157) = 10.19$, $p = .002$, Wilks's $\lambda = .94$, with longer processing times for pro-attitudinal (M = 9.64, SE = .19) compared to counter-attitudinal messages (M = 9.06, SE = .19). Although the result was significant, it was in the opposite direction of H1, such that H1 was not supported. Distance did not significantly affect processing time, $F(1, 157) = 0.22$, $p = .64$, Wilks's $\lambda = .99$. Therefore, H3 was not supported.

We posited a cleaved convergent interaction (see Holbert & Park, 2020) for H5, such that the effect of preexisting attitudes on processing time increases as social closeness increases. Instead, a significant contingent moderation interaction was found such that counter-attitudinal and pro-attitudinal messages from a close source resulted in similar processing times, but counter-attitudinal messages from a distant source resulted in significantly less processing time than pro-attitudinal messages from a distant source, $F(1, 157) = 4.07$, $p = .05$, Wilks's $\lambda = .98$. Therefore, the results, although significant, do not support H5.

Hypotheses 2 and 4 were tested using repeated measures 2 (attitude) × 2 (distance) ANOVA to determine two measures of recall based on signal detection theory, recognition accuracy (A'), and criterion bias (B"; see Figure 2). We expected that recognition accuracy would be highest, and that criterion bias would be lowest for counter-attitudinal messages (H2) and socially close sources (H4). Results indicated that participants, on average, did not differ in their recognition accuracy (A'), $F(1, 157) = 0.88$, $p = .35$, Wilks's $\lambda = .99$, or criterion bias (B"), $F(1, 157) = 0.57$, $p = .45$,

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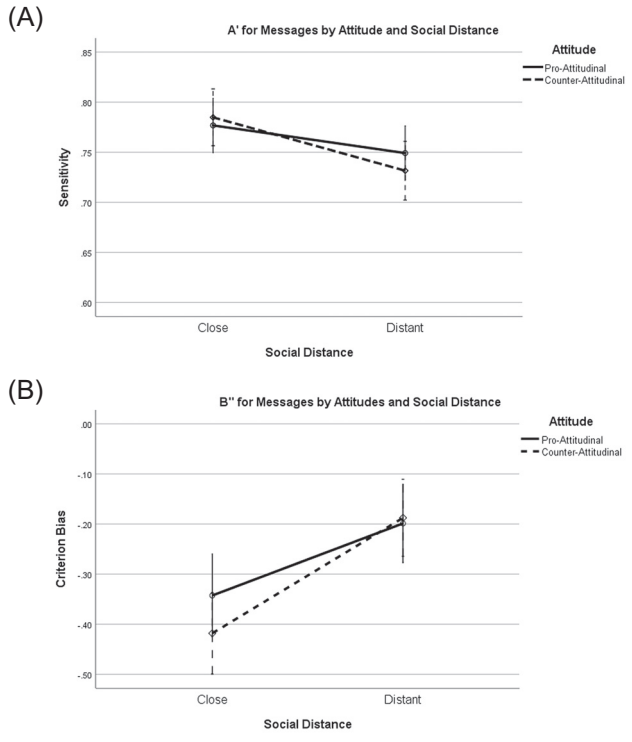

Figure 2. Interaction between attitude and social distance on sensitivity (A') and criterion bias (B''). Error bars: ±2 *SE*.

Wilks's λ = .99, for counter-attitudinal and pro-attitudinal messages. Therefore, H2 was not supported. However, in support of H4, participants had higher recognition accuracy, $F(1, 157) = 15.42$, $p < .001$, Wilks's λ = .99, and lower criterion bias, $F(1, 157) = 16.37$, $p < .001$, Wilks's λ = .91, for socially close compared to socially distant sources.

We posited a transverse negative contributory interaction for H6, with signal detection measures highest for counter-attitudinal messages from socially close sources and lowest for pro-attitudinal messages from socially close sources. No significant interaction between attitude and distance was determined for recognition accuracy, $F(1, 157) = 0.95$, $p = .33$, Wilks's λ = .99, or criterion bias, $F(1, 157) = 0.05$, $p = .81$, Wilks's λ = 1.00. Therefore, H6 was not supported.

Discussion

We manipulated message content to convey pro-attitudinal or counter-attitudinal information and varied social distance of message senders to better understand how people process health messages in a media-rich environment, and more specifically how a person's own motivation shapes message processing and recall (Cappella et al., 2015). Here, we discuss the findings of this study and the implications of the results in terms of theoretical and practical contributions.

Effects of Attitudes on Message Processing

While we found a significant relationship between attitude consistency and processing time, the relationship was in the opposite direction of what we predicted. When participants were presented a pro-attitudinal message, they spent a significantly longer time engaging with the message compared to counter-attitudinal messages. Further complicating the results, the counterarguing manipulation check was successful, demonstrating that participants counterargued significantly more when presented with counter-attitudinal messages. How attitudes impact different measures of message processing like counterarguing and response times has interesting implications as attitude researchers are increasingly using implicit measures and response-time-based paradigms (Bohner & Dickel, 2011). The contradictory results here may be due in part to the findings that e-cigarette users, in general, appear to have an attentional bias to e-cigarette content. Specifically, positive attitudes toward e-cigarette use have been previously associated with longer time looking at stimuli that contain cues related to e-cigarettes (Lochbuehler et al., 2018), and the presence of vapor in public service announcements is associated with greater cognitive resource allocation among e-cigarette users (Sanders-Jackson et al., 2019). It is worth noting that additional analysis demonstrates that these results are consistent even when only looking at smokers (see supplementary materials, Wilcox et al., 2021).

Interestingly, attitudes did not affect message recall despite participants spending more time engaging with pro-attitudinal messages. These findings contradict previous experimental research that people are less likely to remember (as measured by recognition or signal detection theory tasks) information from threatening messages that elicit stronger counterarguing responses (Clayton, Keene et al., 2019; Clayton, Lang et al., 2019). The important difference between when individuals are more likely to recall counter-attitudinal or pro-attitudinal messages may be whether a message elicits a strong emotional or threatening response. Another possible difference to explain discrepant findings is whether a study includes smokers only. Our more generalizable study using nonsmokers and smokers might yield different findings than studies using only nonsmokers that find a positive relationship between counterarguing and recall.

Notably, few studies that apply an ELM approach have measured recall using signal detection theory. Including behavioral measures of memory such as sensitivity (A') and criterion bias (B'') in future studies may better clarify

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how differences in biased message processing affect memory of information.

Effects of Social Distance on Message Processing

Results confirmed our hypothesis (H4) that individuals recalled more from socially close sources compared to socially distant sources despite distance not significantly affecting processing time (H2). People seem better at discriminating between new information from old information (A') and had a lower threshold for recalling old information (B") when the information came from socially close sources. Our results are in line with previous research suggesting that we place more importance on socially close others and discount the importance of socially distant sources (Machunsky et al., 2014).

However, in our study, source cues seem to bias people toward central processing, contradicting previous research that source characteristics operate as heuristic cues that bias people toward peripheral processing (Petty et al., 1998). These findings extend the ELM showing that source cues bias processing even when message agreement is high, and that the multidimensionality of source cues matters. Differences in perceived social distance bias message processing by affecting the memory of message receivers. Researchers interested in using message processing to predict how receivers share messages (i.e., whether a person publicly retweets health information or sends it directly to someone via private message) may want to consider using a CLT framework, as our results demonstrate that messages from socially close sources are better remembered. In line with CLT predictions that socially close sources are more relevant and mentally accessible, our findings suggest source cues bias message processing such that information from socially close sources is more mentally accessible (better recall). Even when holding credibility and likability constant, we show that social distance of a source is a distinct characteristic, and encompasses multiple dimensions like felt closeness, similarity, and self–other overlap.

Interaction Effects on Message Processing

We observed a significant interaction between preexisting attitudes and social distance for processing time. Specifically, attitudes weakly affect processing time when a message is from a socially close source but attitudes strongly affect processing time from a socially distant source. As discussed by Holbert and Park (2020), this contingent moderation interaction carries significant theoretical weight because competing effects are observed based on the level of the moderating factor. Attitudes bias processing time only for socially distant sources rather than socially close sources during message processing.

By comparison, the interaction between attitudes and social distance on A' and B" was not statistically significant. It seems that attitudes are equally motivationally relevant during recall regardless of the source. Our findings are in line with eye-tracking research findings that people give the most attention to social information when viewing e-cigarette ads (Stevens et al., 2020). Literature on eye movement tracking demonstrates that increased attention to a message correlates to increased eye movements and processing times (Rayner et al., 2006). In sum, attitude effects on message processing in online contexts may be particularly susceptible to social distance effects. Such effects should be considered carefully when predicting message processing using an ELM framework. More multidimensional measures of source cues (i.e., social distance) are helpful for information-rich environments like social media, in determining how people will select messages (see Ellison et al., 2020; Lee & Shin, 2019) and later recall a message.

Practical Contributions

Continuous exposure to a high volume of messages be it television, social media, or interpersonal discussion increases the possible reach and exposure to health campaign messages while reinforcing target health messages (Brennan et al., 2016; Hwang, 2010; Kranzler et al., 2019; Southwell & Yzer, 2009). Our results indicate that individuals are more likely to process messages from close sources, especially if the message is pro-attitudinal. Counter-attitudinal messages from distant sources are more likely to be glanced over and forgotten, which is particularly problematic for health campaigns aimed at changing health attitudes or behaviors. More alarming is that exposure to messages that contain pro-substance use content is positively correlated to engaging in risky behavior (Moreno & Whitehill, 2014). This finding combined with findings from the present study suggest targeting individuals with messages perceived as more relevant may lead to greater message recall, which might lead to a greater chance of a person adopting the targeted behavior.

While previous studies suggest that government organizations like the Centers for Disease Control and Prevention (CDC) are perceived as highly credible (for review, see Dutta-Bergman, 2003), messages from such sources may not be as engaging or memorable to target populations as socially close sources. Instead, health campaigns may benefit by targeting specific populations and using message

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sources that appear similar to the target audience. Indeed, a health message from someone perceived as more homogeneous to oneself is more likely to result in attitudes and behavioral intentions that align with the message content (Morgan et al., 2002). A fruitful area for further investigation is the interaction between socially close sources who share messages from credible sources such as the CDC. Creating messages with relevant source cues that bias audiences to engage more will result in audiences remembering the message.

Limitations

Some aspects of the study may limit the conclusions made. We did not specifically measure attitudes toward e-cigarette use in this study. Instead, we categorized attitudes by measuring e-cigarette use behavior. Although unlikely, it is possible that participants' attitudes to e-cigarette use may differ from their behavior. Attitudes about substance can be difficult to measure. Numerous scales and behavioral measures have been developed to measure attitudes about smoking or substance use, with little consensus on which measures are best (White et al., 2018). Previous research, however, supports the decision to link behavior to attitudes, finding that individuals are much more likely to behave and have behavioral intentions similar to their attitudes (Ajzen, 1991). Another possible limitation of the study is that only a relatively small number of e-cigarette users (n = 38) participated. However, our results are reflective of previous findings that among college students, about 14% report using e-cigarettes within the past 30 days (Littlefield et al., 2015). Furthermore, this limitation is mitigated considering our study was well powered, and that all factors were experimentally manipulated.

On social media, some message sources are considerably more socially close (e.g., friends, family, romantic partners) than the comparatively more distal sources we used in this study. As a result, our operationalization of social distance failed to reflect the full spectrum of social distance on which message sources might vary. With that said, we see significant and strong social distance effects on recall (Cohen's d = .66), which suggests that research designs that better maximize experimental variance for social distance may actually detect even larger effects.

Future Directions

Future studies may benefit from exploring how counterarguing impacts message recall and processing time. Counterarguing may not be an accurate indicator of an individual's motivation to process a message, and messages that elicit high counterarguing may actually impede health campaign efficacy. Considering that our results also contradict previous ELM and attitude research findings, disentangling counterarguing from processing times seems pertinent in testing the role of attitudes in biased message processing.

Exploring how message recall and processing time affects retransmission of information may be another fruitful area of future studies. Currently, new work is looking at information sharing and message processing on a neural level (see Cooper et al., 2018; Scholz et al., 2020). Retransmission of health-related content appears driven by an individual's desire to defend their attitudes and engage with attitude consistent content (Cappella et al., 2015). Impression and relationship management motives also affect retransmission, and the potential audiences (i.e., email vs. Twitter) further affect retransmission with individuals sharing more attitude-consistent content with audiences perceived as more like oneself. Expectations or impression management on social media platforms likely differ in how source and attitudes interact to bias message processing, and these differences should be examined in platform-specific ways (Fox & McEwan, 2017; Roulin & Levashina, 2016). Some platforms afford users more anonymity, and are associated with users sharing more disinhibited thoughts (Lea & Spears, 1991). Attitude consistency effects may be heightened if source cues are diminished in these spaces. While we use self-report to measure social distance, or how self-like another person is, a more expansive measure of social distance may be social network organization (see Parkinson, 2016). Extending this study on a larger scale and looking at how individuals are related to sources based on their social network organization may strengthen the findings here.

Conclusion

This study examined how attitude consistency and social distance of message senders affect processing time and message recall. We took a novel approach using an online study to collect behavior data, and made available all of the necessary code and data to extend and replicate this research using open science practices. Messages from socially close sources are recalled more, and messages perceived as pro-attitudinal result in longer time spent processing the message. Although previous findings suggest that attitudes are a key determinant in message-related outcomes, such as processing and memory, attitudes only affected processing time. Health campaigns should be made to appear socially close to target populations considering that such messages are more likely to be remembered and result in longer processing times.

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Open Data
Study design, hypotheses, and analysis plan were pre-registered in accordance with Open Science Practices. There were no deviations from the pre-registration. All data, materials, and code used for this study are on an Open Science Framework project page (https://osf.io/84dhx/).

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