

## **Morally Driven and Emotionally Fueled: The Interactive Effects of Values and Emotions in the Social Transmission of Information Endorsing E-cigarettes**

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Drawing upon the literature on moral foundations theory and the social transmission of information, our study investigated the effects of values and emotions on the sharing of pro-vaping messages on Twitter. Tweets ( $N = 9,542$ ) containing top pro-vaping hashtags during the time of e-cigarette or vaping use–associated lung injury (EVALI) and the federal vape bans were analyzed. A lexicon-based machine classifier customized to vaping discourse and the NRC Word-Emotion Association Lexicon were used to produce the frequencies of moral and emotional words in the corpus. Mixed-effects hurdle negative binomial models were performed to predict the likelihood of a post receiving one and more retweets. Results showed that moral foundations, particularly Authority/subversion and Care/harm, and emotions of anger and sadness predicted the sharing of pro-vaping tweets. Interaction effects indicated that both emotions had a stronger effect on eliciting shares when a post contained lower levels of moral foundations. This study provides insights into the mechanism of how pro-vaping messages are amplified on Twitter, emphasizing the roles of moral values and emotions in enabling the process.

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Vaping, or the use of electronic cigarettes (e-cigarettes), has been widely discussed on news media (Lyu, Wang, Huang, & Ling, 2021) and social media (Ahmed, Marin-Gomez, & Vidal-Alaball, 2020; Hong, Wu, Wijaya, Xuan, & Fetterman, 2021). E-cigarettes are battery-powered devices that typically deliver nicotine, flavorings, and other additives to users via an inhaled aerosol and are popular among youth and young adults. Approximately 9.3% of 18- to 24-year-old young adults (Cornelius, Wang, Jamal, Loretan, & Neff, 2020), 27.5% of high school students, and 10.5% of middle school students reported current e-cigarette use in the United States in 2019 (Cullen et al., 2019).

E-cigarette use is linked to the recent outbreak of e-cigarette or vaping use-associated lung injuries (EVALI) that coincided with the youth vaping epidemic (Centers for Disease Control and Prevention [CDC], 2020). At the peak of the EVALI outbreak, there were 2,807 hospitalized cases and 68 confirmed deaths, with 52% of EVALI patients under the age of 24 (CDC, 2020). In response to EVALI and the popularity of e-cigarettes among youth, in January 2020, the U.S. Food and Drug Administration (FDA, 2019) issued a ban against certain flavored cartridge-based e-cigarette products that may appeal to youth, including fruit and mint flavors.

However, despite the severity of EVALI cases, pro-vaping individuals defended the use of vaping products on social media platforms such as Twitter (Kasson, Singh, Huang, Wu, & Cavazos-Rehg, 2021), with the claim that e-cigarettes help people to quit smoking combustible cigarettes and that restricting vaping infringes on civil liberties (Wang et al., 2022). As marijuana, vitamin E acetate, and generally unregulated products were later identified as probable drivers of the EVALI cases (Gordon & Fine, 2020), pro-vaping individuals blamed the black market or underground cannabis-containing vaping products, instead of general vaping products, for causing the EVALI crisis (Wang et al., 2022). On social media, vaping supporters used hashtags such as "#WeVapeWeVote" to object to government restrictions on vaping (Ahmed et al., 2020).

Pro-vaping individuals compose a fringe group that holds strong opinions about endorsing vaping, while also advocating autonomy and the rights to vape. The pro-vaping groups are particularly vocal and dominate the social media landscape by disseminating pro-vaping narratives. In contrast, content about e-cigarettes' safety concerns raised by public health professionals and government did not appear to be as widespread as pro-vaping messages (McCausland, Maycock, Leaver, & Jancey, 2019). Behind this contrast is that "vape enthusiasts" are collaboratively discrediting tobacco control efforts on social media. For example, in response to the California Department of Public Health's "Still Blowing Smoke" campaign, e-cigarette users, manufacturers, and vendors mounted a coordinated refutation to argue against government regulations of the vaping industry while maintaining the health benefits of e-cigarettes (Allem et al., 2017).

Against this backdrop, limited research exists on the dissemination process for pro-vaping messages online. Given that tobacco control is partly hampered by the failure to communicate effectively to vaping supporters, researchers and practitioners can inform health policy by understanding pro-vaping

discourse on social media (Sangalang, 2015). Our study sought to better understand this fringe group, who often use social media to disseminate pro-vaping information. Because one's moral identity can affect the efficacy of health communications that advocate for health-promoting behaviors (e.g., vaccinations) (Achar, Dunn, & Agrawal, 2021), the current study could also inform on how to more effectively communicate the health risks of vaping with pro-vaping individuals. In this study, we sampled tweets containing pro-vaping hashtags to examine the social transmission of information endorsing e-cigarettes during the EVALI outbreak (August 1, 2019–March 1, 2020; *The Lancet Respiratory Medicine*, 2020). Our study focused on the moral and emotional aspects of pro-vaping messages to reveal the role moral foundations and emotions may play in the social transmission of pro-vaping information on Twitter.

### **Theoretical Backgrounds and Related Works**

#### ***Moral Foundations Theory and the Moralization of Tobacco Use***

Morally laudable standards, or "morals," differentiate the presumed "right" and "wrong" of our actions. People make decisions based on whether they are consistent with their moral values (Haidt & Joseph, 2004). Thus, moral values are core to one's identity and social group (Haidt & Joseph, 2004). The moral foundation theory (MFT) posits that, although individual differences exist in moral stance and intensity, five pairs of moral values are fundamental to human societies: care/harm, fairness/cheating, loyalty/betrayal, authority/subversion, and sanctity/degradation (Graham et al., 2011). Each moral foundation consists of virtue and its opposing vice. Care/harm describes kindness and nurturance versus damage and disruption. Fairness/cheating underscores reciprocal altruism and perceived justice. Loyalty/betrayal is about group coalitions (e.g., patriotism, commitment). Authority/subversion pertains to obeying or challenging the rules of hierarchy. Finally, sanctity/degradation is about senses of disgust and contamination; sanctity refers to purity and sometimes has a religious aspect, contrasting with degradation, which links to hedonic sensations (Graham et al., 2011). The five moral foundations collectively capture a breadth of values that members across different cultures draw upon to make sense of the world (Haidt & Joseph, 2004).

In a recent study that examined moralization and opinion polarization of e-cigarette use, MFT explained disagreements on vaping policies (Wang et al., 2022). The process of assigning moral values to issues that initially had no moral implications constitutes "moralization" (Rozin, 1999). Moralization often happens to issues with health concerns (Rozin & Singh, 1999), especially if they pose threats to vulnerable populations (Wang et al., 2022). For example, smoking tends to be morally sanctioned, more so among people who value the care/harm moral foundation, since secondhand smoke harms bystanders (Koleva, Graham, Iyer, Ditto, & Haidt, 2012). From the 1950s to the end of the 20th century, smoking combustible cigarettes had evolved from a personal preference to a moral issue (Rozin & Singh, 1999). The belief that smoking is immoral became strongly associated with disgust and dislike for smoking, which fostered societal support for smoke-free policies (Berg, Thrasher, O'Connor, Haardörfer, & Kegler, 2015; Rozin & Singh, 1999).

Despite commonalities between vaping (i.e., e-cigarette use) and smoking (i.e., combustible cigarette use) in that they both raise concerns of addiction and harm to vulnerable populations (e.g., youth), vaping supporters perceive e-cigarettes to be a healthier alternative and distinctively different from combustible cigarettes (Wang et al., 2022). Because of these varying perceptions, the morals surrounding

cigarettes and e-cigarettes are likely to be different hence, opening a research gap on the moralization surrounding e-cigarettes. While there are some existing studies (Minton & Gardiner, 2021; Wang et al., 2022; Yang, Maloney, Tan, & Cappella, 2018), the topic remains understudied. For example, Yang et al. (2018) found that visual vaping cues in e-cigarette advertisements can activate moral intuitions in former or current smokers, and thereafter increase their support for vape-free policies. Minton and Gardiner (2021) agreed that morally framed anti-vaping messages are more effective than traditional health warnings to decrease pro-vaping attitudes. However, these two studies focused on how to apply morality in anti-vaping campaigns. They did not study the transmission of messages that are pro-vaping, and thus could not inform us on how to combat morally tinged risk-promoting messages that endorse vaping. To the best of our knowledge, Wang and colleagues (2022) may be the first study to have examined the latent moral values (using lexicon-based computational tools) embedded in both anti-vaping and pro-vaping messages that were user-generated. Wang and colleagues (2022) compared the moral foundations of pro-vapers and anti-vapers on social media and analyzed the moral narratives of the respective groups. However, that study also did not focus on pro-vaping messages or study how pro-vaping posts transmit on social media, which is the focus of the current study. It remains unknown what role moral values play in amplifying pro-vaping messages in the public realm, particularly in the digital space.

### ***Social Transmission of Vaping-Related Moral Content***

Moral values can underlie the communication processes in online interactions (Brady, Wills, Jost, Tucker, & Van Bavel, 2017) where the desire to maintain or enhance one's group identity motivates the person to spread moral content on social media (Brady, Crockett, & Van Bavel, 2020). People's beliefs, attitudes, and behaviors are also affected by others with whom they are socially connected (Christakis & Fowler, 2009). For example, social media hashtags #vapelife and #vapefam enable pro-vaping individuals to express the "vaper" identity and cultivate vaping communities. In addition, the hashtag mechanism increases the visibility of pro-vaping messages that contain these value-laden hashtags. Research on the social transmission of morally loaded pro-vaping messages will provide insights into the emergence of "vaping culture" in online "vaping communities," where people engage in information sharing and discussions around e-cigarettes and vaping (Colditz, Welling, Smith, James, & Primack, 2017).

Moral values underpin information transmission on social media, including news on social media where the use of a moral frame increases the sharing of news articles (Valenzuela, Piña, & Ramírez, 2017). For example, audiences are particularly sensitive to morally framed news that emphasizes the moral foundations of authority/subversion (i.e., authority/respect in the previous MFT typology), fairness/reciprocity (i.e., fairness/cheating), and harm/care (i.e., care/harm; Xu, Sang, & Kim, 2020). Moral content is particularly prone to going viral, since it helps people to make sense of the world (Brosch & Van Bavel, 2012), and fulfill personal goals such as the search for justice and the need to belong to social groups (Brady et al., 2020).

Although previous research found that moral content in a message can lead to an increase in information transmission on social media (Valenzuela et al., 2017), little is known about the social transmission of pro-vaping information. The specific effect of each moral foundation on the information sharing processes, especially during major events—such as the EVALI outbreak and the federal flavor ban on cartridge-based e-cigarettes—is also less studied. Informed by previous research (Brady et al., 2017, 2020; Valenzuela et al., 2017), we propose the following research question.

*RQ1: Does each moral foundation (i.e., care/harm, fairness/cheating, loyalty/betrayal, authority/subversion, or sanctity/degradation) influence the social transmission of pro-vaping tweets?*

### **Social Transmission of Emotional Content**

The emotional aspect of an online message may also influence its social transmission. Emotionally charged tweets tend to induce more retweets and spread faster through social networks than emotionally neutral tweets (Stieglitz & Dang-Xuan, 2013). In addition, information with negative emotions is more attention-grabbing than information with positive emotions because people are biased toward automatically attending to negative content rather than positive content during information processing (Dijksterhuis & Aarts, 2003). More importantly, online information transmission may be driven by not only the valence but also the emotional arousal in the messages (Berger & Milkman, 2012). Emotional arousal refers to the level of physiological arousal or activation in experiencing an emotion (Smith & Ellsworth, 1985). For example, although anger and sadness are both negative emotions, anger is characterized by high arousal and activation, while sadness is, by nature, low arousing and deactivating (Russell & Barrett, 1999). Since information sharing requires action and mobilization, high-arousal content may increase a post's likelihood of being shared, while low-arousal content may decrease action-related behavior (Berger & Milkman, 2012).

However, previous findings on the association between information sharing and emotional arousal are mixed. One study found that news articles incorporating high-arousal emotions like anger tend to receive more shares than those with low-arousal emotions like sadness (Berger & Milkman, 2012). In contrast, another study found that anger is positively associated with the social transmission of climate change discussions but negatively associated with the social transmission of tweets about same-sex marriage (Brady et al., 2017). The mixed effects of anger on information transmission suggest that the impact of emotions may be contingent on the topic of the information. Meanwhile, negative associations are consistently found between the low-arousal emotion of sadness and the sharing of tweets across three topics (i.e., gun control, same-sex marriage, climate change; Brady et al., 2017). Thus, nuances in how high- and low-arousal emotions influencing online information sharing appear to be topic-dependent. By analyzing how different emotions affect the social transmission of pro-vaping messages online during the time of the EVALI crisis and the ban on flavored cartridge-based e-cigarettes, we will gain a better understanding of the concerns and moral arguments of pro-vaping individuals/groups. Based on previous research (Berger & Milkman, 2012; Brady et al., 2017; Russell & Barrett, 1999), we propose the following hypotheses:

*H1: Presence of the high-arousing emotion anger in a pro-vaping tweet leads to more social transmission of the tweet.*

*H2: Presence of the low-arousing emotion sadness in a pro-vaping tweet leads to less social transmission of the tweet.*

### **Interaction Between Moral and Emotional Content on Information Transmission**

According to MFT, communication of moral values is emotionally arousing (Graham et al., 2011). For example, care/harm value often elicits compassion, fairness/cheating arouses anger, and sanctity/degradation

can trigger the feeling of disgust (Haidt & Joseph, 2004). However, one study reported that although sanctity was associated with the emotion of disgust, no other associations between moral foundations and emotions (i.e., compassion, anger, fear) were identified (Landmann & Hess, 2018). The inconsistent findings about the interaction between moral values and emotions point to the need for further research.

Extensive research has shown that negative-valence information is more attention-grabbing than positive-valence information (Dijksterhuis & Aarts, 2003) and that negative emotions are often elicited when one's moral foundations are challenged (Haidt & Joseph, 2004). In our study, we focus on anger and sadness because anger is defined as a high-arousal emotion with demonstrated associations with morals (Salerno & Peter-Hagene, 2013), and sadness is chosen for being a low-arousal emotion (Brady et al., 2017) that may be compared with the high-arousal emotion of anger about their influences on the social transmission of moral content. We pose the following research questions:

*RQ2: How does anger interact with moral foundations to affect the social transmission of pro-vaping tweets?*

*RQ3: How does sadness interact with moral foundations to affect the social transmission of pro-vaping tweets?*

## **Methods**

### ***Sample and Data Collection***

We used Brandwatch Twitter firehose to collect all English language tweets ( $N = 411,039$ ) posted between August 1, 2019, and March 1, 2020, that contained at least one of our 19 vaping-related keywords.<sup>2</sup> The time frame encompassed the EVALI outbreak and the implementation of vaping regulations. Metadata of tweets including the user handle, number of followers, and retweet counts were also collected. Next, we identified the 50 most frequently used hashtags in the data set, of which 14 clearly indicated pro-vaping stances (see Table 1 for the list of pro-vaping hashtags with their frequencies ranked in descending order). Then, we extracted the 37,188 tweets (including retweets, replies, and original tweets) that contained at least one of the 14 pro-vaping hashtags. Of the 37,188 tweets, 9,542 were original tweets that formed the final sample for this study. The Institutional Review Board of Boston University deemed the study to not be human subjects research.

### ***Outcome Variable: Social Transmission of a Post***

Following previous research (Brady et al., 2017; Valenzuela et al., 2017), we operationalized the social transmission of a tweet as its number of retweets. The retweet counts of posts ranged from 0 to 496 ( $M = 2.96$ ,  $SD = 13.72$ ). The median (IQR) of retweets was 0 (1), indicating that over half of the tweets in the data set did not receive any retweets.

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<sup>2</sup> vaping or vape or vaper or vapers or vaper or vaped or evape or vaping or "e-cig\*" or ecig\* or "e-pen" or epen or "e-juice" or ejuice or "e-liquid" or eliquid or "cloud chasing" or cloudchasing or vapepen

**Table 1. Pro-Vaping Hashtags Among the Top 50 Hashtags Identified From Vaping-Related Tweets Posted Between August 1, 2019, and March 1, 2020 (N = 411,039).**

Rank in Top 50 Hashtags	Hashtag	Frequency
1	#WeVapeWeVote	21,730
4	#vapingsaveslives	6,639
6	#vapefam	3,586
7	#wevapevote	3,567
13	#vapingsavedmylife	2,434
14	#vapelif	2,413
17	#ivapeivote	2,331
18	#flavorssavelives	2,129
26	#vapers	1,794
27	#msabloodmoney	1,712
29	#vapeon	1,511
34	#vaper	1,217
38	#vapelyfe	1,024
41	#vapecommunity	955

#### ***Moral Words in a Post***

We applied a dictionary-based machine classifier (Frimer, 2019) customized to vaping (Wang et al., 2022). The dictionary includes words that indicate the five moral foundations (i.e., care/harm, fairness/cheating, loyalty/betrayal, authority/subversion, and sanctity/degradation). We modified the lexicon to capture more moral-laden words that are present in vaping discourses but not reflected in the original lexicon. The words that we added to Frimer's (2019) dictionary include "save, harmless, death," and "EVALI" for care/harm; "privilege, interest group," and "big tobacco" for fairness/cheating; "fan, national," and "un-American" for loyalty/betrayal; "legislation, vote," and "libertarian" for authority/subversion; and finally, "nicotine, tetrahydrocannabinol," and "vitamin e acetate" for sanctity/degradation.<sup>3</sup> In identifying these words from a different data set about vaping, our research team took a consensus-based decision-making approach.

#### ***Emotional Words in a Post***

We used the NRC Word-Emotion Association Lexicon (Mohammad & Turney, 2013) to identify emotional words in each post. The NRC lexicon is a list of English words and their associations with eight social emotions (i.e., anger, fear, anticipation, trust, surprise, sadness, joy, and disgust). For each post, we summed the counts of words containing each emotion of interest (i.e., anger or sadness) to examine the effect of the high- or low-arousal emotion on the social transmission of pro-vaping tweets.

<sup>3</sup> Code for the vaping-specific moralizer with the full list of additional moral words are available: [https://github.com/wang-yunwen/vaping\\_moralizer/](https://github.com/wang-yunwen/vaping_moralizer/)

### **Statistical Analyses**

In our data set, 6,379 (66.9%) tweets received no retweet, causing the distribution of the dependent variable to be skewed, overdispersed (Ver Hoef & Boveng, 2007), and zero-inflated (Cheung, 2002). We thus used hurdle negative binomial models to analyze zero-inflated social media engagement count data (Bhattacharya, Srinivasan, & Polgreen, 2017; Bohn, Buchta, Hornik, & Mair, 2014). Previous research has also applied hurdle models on social media engagement data (e.g., post likes; Bhattacharya et al., 2017) to tackle the problem of zero inflation.

The hurdle model is a two-part regression model, with a *zero portion* for the inflated zero counts and a *nonzero portion* for the positive counts. The *zero portion* predicts the likelihood of having at least one retweet with logistic regression. The count portion (i.e., *nonzero portion*) models the probability of observing more positive counts under a zero-truncated negative binomial model. The regression coefficients in the *zero portion* are exponentiated as odds ratios (OR), while the exponentiated regression coefficients in the *nonzero portion* are treated as incident rate ratios (IRR). R (Version 1.4.1106) and R package *glmmADMB* were used for the analyses. Approximately 47% of users in our sampled data set posted more than one tweet, causing a certain level of data nonindependence and autocorrelation. Thus, we included random effects of tweet authors. Specifically, we performed mixed-effects logistic regression models to predict the likelihood of receiving at least one retweet. In addition, we used mixed-effects, zero-truncated negative binomial models to predict the probability of receiving more positive retweets.

For the main effects of moral foundations (RQ1) and emotions (i.e., anger, H1; sadness, H2) on information transmission (i.e., the number of retweets), we conducted a hurdle model with each of the five moral foundations, as well as anger and sadness, as the independent variables, holding Twitter follower counts constant. Variance inflation factor scores for all independent variables in the model were under 6, indicating no multicollinearity.

For the interaction effects between moral foundations and anger (RQ2) and sadness (RQ3) on post sharing, we ran two separate hurdle models. Each hurdle model contained all five moral foundations and one of the two emotions. This was to avoid multicollinearity among the two emotion predictors. Both hurdle models controlled for Twitter follower counts. Variance inflation factor scores for all independent variables in the two models were under 6, also indicating no multicollinearity.

## **Results**

### **Descriptive Statistics**

The analyzed data set consists of 9,542 tweets posted by 1,682 unique Twitter users. About 47% of the 1,682 users ( $n = 790$ ) posted more than one pro-vaping tweet, with 13 users posting over 100 pro-vaping tweets. On average, each Twitter user posted 6 posts ( $SD = 19.7$ ). The maximum number of tweets posted by one Twitter user was 465.



After removing emojis and URLs, the average word count of a tweet in the current pro-vaping data set was 32. In the 9,542 tweets, 9,096 (95%) tweets contained at least one moral word. Care/harm was the most common moral foundation in this data set, with 66% of tweets containing at least one word about care/harm morals ( $n = 6,328$ ), followed by authority/subversion ( $n = 5,186$ ) at 54%, loyalty/betrayal ( $n = 3,188$ ) at 33%, sanctity/degradation ( $n = 2,158$ ) at 23%, and fairness/cheating ( $n = 597$ ) at 6%.

For emotions, anger was slightly more prevalent in pro-vaping tweets ( $n = 5,638$ ) at 59% than sadness ( $n = 5,506$ ), which occurred in 58% of the tweets (see Table 2 for an example of pro-vaping tweets that indicate the moral foundations and emotions).

**Table 2. Examples of Five Moral Foundations in Pro-Vaping Tweets.**

Moral Foundation	Tweet Content	Sadness Words	Anger Words
Care/harm	Undoubtedly, there are more pressing concerns at hand #vapingsavedmylife #vapingsaveslives. Each year, cigarettes <b>killed</b> 480,000 people, whereas alcohol drinks <b>killed</b> thousands, detergents <b>killed</b> 10, and flavored vaping juice <b>killed</b> zero & has <b>saved</b> people's lives. <b>#Harmreduction</b>	Kill	None
Fairness/cheating	We all agree that adolescents should not vape, smoke, drink, or use drugs. In reality, adolescents do all of the above. However, people who are of legal age shouldn't be deprived of their basic <b>rights</b> , as well as individual <b>freedoms</b> . I won't follow <b>unjust</b> policies. <b>#WeVapeWeVote #vapingsavedmylife</b>	Deprived, vote	Deprived, vote, unjust
Loyalty/betrayal	How far the anti-vaping <b>community</b> will continue to destroy the industry in our <b>community</b> . Watch this video from the public good projects with support from @handle to demonstrate how the anti-vaping groups monitor our vape <b>community</b> . <b>#WeVapeWeVote</b>	Destroy, vote	Destroy, vote
Authority/subversion	@Twitter handle @twitter handle @twitter handle @twitter handle our <b>legislators</b> blame the wrong perpetrator. The youth vaping epidemic does not exist, the number of minors who were "never-smokers" before starting vaping is quite low. Just be honest and acknowledge the	Epidemic, hurting, vote, debt	Blame, epidemic, hurting, vote

	<b>states</b> are hurting to pay the MSA debts because of the low in tobacco sales. <b>#WeVapeWeVote</b>		
Sanctity/degradation	They're lying! JUUL Box displays 50mg <b>Nic.</b> The adolescents understood it contained <b>Nicotine</b> . If adolescents are addicted to <b>Nicotine</b> , then ditch the 50mg <b>Nicotine</b> . We vape with lower <b>Nicotine</b> . #WeVapeWeVote	Vote	Lying, vote

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*Note.* Example tweets were paraphrased to avoid searchability on the web. Corresponding moral words are retained and bolded in the tweet content.

### ***Main Effects of Moral Foundations and Emotions on Pro-Vaping Information Sharing***

To test the main effects of moral foundations (RQ1) and the two emotions (i.e., anger, H1; sadness, H2) on pro-vaping information sharing, we ran all five moral foundations, as well as anger and sadness, in one hurdle model.

For the *zero portion* of the hurdle model, authority/subversion (OR = 1.16,  $p < .001$ , 95% CI [1.09, 1.23]), anger (OR = 1.18,  $p < .001$ , 95% CI [1.08, 1.30]), and sadness (OR = 1.21,  $p < .001$ , 95% CI [1.10, 1.34]) all predicted a post receiving at least one retweet. That is, compared with the 66.9% of tweets in this data set that received zero retweets, tweets containing more words about authority/subversion, anger, and sadness were more likely to be retweeted at least once (see Table 3 *zero portion*).

For the *nonzero portion* of the hurdle model, namely among tweets that had received one or more retweets, the predictors of more pro-vaping information sharing (i.e., the number of retweets) were care/harm (IRR = 1.06,  $p < .001$ , 95% CI [1.03, 1.09]), authority/subversion (IRR = 1.05,  $p = .002$ , 95% CI [1.02, 1.08]), anger (IRR = 1.07,  $p = .005$ , 95% CI [1.02, 1.13]), and sadness (IRR = 1.06,  $p = .03$ , 95% CI [1.00, 1.11]; see Table 3 *nonzero portion*).

Thus, the above results answered RQ1 (effects of five moral foundations on post sharing), supported H1, which hypothesized a positive association between anger and post sharing, but rejected H2 by also suggesting a positive association between sadness and post sharing.

About RQ1, two of the five moral foundations (i.e., authority/subversion, care/harm) promoted the social transmission of pro-vaping tweets. The authority/subversion moral foundation in pro-vaping tweets was a significant predictor for *both* the *zero* and *nonzero portions* of the hurdle model, indicating that authority/subversion words not only increased the odds for pro-vaping posts to have at least one retweet (i.e., clearing the "hurdle") but also had a positive association with the number of retweets larger than zero. For care/harm, although words indicating care/harm predicted more shares of a post if a post had already gotten its first retweet, it did not significantly help the post to get its first retweet. The other three moral foundations were not significant predictors of pro-vaping information sharing (i.e., the number of retweets) in both scenarios.

**Table 3. Hurdle Negative Binomial Model With Moral Values and Emotions Predicting Pro-Vaping Information Sharing (i.e., Retweeting).**

	Zero Portion (Likelihood of Retweeting)			Nonzero Portion (Number of Retweets)		
	Estimate (SE)	OR	<i>p</i>	Estimate (SE)	IRR	<i>p</i>
<b>Intercept</b>	-1.687 (0.084)	0.185	<.001***	1.309 (0.059)	3.71	<.001***
<b>Number of Followers/1,000</b>	0.075 (0.015)	1.078	<.001***	0.004 (0.001)	1.00	<.001***
<b>Moral Foundations</b>						
Care/harm	0.019 (0.025)	1.019	.447	0.057 (0.014)	1.06	<.001***
Fairness/cheating	0.114 (0.089)	1.121	.201	0.033 (0.046)	1.03	.466
Loyalty/betrayal	0.048 (0.049)	1.050	.328	0.028 (0.031)	1.03	.364
Authority/subversion	0.148 (0.031)	1.159	<.001***	0.048 (0.015)	1.05	.002**
Sanctity/degradation	0.003 (0.044)	1.002	.950	-0.028 (0.025)	0.97	.260
<b>Anger</b>	0.167 (0.047)	1.182	<.001***	0.069 (0.025)	1.07	.005**
<b>Sadness</b>	0.194 (0.049)	1.214	<.001***	0.055 (0.026)	1.06	.033*

Note. The estimate/coefficient (SE), exponent of coefficient (OR and IRR); \**p* < .05, \*\**p* < .01, \*\*\**p* < .001.

As for H1, anger as a high-arousal emotion increased the likelihood of a post being shared (i.e., the *zero portion* of the hurdle model) and increased its number of retweets (i.e., the *nonzero portion* of the hurdle model).

H2 was rejected. Instead of the negative association presumed, sadness as a low-arousal emotion was found to be positively associated with the number of retweets (in both *zero* and *nonzero portions* of the hurdle model). Based on this data set, anger and sadness both led to more retweets. Contrary to our expectation, the level of emotional arousal (i.e., high or low arousal) did not make a difference in the social transmission of pro-vaping information.

### **Interaction Effects Between Anger and Moral Foundations**

For the *zero portion* of the hurdle model, anger was found to interact only with one moral foundation: authority/subversion (OR = 0.85, *p* < .001, 95% CI [0.80, 0.89]; Table 4). A post was more likely to be shared at least once when it contained more words about anger, per the finding that confirmed H1. However, the interaction effect between anger and authority/subversion indicated that the effect of anger depends on the strength of authority/subversion morality. Anger had a stronger effect on whether a post received at least one share when it contained a lower level of authority/subversion than when it contained a higher level of authority/subversion. Thus, anger had a greater effect on information sharing when authority/subversion was lower.

The *nonzero portion* hurdle model showed that anger interacted with four of the five moral foundations: care/harm (IRR = 0.93, *p* = .021, 95% CI [0.87, 0.99]), loyalty/betrayal (IRR = 0.85, *p* = .004, 95% CI [0.75, 0.95]), authority/subversion (IRR = 0.90, *p* = .004, 95% CI [0.84, 0.97]), and

sanctity/degradation (IRR = 0.91,  $p = .026$ , 95% CI [0.83, 0.99]) in predicting more retweets after the post received one share (Table 4). That is, similar to the *zero portion* of the hurdle model, anger in a post predicted more shares when the post contained lower levels of care/harm, loyalty/betrayal, authority/subversion, and sanctity/degradation, compared with posts that contained higher levels of these four moral foundations. The results suggest that while morals can elicit more retweets, anger lifts or fuels the effect of morals on eliciting more shares, and the effect of anger is more pronounced when lower levels of morals are present in the tweet.

**Table 4. Hurdle Negative Binomial Model With Interaction Effects Between Moral Values and Anger Predicting Pro-Vaping Information Sharing (i.e., Retweeting).**

	Zero Portion (Likelihood of Retweeting)			Nonzero Portion (Number of Retweets)		
	Estimate (SE)	OR	$p$	Estimate (SE)	IRR	$p$
<b>Intercept</b>	-1.890 (0.101)	0.151	<.001***	-0.351 (0.162)	0.704	.031*
<b>Number of Followers/1,000</b>	0.075 (0.015)	1.078	<.001***	0.007 (0.003)	1.007	.016*
<b>Moral Foundations</b>						
Care/harm	0.077 (0.041)	1.080	.061	0.185 (0.053)	1.203	<.001***
Fairness/cheating	-0.185 (0.183)	0.831	.310	0.185 (0.203)	1.204	.361
Loyalty/betrayal	0.041 (0.066)	1.042	.531	0.315 (0.089)	1.370	<.001***
Authority/subversion	0.402 (0.049)	1.494	<.001***	0.279 (0.068)	1.322	<.001***
Sanctity/degradation	0.079 (0.074)	1.082	.286	0.184 (0.084)	1.202	.028*
<b>Anger</b>	0.554 (0.069)	1.740	<.001***	0.566 (0.092)	1.761	<.001***
<b>Interaction Effects</b>						
Care/harm × Anger	-0.043 (0.025)	0.958	.085	-0.074 (0.032)	0.929	.021*
Fairness/cheating × Anger	0.167 (0.089)	1.182	.060	-0.021 (0.094)	0.979	.819
Loyalty/betrayal × Anger	0.014 (0.053)	1.015	.781	-0.168 (0.058)	0.845	.004**
Authority/subversion × Anger	-0.166 (0.027)	0.847	<.001***	-0.106 (0.037)	0.899	.004**
Sanctity/degradation × Anger	-0.044 (0.042)	0.957	.290	-0.097 (0.044)	0.907	.026*

Note. The estimate/coefficient (SE), exponent of coefficient (OR and IRR); \* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$

#### **Interaction Effects Between Sadness and Moral Foundations**

For the *zero portion* of the hurdle model, sadness was found to interact only with two of the five moral foundations: care/harm (OR = 0.94,  $p = .013$ , 95% CI [0.88, 0.99]) and authority/subversion (OR = 0.87,  $p < .001$ , 95% CI [0.82, 0.92]; Table 5). The *nonzero portion* hurdle model showed a significant interaction effect between sadness and authority/subversion (IRR = 0.86,  $p < .001$ , 95% CI [0.80, 0.92]).

As mentioned above with the main effect, a post tended to receive at least one retweet and more retweets when it contained sadness. The interaction effect between sadness and authority/subversion further indicated that the impact of sadness depends on authority/subversion moral content. Like anger, sadness has a stronger effect on retweeting (both *zero and nonzero portions*) when a post contains lower levels of authority/subversion than when it contained higher levels of authority/subversion. In addition, the interaction effect between sadness and care/harm suggests that sadness fuels the effects of care/harm on eliciting the first retweet (the *zero portion*) when there are lower levels of care/harm present in the tweet.

**Table 5. Hurdle Negative Binomial Model With Interaction Effects between Moral Values and Sadness Predicting Pro-Vaping Information Sharing (i.e., Retweeting).**

	Zero Portion (Likelihood of Retweeting)			Nonzero Portion (Number of Retweets)		
	Estimate (SE)	OR	<i>p</i>	Estimate (SE)	IRR	<i>p</i>
<b>Intercept</b>	-1.869 (0.101)	0.154	<.001***	-0.283 (0.156)	0.754	.070
<b>Number of Followers/1,000</b>	0.074 (0.015)	1.077	<.001***	0.007 (0.003)	1.007	.016*
<b>Moral Foundations</b>						
Care/harm	0.102 (0.041)	1.107	.012*	0.112 (0.049)	1.118	.024*
Fairness/cheating	0.117 (0.170)	1.124	.491	0.234 (0.198)	1.263	.238
Loyalty/betrayal	0.042 (0.065)	1.043	.511	0.195 (0.084)	1.215	.021*
Authority/subversion	0.348 (0.048)	1.416	<.001***	0.322 (0.065)	1.379	<.001***
Sanctity/degradation	-0.060 (0.071)	0.942	.398	0.103 (0.081)	1.108	.205
<b>Sadness</b>	0.556 (0.074)	1.742	<.001***	0.579 (0.093)	1.785	<.001***
<b>Interaction Effects</b>						
Care/harm × Sadness	-0.067 (0.027)	0.936	.013*	-0.021 (0.032)	0.979	.514
Fairness/cheating × Sadness	0.025 (0.099)	1.025	.803	-0.049 (0.113)	0.951	.658
Loyalty/betrayal × Sadness	0.015 (0.056)	1.015	.790	-0.087 (0.062)	0.917	.162
Authority/subversion × Sadness	-0.143 (0.029)	0.867	<.001***	-0.151 (0.035)	0.859	<.001***
Sanctity/degradation × Sadness	0.063(0.043)	1.065	.139	-0.052 (0.044)	0.949	.234

Note. The estimate/coefficient (SE), exponent of coefficient (OR and IRR); \**p* < .05, \*\**p* < .01, \*\*\**p* < .001.

## Discussion

Drawing upon the literature on MFT and social transmission of information, our study contributed to the literature by addressing the research gap on how moral values and emotions interactively affect the

social sharing of pro-vaping messages on Twitter. We will discuss the implications of the main effects (i.e., moral foundations and emotions, respectively), as well as the interaction effects between moral foundations and emotions as they pertain to the emergence of “vaping communities” on Twitter (Colditz et al., 2017).

Our findings suggest that pro-vaping Twitter discourse is charged with moral values, with 95% of the tweets in our data set containing at least one moral word. Consistent with findings of previous research (Brosch & Van Bavel, 2012), our study demonstrates that moral content (particularly care/harm and authority/subversion) promotes the social transmission of pro-vaping information on Twitter. Care/harm and authority/subversion are two moral foundations that influence the social transmission of online information although Xu et al. (2020) report that fairness/cheating also promotes sharing of partisan news. A lack of consistent sets of moral foundations associated with the social sharing of online information may be attributed to the type of content. Likewise, it may also be attributed to the modified lexicon (Wang et al., 2022) we used that captured more moral words about vaping, hence producing more context-relevant results than research using a noncustomized lexicon (Xu et al., 2020). Future research should examine the unique expressions of situational moral virtues and vices to better understand fringe online communication for diverse social issues, as people may use divergent moral arguments when they approach different social issues. For example, “EVALI” (e-cigarette or vaping use-associated lung injury) is one of the most popular keywords in vaping discourse; it clearly indicates the care/harm moral foundation but was not included in the generic moral classifier. As mentioned in the methods section, we added this type of vaping-specific moral words to the lexicon before running the classifier. For computational social science research that involves lexicon-based automated classification of language features, customizing lexicons to specific domain knowledge may improve research validity.

Moreover, while previous research focuses on descriptive analysis of the major themes including political referendum, institutional distrust, individual rights, and smoking cessation (Kirkpatrick et al., 2021) in online pro-vaping communications, our study provides insights into how vaping-related messages get amplified on social media from the perspective of MFT. Specifically, pro-vaping individuals are more responsive to content containing care/harm and authority/subversion moral foundations. According to previous research on Facebook pages, the care/harm and authority/subversion moral foundations not only apply to anti-vaping communities with support for vape bans but also relate to pro-vaping communities that perceive their interests to be challenged by vaping regulations (Wang et al., 2022). Our study corroborates the findings on Facebook posts by finding the main effects of care/harm and authority/subversion on amplifying pro-vaping messages on Twitter (Wang et al., 2022). Our results suggest that care/harm and authority/subversion might drive the first share of pro-vaping messages on Twitter, and authority/subversion moral foundation leads to more shares of pro-vaping tweets.

It is noteworthy that the *zero portion* and *nonzero portions* of the hurdle model predicting post shares revealed different results. Although authority/subversion content predicted a post having at least one retweet and more retweets (i.e., *zero* and *nonzero portions*, respectively), care/harm moral content elicited more retweets only when the first retweet had already happened. That is, the propagating effect of care/harm words only held true after a post had the initial visibility and endorsement (i.e., at least one share), emphasizing the imperative leap from zero to one. Most tweets did not get shared—66.9% of tweets received no shares in our study. Another study consisting of a random sample of 10,000 tweets from

1,560,217 tweets found that only 219 (2.2%) tweets received one or more shares after 19 days (Suh, Hong, Pirolli, & Chi, 2010). Similarly, of 1 million tweets on four topics (i.e., climate change, 2020 election, crowdfunding, and gun control), over 75% of tweets were never retweeted (Berry, 2020). Currently, there exists a gap in the literature on the underlying mechanism of the leap from zero to one share on social media. Methodologically, our findings highlight the advantages of applying hurdle models in zero-inflated social media data, as was also suggested by previous studies (Bhattacharya et al., 2017; Bohn et al., 2014). With hurdle models, we were able to identify the difference in sharing patterns between tweets with shares and without shares. As Hofstetter, Dusseldorp, Zeileis, and Schuller (2016) argued, direct aggregation of both *zero* and *nonzero* portions of the hurdle model might result in a simplistic generalization of the whole sample, missing key nuances. Future research may consider distinguishing between receiving at least one retweet from receiving more retweets when studying information transmission on social media.

Our study expands on previous research demonstrating that morals elicit more information transmission (i.e., shares) by examining the interaction effects between morals and emotions. We found that the effects of high- and low-arousal emotions on the social transmission of pro-vaping messages were mixed. In our study, anger as a high-arousal emotion consistently increased post shares as well as the likelihood of a post receiving at least one share. The results suggest that although morals can elicit more retweets, anger lifts or fuels the effect of morals on eliciting more shares, and the effect of anger is more pronounced when lower levels of morals are present in the tweet. This effect of anger on message transmission is not surprising, as it is consistent with previous findings (Berger & Milkman, 2012; Brady et al., 2017). However, as Brady et al. (2017) pointed out, anger might have different effects on information sharing depending on the context: Anger increased the social transmission of information about climate change, which was dominated by negative emotions, while anger decreased the social transmission of information about same-sex marriage which was predominantly positive. Future research should further explicate the moderating role of issue context in determining the effect of low- and high-arousal emotions on the social transmission of online information.

Similarly, we found that sadness as a low-arousal emotion had the same effect of increasing social transmission of pro-vaping information as the high-arousal emotion of anger. This finding is different from previous research (Brady et al., 2017) that identified a negative association between low-arousal sadness and the social transmission of information about various moral topics on Twitter. This inconsistency might result from the different ways in which emotions are induced and expressed. Sadness in the pro-vaping context may come from vaping supporters' sense of helplessness in the face of federal and state bans of flavored vaping products, which ignites their motives to share a tweet charged with sadness. Although the public and media have emphasized the negative effects of vaping on public health (e.g., EVALI; Leas et al., 2021), our findings suggest that pro-vaping individuals should be recognized for their sadness during vaping-policy transitions because it could foment distrust in the government and health agencies.

In addition, we note several important findings about the interactive effects of moral and emotional content on post sharing. Anger interacted with four of the five moral foundations (i.e., care/harm, authority/subversion, loyalty/betrayal, sanctity/degradation), while sadness interacted with two moral foundations (i.e., care/harm, authority/subversion) to predict sharing of pro-vaping messages on Twitter. Our results are consistent with the previous research finding that anger could be a more common emotion that elicits moral foundations (Landmann & Hess, 2018). We also found that, while morals elicit more

retweets, anger and sadness fuel the effects of morals on eliciting more shares when a post contains lower levels of moral values than when a post contains higher levels of moral values. These findings may suggest that moral and emotional contents are intertwined to influence information transmission, with moral content promoting information transmission through the expression of emotions. Our study provides evidence of the "moral contagion" phenomenon on social media (Brady et al., 2017). More research is needed to fully understand the phenomenon and its underlying mechanism.

### ***Limitations and Future Directions***

We included only two negative emotions (i.e., anger, sadness) in testing the effect of discrete emotions on pro-vaping information sharing. Therefore, our interpretations should be viewed as limited to these emotions. Whether the findings hold true for other emotions, such as anticipation, trust, surprise, and joy, are beyond the scope of this study but are worth investigating in future research. Future research may consider the interaction effects between moral foundations and positive emotions (e.g., happiness, trust) when examining issues that are generally positive, such as same-sex marriage (Brady et al., 2017). In addition, we could not determine if the analyzed posts are affiliated with or sponsored by the vaping industry. Thus, findings of the current study relied on the assumption that the pro-vaping tweets in this study represent individuals' moral perceptions and opinions of vaping. Moreover, posts from the vaping industry might not represent moral perceptions of vaping, but rather from the perspective of the companies' benefits. Future research may distinguish posts that are from pro-vaping individuals and the vaping industry when examining the social transmission of pro-vaping messages in relation to moral values, and also when designing intervention messages.

Although the scope of this study is the social transmission of moral and emotional words, there have been well-documented concerns about social bots' impact on social media conversations about public health threats (Allem, Ferrara, Uppu, Cruz, & Unger, 2017; McCausland et al., 2020; Zhang, Qi, Chen, & Liu, 2022). However, there has not been a consensus in academia as to how to distinguish those automated accounts from human users (Zhang et al., 2022), and the impact of social bots remains ambiguous. Future studies may investigate whether account types (human users vs. social bot accounts) would impact how moral values and emotions influence information transmission on social media.

Identity is a major means to tailor and increase the effectiveness of health prevention messages. Health communications that are sensitive to intergroup interactions and identities are more effective than individual-level health communication (Gasiorek, 2015). However, although the relation of vapers' identities to their attitudes and behaviors toward vaping is important, it was not investigated in the current study. More comprehensive research of moral values and psychological mechanisms from both pro- and anti-vaping individuals is necessary to determine whether vaping is undergoing a similar or different moralization process in the 21st century compared with the moralization of smoking combustible cigarettes in the 20th century.

### ***Conclusions***

In conclusion, moral values, particularly the authority/subversion and care/harm moral foundations, drive social sharing of pro-vaping tweets, and the emotions of anger and sadness fuel such



social sharing but its impact is greatest for tweets with fewer moral values. In other words, moral values drive social sharing with emotions fueling propagation when morals are low.

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