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Patient-Centered Innovation

Applying harm reduction to COVID-19 prevention: The influence of moderation messages and risk infographics

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Abstract

Objective: We propose that harm reduction messages advocating moderation versus abstinence from social interaction will be seen as less threatening and increase intentions to follow COVID-19 guidelines. We also examine two important moderators: the influence of risk framing and willingness to risk infection.

Method: A 2 x 2 between-participants, randomized experiment (N = 476) varied infographics portraying low-risk behaviors, like going camping, versus high-risk behaviors, like attending a concert, followed by either moderation or abstinence guidelines. Participants in two additional control groups saw an infographic displaying either a full range of risk behaviors or behaviors that pose no risk, each followed by generic guidelines.

Results: Regression analyses show moderation messages are less freedom-threatening only when presenting low-risk behaviors. Persons more willing to risk infection found all messages more freedom-threatening; however, for these individuals, moderation messages increased behavioral intentions when risks were presented as high.

Conclusion: This study suggests harm reduction may be applied effectively in a pandemic, where the behavior of risk-tolerant individuals, at a population level, could have suboptimal effects on curbing virus transmission.

Practice implications: Health educators should communicate harm reduction with certain populations but also test to ensure messaging, including visuals communicating relative risks, are received as intended.

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1. Introduction

As the novel coronavirus (SARS-CoV-2/COVID-19) spread across the globe, public health efforts to contain the virus and reduce community spread were met with resistance [1]. Notably, mitigation efforts were less successful in places where individual freedoms are valued more than collective wellbeing [2,3]. In the United States, measures such as stay-at-home orders and mask requirements were criticized for violating personal freedom [4,5], and efforts to discourage risky behavior failed to gain public acceptance [6,7]. One challenge to communicating about reducing one’s risk of spreading or coming into contact with the virus is that everyday activities like grocery shopping and going out to eat become behaviors with greater-than-normal risk during the pandemic. Some of the riskiest activities can have important cultural meaning or personal benefits (e.g., attending religious services or athletic events).

Many communication and education efforts during the pandemic have focused on absolute adoption of recommended behaviors (e.g., avoidance of all behaviors resulting in increased transmission). Promoting cessation of everyday behaviors presents challenges, as people may perceive cessation as violating their freedom, hindering the adoption of recommended behaviors. One approach to public health messaging that could be effective in such instances is harm reduction [8]. Harm reduction focuses on improving overall health outcomes by emphasizing reduction, rather than cessation, of risk behaviors. Given some initial resistance among the US public regarding COVID-19 recommendations, this study examines the potential of harm reduction messaging and risk framing on how people process information about COVID-19 related behaviors.
1.1. Harm reduction and psychological reactance

The primary purpose of harm reduction interventions, used in the 1970s/1980s in response to infectious diseases like HIV, is to reduce negative health effects without eliminating risk behaviors completely [8]. Unlike abstinence-only approaches, the harm reduction model supports behavior changes from moderation to abstinence as long as the changes reduce potential harms from those behaviors [9]. The harm reduction approach has been employed across a range of public health issues in addition to infectious diseases [10].

Communication has a crucial role to play in harm reduction interventions, given its potential to inform individuals’ health decisions in support of personal and public health goals. This is particularly true when people’s understanding of relative risks has implications on their decision making. Karamouzian and colleagues have already made the case for aligning communication surrounding harm reduction interventions to reflect the unique challenges posed by a pandemic for those typically targeted with this approach [11].

The harm reduction model has traditionally been used to lessen the impact of substance use or sexual risk-taking behaviors. While it has been used in other contexts, such as promoting safe sleep to reduce infant deaths [12], there are important contextual differences to consider when applying harm reduction principles to COVID-19 health promotion. The ongoing coronavirus pandemic is something the entire population must manage, knowledge about the pandemic and solutions is fluid, and politicization and misinformation likely influence individual behaviors more so than past contexts.

An additional concern can best be understood within the context of psychological reactance theory (PRT), which posits people resist complying with messages perceived as threatening behavioral freedoms [13]. The result can lead to boomerang effects, where individuals seek to affirm or restore their behavioral freedom by resisting recommended behaviors or engaging in opposing behaviors [14,15].

Messages that are rigid or controlling in nature have been shown to increase perceived freedom threat or the belief that the message is trying to make a decision for you [16]. Conventionally, this has been demonstrated through the use of explicit, forceful, or dogmatic language [17,18]. However, any communication that eliminates or increases difficulty of engaging in desired behaviors constitutes a freedom threat [19]. Zero-tolerance messaging is by nature rigid, eliminating the option to engage in any behavior that poses a risk. Slavin and Earleywine isolated the effect of abstinence messaging and found it induced greater reactance and less favorable attitudes towards recommended behavior [20]. The relationship between abstinence and reactance has received scant attention beyond substance use, and certainly not in the context of a global pandemic. COVID-19 interventions, such as stay-at-home orders, advocating abstinence from everyday activities may be seen as threatening one’s freedom to choose and decrease intention to comply as a means of restoring freedom.

One principle of the harm reduction approach is helping individuals maintain autonomy over their health decisions [21]. Messaging emphasizing moderation rather than abstinence allows flexibility to engage in modified risks. COVID-19 interventions, such as attending small outdoor events, that reduce rather than eliminate risk should be perceived as less of a threat to freedom than abstinence messages and may increase intention to comply with recommended behaviors. Thus, we predict participants exposed to harm reduction messages will perceive less freedom threat than participants exposed to abstinence messages (H1a) and will report greater intention to engage in the recommended behaviors (H1b).

The harm reduction approach acknowledges some individuals derive important benefits from engaging in the risk behavior in question [21]. In the context of COVID-19, such benefits may include fulfilling economic, spiritual, or social needs tied to in-person interactions. Abstinence messaging may be particularly threatening to such individuals [19]. The role of trait reactance, or an individual’s predisposition to see a message as freedom threatening, has been widely considered in reactance research [22]. Situational factors may also increase an individual’s tendency to view persuasive communication as threatening [14]. In this study, we suggest people motivated to risk COVID-19 exposure to do things that are important to them may be more reactive to prevention messaging, seeing it as more threatening (H2a) and having lower intentions to comply (H2b). Because harm reduction messaging allows one to engage in risk behaviors, it may be more effective with these individuals, reducing perceived freedom threat (H3a) and increasing intention to engage in prevention behaviors (H3b).

1.2. Infographics visualizing relative risk information

Both PRT and the harm reduction approach assume people value autonomy and freedom. However, the benefits of maintaining or restoring one’s freedom may depend on the level of risk involved. At least one study found exercising freedom was less desirable under high-risk conditions [23], but research has not directly considered how information about relative risks influences perceived freedom threat and subsequent behavior intentions.

To present relative risks of various behaviors, health educators often provide information using visual information. Presenting visual information about health to people often results in positive, intended effects on key outcomes like attention, comprehension, and behavioral adherence [24]. There are numerous ways public health communicators visualize risk information, including graphical or illustrative displays [25]. Infographics have become a tool regularly used and tested as a means to inform people about health and risk information [26–28]. There are numerous examples of infographics visualizing risk throughout the COVID-19 pandemic. Johns Hopkins University created an infographic with basic information about COVID-19, symptoms, and ways to protect oneself from the virus [29]. The Centers for Disease Control and Prevention and The Lancet offer a variety of communication tools and infographics about COVID-19 risks [30,31].

Infographics continue to be studied across the world as a pandemic communication tool, with many current studies—some awaiting peer review—focused on the process of creating infographics [32,33] or their effects [34–36]. One study found newspaper infographics in India focused on risk information more than efficacy information [37]. Another study found evidence that infographics seem beneficial for rapid clinical knowledge dissemination [32]. Consistent with health communication research outside the pandemic, evidence suggests infographics can have a positive influence—though many studies focused on perceptions and not behavioral outcomes. Additionally, many studies simply add (or exclude) an infographic, providing limited guidance about how to design infographics to enhance effectiveness. Recent research on infectious diseases in general suggests visualizations can shape risk perceptions—certain features like warm colors (e.g., red or orange) might increase risk perceptions [38]. Indeed, research has found a connection between color cues and risk perceptions for health topics [39,40].

One way to communicate higher risk would be to use warmer colors to indicate riskier behaviors and cooler colors to indicate less risky behaviors. The meaning and effects of colors varies greatly across people and places, with many differences linked to cultural influences [42]. For example, red is often viewed in the US as indicating danger, though in other countries (e.g., China) red can communicate happiness [43]. Indeed, in the current study red text signals danger (i.e., higher risk).
Another way to communicate higher risk is to demonstrate that risk “grows” as behaviors become more problematic. The Texas Medical Association used colors and bars of increasing size to demonstrate the risk one takes when engaging in different activities [44]. We took this infographic and modified it for the present study to determine if varying type and quantity of risk information displayed influenced risk perceptions and behavioral intentions about COVID-19. Two questions focus our attempt at understanding the effect of visual feature variations on risk perceptions: How do visual variations of the magnitude of risky day-to-day activities influence how people perceive their own risk? (RQ1) Does willingness to risk infection interact with visual variations to shift perceived risk? (RQ2).

People typically view infographics in the context of additional information about a particular health condition. Visual content often interacts with other message features like framing [45] or freedom-threatening language [39] to influence outcomes of interest. Armstrong and colleagues found using the color red in a message strengthened the effect of freedom threatening language compared to other colors [39]. Although they do not address risk factors directly, the authors note the association of red and heightened threat/risk perceptions. Thus, their findings suggest freedom threat increases under higher risk perceptions, countering suggestions that freedom is less desirable as risk increases [23]. In considering how infographics fit with a harm reduction approach, this study examines whether emphasizing varying risk levels, through a combination of visual features, moderates the effect of harm reduction messages on freedom threat and behavioral intentions: Is the effect of harm reduction messaging strengthened or attenuated under varying levels of risk? (RQ3).

2. Method

2.1. Procedures

This study employed a between-participants 2 (low-risk/high-risk infographic) x 2 (abstinence/moderation guidelines) experimental design plus two control groups to test the hypotheses and research questions. Participants were randomly assigned to one of the six conditions (Fig. 1). The data for this analysis were collected in Week 20 (July 24–28, 2020) of a larger, multi-week dataset (COVID Communication Weekly), which surveyed 400–500 adults in the US every week using a repeated, cross-sectional design (unique participants each week). The study was administered by Qualtrics Panels and had two basic components: (1) a core set of communication items measured all weeks to examine shifts across time and (2) a message experiment that changed each week (e.g., the current study). Study procedures were approved by the Institutional Review Board of the University of Utah [00131482], and all participants gave consent before the study began.

The infographic stimuli were based on an existing COVID infographic developed by medical professionals. Participants in the low-risk infographic condition saw 12 risk behaviors, six of which were identified on the original chart as posing low risk of infection (e.g., getting restaurant takeout) and six that were identified as moderate risk (e.g., going to a backyard barbeque). Participants in the high-risk infographic condition also saw 12 risk behaviors—the same six moderate-risk behaviors and an additional six high-risk behaviors (e.g., attending a large religious service). Participants in one of the two control conditions saw an infographic with all of the low-, moderate-, and high-risk behaviors (full-risk control). In the other control condition, participants saw an infographic with four items the World Health Organization deems as posing no risk of infection (no-risk control). See Appendix A.1.

The guideline conditions varied advising participants to adhere strictly to social distancing measures (abstinence) or engage in moderate levels of social interaction (moderation). For instance, participants in the abstinence condition were advised to “Stay at home and do not leave except for essential reasons only” and “Cancel all social activities. Interact with immediate household members only.” Participants in the moderation condition were advised to “Stay home when you can and limit the number of non-essential outings” and “Attend outdoor social activities with 10 or fewer people you know.” The control condition advised participants to adhere to COVID-19 prevention guidelines from public health officials but did not present specific recommendations. See Appendix A.2.

Before viewing the infographic, participants answered questions about demographics and their willingness to risk COVID infection. After viewing the infographic, participants rated the perceived level of risk for a range of behaviors before seeing the message. Participants who saw the low- or high-risk infographics were then randomized to view the abstinence or moderation guidelines. Participants who saw the full- or no-risk infographics viewed the generic guidelines. Finally, participants responded to items for the dependent variables of interest.

Participants (N = 476) were recruited using convenience quota sampling, approximating race, gender, and high-school attainment trends of the US [46]. Participants predominantly identified as White (76%), African-American/Black (14%), Asian (6.5%), or Native American (3.8%); 16.4% identified as Hispanic/Latino. They ranged in age from 18 to 87 (M = 38.76, SD = 18.73). There were slightly more male participants (51%). Most participants reported completing high school (45%) or some college (32%). Only 3% of participants reported testing positive for COVID-19.
2.2. Measures

Risk willingness served as a moderator, measured before exposure. We used a single item to measure the extent to which participants believed “Getting COVID-19 is worth the risk if I can do the things that are important to me.” Participants responded on a 5-point agreement scale (M = 2.11, SD = 1.09). Responses were moderately skewed (−0.84) toward the low end.

Risk perceptions were measured via 24 risk-behavior items taken from the original infographic. Items included all low-, moderate-, and high-risk behaviors featured on the stimuli plus 6 additional behaviors: eating outside at a restaurant, going to a library, walking in a busy part of town, eating inside at a restaurant, hugging a friend, and attending a wedding. These additional items were included to ensure participants were not just rating behaviors on the charts they saw differently than other risk behaviors. Items were rated on 10-point scales from not at all to extremely risky. Reliability for the full model with higher-risk behaviors, we added interaction terms for predictor of risk perception for higher-risk behaviors. In a follow-up model with higher-risk behaviors, we added interaction terms for the three infographic conditions by risk willingness. There were no significant interaction effects with the high- or low-risk infographic conditions. There was a significant negative interaction for the full infographic condition. To probe that interaction, we ran moderation analyses using PROCESS for SPSS (Model 1 [49]) with 5000 bias-corrected bootstrapped samples (95% CI). There was a significant negative effect of the full infographic message at level 4 of risk willingness (b = -1.31, SE = .51, 95% CI: -2.31, -0.31, p = .01, R²-change = 0.01).

Table 3 provides results for H1-H3 and RQ3. H1a and H1b predicted harm reduction guidelines would produce lower levels of perceived freedom threat and greater intention to engage in the recommended prevention behaviors than abstinence guidelines. We ran OLS regression models with the high-risk abstinence condition as the comparison group and risk willingness as a covariate. Only the low-risk harm reduction condition produced freedom threat in comparison to the high-risk abstinence condition. There were no differences between the high-risk moderation and abstinence conditions on freedom threat. Thus, H1a is supported only under low-risk exposure. This finding also addresses RQ3, suggesting higher levels of risk attenuate the effects of harm reduction messaging in reducing freedom threat. H1b was not supported. There were no differences between any of the message conditions on behavioral intention. In both preceding models, risk willingness was a significant predictor, increasing freedom threat and reducing behavioral intentions. Thus, H2a and H2b are supported.

H3a and H3b predicted harm reduction messages would reduce perceived freedom threat and increase behavioral intention among individuals willing to take risks than abstinence messages. Two interaction terms, one for each harm reduction condition by risk willingness, were added to each of the previous models. H3a was not supported as neither high-risk or low-risk moderation conditions had a significant effect on freedom threat. H3b is supported only under high-risk exposure. The interaction of the high-risk moderation condition and risk willingness was positive and significant. There were no direct or indirect effects of the low-risk moderation condition. To probe the interaction, we ran moderated mediation analyses (PROCESS model 8), controlling for potential direct and mediating effects of perceived freedom threat. There was a significant positive effect of the high-risk moderation message on intentions at level 4 of risk willingness (b = 0.69, SE = 0.30, 95% CI: 0.09, 1.28, p = .02, R²-change = 0.01). See Fig. 2. Freedom threat was a significant negative predictor of intent but did not mediate the effect of the message. See Table 4.

3. Results

RQ1 and RQ2, which asked whether infographics highlighting different levels of risk influence risk perceptions and whether greater willingness to take risk moderates this effect. To answer RQ1, we ran an OLS regression model with low-, high-, and full-risk infographic conditions as predictors and risk willingness as a covariate. The no-risk infographic was the comparison condition. We examined effects for lower- and higher-risk behaviors. See Table 2 for results. There were no main effects of the infographic conditions in either model, but risk willingness was a significant negative predictor of risk perception for higher-risk behaviors. In a follow-up model with higher-risk behaviors, we added interaction terms for the three infographic conditions by risk willingness. There were no significant interaction effects with the high- or low-risk infographic conditions. There was a significant negative interaction for the full infographic condition. To probe that interaction, we ran moderation analyses using PROCESS for SPSS (Model 1 [49]) with 5000 bias-corrected bootstrapped samples (95% CI). There was a significant negative effect of the full infographic message at level 4 of risk willingness (b = -1.31, SE = .51, 95% CI: -2.31, -0.31, p = .01, R²-change = 0.01).

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4. Discussion and conclusion

4.1. Discussion

This study examined related issues to using visualizations of risk within harm reduction messaging and the effect of these strategies for individuals more willing to take risks during the COVID-19 pandemic. Our infographic manipulations had no discernible effect on how participants perceived the riskiness of specific COVID-risk behaviors, with the exception of the full-risk infographic that inhibited freedom threat.
decreased risk perceptions for more risk-willing individuals. However, we found evidence visual risk framing sometimes interacts with message guidelines to influence perceived freedom threats. Whereas abstinence messages increased perceived freedom threat when paired with infographics highlighting high- and low-risk behaviors, harm reduction messages only reduced freedom threat when paired with the low-risk infographic. Further, participants exposed to the full-risk infographic paired with a control message had increased freedom threat perceptions for more risk-willing individuals. Whereas abstinence messages increased perceived freedom threat when paired with infographics highlighting high- and low-risk behaviors, harm reduction messages only reduced freedom threat when paired with the low-risk infographic. Regression coefficients for freedom threat and behavior intention models (H1–H3, RQ3).

4.1. Limitations and future research

The results of this study should be considered in the context of study limitations. The inclusion of moderate-risk behaviors in both infographic treatment conditions may have influenced the risk perception results. Alternatively, participants may have been aware of the full range of risks as we were five months into the pandemic during data collection. It is also not clear why moderation messages would increase behavioral intentions among risk-willing individuals without also reducing perceived freedom threat. Future research should consider intervening variables not considered here that may have implications in the context of global pandemics. These may include uncertainty about how long guidelines should be followed. Individuals may be more willing to adhere to abstinence guidelines for a defined time (e.g., two-week lockdown) than when restrictions are prolonged indefinitely.

The US ranks high as an individualistic culture. Thus, our results may not generalize to collectivist populations, including more communal subcultures within otherwise individualistic nations. At the same time, collectivistic thinking can be primed [47]; some COVID-19 prevention campaigns urged audiences to protect their communities using messages like “we are in this together.” Future research may consider whether responses to harm reduction guidelines shift when tradeoffs between independent goals and the interdependent nature of a crisis are salient.

Table 2
Regression coefficients for risk perception models (RQ1 and RQ2).

|                         | Perceptions of lower-risk behaviors | Perceptions of higher-risk behaviors | Interaction model higher-risk behaviors |
|-------------------------|------------------------------------|-------------------------------------|----------------------------------------|
|                         | b (SE) t                           | b (SE) t                            | b (SE) t                               |
| Low-risk Infographic    | -0.41 (0.28) -1.48                 | 0.03 (0.29) 0.10                    | 0.21 (0.54) 0.38                      |
| High-risk Infographic   | -0.28 (0.28) -1.02                 | -0.07 (0.19) -0.42                  | -0.16 (0.53) -0.29                    |
| Full-risk Infographic   | -0.59 (0.33) -1.81                 | -0.31 (0.33) -0.91                  | 0.83 (0.62) 1.33                      |
| Risk Willingness        | -0.12 (0.07) -1.55                 | -0.54 (0.08) -7.08                  | -0.43 (0.17) -2.54                    |
| Risk Will*Low           | 0.02 (0.21) 0.10                   |                                    |                                        |
| Risk Will*High          | -0.08 (0.22) -0.39                 |                                    |                                        |
| Risk Will*Full          | -0.55 (0.25) -2.18                 |                                    |                                        |
| Age                     | 0.002 (0.01) 0.41                  | 0.02 (0.01) 2.69                    | 0.02 (0.01) 2.71                      |
| Education               | -0.35 (0.19) -1.88                 | -0.07 (0.19) -0.34                  | -0.06 (0.19) -0.33                    |
| Political Ideology      | -0.22 (0.09) -2.55                 | -0.40 (0.09) -4.38                  | -0.39 (0.09) -4.33                    |
| Constant                | 6.27 (0.41) 15.32                  | 8.88 (0.42) 21.11                   | 8.63 (0.53) 16.26                     |
| R²                      | 0.04 0.16                          |                                    | 0.17                                   |

Note: No-risk infographic is the comparison condition.
_ p ≤ .05, ** p ≤ .01, *** p ≤ .001

Table 3
Regression coefficients for freedom threat and behavior intention models (H1–H3, RQ3).

|                         | Freedom threat b (SE) t | Behavior intention b (SE) t | Interaction models Freedom threat b (SE) t | Behavior intention b (SE) t |
|-------------------------|------------------------|-----------------------------|-------------------------------------------|-----------------------------|
| High-risk Moderation    | 0.20 (0.16) 1.00       | 0.03 (0.19) 0.17            | 0.04 (0.26) 0.14                         | -0.71 (0.31) -2.12          |
| Low-risk Abstinence     | -0.05 (0.16) -0.30     | -0.07 (0.19) -0.28          | -0.04 (0.16) -0.27                       | -0.03 (0.19) -0.18          |
| Low-risk Moderation     | -0.45 (0.16) -2.75     | 0.07 (0.19) 0.34            | -0.68 (0.27) -2.50                       | -0.42 (0.32) -1.33          |
| Full-risk Control       | -0.16 (0.16) -1.01     | -0.23 (0.19) -1.18          | -0.17 (0.16) -1.01                       | -0.24 (0.19) -1.23          |
| No-risk Control         | -0.36 (0.16) -2.27     | 0.14 (0.19) 0.72            | -0.36 (0.16) -2.27                       | 0.13 (0.19) 0.71            |
| Risk Willingness        | 0.29 (0.04) 7.74       | -0.24 (0.05) -5.13          | 0.26 (0.04) 5.97                         | -0.33 (0.05) -6.12          |
| Risk Will*HighMod       | 0.08 (0.10) 0.75       | 0.37 (0.12) 3.06            | 0.12 (0.11) 1.05                         | 0.24 (0.13) 1.87            |
| Risk Will*LowMod        | 0.12 (0.11) 1.05       | 0.24 (0.13) 1.87            | 0.02 (0.05) -4.81                        |                             |
| Freedom Threat          | 0.04 0.20              | 0.02 (0.06) -4.61           | 0.01 (0.003) 2.09                        | 0.01 (0.003) 4.37           |
| Age                     | 0.01 (0.003) 2.06      | -0.25 (0.06) -4.61          | 0.01 (0.003) 2.09                        | 0.01 (0.003) 4.37           |
| Education               | 0.01 (0.10) 0.14       | 0.11 (0.11) 0.98            | 0.01 (0.10) 0.15                         | 0.11 (0.11) 0.98            |
| Political Ideology      | 0.14 (0.04) 3.21       | -0.16 (0.05) -3.02          | 0.14 (0.05) 3.14                         | -0.16 (0.05) -3.06          |
| Constant                | 1.43 (0.22) 6.63       | 6.82 (0.27) 25.70           | 1.49 (0.22) 6.73                         | 7.02 (0.27) 25.93           |
| R²                      | 0.18 0.22              |                             |                                         |

Note: High-risk abstinence is the comparison condition.
_ p ≤ .05, ** p ≤ .01, *** p ≤ .001
Participants with higher levels of education were underrepresented in our sample. This could explain why education was unrelated to effects. Increasing representation of individuals with less education is a strength of this study, but future studies should recruit more highly educated participants. Alternatively, the role of health literacy in processing infographics and behavior guidelines should be considered. Times of high stress and anxiety tax people’s ability to integrate changing health information into their decisions. Such research could be framed by a universal precautions perspective, given people retain more information from simpler messages regardless of their health literacy level [48].

The current study controlled for political ideology, but future studies might consider the effect of harm reduction messages among individuals with low trust in government as well as those more likely to espouse conspiracy beliefs. Finally, this study provides evidence of causal effects, but only measured behavioral intentions. Subsequent studies could strengthen these results by examining actual behaviors and other effectiveness indicators.

4.2. Conclusion

This study provides evidence that COVID-19 restrictions spur reactance. Although harm reduction messaging may not reduce freedom threat for high-risk behaviors, our results suggest it may improve compliance with guidelines among those more likely to risk exposure.

4.3. Implications for practice

An important practical implication of this research is the infographic manipulations generally had no impact on evaluations of risk behaviors. A principle underlying the creation of this and comparable visuals is they provide the public with accurate information about the riskiness of different behaviors. In practice, health educators and message designers should test such aids to discover gaps between their intended and actual impact before releasing to the public. This includes the potential for counterproductive effects as the full infographic in this study appeared to reduce perceived risk for some risk-willing individuals. Alternative approaches might include developing visuals highlighting behaviors to avoid, rather than a full-range of risks, balanced with low-risk alternatives to meet the underlying social needs that drive risk taking.

Only 16% of participants agreed COVID-19 is worth the risk of doing things that are important to them, with an additional 20% undecided, in this sample. This is a significant share when thinking about the transmissibility of COVID-19 and the potential for small groups to drive spread. Still, these individuals were the minority, and most participants were equally receptive to abstinence messaging.

Table 4
Summary of findings.

| Research Question/Hypothesis | Finding |
|------------------------------|---------|
| RQ1                          | No direct effect of infographics on risk perceptions |
| RQ2                          | Negative relationship between risk willingness and risk perceptions for higher risk behaviors. Viewing the full-risk infographic further decreased risk perceptions among those more likely to risk infection |
| H1a                          | Moderation message reduces freedom threat compared to abstinence message but only when low-risk behaviors are presented |
| H1b                          | Not supported. No direct effect of guidelines on behavior intention |
| RQ3                          | Higher levels of risk attenuates effect of moderation messages on freedom threat |
| H2a                          | Risk willingness increases perceived freedom threat |
| H2b                          | Risk willingness reduces behavior intention |
| H3a                          | Not supported. No interaction between moderation message and risk willingness on freedom threat |
| H3b                          | When risk is presented as high, moderation compared to abstinence messages increase intentions for those more likely to risk infection |
Moderation messaging may need to be tailored to individuals with higher risk tolerance rather than a broad strategy. Additionally, neither education nor communication alone can solve such public health issues. Policies and enforcement solutions to address COVID-19 are essential to achieve desired public health outcomes.

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**Declarations of interest**

None.

**Appendix A**

**Experimental Stimuli.**

A.1 Infographic stimuli.

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**CRediT authorship contribution statement**

**Deena Kemp:** Conceptualization, Methodology, Visualization, Data curation, Analysis, Writing – original draft, Writing – review & editing, Project administration, **Andy King:** Conceptualization, Methodology, Visualization, Investigation, Data curation, Analysis, Writing – original draft, Writing – review & editing, Funding acquisition, Project administration, **Sean Upshaw:** Conceptualization, Methodology, Visualization, Writing – original draft, Writing – review & editing, **Mike Mackert:** Conceptualization, Methodology, Visualization, Writing – original draft, Writing – review & editing, Supervision, **Jakob Jensen:** Investigation, Data curation, Writing – review & editing, Funding acquisition.

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**Note:** Adapted from Texas Medical Association [44].

a. Low-risk infographic
b. High-risk infographic
c. Full-risk infographic
d. No-risk infographic

**A.2 Guideline stimuli**

**Abstinence Guidelines.**

The coronavirus is a highly contagious respiratory infection. To contain the virus and slow its spread you should follow these guidelines: Stay at home and do not leave except for essential reasons only. Wear a mask outside your home at all times. Cancel all social activities. Interact with immediate household members only. Cancel all vacation and leisure travel plans. Do not make plans to travel. Postpone all non-emergent medical appointments. Do not conduct any commercial business, such as shopping, in person.
Moderation Guidelines.
The coronavirus is a highly contagious respiratory infection. To contain the virus and slow its spread you should follow these guidelines: Stay home when you can and limit the number of non-essential outings. Wear a mask whenever you will be within six feet of other people. Attend outdoor social activities with 10 or fewer people you know. Make vacation and leisure travel plans that allow for social distancing. Keep non-emergency medical appointments if you can avoid contact with sick people. Be cautious about where you conduct commercial business, such as shopping, in person.

Generic Guidelines
The coronavirus is a highly contagious respiratory infection. To contain the virus and slow its spread you should follow the recommended guidelines about staying at home, wearing masks, and engaging in social activities including leisure travel, medical appointments, and commercial business.

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