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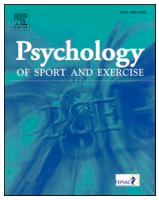

Does messaging matter? A registered report on appearance-versus health-based message framing in exercise appeals targeted towards women

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ABSTRACT

Objective: Prospect theory proposes that message framing differentially impacts the likelihood of engaging in health-related behaviors. Specifically, gain-framed messages that highlight the *benefits* of engaging in a behavior are more effective at promoting preventative behaviors than loss-framed messages highlighting the *costs* associated with a lack of engagement. Research suggests that gain-framed messages may more successfully reduce psychological reactance compared to loss-framed messages, which in turn, may promote behavioral change. However, reactance as a mechanism has been largely overlooked in the literature and support for this hypothesis is mixed. These conflicting results may be due to additional factors, such as outcomes of the targeted behavior (health vs. appearance) and goal orientation. Therefore, the present study examined whether message framing (gain- vs. loss-framing) and the fit between a health message's outcomes of focus (i.e., health vs. appearance) and an individual's goal orientation predict psychological reactance, and in turn, cognitive and behavioral outcomes related to exercise.

Design: This study employed a randomized trial with four experimental groups composed of insufficiently active women. Specifically, participants were randomized to view a loss- or gain-framed video emphasizing either health- or appearance-related outcomes.

Results: Counter to expectations, there were no between-group differences on exercise-related attitudes and intentions immediately post-intervention, or self-reported behavior at 1-week post intervention. However, when health outcomes were emphasized, loss-framed messages generally elicited more reactivity than gain-framed messages. This finding was not replicated for the appearance conditions. Appearance messages also generally elicited more reactance than health messages. Meanwhile, reactance did not predict changes in exercise-related attitudes, intentions, or self-reported behavior, and the relationship between messaging content and reactance was generally not moderated by goal orientation.

Conclusion: For young inactive women, receiving messages geared towards appearance-related risks of inactivity (e.g., weight gain) tended to produce more reactivity than messages geared towards health-related risks of inactivity (e.g., weakened immune system). However, this did not change exercise-related attitudes, intentions, or self-reported behaviors. Health gain-framed education regarding exercise may be an important part of a comprehensive intervention toolkit, but is likely not enough in and of itself to support or hinder exercise engagement, regardless of framing or emphasized outcomes.

1. Introduction

Women are regularly exposed to messages concerning their health, which can play an important educational role, as repeated exposures provide opportunities to learn about the consequences of behavior on health-related outcomes (Hornik, 2002; Viswanath, 2005). Messaging is a form of communication that is used to educate target groups about issues, such as health, and to subsequently change behavior, either directly or indirectly (Williamson et al., 2020). Health messages are vital as perception of risk (i.e., threat) often precedes behavioral change (Ferrer & Klein, 2015). However, exposure to messages can also lead to reactance, which can lead individuals to discount message content (Kim

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& So, 2018; Rains, 2013), and in turn, may undermine intentions for subsequent behavior change (Mann et al., 2013). Understanding how individuals engage with specific message-framing approaches may be key to counteracting potential reactance, and subsequently, may support behavioral initiation.

1.1. Why do individuals discount messages?

Unfortunately, individuals are prone to react defensively and to reject negative information that is personally relevant (Sherman & Cohen, 2002). This phenomenon can be explained by psychological reactance theory (Brehm, 1966), which aims to explain the reasons why persuasive messages are not always successful in eliciting behavioral change (Dillard & Shen, 2005; Rains, 2013; Richards & Banas, 2015), and cognitive dissonance theory (Festinger, 1957), which aims to explain how individuals reduce feelings of discomfort when they hold knowledge that is inconsistent with their own behavior. According to psychological reactance theory, when presented with messages perceived as a threat to their autonomy and behavioral choices, individuals tend to strive to eliminate the experience of negative affect and cognitions by responding unfavorably towards such messages. Thus, reactivity results from the belief that individuals have the choice to engage in each behavior based on their own will (Kim & So, 2018), and when individuals perceive that their autonomy is threatened, this reactance motivates them to engage in certain behaviors or cognitions against the message content (Richards & Banas, 2015). Specifically, reactivity often results in adopting attitudes *opposing* those being presented (Rains, 2013) as attitudinal changes are objectively easier to make than changes to actual behavior (Festinger, 1957). Consequently, campaigns that promote health behaviors have often been ineffective (e.g., Richards & Banas, 2015).

1.2. Prospect theory

The risk-framing hypothesis of prospect theory predicts under which conditions psychological risk will be mitigated. Prospect theory delineates gain- and loss-framed messaging by highlighting potential benefits from engaging in a behavior or potential losses from not engaging in a behavior, respectively (Kahneman & Tversky, 1979). It is proposed that gain-framed messages are more persuasive and produce less reactance than loss-framed messages when encouraging health-promotive behaviors (e.g., exercise) whereas loss-framed messages are more persuasive and produce less reactance than gain-framed messages when the behavior is risky (e.g., illness detection procedures; Li & Lee, 2021; Rothman et al., 1993; Williamson et al., 2020). The limited research on the relationship between how health messages are framed and reactance is mixed. Specifically, studies have shown that gain-framed messages mitigate reactance for certain prevention behaviors, such as sun safety (Cho & Sands, 2011; Shen, 2014), whereas it amplifies reactance for other prevention behaviors, such as exercise (Ratcliff et al., 2019). Additionally, the claims made by prospect theory (Kahneman & Tversky, 1979) are not strongly supported by meta-analytic evidence on the theory of planned behavior, which proposes that behavior is a direct result of intentions and an indirect result of attitudes (Ajzen, 1991; Gallagher & Updegraff, 2012; O'Keefe & Jensen, 2006; 2007). Specifically, the benefit of gain-framed messages over loss-framed messages on changing attitudes, intentions, and behavior, although significant, is minimal in terms of overall effect sizes ($r = .03$ to $.08$) as well as exercise-specific effect sizes ($r = .11$ to $.16$; Gallagher & Updegraff, 2012; O'Keefe & Jensen, 2006; 2007).

1.3. Outcomes highlighted in messages

The effects of message framing may be further clarified by examining additional message features (Quick et al., 2013). Messages may focus on a variety of outcomes, including the health outcomes associated with behavioral engagement, which are often seen in messaging by health associations (e.g., American Heart Association), or on appearance outcomes associated with behavioral engagement, which are frequently showcased in popular media (e.g., Aubrey & Hahn, 2016). Appearance-based messaging has shown to be advantageous over health-based messaging for various health behaviors (Heckman et al., 2009). For example, young adults who were exposed to appearance-based messages (e.g., premature aging and hyperpigmentation) wore sunscreen more frequently than young adults who were exposed to a health-based message (i.e., skin-cancer; Cheng et al., 2019; Tuong & Armstrong, 2014). Additionally, university students randomized to view an appearance-based poster emphasizing waist size were more likely to choose fruit as a snack than students who viewed a health-based poster emphasizing heart health (Appleton, 2016). However, several studies found no differences in exercise-related attitudes and intentions, which are important precursors of behavior (Ajzen, 1991), after participants read either an appearance- or health-based message (Berry & Howe, 2004; Gaston & Gammage, 2010; Rhodes & Courneya, 2001).

To date, much research has separately examined the influence of gain- and loss-framing or appearance- and health-focused message-related reactance or acceptance, and in turn, attitudes, intentions, and behavioral change. However, less is known about the potentially interactive effects of message framing and content focus on these outcomes. An initial study by Gallagher and Updegraff (2011) examined the impact of gain- and loss-framed messages, which emphasized either extrinsic (e.g., appearance) or intrinsic (e.g., increased self-esteem) outcomes. Gain-framed messages highlighting intrinsic outcomes and loss-framed messages highlighting extrinsic outcomes were more effective at increasing exercise behavior for participants with high versus low need for cognition (i.e., for those whose personality makes them more inclined to engage in effortful thinking; Gallagher & Updegraff, 2011). However, message perception (i.e., perceived risk and reactance) was not examined as a mechanism of behavior change. Moreover, physical health outcomes, which are commonly highlighted in messaging campaigns, were confounded with other message content (i.e., presented alongside outcomes such as appearance and self-esteem). Additionally, the fit between message content and individuals' pre-existing goals was not examined.

1.4. Goal contents theory

Much of the research relying on prospect theory (Kahneman & Tversky, 1979), as well as research examining message content, has largely overlooked Rothman and Salovey's (1997) suggestion that individual differences can influence message perception (Cesario et al., 2013). Goal contents theory, which falls under the self-determination theory umbrella (Deci & Ryan, 2012), proposes that goals vary in terms of content (Sebire et al., 2009). Specifically, goal orientation, which is the tendency for people to be driven by external goals, such as appearance, or more intrinsic goals, such as health, represent individual differences that have been shown to moderate message efficacy.

For example, Cornelis et al. (2014) found that the benefit of an exercise message was moderated by the goal orientation of participants insofar that individuals who were motivated by their appearance benefited from appearance-based messages, whereas individuals who were motivated by health benefited from health-based messages. This aligns with similar research indicating that fitting message content to match an individual's motives is an effective means of persuasion (e.g., Aspden et al., 2014; Clary et al., 1994). Conversely, presenting individuals with messages that are not fitted to their motives promotes higher reactance. For example, Aspden et al. (2014) found that individuals with higher appearance motives presented with a health-based message on sun safety had greater reactance than those presented with an appearance-based message. Thus, the fit between the content of a message and the goals of an individual may improve message persuasion

through reduced reactance.

1.5. Aims and hypotheses

Taking a transparent, open science, multiverse approach (Simmons et al., 2011; Steegen et al., 2016), the present study utilized psychological reactance theory to better understand the influence of message content on behavior change by examining which type of exercise-related message is most effective at changing attitudes, intentions, and exercise behavior in inactive women as well as whether perceived risk and message reactance precede this change (Figure 1). The secondary purpose of this research was to integrate goal contents theory within prospect theory and psychological reactance theory by examining whether pre-existing goals (extrinsic vs. intrinsic) moderate the relationship between message group (i.e., gain- vs. loss-frames × appearance- vs. health-related) and message-related reactance and perceived risk, and in turn, behavioral intentions and change.

It was hypothesized that (1) gain-framed messages would be more effective than loss-framed messages for changing exercise-related attitudes, intentions, and behavior. That is, gain-framed health- and appearance-related messages would be more effective than loss-framed health- and appearance-related messages, and (2) gain-framed messages would result in lower levels of reactance and higher levels of perceived threat to health/appearance in comparison to loss-framed messages. No a priori predictions were made between the differences between health- and appearance-related messaging for hypotheses 1 and 2. Additionally, it was hypothesized that (3) reactance and perceived threat to health/appearance would predict exercise-related attitudes, intentions, and behavior, insofar that higher levels of reactance would lead to less positive attitudes, intention, and behavior, whereas higher levels of threat would lead to more positive attitudes, intentions, and behavior, and (4) the relationship between message group and both reactance and perceived threat to health/appearance would be moderated by goal orientation. It was expected that appearance-related messages would lead to especially low levels of reactance and higher levels of perceived threat to appearance for those who have higher levels of extrinsic appearance-related goals and that health-related messages would lead to especially low levels of reactance and higher levels of perceived threat to health for those who have higher levels of intrinsic health-related goals. Moreover, it was expected that gain-framed messages would be more supportive of exercise-related change than loss-framed messages. The hypotheses, data collection plan, and planned statistical analyses were all pre-registered on the Open Science Framework prior to data collection (https://osf.io/62m3n).

2. Piloting the messages

Messages were pilot tested on Prolific, an online participant pool platform, and paid in accordance with Prolific guidelines of rates equivalent to or greater than £6.00 ($8.00 USD) an hour. Participants were *cis*-gendered women from the United States between the ages of 18 and 25 who reported that they did not engage in regular exercise. Inclusion criterion were set using Prolific's pre-screeners and validated using a brief pre-screening questionnaire.

Participants were paid £0.15 (approximately $0.20 USD) for completion of the pre-screening questionnaire, regardless of their responses. Eligible participants were forwarded to the main pilot test where they were randomly assigned to one of the four message groups. Participants who completed the main pilot test were paid £1.25 (approximately $1.66 USD) if they did not fail a random response check (i.e., '*Please answer two to this question*'). After viewing the message, participants were asked: (1) '*The message I just viewed discussed what I could gain from engaging in regular physical activity,*' (2) '*The message I just viewed discussed what I could lose from not engaging in regular physical activity,*' (3) '*The message I just viewed discussed health-related outcomes associated with regular physical activity,*' (4) '*The message I just viewed discussed appearance-related outcomes associated with regular physical activity,*' and (5) '*The message I just viewed was scientifically based.*' These items were rated on a 5-point Likert-type scale ranging from *'Strongly Disagree'* [1] to '*Strongly Agree*' [5]. An open-format attention-check item was also included, which asked participants to identify the health-behavior discussed in the presented message.

A total of 49 participants were included in the pilot study (Julious, 2005). However, one participant failed the random response check leaving a total of 48 participants for analyses. Pilot participants had an average age of 22.13 years (SD = 2.10). Participants engaged in an average of 116.92 MET minutes per week (SD = 151.27), which is equivalent to 29.23 min of moderate activity or 14.62 min of vigorous activity.

Full results can be viewed in Table 1. The 12 participants assigned to the appearance gain-framed condition agreed that the message content addressed appearance-related gains of regular physical activity and did not agree that the content was loss-framed or focused on health outcomes. Similarly, the 13 participants assigned to the appearance loss-framed condition agreed that the message addressed appearance outcomes and did not agree that the message addressed health outcomes Additionally, participants agreed that the message was about the losses and did not agree that the message focused on gains.

The 11 participants assigned to the health gain-framed condition

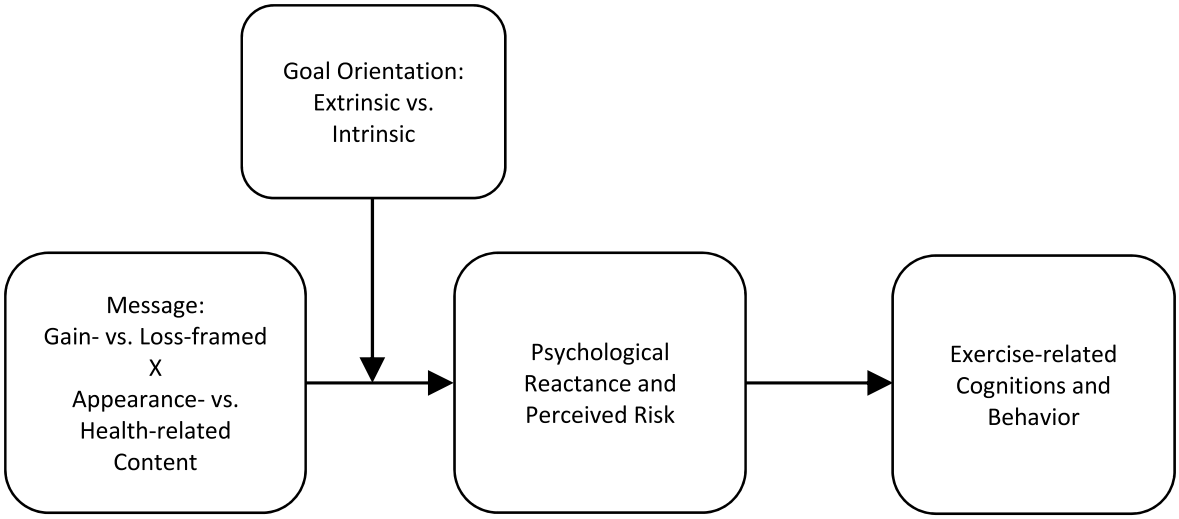

Fig. 1. Theorized pathway of action.

Table 1
Mean (SD) message perception among pilot participants.

	Scientific	Message Outcome		Message Framing	
		Health	Appearance	Gain	Loss
Appearance Gain-Framed	3.83 (0.83)	2.83 (1.47)	4.75 (0.45)	4.41 (0.67)	2.58 (1.00)
Appearance Loss-Framed	4.15 (0.69)	3.62 (1.44)	4.00 (1.63)	3.31 (1.38)	4.23 (1.17)
Health Gain-Framed	4.54 (0.69)	4.36 (1.28)	2.00 (1.18)	4.46 (1.21)	3.90 (1.13)
Health Loss-Framed	4.25 (0.87)	4.25 (0.97)	1.92 (0.90)	3.50 (1.24)	4.67 (0.65)

Note. 1 = *Strongly Disagree*, 5 = *Strongly Agree.*

agreed that the message addressed health-related gains of regular physical activity and did not agree that the message was focused on the losses or on appearance outcomes. Similarly, the 12 participants in the health loss-framed condition agreed that the message addressed health outcomes and disagreed that the message addressed appearance outcomes. Further, participants agreed that the message was about the losses and did not agree that the message focused on gains. Across conditions, participants largely agreed that the messages were scientific in nature. Moreover, all participants correctly identified that the behavior discussed in the messages was exercise.

3. Method

3.1. Participants

Participants (N = 369) were recruited through Prolific. Inclusion criterion required that participants were emerging female adults (ages 18 through 25) residing in the United States that identified as *cis*-gendered women and did not regularly engage in exercise (i.e., fewer than 150 min of moderate or 75 min of vigorous physical activity per week; fewer than 600 metabolic equivalent (MET) minutes where 1 min of moderate activity is equivalent to 4 MET minutes and 1 min of vigorous activity is equivalent to 8 MET minutes; World Health Organization, 2020). These criteria were selected using Prolific pre-screeners and were validated using a pre-screening questionnaire. Only women were recruited as the risks of not exercising may not be equally weighted between women and men (Craft et al., 2016). The purpose of the project was disguised to participants as concerning 'personal values and memory' to reduce self-selection bias related to a desire to increase activity levels. This project was ethically approved by the School of Humanities, Social Sciences, and Law Research Ethics Committee at the University of Dundee.

3.2. Procedure

Participants first completed a brief pre-screening questionnaire for which they were paid £0.14 (approximately $0.19 USD) upon completion, regardless of their eligibility. Participants were recruited using active consent for the pre-screening questionnaire. Eligible participants were given access to the main study for which they were paid £5.63 (approximately $7.46 USD) for the first portion of the main study (i.e., baseline, experimental manipulation, immediate follow-up) and £0.50 for the second portion of the main study (i.e., 1-week follow-up; Figure 2). Participants were given an informed consent sheet before answering baseline measures and being randomly assigned to view and listen to one of four scientific messages that included the consequences of insufficient physical activity (Supplementary File 1; Figure 2).

Participants subsequently completed a questionnaire about their perceptions of the message and measures of exercise-related attitudes and intentions immediately after the experiment. Lastly, participants self-reported on their exercise behavior over the previous seven days at baseline and the 1-week follow-up (Figure 2).

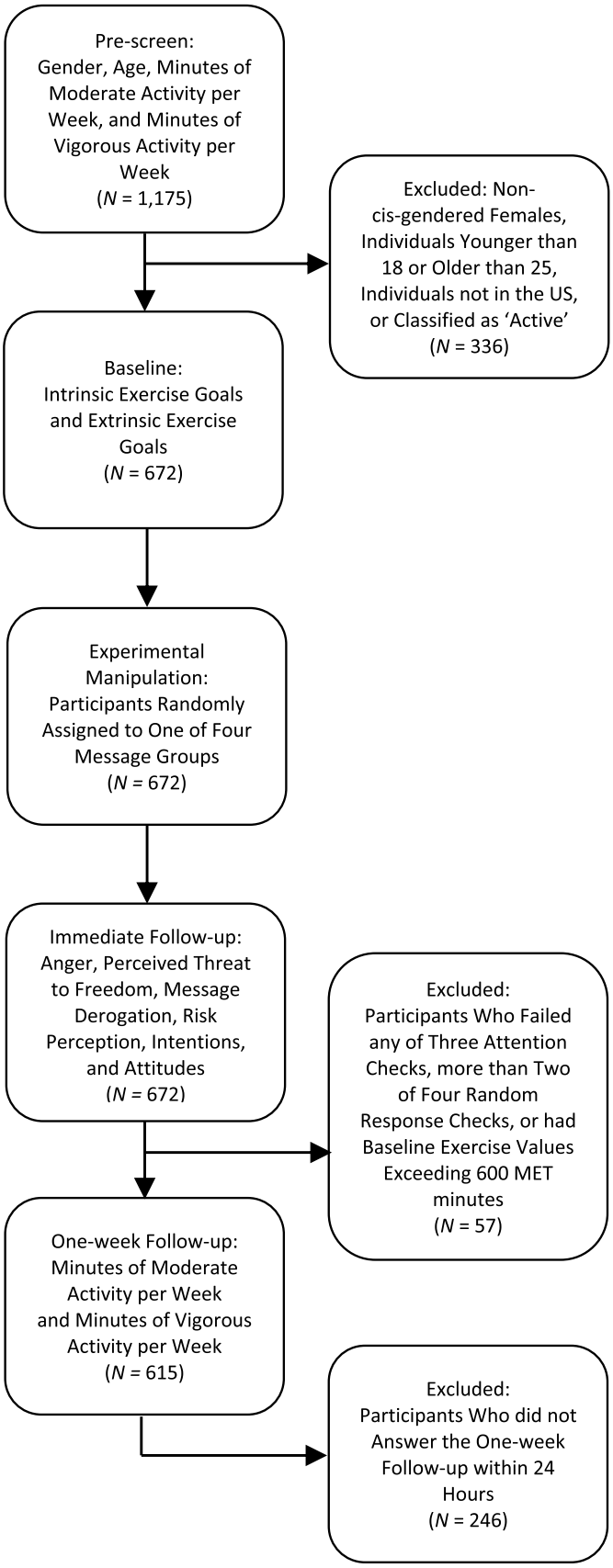

Fig. 2. Study design and recruitment (N = 369).

3.3. Power analysis

Power analyses were conducted for all hypotheses using G*Power and specifying small-medium effect sizes based on previous research (Faul et al., 2009; Gallagher & Updegraff, 2012; O'Keefe & Jensen, 2006; 2007). For hypotheses 1 and 2, a power analysis for a one-way, fixed-effects ANOVA was conducted (1-β = .80, α = .05) with a small-medium effect size (f = .175). This analysis resulted in a required sample size of 360 (i.e., 90 per group). For hypothesis 3, a power analysis for multiple linear regression with an R^2 increase was specified with four total predictors and four tested predictors (1-β = .80, α = .05). A small-medium effect size was specified (f^2 = .085), which resulted in a total required sample size of 146 (i.e., 37 per group). For hypothesis 4, a power analysis for multiple linear regression with an R^2 increase was specified with five total predictors and three tested predictors (1-β = .80, α = .05). A small-medium effect size was specified due to hypothesized interaction effects (f^2 = .03), which resulted in 368 participants needed (92 per group).

3.4. Pre-screening measures

Age, gender, and activity engagement were assessed using self-report measures to verify responses to the Prolific pre-screeners. Self-reported engagement in moderate and vigorous exercise were assessed using the short form of the International Physical Activity Questionnaire (IPAQ; Craig et al., 2003). Total MET minutes of moderate and vigorous activity over the previous 7 days were calculated.

3.5. Baseline measures

Quality of exercise goals was assessed using the intrinsic health subscale (e.g., "*To increase my resistance to illness and disease*") and the extrinsic appearance subscale (e.g., "*To improve the look of my overall body shape*") of the Goal Content for Exercise Questionnaire (Sebire et al., 2008, 2009). Each subscale consists of four items with response options ranging from '*Not at all Important*' [1] to '*Extremely Important*' [7] on a 7-point Likert-type scale.

3.6. Experimental manipulation

Participants watched a video presenting a scientific message about physical activity and were asked to remember as much content as possible. The background and speaker were consistent across messages. Each video was closed-captioned, contained no images, and was displayed on a dark blue background with white font. Moreover, all four messages were approximately equal in length (311–325 words; 2:15 min - 2:25 min) and included eight in-text citations each. Additionally, all four messages were written in an objective and scientific manner, as these types of messages are perceived as more credible (Supplementary File 1; Berry & Shields, 2014).

Three follow-up attention check items were administered after participants viewed the message. The first item asked participants to identify the behavior discussed in the scientific message (i.e., exercise). The second item asked participants whether the message mentioned the *risks* of not exercising or the *benefits* of exercising. The third item asked participants whether the message mentioned *appearance-* or *health-related* outcomes. Participants were excluded from data analysis if they incorrectly answered any attention checks (see Figure 2). Additionally, participants were asked to indicate whether they learned any new information after reading the message to determine past exposure to the message content (i.e., '*Which, if any, facts from the message you just read were new to you?*').

Four random response check items were embedded within the survey. These items asked participants to choose a specific response option (e.g., '*If you are reading this, choose agree*') as random responding has been shown to drastically alter effect sizes (Credé, 2010). Therefore, a conservative approach was taken as participants who failed more than two random response check questions were excluded from analyses, in accordance with Prolific payment guidelines (Prolific, 2023).

3.7. Dependent measures for immediate follow-up

Psychological reactance was measured using anger, perceived threat to freedom of choice, and message derogation. First, items assessing feelings of *anger* were preceded with the statement '*After viewing this message* ….' and measured using the following items adapted from Dillard and Peck (2000): (1) *I was irritated*, (2) *I was angry*, (3) *I was annoyed*, and (4) *I was aggravated*. Second, perceived threat to freedom of choice was measured using four items: (1) *The message threatened my freedom to choose*, (2) *The message tried to make a decision for me*, (3) *The message tried to manipulate me*, and (4) *The message tried to pressure me* (Dillard & Shen, 2005). The extent to which participants derogated message information was measured with four items adapted from Ruiter et al. (2003; i.e., *This message was exaggerated*, *This message was distorted*, *This message was overblown*, *This message was overstated*). Responses range from '*Strongly Disagree*' [1] to '*Strongly Agree*' [5] on a 5-point Likert-type scale for anger, perceived threat to freedom, and message derogation.

Perceived threat to health/appearance was assessed based on 'absolute risk' of physical inactivity for the self and adapted from Williams et al. (2011; e.g., '*How likely is it you will have the following condition sometime in your life …* '). The items associated with the health risks of physical inactivity included a type-2 diabetes diagnosis, compromised heart health, compromised bone health, hormonal imbalance, and viral infection. The items associated with the appearance risks of physical inactivity included becoming overweight or obese, higher levels of belly fat, reduced muscle tone, saggy skin, and cellulite. Responses range from '*Very Unlikely*' [1] to '*Very Likely*' [5] on a 5-point Likert-type scale for both health- and appearance-related risks.

Decisional intentions were assessed using a question that measures the extent to which participants intend to be physically active over the 1-week follow-up period (i.e., '*I intend to engage in physical activity _____ days during the next week*'), adapted from Courneya (1994). Answers were recorded using a drop-down menu ranging from '0' to '7.'

Attitudes towards physical activity were assessed based on affective attitudes and instrumental attitudes, using a 7-point Likert-type scale ranging from '*Strongly Disagree*' [1] to '*Strongly Agree*' [7] adapted from Rhodes and Courneya (2003). Items were preceded with the statement '*Over the next week, engaging in physical activity on a regular basis would be* ….' Affective attitudes towards exercise were measured using the items: (1) *enjoyable*, (2) *exciting*, and (3) *pleasant*. Instrumental attitudes towards exercise were measured using the items: (1) *wise*, (2) *beneficial*, and (3) *useful*.

3.8. Dependent measure for 1-week follow-up

Participants also completed the short form of the IPAQ at the 1-week follow-up to assess the influence of messages on their moderate and vigorous exercise behavior during the previous 7 days (Craig et al., 2003). The follow-up had to be completed within 24 hours of administration for payment and participant inclusion in the data.

3.9. Statistical analyses

The data was cleaned through several steps. First, to ensure the quality of the data, any participants who failed more than two of the four random response checks were eliminated, were not counted towards the final sample size, and were not paid in accordance with Prolific guidelines (Prolific, 2023). Participants also did not count towards the final sample size if they failed any of the three attention check items (Figure 2). Prolific prohibits withholding payment based on 'memory-type' items. Thus, participants who failed any attention checks but

passed at least two of the random response checks were still compensated for their time. Second, missing data was controlled for in both the baseline and follow-up surveys by requiring a response to each item. For the follow-up survey, participants were only paid if they completed both portions of study – in accordance with Prolific longitudinal study guidelines (Prolific, 2023b). To that end, only data from participants with complete data who completed the 1-week follow-up within 24 hours of administration were included.

Third, a multiverse approach was taken with results being analyzed in four ways: (1) with the removal of univariate outliers within groups (using the z-score >3.00 cut-off), (2) with the removal of multivariate outliers only (using Mahalanobis distance values with multivariate outliers removed and the analysis re-conducted until there are no remaining outliers present [hypothesis 1 and 2 critical value $\chi^2 = 13.82$; hypothesis 3 critical value $\chi^2 = 20.52$; hypothesis 4 critical value $\chi^2 = 18.47$]; $p < .001$), (3) with the removal of both univariate and multivariate outliers, with univariate outliers removed first, and (4) without the removal of any outliers to assess the robustness of the results across researcher degrees of freedom in the data cleaning phase (Simmons et al., 2011; Steegen et al., 2016). Results that did not differ in terms of significance (i.e., p values) or the direction of the effect (i.e., when results were robust across the entirety of the multiverse analyses) are only reported with the inclusion of both univariate and multivariate outliers. For more details, please see the full description of the multiverse analyses results on the files section of the OSF project page (https://osf.io/z78hk/).

Fourth, checks for successful randomization for MET minutes of moderate and vigorous physical activity over the previous 7 days were assessed with a univariate ANOVA.

Hypotheses 1 and 2 were tested using a one-way ANOVA. It was determined whether the data met assumptions of ANOVA for hypotheses 1 and 2, and the assumptions of multiple linear regression for hypotheses 3 and 4. The following assumptions of ANOVA were tested: (1) independence of cases, (2) normality, and (3) homogeneity of variance. The four-group, between-subjects design allows for the assumption of independence of cases to be met. Normality was assessed using a Shapiro-Wilk test. Finally, homogeneity of variance was assessed using a Levene's test.

Hypothesis 3 was tested using multiple linear regression, whereas hypothesis 4 was tested using Andrew Haye's PROCESS model 2 with 5,000 bootstrapped samples and group membership as a multicategorical variable (using indicator or dummy coding; Hayes & Montoya, 2017), extrinsic and intrinsic goal orientation as moderator variables, and reactance (i.e., anger, perceived threat to freedom, message derogation), and perceived threat to health/appearance (i.e., absolute risk) as dependent variables (Hayes, 2013). The following assumptions of multiple linear regression were assessed: (1) linearity, (2) multivariate normality, (3) absence of multicollinearity, (4) absence of autocorrelation, and (5) homoscedasticity. Linearity was assessed between the independent variable and the dependent variables using a scatterplot, whereas multivariate normality was assessed between the independent variable and the dependent variables using a normal probability plot. Multicollinearity was assessed using a correlation matrix, with correlations greater than .90 representing multicollinearity between independent variables (Tabachnick & Fidell, 2012). In addition, both tolerance and variance inflation factors were examined, with tolerance scores lower than 0.2 indicative of multicollinearity, and variance inflation factors greater than 10 being indicative of multicollinearity. Autocorrelation was assessed using a Durbin-Watson test with a value close to 2 (i.e., >1 and <3) being indicative that the residuals are independent from one another. Finally, homoscedasticity was assessed using a standardized residual versus standardized predicted values plot with a lack of funneling indicating that the assumption was met.

4. Results

4.1. Preliminary results

Participant inclusion and exclusion at each stage of the study can be viewed in Figure 2. All included participants ($N = 369$) identified as female and ranged from 18 to 25 years of age ($M = 22.04$, $SD = 1.96$). Descriptive statistics and tests of internal consistency can be viewed in Table 2. There were no between-group differences at baseline for moderate and vigorous physical activity engagement, $F(3, 365) = 0.04$, $p = .988$, $\eta^2 < .001$, 95 % CI [0.00, 0.00] (Table 2). Across groups, participants engaged in a total of 143.09 ($SD = 160.94$) MET minutes of exercise over the previous seven days. This is equivalent to 35.77 min of moderate or 17.89 min of vigorous activity. In accordance with the scoring procedure for the IPAQ, participants were considered to have 'low levels' of activity. Additionally, 76.20% of participants reported learning at least one new fact from the message content that they received. In a manipulation check, participants in the health groups (collapsed across gain- and loss-framed) reported more perceived threat to their health ($M = 3.22$, $SD = 0.79$) than participants in the appearance groups ($M = 2.87$, $SD = 0.70$), $F(1, 365) = 19.55$, $p < .001$. However, participants in the appearance groups did not report more perceived threat to their appearance ($M = 3.60$, $SD = 0.81$) than participants in the health groups ($M = 3.62$, $SD = 0.80$), $F(1, 365) = 0.03$, $p = .871$.

All statistical assumptions were met unless otherwise stated. For more details, please see the full description of the data and assumption tests on the files section of the OSF project page (https://osf.io/z78hk).

4.2. Hypothesis 1

It was hypothesized that gain-framed messages would be more effective than the paired loss-framed (i.e., health or appearance) messages for changing exercise-related attitudes, intentions, and self-reported behavior. Within experimental groups, the hypothesis of a normal population distribution was rejected across the four outcomes (Shapiro-Wilk = .80-.97, $p < .05$). However, one-way ANOVAs are relatively robust to violations of normality, especially when group sizes are greater than 20 (Blanca et al., 2017).

There were no significant between-group differences for affective attitudes, $F(3, 365) = 0.57$, $p = .632$, $\eta^2 = .01$, 95 % CI [0.00, 0.02], instrumental attitudes, $F(3, 365) = 1.07$, $p = .364$, $\eta^2 = .01$, 95 % CI [0.00, 0.03], exercise intentions, $F(3, 365) = 1.32$, $p = .268$, $\eta^2 = .01$, 95 % CI [0.00, 0.03], or self-reported exercise behavior at the week 1 follow-up, $F(3, 365) = 0.85$, $p = .467$, $\eta^2 = .01$, 95 % CI [0.00, 0.03] (Table 2). Thus, hypothesis 1 was not supported across outcomes. Results were robust across the entirety of multiverse analyses.

4.3. Hypothesis 2

It was hypothesized that gain-framed messages would result in lower levels of reactance and higher levels of perceived threat to health/appearance compared to loss-framed messages. Results were consistent across the entirety of multiverse analyses.

4.3.1. Reactance

The assumption of homogeneity of variance was not met for all three tests of reactance (Levene's test = 7.85-12.47, $p < .05$). In addition, within experimental groups, the hypothesis of a normal population distribution was rejected across outcomes (Shapiro-Wilk = .71-.95, $p < .05$). Thus, a series of Welch ANOVAs were used to assess the effect of group membership on reactance. Group membership significantly predicted anger, $F(3, 194.99) = 13.74$, $p < .001$, with a small effect size, $\eta^2 = .08$, 95 % CI [0.03, 0.13]; perceived threat to freedom, $F(3, 196.52) = 7.62$, $p < .001$, with a small effect size, $\eta^2 = .05$, 95 % CI [0.01, 0.10]; and message derogation, $F(3, 189.47) = 23.09$, $p < .001$, with a small to medium effect size, $\eta^2 = .13$, 95 % CI [0.07, 0.19]. Given the

Table 2
Mean (*SD*) descriptive statistics stratified by group membership.

	Cronbach's Alpha	Health Loss-Framed (N = 98)	Health Gain-Framed (N = 92)	Appearance Loss-Framed (N = 81)	Appearance Gain-Framed (N = 98)
Baseline					
Baseline MET Exercise Minutes	–	146.73 (168.06)	139.65 (161.00)	145.33 (162.35)	140.82 (154.70)
Appearance Goals	0.88	5.27 (1.42)	5.38 (1.23)	5.04 (1.47)	5.15 (1.35)
Health Goals	0.82	5.44 (0.97)	5.29 (0.99)	5.41 (1.12)	5.42 (1.09)
Post-Intervention					
Anger	0.93	2.17 (0.95)	1.72 (0.67)	2.56 (1.15)	2.18 (1.09)
Threat to Freedom	0.85	1.90 (0.79)	1.65 (0.64)	2.20 (1.02)	2.03 (0.89)
Message Derogation	0.94	1.76 (0.77)	1.47 (0.48)	2.29 (1.07)	2.21 (1.00)
Appearance Risk	0.80	3.67 (0.75)	3.56 (0.83)	3.65 (0.79)	3.57 (0.82)
Health Risk	0.76	3.36 (0.85)	3.06 (0.70)	2.82 (0.77)	2.92 (0.63)
Affective Attitude	0.90	3.97 (1.36)	3.76 (1.46)	3.75 (1.43)	3.90 (1.28)
Instrumental Attitude	0.88	6.17 (0.79)	6.03 (1.01)	6.00 (1.00)	5.93 (1.00)
Exercise Intention	–	3.09 (1.40)	2.84 (1.56)	2.86 (1.54)	2.67 (1.46)
Week 1 MET Exercise Minutes	–	270.12 (311.46)	229.57 (259.69)	289.04 (379.10)	301.06 (350.32)

Note. Values after the removal of individuals who failed at least one manipulation check (N = 42), with outliers included. 'MET' minutes refers to metabolic equivalent minutes.

heterogeneity of variance between groups, a Games-Howell post-hoc test was used for all tests, which corrects for family-wise error (Table 2; Sauder & DeMars, 2019). Group means and standard deviations can be seen in Table 2. First, regarding anger as an outcome, the health gain-framed condition scored significantly lower on anger than either of the appearance conditions and the health loss-framed condition (*ps* < .004). There were no significant differences between the health loss-framed condition and either of the appearance conditions (*ps* > .05). Similarly, there was no difference between the loss-framed and gain-framed appearance conditions (p = .111). Second, regarding perceived threat to freedom as the outcome, the health gain-framed condition was not significantly different than the health loss-framed condition (p = .069). However, individuals in this group did score significantly lower on perceived threat to freedom than individuals in either of the appearance conditions (*ps* < .006). There were no significant differences between the health loss-framed condition and either of the appearance conditions (*ps* > .05). Moreover, there was no difference between the loss- and gain-framed appearance conditions (p = .629). Finally, regarding message derogation as the outcome, the health gain-framed condition scored significantly lower than the health loss-framed condition (p = .014) and both appearance conditions (*ps* < .001). The health loss-framed condition reported significantly less message derogation than either of the appearance conditions (*ps* < .004) with no differences found between the two appearance conditions (p = .956).

Taken together, the hypothesis was partially supported for the health conditions insofar that the gain-framed messaging led to reduced reactance (i.e., anger and message derogation) than the loss-framed messaging. However, this result was not replicated in the appearance conditions. Moreover, the exploratory portion of these analyses comparing health- and appearance-based messaging revealed that, generally, the health gain-framed conditions led to less reactance than either of the appearance-related conditions. This result did not extend to the comparison between the health loss-framed condition or the appearance conditions.

4.3.2. Perceived threat to health/appearance

The assumption of homogeneity of variance was not met for perceived health threat (Levene's test = 3.90, p < .05). In addition, within all experimental groups except for the health gain-framed group, the hypothesis of a normal population distribution was rejected (Shapiro-Wilk = .95-.98, p < .05). Thus, a Welch ANOVA was used with Games-Howell post-hoc analyses (Table 2; Sauder & DeMars, 2019). Group membership significantly predicted perceived health threat, F(3, 198.59) = 8.00, p < .001, with a small effect size, η^2 = .07, 95 % CI [0.03, 0.12]. Group means and standard deviations can be seen in Table 2. The health gain-framed condition scored significantly lower on perceived health threat than the health loss-framed condition (p = .045). There were no significant differences between the health gain-framed condition and the appearance conditions (*ps* > .131). The health loss-framed condition scored significantly higher than either of the appearance conditions (*ps* < .001), and there were no differences between the two appearance conditions (p = .790). Thus, the hypothesis was not supported insofar that the health-related gain-framed condition scored significantly lower than the loss-framed condition on perceived health threat, which was counter to expectations.

The assumption of normality within conditions was rejected for the outcome of perceived appearance threat (Shapiro-Wilk = .88-.96, p < .05). There was no significant main effect of group membership on perceived appearance threat, F(3, 368) = .44, p = .722 (Table 2). Thus, the hypothesis was rejected.

4.4. Hypothesis 3

It was hypothesized that reactance and perceived threat to health/appearance would predict exercise-related attitudes, intentions, and self-reported behavior insofar that higher levels of reactance would lead to less positive attitudes, weaker intentions, and fewer minutes of moderate to vigorous activity engagement and higher levels of perceived threat to health/appearance would lead to more positive attitudes, stronger intentions, and more minutes of moderate to vigorous activity engagement. Results were the same across the entirety of multiverse analyses, unless otherwise noted.

4.4.1. Attitudes

When examining the correlation coefficients between the individual predictors and affective attitudes, only the relationship between appearance-related threat perception and affective attitudes was significant, r(369) = -.11, p = .030 (See Supplementary File 2 for full results). This result was mirrored in the results of the multiple linear regression, with only appearance-related threat being related to affective attitudes (p = .016; Table 3). However, this relationship was in the opposite direction than hypothesized. That is, higher levels of perceived threat to appearance were related to less positive affective attitudes towards exercising.

When examining the correlation coefficients between the individual predictors and instrumental attitudes, each individual predictor was significantly related to instrumental attitudes (perceived threat to health: r(369) = .13, p = .012; perceived threat to appearance: r(369) = .13, p = .012; anger: r(369) = -.18, p < .001; perceived threat to

Table 3
Regression results for hypothesis 3 with attitudes as the outcome.

Variable	*b*	*SE*	*β*	*t*	*p*
Affective Attitudes					
Model Results	$F(5, 363) = 1.20, p = .310$				
Constant	4.34	0.39		11.42	<.001
Health Threat	0.12	0.11	0.07	1.11	.269
Appearance Threat	−0.26	0.11	−0.150	−2.42	.016
Anger	0.02	0.10	0.01	0.18	.856
Threat to Freedom	−0.01	0.12	−0.01	−0.12	.904
Message Derogation	−0.00	0.11	−.00	−0.02	.987
Instrumental Attitudes					
Model Results	$F(5, 363) = 6.67, p < .001$				
Constant	5.79	0.26		22.57	<.001
Health Threat	0.11	0.07	0.09	1.53	.126
Appearance Threat	0.14	0.07	0.12	1.93	.054
Anger	−0.06	0.07	−0.06	−0.87	.383
Threat to Freedom	−0.12	0.08	−0.11	−1.49	.138
Message Derogation	−0.12	0.08	−0.120	−1.64	.101

freedom: $r(369) = -.19, p < .001$; and message derogation: $r(369) = -.22$, $p < .001$; Supplementary File 2). These relationships were in the hypothesized direction, with perceived threat to health/appearance being positively related to instrumental attitudes, and reactance being negatively related to instrumental attitudes. However, when these predictors were examined non-independently in the multiple linear regression model, only appearance-related threat was trending towards significance in the hypothesized direction when outliers were not removed (Table 3). This result was replicated when univariate outliers were removed. When multivariate outliers or univariate and multivariate outliers were removed, the relationship between appearance-related threat and instrumental attitudes was significant ($p = .027$ and .012, respectively) in the hypothesized direction. Specifically, this result occurred in 50% of models.

4.4.2. Intentions

When examining the correlation coefficients between the individual predictors and exercise intentions, only anger significantly predicted intention, $r(369) = -.11$, $p = .041$ (Supplementary File 2). This relationship was in the hypothesized direction, as individuals who felt more anger after receiving the exercise message intended to engage in less exercise over the upcoming week. However, only appearance-related threat was significantly related to exercise intentions when these predictors were examined non-independently in the multiple linear regression model ($p = .035$; Table 4). The direction of the relationship was counter to the hypothesis insofar that individuals who had reported more threat to their appearance after receiving the exercise message intended to engage in less exercise over the upcoming week.

4.4.3. Self-reported behavior

The assumption of multivariate normality was not met, with points deviating from the diagonal line of the normal probability plot. Similarly, the assumption of absence of autocorrelation was not met, Durbin-Watson = .09, and the assumption of homoscedasticity was not met, with evidence of funnelling on the standardized residual versus standardized predicted values plot.

Table 4
Regression results for hypothesis 3 with intention as the outcome.

Variable	*b*	*SE*	*β*	*t*	*p*
Model Results	$F(5, 363) = 2.05, p = .071$				
Constant	3.45	0.41		8.37	<.001
Health Threat	0.189	0.12	.10	1.60	.111
Appearance Threat	−0.24	0.11	−.13	−2.12	.035
Anger	−0.14	0.10	−.10	−1.34	.181
Threat to Freedom	0.13	0.13	.07	0.98	.327
Message Derogation	−0.120	0.12	−.07	−0.98	.326

When examining the correlation coefficients between the individual predictors and self-reported exercise behavior, none of the predictors were significant (*ps* > .05; Supplementary File 2). Due to the assumptions of multiple linear regression being violated, a bootstrapped multiple regression with 5,000 samples and 95% biased corrected accelerated (i.e., BCa) confidence intervals was used (Field, 2013; Johnston and Faulkner, 2021). In the combined model, anger significantly predicted exercise at the 1-week follow-up ($p = .047$; Table 5). This relationship was counter to expectations insofar that individuals who felt more anger after receiving their respective exercise message engaged in more exercise over the proceeding 7 days. This result was not present when univariate outliers were removed or when multivariate outliers were removed. There were no multivariate outliers after the removal of univariate outliers. Therefore, this relationship was only present in 33.33% of models.

4.5. Hypothesis 4

It was hypothesized that the relationship between message group and both reactance and perceived threat to health/appearance would be moderated by goal-orientation. Across outcomes, the hypothesized moderation of the relationship between group membership and reactance and perceived threat to health/appearance by extrinsic appearance goals and intrinsic goals were not supported in the hypothesized direction. Thus, only the main analysis is reported and full model results and data can be found under the files section of the OSF project page, including iterations from the multiverse analyses (https://osf.io/z78hk/). An exploratory, pre-registered, version of this analysis that collapsed across gain- and loss-framed messages within the health and appearance groups also did not support the initial hypothesis. In addition, this hypothesis was not supported when examining health (gain and loss) and appearance (gain and loss) groups separately.

4.5.1. Perceived health threat

When the appearance loss-framed group was specified as the reference group, health-related threat was not predicted by indicator (i.e., dummy) coded group membership, *ps* > .461, nor was it predicted by extrinsic appearance goals or intrinsic health goals, *ps* > .237. Additionally, the interactions between indicator groups and both appearance goals and health goals, *ps* > .150, were not significant predictors of perceived threat to health.

When the appearance gain-framed group was specified as the reference group, the absence of the main effects of indicator grouping and both goals replicated, *ps* > .086. Generally, the interaction terms were also non-significant (*ps* > .05). However, there was a significant interaction between extrinsic appearance goals and the indicator coding of the loss-framed health group compared to the gain-framed appearance group, $\beta = -.158$, $SE = .075$, $p = .036$. This interaction was not hypothesized as it occurs between an externally based appearance outcome and an internally based health outcome. Individuals in the health loss-framed condition were less protected from perceiving a threat to their health at most levels of appearance goals compared to the gain-framed appearance group (Figure 3).

When the health loss-framed condition was specified as the reference

Table 5
Bootstrapped regression results for hypothesis 3 with exercise as the outcome.

Variable	*b*	Bias	*SE*	*p*	BCa 95 % CI
Model Results	$F(5, 363) = 1.22, p = .301$				
Constant	339.35	2.14	86.61	<.001	181.30, 517.24
Health Threat	−17.62	−0.84	25.43	.484	−69.92, 28.97
Appearance Threat	−19.82	−0.26	23.46	.406	−63.65, 25.92
Anger	44.16	0.35	21.98	.047	2.96, 87.79
Threat to Freedom	−2.92	0.08	23.79	.902	−52.28, 43.72
Message Derogation	−16.12	0.27	27.67	.553	−69.16, 39.17

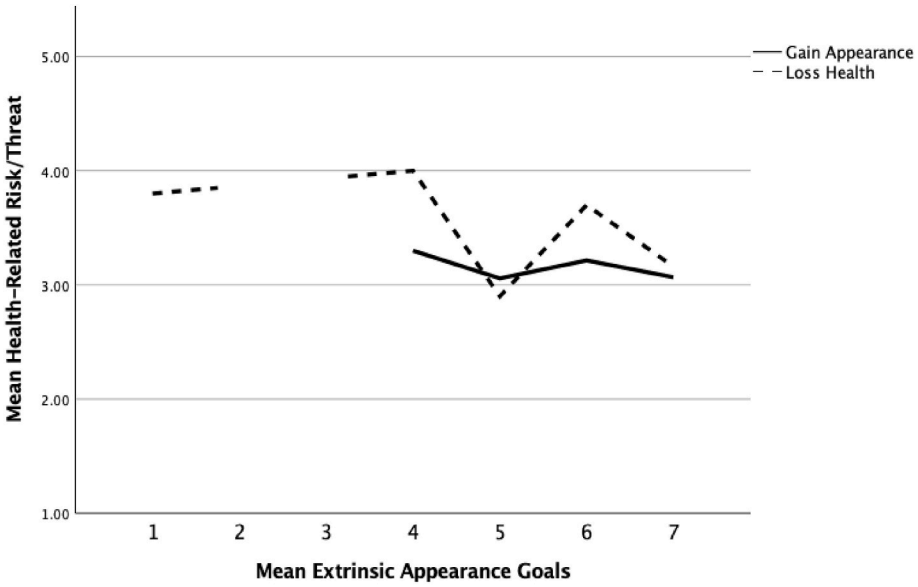

Fig. 3. Interaction between appearance goals and perceived health threat.

group, there were no main effects of the indicator groupings, *ps* > .180. In addition, there was not a significant main effect of extrinsic appearance goals on health perceived threat, $p = .133$. However, there was a significant interaction between extrinsic appearance goals and the indicator grouping comparing the health loss-framed group to the appearance gain-framed group, $\beta = .16$, $SE = .08$, $p = .036$. This interaction was the same trend observed as the analyses with the gain-framed appearance group as the reference group. There was a significant main effect of intrinsic health goals, $\beta = .18$, $SE = .08$, $p = .020$. However, there were no interactions between intrinsic health goals and the indicator groupings, *ps* > .390.

When the health gain-framed condition was used as the reference category, there were no main effects of indicator grouping, extrinsic appearance goals, nor were there any significant interactions, *ps* > .150. There was a main effect of intrinsic health goals, $\beta = .24$, $SE = .08$, $p = .002$, insofar that individuals with stronger health goals reported higher perceived threat to their health after receiving their respective message. Results were consistent across the entirety of the multiverse analysis.

4.5.2. Perceived appearance threat

When the appearance loss-framed group was specified as the reference group, appearance-related threat was only predicted by one indicator grouping. Specifically, the gain-framed appearance group reported having lower levels of appearance-related threat compared to the loss-framed appearance group, $\beta = -1.45$, $SE = .71$, $p = .041$, counter to hypotheses. Additionally, there was a main effect of extrinsic appearance goals, $\beta = .12$, $SE = .06$, $p = .038$. Specifically, individuals with higher levels of extrinsic appearance goals also felt more threat to their appearance after viewing their respective exercise message. However, there was no main effect of intrinsic health goals nor were there any significant interactions between indicator groupings and either appearance or health goals, *ps* > .069.

When the appearance gain-framed group was specified as the reference, the results replicated in terms of the main effect of indicator group and extrinsic appearance goals, and regarding the absence of interactions. However, there was also a main effect of intrinsic health goals, $\beta = .17$, $SE = .07$, $p = .017$. That is, individuals with higher levels of intrinsic goals also had higher levels of perceived threat to appearance.

When the health loss-framed condition was specified as the reference, there were no main effects of indicator group or intrinsic health goals, *ps* > .063. However, there was a main effect of extrinsic appearance goals, $\beta = .17$, $SE = .05$, $p = .003$. That is, individuals who had higher levels of appearance goals also had higher levels of appearance-related threat. There were no significant interactions in the model, *ps* > .126.

When the gain-framed health condition was the reference, the results were largely replicated from when the loss-framed health condition was the reference group. However, there was also a main effect of intrinsic health goals, $\beta = .17$, $SE = .08$, $p = .043$. That is, individuals who had stronger health goals experienced more appearance-related threat. The full multiverse iteration is available on the Open Science Framework (https://osf.io/z78hk/).

4.5.3. Anger

When the loss-framed appearance group was specified as the reference, anger was not predicted by indicator groups, nor was it predicted by extrinsic appearance goals, or intrinsic health goals, *ps* > .344. The interactions between indicator groups and appearance goals and health goals, *ps* > .239, were also not significant predictors of anger.

When the gain-framed appearance group was specified as the reference, the results replicated regarding the absence of main effects of indicator groupings and intrinsic health goals and interactions. However, anger was predicted by extrinsic appearance goals, $\beta = -.19$, $SE = .07$, $p = .008$. Individuals with higher levels of extrinsic appearance goals felt less anger after receiving their respective exercise message.

When the loss-framed health group was specified as the reference, there were no main effects of indicator groups, *ps* > .258, nor were there main effects of extrinsic appearance goals or intrinsic health goals, *ps* > .483. In addition, none of the interaction terms were significant, *ps* > .137. Results were replicated when the gain-framed health group was the reference category. Results were consistent across the entirety of the multiverse analysis.

4.5.4. Threat to freedom

When the loss-framed appearance group was specified as the reference, none of the indicator groupings were significant, *ps* > .304. There was a main effect of extrinsic appearance goals on perceived threat to freedom, $\beta = -.14$, $SE = .06$, $p = .035$. There was no main effect of intrinsic health goals on perceived threat to freedom, nor were there any significant interactions between indicator groups and appearance or health goals, *ps* > .05.

When the gain-framed appearance group was specified as the reference, indicator groupings were not significant nor were the main effect

of intrinsic health goals or the interaction terms (*ps* > .05). However, the main effect of extrinsic appearance goals was also non-significant in this model, $p = .423$. When both the loss-framed health and gain-framed health groups were listed as the reference categories, the results replicated those using the gain-framed appearance group as the reference. That is, none of the main effects or interaction terms were significant (*ps* > .05). The full multiverse iteration is available on the Open Science Framework (https://osf.io/z78hk/).

4.5.5. Message derogation

When the loss-framed appearance group was listed as the reference, none of the indicator groupings were significant, *ps* > .616. There were also no significant main effects of either extrinsic appearance goals or intrinsic health goals, *ps* > .129, on perceived threat to freedom. Additionally, there were no significant interactions between indicator groups and either appearance or health goals, *ps* > .107. These results were replicated across all four reference groups.

5. Discussion

Meta-analytic evidence on the effect of message framing has supported a small effect size regarding the benefit of gain-framed over loss-framed messages (Gallagher & Updegraff, 2012; O'Keefe & Jensen, 2006; 2007). Researchers have suggested that to enhance not only understanding of, but also the impact of health-related messages, other message features need to be examined (Quick et al., 2013) and individual determinants need to be considered (Rothman & Salovey, 1997). Thus, the purpose of the present study was two-fold. First, the present study aimed to understand the influence of message content on self-reported behavior change by examining which type of exercise-related messages (i.e., gain- vs. loss-framed and health- vs. appearance-outcome focused) are most effective at changing attitudes, intentions, and self-reported behavior in inactive women, as well as whether perceived threat to health/appearance and message reactance precede this change. Second, the present study sought to examine whether the relationship between exercise message type, reactance, and perceived threat to health/appearance was moderated by the quality of exercise goals.

No benefit of gain- versus loss-framed messaging was found for changing exercise-related attitudes, intention, or self-reported behavior, despite most participants having learned new information about exercising from the intervention content (Hypothesis 1). This result is not aligned with the meta-analytic evidence that gain-framed messages have a small but significant benefit over loss-framed messages regarding changing attitudes, intention, and self-reported behavior, including those specific to exercising (Gallagher & Updegraff, 2012; O'Keefe & Jensen, 2006; 2007), nor is it aligned with the health literacy research linking literacy to behavioral engagement (McAnally & Hagger, 2023). Although 76.20% participants reported learning something new from the message they viewed, the absence of a significant effect is not entirely surprising as education in and of itself is often viewed as a necessary but insufficient condition of health behavior change (e.g., Arlinghaus & Johnston, 2018). Indeed, prior research has shown that education alone is insufficient for recruiting inactive women into exercise interventions insofar that 70% of individuals declined an invitation for an exercise intervention (More, Burd, et al., 2022). Moreover, results from the present study and other message-framing research likely present an overinflated estimate of attitudinal and behavioral change as recent research has shown that in more naturalistic settings, where information can be more easily ignored, individuals may engage in deliberate ignorance and choose not to engage with relevant health-behavior messages (Kadel et al., 2023).

In line with study hypotheses, loss-framed messages were found to lead to more psychological reactance (i.e., anger, perceived threat to freedom, and message derogation) than gain-framed messages for health- but not appearance-based messages (Hypothesis 2). In an exploratory portion of these analyses, it was also found that messages highlighting health loss-framed, and appearance outcomes led to more psychological reactance than messages highlighting gain-framed health outcomes. The protective nature of health-related gain-framed messaging is in line with the theoretical proposition that gain-framed messages should lead to less reactance when a behavior is health promotive, such as exercise (i.e., Li & Lee, 2021; Rothman et al., 1993; Williamson et al., 2020). However, it must be noted that this proposition was not supported when comparing gain- and loss-framed appearance messages, in which there were no differences in reactance. Further, the current findings do not align with previous research showing that appearance-based messaging is advantageous over health-based messaging (e.g., Heckman et al., 2009) insofar that health loss-framed and appearance-based messaging led to higher levels of message reactance compared to health gain-framed messaging. However, these effects, though significant, were small in magnitude and largely unrelated to both predictors of exercise behavior as well as to self-reported exercise behavior at follow-up (Hypothesis 1, 2, and 3). The exception to this is that individuals with higher levels of appearance-based threat (e.g., belief that because they were inactive, they were likely to gain weight, have cellulite) had lower intentions to exercise (Hypothesis 3). This result, although counter to expectations and the theoretical proposition that threat/risk perception is needed for behavioral change (Ferrer & Klein, 2015), is aligned with previous research indicating that negative body image is a barrier to exercise engagement as a result, at least in part, of societal expectations regarding appearance (More & Phillips, 2019; Mu & Wu, 2020).

It was found that, generally, intrinsic health and extrinsic appearance goals did not explain when people reacted to or perceived threat to their health/appearance from viewing exercise-related messages. Broadly speaking, the exception to this was that individuals who viewed a health-related message were protected from perceiving threats to their own health when they had higher levels of extrinsic appearance-based goals. Similarly, individuals who viewed an appearance-related message were protected from perceiving threats to their own appearance when they had higher levels of intrinsic health-based goals (for full results see: https://osf.io/z78hk/). Thus, having goals that are unrelated to health message content protects individuals from feeling threat or a sense of personal risk when viewing health-related messages. This is not necessarily ideal, as theory indicates that some level of threat/risk perception is needed for behavioral change (Ferrer & Klein, 2015). Importantly, being healthy and meeting societal norms for appearance are not always mutually inclusive categories as highlighted by research on the Health at Every Size movement (e.g., Robison, 2005) and on the metabolically obese, normal weight phenotype (Ding et al., 2016).

Finally, there was an increase in MET minutes of exercise across groups ranging from 89.92 (Health Gain-Framed) to 160.24 (Appearance Gain-Framed) over the course of the 1-week follow-up (Table 1). This corresponds to an increase in 22.48-40.06 min of moderate activity per week or 11.24-20.03 min of vigorous activity per week. This increase did not significantly vary across groups, and none of the groups met the minimum recommendation of 600 MET minutes per week at follow-up. Although there is a dose-response relationship between exercise and health outcomes, whereby some exercise engagement is better than no or less engagement (e.g., Ohkawara et al., 2007), it cannot be determined using the current data whether this change was sustained over a longer period, whether this effect was caused by receiving a exercisemessage, or whether this reflects natural fluctuations in physical activity.

The present study is not without limitations. First, only participants from a very specific demographic were recruited (i.e., *cis*-gendered women residing in the United States who did not meet weekly exercise recommendations and who were between the ages of 18-25). These eligibility criteria were used to ensure that the message content was as relevant as possible for each participant. More research will be needed to determine the generalizability of the current findings to other

populations, such as those residing outside of the United States, older adults, transgendered women, *cis*- and transgendered men, and non-binary individuals (Yarkoni, 2022). Second, classification of potential participants as 'inactive' or 'active' and the measured behavioral intervention outcome were based on self-reported engagement in moderate and vigorous physical activity over the previous seven days, which is problematic given that participants tend to be inaccurate at estimating the amount of time that they engage in exercise (Prince et al., 2008). Specifically, people tend to overestimate the amount of time that they are physically active (Downs et al., 2014). Additionally, people can fluctuate in terms of the amount of exercise that they engage in on a day-to-day or week-to-week basis. Thus, by utilizing a measure of self-reported exercise behavior, the present study may have been overly conservative during the intervention recruitment phase, and the observed change in behavioral engagement that occurred across groups after the intervention is likely an overestimation. Therefore, future research should aim to utilize a more objective means of assessing physical activity over a longer period, both prior to intervention enrolment, and after intervention administration, such as through using accelerometers. Third, there has been some debate about the quality of data collected through online participant platforms. For example, Chmielewski and Kucker (2020) found that data quality worsened in samples recruited through online platforms between 2015 and 2018 using the same experimental protocol across four waves. However, an abundance of research has demonstrated that participants recruited online are similarly or even less careless in their responding than participants from undergraduate research pools (e.g., Kees et al., 2017). For example, More and colleagues (2022) found no difference between undergraduate students and online samples on longstring responding indices (i.e., answering with the same response option consecutively). Further, participants online have been shown to pay more attention to surveys than undergraduate students (Capaldi, 2017), and using online recruitment platforms offers some additional benefits, such as not restricting participation to a geographic location.

5.1. Conclusion

The present research is aligned with previous studies demonstrating the benefit of gain-framed exercise messages over loss-framed appeals, which are perceived as more threatening to young women. Additionally, it was found that health gain-framed messages produced less psychological reactance than health loss-framed messages as well as both gain- and loss-framed appearance messages. Thus, considering the relationship between reactance and message avoidance (e.g., Dillard & Shen, 2005; Rains, 2013; Richards & Banas, 2015), it is recommended that messages aimed at promoting exercise should be gain-framed and highlight health outcomes. This is supported by the result that, although there were differences between the health and appearance groups regarding perceptions of threat to personal health, there were no differences between the groups on perceptions of threat to physical appearance.

However, the present research also demonstrated that health messaging alone, regardless of framing or the highlighted outcome, is not enough in and of itself to lead to clinically significant changes in intentions to, or engagement in, exercise (Sharma, 2021). Additionally, even though weekly recommendations for physical activity specify 75 min of vigorous activity or 150 min of moderate activity, health benefits can be achieved at 50% of this prescribed dose (Warburton & Bredin, 2016; World Health Organization, 2020). Specifically, at the week 1 follow-up, only those in the appearance gain-framed condition engaged in 50% of the recommended weekly dose of exercise (i.e., 37.5 min of vigorous or 75 min of moderate activity per week), with the other experimental groups falling below this threshold (Table 2). However, there was no evidence that these changes were sustained over the longer term. Given the lack of clinically significant results, interventions targeting exercise initiation should supplement educational materials with other active ingredients (e.g., see the behavior change technique taxonomy; Michie et al., 2013).

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The data is publicly available on the Open Science Framework. URLs for accessing the data have been shared in this manuscript.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.psychsport.2023.102555.

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