PROMOTING LIFESPAN PHYSICAL ACTIVITY USING DIFFERENT COMMUNICATION STRATEGIES

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Abstract

Research aims to understand the influence of health messages dichotomized as ‘gain’ or ‘loss’ (i.e., ‘benefits of physical activity [PA]’ vs. the ‘consequences of physical inactivity’). This is the first study to investigate the influence of such messages in the context of aging-related risk. A randomized experimental survey design was used to answer these research questions: a) which message frame is optimal for eliciting PA intentions in varying levels of risk?; b) how do risk and framed health messages influence aging perception outcomes?; and c) what demographic factors influence this relationship? Findings indicated the manipulations did not alter current PA intentions but did alter future PA intentions. High-risk, loss-framed messages resulted in greater future PA intentions yet increased aging anxiety. Results do not conclusively support an optimal combination of risk and message frame manipulation but outline conflicting outcomes between motivating lifespan PA and reinforcing negative aging PA attitudes.

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Literature Review

Physical Activity Across the Lifespan

Aging is a lifelong process. Physical activity (PA) lifespan researchers postulate PA and physical fitness patterns go through several transitions, changes, and consistencies in accordance with the many biological and psychosocial events that occur throughout an individual's life (Malina, 1996). The well-known fact that most adults are inactive in tandem with steadily declining PA patterns throughout adulthood (Haskell et al., 2007) highlights a key concern that warrants consideration across various stages of the lifespan.

Accordingly, researchers have used a trajectory approach to identify determinants, predictors, and outcomes of PA participation across the lifespan (Lounassalo et al., 2019). A systematic review of PA trajectory research shows being born into a family with higher socioeconomic status is associated with greater levels of PA across the lifespan (Artaud et al., 2016; Kwon, Janz, Letuchy, Burns, & Levy, 2016). In addition, gender, smoking, and obesity are all reliable indicators of PA trajectories from early to later life (Lounassalo et al., 2019). Although PA patterns decline throughout adulthood, longitudinal research has shown PA levels to be relatively consistent across the lifespan, allowing future PA participation to be predicted from previous levels (Borodulin et al., 2012).

Despite this documented consistency of PA trajectories, there are several known life events that may alter an individual's PA levels, such as the birth of a child or diagnosis of a chronic condition (Pettee Gabriel et al., 2017; Rovio et al., 2018). Therefore, researchers and policy makers alike seek to explore methods by which PA trajectories can be altered so that individuals may receive the multitude of benefits offered by PA engagement. Such benefits include a reduced risk of all-cause mortality and cardiovascular events (Myers et al., 2002).

Additionally, 150 minutes of moderate-vigorous PA a week is associated with reduced risk for numerous chronic diseases including hypertension, type 2 diabetes, and cancer (McKinney et al., 2016). Individuals who are sedentary avoid the numerous benefits to PA. Sedentary individuals are at an increased risk for abdominal and visceral fat (Dumith, Hallal, Reis, & Koh, 2011) as well as an increased risk of mortality and metabolic disease (Owen, Healey, Matthews, & Dunstan, 2010). Health information messages serve to increase PA behaviours and prevent chronic diseases associated with a sedentary lifestyle.

Using Messages to Promote Physical Activity Across the Lifespan

In general, the likelihood of a behaviour (or behaviour change) to occur is positively correlated with exposure to messages promoting that behaviour (Sundar, Kardes, & Wright, 2015). Importantly, Latimer, Brawley, and Bassett (2010) distinguish between messages and messaging. Messages are the information conveyed to the public (e.g., PA guidelines, consequences of physical inactivity). Messaging is the process of getting a message to a target audience, for example, through various media platforms. Although considerable research has focused on optimal platforms for conveying a message, only recently has the content of the message been given similar attention. Within this research domain, the effect of dichotomizing messages in terms of gains (highlighting the benefits of a behaviour) or losses (highlighting the consequences of not engaging in a behaviour) has been explored in various contexts, with mixed results.

Health information messaging is a commonly employed strategy to increase PA among the general population. Particularly within health care settings, including the physician's office and hospitals, individuals are regularly exposed to health messages that encourage various health-promoting behaviours in terms of gains or losses. This differential framing has been

shown to alter the behavioural outcome of the target audience (i.e., the framing effect; O'Keefe & Jensen, 2007). Although there are numerous studies to support the framing effect (e.g., Latimer et al., 2008), one meta-analysis showed no statistical significance for this effect concerning disease prevention behaviours (O'Keefe & Jensen, 2007). In O'Keefe and Jensen's (2007) review, gain-framed messages were superior to loss-framed messages in promoting dental hygiene behaviours but not for other disease prevention behaviours. This provides evidence for the specific contextual factors required for a framing effect to be uncovered.

Given the plethora of benefits achieved by engaging in PA (McKinney et al., 2016; Reiner, Niermann, Jekauc, & Woll, 2013), researchers have turned their attention to understanding which message frame is superior for differing audiences at eliciting this behaviour (Vanroy, Seghers, van Uffelen, & Boen, 2019). One meta-analysis found gain-framed messages to be advantageous over loss-framed messages at promoting PA behaviour, but not intention (Gallagher & Updegraff, 2012). This was particularly true for older adults, who show a preference for gain-framed messages (labelled 'positive frame' in Shamaskin, Mikels, & Reed, 2010).

Indeed, message framing researchers have sought to understand the use of messages to promote PA in an aging context simply by comparing younger and older cohorts. Yet, studies often uncover age itself does not predict how a message is received. Motivational disposition that changes with age was the proposed mechanism for the framing effect found among older adults (Shamaskin et al., 2010). Motivational disposition is made up of two distinct systems. One system, the behavioural activation system (BAS), controls an individual's appetitive motivation, the tendency to approach favourable outcomes. The other, the behavioural inhibition system (BIS), controls aversive motivation, the tendency to avoid unfavourable outcomes (Gray, 1990).

Given that these motivational systems change throughout the lifespan and are central to regulating behaviour, research understanding these systems in a lifespan messaging context is warranted. The perceived risk of PA is another predictor of a health message's effectiveness that is associated with age. Previous research has shown risk perceptions of both the behaviour (e.g., PA) and the behaviour's outcome (e.g., soreness from PA) can influence how a framed health message is received (van 't Riet et al., 2014). The interaction of risk and messages is grounded in prospect theory.

Risk and Message Frame (Prospect Theory)

Prospect theory was proposed to understand individuals' decision making processes when faced with uncertainty (Kahneman & Tversky, 1979; Tversky & Kahneman, 1985). For example, participants in one study were faced with a theoretical situation concerning the outbreak of a disease that is expected to kill 600 people (Tversky & Kahneman, 1981). Participants were asked to endorse a program that guaranteed 200 people would be saved or a program that had a 0.33 probability of saving all 600 people and 0.67 probability of saving no people. Given that the situation was presented in terms of gains (i.e., saving 200 people) participants preferred the first program, as it contains a certain outcome rather than one of probability and risk. When the emphasis was placed on losses (i.e., guaranteeing 400 people will die), participants preferred a program with a 0.33 probability of saving all 600 people and a 0.67 probability that all would die. These findings highlight variations in individuals' decision making when faced with messages varying in emphasis (i.e., frame) and risk. In sum, prospect theory poses that individuals are 'risk-seeking' when faced with losses and 'risk-averse' when faced with potential gains (Salovey, Schneider, & Apanovitch, 2012).

Therefore, according to prospect theory, individuals are motivated to act on a given behaviour based on the risk of engaging in that behaviour. Recent research also poses that risk influences the relationship between the message frame and the target behaviour (Updegraff, Brick, Emanuel, Mintzer, & Sherman, 2015). When applied to health behaviours, gain-framed messages are thought to be better for promoting low-risk behaviours (e.g., PA) and loss-framed messages are thought to be better for promoting high-risk behaviours (e.g., cancer screening), referred to as the "risk-framing hypothesis" (Rothman & Salovey, 1997). The dichotomization of high-risk versus low-risk behaviours is sometimes labelled the "prevention-detection distinction". Prevention behaviours are often perceived as low-risk because they preclude health issues and detection behaviours are often perceived as high-risk because they have the potential to uncover health issues (Salovey, Schneider, & Apanovitch, 2002).

Risk perception is how an individual assigns risk to a given behaviour and is determined by the biographical characteristics of that individual such as age, gender, experiences, and socio-cultural context (Green, Grant, Hill, Brizzolara, & Belmont). Individual differences in risk perception create variability in the message frame most effective at eliciting behaviour change (Apanovitch, McCarthy, & Salovey, 2003). By manipulating risk in the current study, the aim was to understand if and how risk moderates the relationship between message frame and a) current PA planning and b) future PA planning; thus, understanding the role of risk perceptions in a lifespan PA context.

Risk and Physical Activity Engagement Across the Lifespan

There are practical implications for understanding the effect of message framing in the context of risk. For example, an individual may be prescribed PA by their physician in light of a recent medical diagnosis (e.g., high blood pressure or obesity; Lithopoulos, Bassett-Gunter,

Martin Ginis, & Latimer-Cheung, 2017). In addition, individuals may be likely to read PA promoting messages when they are faced with health concerns. Understanding health messages in a risk and lifespan context is particularly important as individuals may face numerous instances when their age and aging processes become salient to them. Phrases such as “I’m getting old” and “I’m not as young as I once was”, are not uncommon among younger and middle-aged adults and provide evidence for age-related risk perceptions becoming salient well before older adulthood.

The intersection of PA risk and aging has been replicated in diverse settings in the current literature. Simply put, advancing age is a risk factor for engaging in sedentary behaviour (DiPietro, 2001). Feelings of lack of safety to engage in PA in one’s community and perceptions of risk of engaging in PA with one or more chronic conditions are well-documented barriers to PA engagement among older adults (Rimmer, Riley, Wang, Rauworth, & Jurkowski, 2004; Watson et al., 2016). Nutrition and adequate sleep are considered the dominant behaviours for healthy aging, whereas PA and activities that result in fatigue are considered inherently risky (Massie & Meisner, 2019; O’Brien Cousins, 2000). Understanding the notion of conflating risk and aging is pivotal to promoting PA across the lifespan.

Unfortunately, studying aging related risk and its consequences exclusively among older adults is a common yet outdated practice. Aging is an ongoing and inevitable process that occurs to each of us. Aging anxiety centres around an individual’s worry and perceived threat associated with the aging process (Sargent-Cox, Rippon, & Burns, 2014). Often, aging anxiety is linked with biopsychosocial outcomes associated with getting older and is unique to general anxiety (Lynch, 2000). In 1993, Lasher and Faulkender designed the Anxiety about Aging Scale (AAS) to test four dimensions of aging anxiety: Fear of Old People, Psychological Concerns, Physical

Appearance, and Fear of Losses. If messages that highlight aging risk are to be used to promote PA, their benefits and consequences must be equally understood.

Further, a negative outlook of aging processes does not appear when an individual becomes an older adult. Rather, aging anxiety and negative stereotypes are embodied across the lifespan (Meisner & Levy, 2016). Accordingly, the effects of aging on PA promotion are best understood through a lifespan paradigm. Despite this, it is not known if aging-related risk can be made self-relevant to predominantly younger participants and subsequently used to influence current and future PA intentions. Accordingly, the present study seeks to understand if undergraduate students in the field of health can be influenced by aging health-risk information as it pertains to PA and if this information subsequently impacts the efficacy of framed health messages.

The Reverse-Message Framing Effect

Despite the heterogeneity of risk perceptions among segments of the population, health research often deems PA a low-risk behaviour (O'Keefe & Jensen, 2007). Accordingly, a loss-framed message's ability to elicit greater levels of PA than gain-framed messages is a reverse-message framing effect as it is inconsistent with prospect theory (Kahneman & Tversky, 1979). Although PA is often considered a low-risk behaviour, research has found reverse-message framing effects for PA participation among sedentary older adults with type 2 diabetes (Li, Ng, Cheng, & Fung, 2017). Researchers found older adults with type 2 diabetes responded to loss-framed messages with greater levels of objectively measured PA than gain-framed messages over two-weeks. This finding speaks to the importance of an individual's subjective appraisal of the risk of engaging in a particular behaviour (Bassett-Gunter, Ginis, & Latimer-Cheung, 2013; Li et al., 2017). Though Li et al. (2017) attributed their findings to the perceived risk of engaging

in PA by their clinical population, they were unable to propose underlying mechanisms and called on future research to better understand the intersection of perceived risk and PA. This is one way the current study directly expands on prior research.

Despite a reverse-framing effect being uncovered among older adults, it has been documented by other studies that loss-framed messages (and losses in general) are less impactful for older adults than for younger adults (Larkin et al., 2007; Mikels & Reed, 2009; Mikels et al., 2016). Older adults prefer messages that result in positive emotions whereas younger adults have been shown to be influenced to a greater extent by messages that evoke negative affect from loss-framed messages (Liu, Shuster, Mikels, & Stine-Morrow, 2019). Therefore, in the context of PA messages, it seems more likely that a reverse-message framing effect would be found among a younger cohort.

Purpose

The current study sought to explore whether or not aging-related risk perceptions influence individuals' responses to gain- or loss-framed messages regarding lifespan PA. Doing so allows interventions to be better equipped to promote PA throughout the lifespan (O'Brien Cousins, 2000). Previous literature has studied the effect of risk perception on PA participation (Stephan, Boiche, Trouilloud, Deroche, & Sarrazin, 2011) and framing effects on individuals exposed to health-risk information (Bassett-Gunter et al., 2013). The ability of manipulated aging risk perceptions to influence the efficacy of framed health messages is unknown. This study fills a gap in the literature by seeking to understand the role of manipulated risk on one's response to PA framed messaging and subsequent PA intentions. By recruiting a younger participant sample, this study seeks to inform health promotion strategies useful for altering PA trajectories in early adulthood that continue into older adulthood. Such strategies would be

particularly effective as they may alter PA trajectories positively before the onset of previously mentioned life-changing events that decrease PA (Pettee Gabriel et al., 2017; Rovio et al., 2018).

Research Questions and Hypotheses

This study seeks to answer the following research questions:

1) Which message frame is optimal at eliciting PA intentions in varying contexts of risk? Guided by prospect theory and previous research (Kahneman & Tversky, 1979; Latimer et al., 2010; Tversky & Kahneman, 1985) four hypotheses were formulated based on the first research question:
    i) Gain-framed messages will elicit greater current PA intentions in the low- risk manipulation;
    ii) Loss-framed messages will elicit greater current PA intentions in the high-risk manipulation;
    iii) Gain-framed messages will elicit greater future PA intentions in the low-risk manipulation; and
    iv) Loss-framed messages will elicit greater future PA intentions in the high-risk manipulation
2) How does manipulating lifespan risk influence participants' perceptions of aging?
3) What are some of the demographic factors that influence the relationship between the experimental manipulations and PA and aging outcomes?

Methods

Methodology

This is a primary, quantitative and exploratory study. Questionnaires were used for data collection as this study is cross-sectional. The hard-copy questionnaires were administered at York University in a lab setting. An in-person design was preferred over an online study format to safeguard participants from any discomfort when faced with questions regarding aging, as well as to answer any concerns in real-time. In addition, an in-person study design increases the likelihood participants would complete the entire study even when faced with mild discomfort. York University was chosen as the setting as it is the most convenient location for both the researchers and the participants, as all researchers involved in the study and the participant pool reside at York University.

Participants and Recruitment

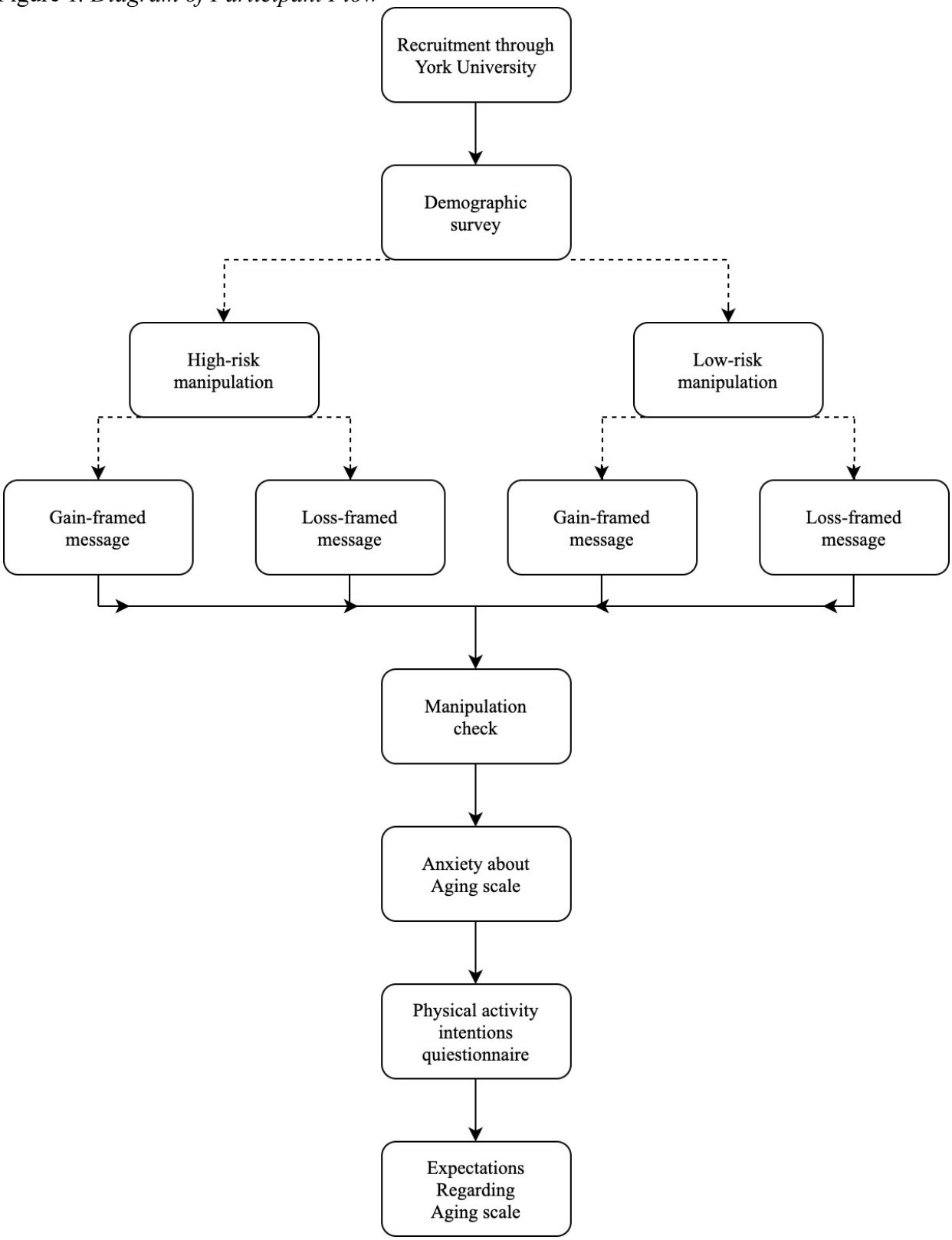
Participants were Canadian post-secondary students at York University from any academic unit. Participants were recruited via participant pool (Appendix A), poster (Appendix B) and email (Appendix C). This research was classified as minimal risk, and participants individually consented to partake in the study. Demographic information was assessed (Appendix D) including age, sex, ethnicity, education, baseline PA levels using the International Physical Activity Questionnaire - Short Form (IPAQ-SF; Craig et al., 2003), and motivational disposition using the behavioural inhibition system and behavioural activation system scales (Carver & White, 1994). These variables have been explored in previous research as mediators of message frame and behaviour change (Mikels et al., 2016; Shen & Dillard, 2007; Toll et al., 2008; Williams, Saken, Gough, & Hing, 2019) and will be necessary to answer the third research question. Exclusion criteria included participants who are younger than 16 years of age.

Participants were recruited from the Kinesiology Undergraduate Research Experience (KURE) participant pool. When this pool was no longer able to provide participants, recruitment took place via email and posters. Based on the study design (i.e., four experimental conditions), 253 participants were recruited with 60-65 participants in each group. This is congruent with previous similar studies (Vanroy, Seghers, van Uffelen, & Boen, 2019).

Design and Procedure

The study consisted of experimental manipulations of aging-related risk perceptions and message frame, resulting in a 2 (risk; high versus low) x 2 (frame; gain versus loss) between participants design. An overview of the study procedure is displayed in Figure 1. A manipulation check was performed (Appendix G) to assess the effects of the risk manipulation and message frame. Participants then completed the Anxiety about Aging Scale (AAS; Appendix H) to assess the way the messages influenced their aging anxiety in accordance with the second research question. Finally, participants were asked to report current and future PA intentions (Appendix I) and complete the Expectations Regarding Aging (ERA-12; Appendix J) scale to facilitate answering the first and second research questions, respectively. Participants were thanked for their time and received course credit if recruited from the KURE system. All procedures were approved by York University's Research and Ethics Board (Ethics Protocol #2556).

Figure 1. *Diagram of Participant Flow*



Notes: Dashed lines indicate randomized assignments.

Manipulations

Risk Perceptions. Directly preceding the writing task, participants were exposed to one of two messages (Appendix E) that elicit high- or low-risk perceptions associated with physical aspects (i.e., function, mobility, activity) of the aging process. The low-risk perception group read "95% of older adults can expect to maintain their physical functioning (World Health Organization, 2019)." The high-risk perception group read "95% of older adults can expect to have poor physical functioning (World Health Organization, 2019)." This, in addition to the aging self-relevancy writing task, was used to position the study within an aging context and induce varying degrees of risk as it pertains to physical functioning and PA across the lifespan. Risk perceptions have been previously proposed as a possible mediator for the relationship between framed messages and PA intentions (Lithopoulos et al., 2017).

Aging Self-Relevancy. Participants were then asked to write what they believe their life will be like when they are 85 years old, paying particular attention to physical functioning. This served as an explicit prime to invoke feelings of health-related risk, uncertainty, and/or aging anxiety that is often associated with the aging process, particularly in relation to PA (Meisner & Levy, 2016; O'Brien Cousins, 2000). In addition, the writing task served to reinforce the risk perception statements mentioned above. Messages that are made personally relevant to the reader have been shown to be more persuasive than those that do not (Rothman, Martino, Bedell, Detweiler, & Salovey, 1999).

Framing. The framing manipulation (van 't Riet, Ruiter, Werrij, & De Vries, 2010) consisted of a health message roughly one page in length (Appendix F) that either: a) highlighted the benefits of engaging in PA (gain-framed) or b) highlighted the negative consequences of being physically inactive (loss-framed). These benefits or consequences center around various

aspects of physical health such as a healthy heart, cancer risk, and diabetes risk. A direct comparison of a gain- and loss-framed message can be found in Table 1. The gain-framed message given to participants contained 314 words; the loss-framed message contained 307 words. The content of both messages was identical and are included in Appendix F. After being exposed to either gain- or loss-framed messages, participants responded to 10 items that served as a manipulation check (Appendix G; e.g., "Indicate to what extent the information you just read made you feel: 1 = *Very Happy* to 7 = *Not at All Happy*). Items from the current study were also used in research by van 't Riet et al. (2010) and similar to a manipulation check used in Schneider et al. (2001). Gain-framed messages were expected to elicit greater positive affect and loss-framed messages were expected to elicit greater negative affect based on these studies in addition to Mikels et al. (2016).

Table 1. *Gain- Versus Loss-Framed Messages Sample*

Frame	Content Sample
Gain	Being sufficiently physically active increases your chance of a healthy and strong heart. A healthy heart is an important condition for a long and healthy life, so there is plenty of reason to be physically active.
Loss	Being insufficiently physically active increases your risk of cardiovascular diseases. Cardiovascular diseases are the number one cause of death in Canada, so there is plenty of

	reason to make sure that you are not physically inactive.

Measures

Table 2 displays which measures were administered pre-test and which measures were administered post-test.

Pre-test (Demographic) Questionnaire. The pre-test questionnaire (Appendix D) contained an item to assess program, degree, year of study, age, gender, and ethnicity. Also included in this survey was the International Physical Activity Questionnaire – Short Form (IPAQ-SF; Craig et al., 2003) to assess baseline PA levels. This survey asked participants to report the a) frequency (number of days in the past week) and b) duration (minutes on one day) they performed vigorous PA, moderate PA, and walking. Sitting duration was also reported. Previous research using a population congruent with the current study's sample has demonstrated the IPAQ-SF to have acceptable levels of validity and reliability (Dinger, Behrens, & Han, 2006). Responses to these items were multiplied to calculate weekly PA volume in minutes for each intensity. Finally, the behavioural inhibition and behavioural activation system (i.e., BIS/BAS) scales were administered to measure participants' motivational disposition (Carver & White, 1994). Specifically, this scale measures participants' motivation to approach favourable outcomes or avoid unfavourable outcomes. As previously stated, motivational disposition has been shown to moderate framing effects in previous research and is central to answering the third research question (Updegraff et al., 2015). Responses to BIS/BAS scale items were reverse-scored.

PA Intentions. Consistent with previous research (Conroy, Elavsky, Doerksen, & Maher, 2013), participants' intentions to engage in PA currently was assessed using three items (Appendix I). An example of an item was, "I plan to take part in regular physical activity in the next week." Participants responded to these questions using a seven-point Likert scale (1 = *Strongly Disagree* to 7 = *Strongly Agree*). Intentions are commonly measured as a useful predictor of future PA behaviour (Lithopoulos et al., 2017). A meta-analysis by Rhodes and de Bruijn (2013) found 54% of participants who intended to increase PA later went on to do so, whereas only 2% of individuals lacking this intention increased PA behaviour. Therefore, PA intentions are a suitable measure of the effect of health messaging to promote PA when objectively measured PA behaviour is impractical (Webb & Sheeran, 2006). Cronbach's alpha (Cronbach, 1951) was assessed as a measure of reliability ($\alpha = .79$).

Future PA Intentions. Future PA intentions were assessed using the IPAQ-SF scale (as used in the pre-test questionnaire). The survey was modified to be future-oriented and assess predicted PA levels when participants are 85 years old (Appendix I). For example, the question: "During the last 7 days, on how many days did you do moderate physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis?", was re-worded as: "When you are 85 years old, on how many days will you do moderate physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis?". Similar to baseline PA, future PA intentions were calculated by multiplying participants' self-reported duration and frequency of PA for each intensity. Future weekly PA volume for each intensity (in addition to future sitting intentions) were used as primary outcome variables in this study. Secondary outcome variables were computed by calculating the difference between participants' self-reported baseline PA and future-oriented PA intentions. For example, if a participant self-reported 20 minutes of vigorous

PA on three days in the last week and reported future PA intentions of 20 minutes of vigorous PA on two days per week at age 85, the participant's baseline weekly vigorous PA volume was computed as 60 minutes per week (i.e., 20 x 3) and future vigorous PA intentions was computed as 40 minutes per week (i.e., 20 x 2). Therefore, the participant's vigorous PA change was 20 minutes (i.e., 60 – 40). Higher PA change scores indicated greater baseline PA compared to future PA intentions and lower scores indicated higher future PA intentions relative to baseline PA.

Aging Anxiety and Expectations. Aging anxiety was also measured using the Anxiety about Aging Scale (AAS; Lasher & Faulkender, 1993) to answer the second research question and can be found in Appendix H. This is a valid and reliable measure of one's attitude and behaviour towards older adults and has been used in previous research (Sargent-Cox et al., 2014). A sample item from this scale is, "I enjoy being around old people": responses were given on a five-point Likert scale (1 = *Strongly Disagree* to 5 = *Strongly Agree*). Some items, such as the example provided, were reverse-scored so that higher scores indicated higher aging anxiety. The importance of aging anxiety in an undergraduate cohort is well-documented. Allan and Johnson (2009) found that aging anxiety (measured by the AAS) among undergraduate students mediated the effects of knowledge about aging and ageism. Of importance to the current study, aging anxiety is a mediating factor in one's adjustment to aging processes (Lasher & Faulkender, 1993). Cronbach's alpha (Cronbach, 1951) was assessed as a measure of reliability for each AAS sub-scale as well as overall AAS score ($\alpha_{FearofOldPeople} = .83$, $\alpha_{PsychologicalConcerns} = .80$ $\alpha_{PhysicalAppearance} = .71$ $\alpha_{FearofLosses} = .67$, $\alpha_{Overall} = .80$) One item was removed from the Psychological Concerns (item 6) and Physical Appearance (item 11) sub-scales to increase reliability.

Participants' aging expectations were measured using the ERA-12 (Appendix J; Sarkisian, Steers, Hays, & Mangione, 2005) in order to answer the second research question. This survey demonstrates acceptable levels of reliability and validity measuring participants' levels of physical and mental health expectations and cognitive function regarding aging, as well as one item regarding global expectations of aging (Sarkisian et al., 2005). A recent systematic review of 11 ageism scales (Ayalon et al., 2019) revealed the expectations regarding aging (ERA) scale had the highest content validity, structural validity, and internal consistency. Cronbach's alpha (Cronbach, 1951) was assessed as a measure of reliability for each ERA sub-scale as well as overall ERA score ($\alpha_{PhysicalHealth} = .64$, $\alpha_{MentalHealth} = .65$, $\alpha_{CognitiveFunction} = .79$, $\alpha_{Overall} = .82$).

Table 2. *Administration of Questionnaires at Different Time Points*

Appendix	Measure	Baseline	Post-manipulation
D	Demographic Questionnaire	✓	
D	Motivational Disposition Questionnaire	✓	
D	Physical Activity Questionnaire	✓	
G	Health Message Manipulation Check		✓
H	Anxiety About Aging Scale		✓
I	Physical Activity Intentions Questionnaire		✓
I	Future Physical Activity Planning Questionnaire		✓
J	Aging Expectations Questionnaire		✓

Statistical Analyses

SPSS 26.0 was used for statistical analyses (IBM Corporation, Armonk, NY, USA). Means, standard deviations, skewness, and kurtosis values were calculated for all continuous variables (Appendix K) to assess normality. Levene's test (Levene, 1960) was used to assess homogeneity of variance. Correlation matrices (Appendix L) were used to estimate the relationship between covariates and outcome variables. In addition, matrices were used to determine if covariates were correlated with one another.

Two (risk: high versus low) by two (message frame: gain versus loss) analyses of variance (ANOVA) were used to determine the relationship between the manipulations and outcome variables in order to answer the first and second research questions. Finally, analyses of covariance (ANCOVA) were used identify significant covariates that influence the relationship between manipulations and outcomes in order to answer the third research question. ANCOVA also served to assess the first and second research questions at the multivariate level.

Parametric statistical models were used unless data violated assumptions of such tests. In such cases, descriptive statistics were analyzed to assess if parametric models were still justified. If not, non-parametric tests were used. For example, in the current study, data were considered normally distributed based on the central limit theorem. The central limit theorem states that when samples are large (i.e., > 30), the sampling distribution will take the shape of a normal distribution regardless of the shape from which the sample was taken. (Field, 2009; Kwak & Kim, 2017; Lumley, Diehr, Emerson, & Chen, 2002). In addition, the power of *F* seems to be unaffected by non-normality when group sizes are equal (Donaldson, 1968; Field, 2009). Finally, ANOVA is robust when the assumption of homogeneity of variance is violated as long as groups are equally distributed. Tests of normality and homogeneity of variance tend to incorrectly

produce significant results with a large sample size (Field, 2009). Therefore, in some instances, use of parametric tests were still justified despite violations of such tests.

Results

Descriptive Statistics and Management of Raw Data

Preliminary analyses were conducted to obtain descriptive statistics. Outliers were identified as having a z-score of ± 3.29 (Field, 2009) and were altered to the closest score within the ± 3.29 criteria. Outliers were found in the baseline PA (n = 12), future PA intentions (n = 8), ERA (n = 1), and AAS (n = 1) variables. Table 3 shows descriptive statistics of the raw dataset before data management (i.e., outlier removal and missing data analyses). Overall, the mean age of the sample was 21.1 years old (SD = 6.1). Total weekly PA volume was assessed for vigorous (M = 220.9, SD = 361.2), moderate (M = 211.0, SD = 335.8), and walking (M = 652.7, SD = 855.4) intensities. The highest reported rates of each intensity were 3,600; 2,100; and 6,000 minutes per week, respectively. The lowest reported rate for each activity was zero minutes per week. For time spent sitting, participants reported an average of 400.6 minutes (SD = 211.8) on an average day last week. The highest reported time spent sitting was 2,160 minutes on one day, the lowest was zero minutes.

Rates of missing data were relatively low. For demographic variables: 2.8% (n = 7) of data were missing for age, 0% were missing for gender, 0.4% (n = 1) were missing for program of study, and 0% were missing for ethnicity. For baseline activity variables: 2.8% (n = 7) of vigorous PA data were missing, 9.1% (n = 23) of moderate PA data were missing, and 16.6% (n = 42) of walking data were missing. Time spent sitting contained the most missing data, with 21.7% missing (n = 55).

Table 3. *Characteristics of Raw Dataset*

Continuous Variables	***M* (SD)**	**Min-Max**	**Missing *n* (%)**
Age	21.1 (6.1)	18.0-69.0	7 (2.8)
BAS Drive	3.1 (1.2)	1-7	0 (0.0)
BAS Fun Seeking	3.1 (1.2)	1-6	0 (0.0)
BAS Reward Responsiveness	2.0 (0.9)	1-7	0 (0.0)
BIS	5.1 (1.11)	1-7	0 (0.0)
Total Weekly PA (mins)			
Vigorous	220.9 (361.2)	0.0-3600.0	7 (2.8)
Moderate	211.0 (335.8)	0.0-2100.0	23 (9.1)
Walking	652.7 (855.4)	0.0-6000.0	42 (16.6)
Sitting (on one day)	400.6 (211.8)	0.0-2160.0	55 (21.7)
Categorical Variables	***n***	**%**	
Gender			0 (0.0)
Male	84	33.2	
Female	168	66.4	
Program			1 (0.4)
Kinesiology	151	59.7	
Psychology	37	14.8	
Other	64	25.3	
Ethnicity			0 (0.0)
Caucasian	49	19.4	
Middle Eastern	43	17.0	
South Asian	62	24.5	
Other	99	39.1	

Descriptive statistics were run to identify missing data. Missing data were dealt with on a variable-by-variable basis. A Little's MCAR test was used to determine if data were missing completely at random (Little, 1988). Results of the Little's MCAR test can be found in Appendix M. The null hypothesis for this test states that data are missing completely at random. Since this test yielded no significant results across all continuous variables used in this study, the null hypothesis is accepted. Additional analyses were performed where appropriate to ensure data were missing completely at random.

For single and double item continuous measures (i.e., IPAQ, future-oriented IPAQ, and age) if an item was missing, it was replaced with the mean of the experimental group to which that participant belongs. For multi-item measures (e.g., ERA) missing data were replaced with the participant's sub-scale mean (n = 11). Missing categorical data (e.g., program) were replaced with the sample mode (Mode = Kinesiology, n = 1). This method of dealing with missing data was considered adequate given the low amount of missing data in this study. After data management, no missing data remained. Therefore, 253 cases exist for each variable, with the exception of gender. One participant identified as genderqueer. Given the low sample size, this participant was not included in analyses using gender, which resulted in a sample size of 252 participants for those analyses.

Descriptive Statistics of Analytical Sample

Descriptive statistics of the final dataset used for analyses are reported in Table 4. Of the overall sample of 253 participants, the mean age was 21.1 (*SD* = 6.0) and the mode was 19.0. Most of the sample was female (66.4%, *n* = 168), self-identified as South Asian (24.5%, *n* = 62), and a member of the Kinesiology program (60.1%, *n* = 152) at York University. Overall, participants reported similar levels of vigorous (*M* = 194.6, *SD* = 196.9) and moderate (*M* =

187.8, *SD* = 232.7) weekly PA participation. Participants reported walking an average of 594.6 minutes per week (*SD* = 580.0) and sitting an average of 390.2 minutes (*SD* = 145.7) on an average day in the last week.

Table 4 also shows descriptive statistics of the final dataset stratified by each experimental group. Experimental groups had an even distribution (*n* = 65, 62, 63, 63) of participants and did not significantly differ in any of the demographic variables assessed (using Pearson correlation or Chi-Square, significance set at $p < .05$; Table 4).

Table 4. *Participant Characteristics*

	M (SD)	**Min-Max**	**M (*SD*)**		**M (*SD*)**	
	Overall Sample		High-Risk		Low-Risk	
Continuous Variables	*n* = 253		Gain Frame (*n* = 65)	Loss Frame (*n* = 62)	Gain Frame (*n* = 63)	Loss Frame (*n* = 63)
Age	21.1 (6.0)	18-69	20.4 (3.7)	21.6 (6.3)	20.4 (3.1)	22.0 (9.0)
BAS Drive	3.1 (1.2)	1-7	3.0 (1.3)	2.85 (1.0)	3.1 (1.1)	3.4 (1.3)
BAS Fun Seeking	3.1 (1.2)	1-6	2.9 (1.2)	3.0 (1.2)	3.3 (1.0)	3.4 (1.3)
BAS Reward Responsiveness	2.0 (0.9)	1-7	2.0 (0.74)	1.8 (0.6)	2.0 (0.8)	2.3 (1.2)
BIS	3.0 (1.1)	1-7	3.0 (1.2)	3.0 (1.1)	2.8 (0.78)	3.1 (1.3)
Baseline Weekly Vigorous PA (mins)	194.6 (196.9)	0-800	189.03 (193.17)	215.5 (214.7)	214.8 (193.5)	159.6 (184.6)
Baseline Weekly Moderate PA (mins)	187.8 (232.7)	0-960	199.1 (243.3)	161.2 (168.7)	219.5 (276.2)	170.6 (229.4)
Baseline Weekly Walking (mins)	594.6 (580.0)	0-2500	557.3 (588.1)	579.9 (529.6)	563.5 (542.6)	678.6 (602.3)
Baseline Weekly Sitting (mins)	390.2 (145.7)	0-860	390.0 (155.4)	415.3 (143.2)	377.0 (133.8)	379.1 (141.3)
	n	**%**	***n* (%)**		***n* (%)**	
	Overall Sample		High-Risk		Low-Risk	
Categorical Variables			Gain Frame	Loss Frame	Gain Frame	Loss Frame
Gender						
Male	84	33.2	25 (9.9)	22 (8.7)	16 (6.3)	21 (8.3)
Female	168	66.4	39 (15.4)	40 (15.8)	47 (18.6)	42 (16.6)
Program						
Kinesiology	153	60.5	42 (16.6)	41 (16.2)	33 (13.0)	37 (14.6)
Other	100	39.5	23 (9.1)	21 (8.3)	30 (11.8)	26 (10.3)
Ethnicity						
Caucasian	49	19.4	12 (4.7)	8 (3.2)	14 (5.5)	15 (5.9)
Middle Eastern	43	17.0	8 (3.2)	18 (7.1)	7 (2.8)	10 (4.0)
South Asian	62	24.5	20 (7.9)	11 (4.3)	14 (5.5)	17 (6.7)
Other	99	39.1	15 (5.9)	37 (14.6)	27 (10.7)	21 (8.3)

Notes*:* $p > .05$ for all variables using Pearson Correlation or Chi-Square.

Risk Manipulation Check

Independent samples t-tests were conducted to assess if the risk manipulation was effective. A complete list of the manipulation check analyses can be found in Table 5. Despite certain items being created to assess the risk manipulation and others to assess the message frame, both manipulations were assessed using all manipulation check items. This procedure was carried out to measure any significant overlap between the items used to assess the risk manipulation (e.g.,

risk of PA) and the message frame (e.g., benefit and tone). Overall, none of the risk manipulation items revealed statistically significant findings. For example, participants were asked to indicate to what extent the message highlighted the risks of PA on a seven-point Likert scale (1 = *No Risk* to 7 = *Extreme Risk*). The results indicated that participants' responses did not differ significantly based on assignment to the high- or low-risk condition (M_H = 5.4, SE = .160; M_L = 5.5, SE = .15; $t(251) = -0.44$, $p = .66$, $r = .03$). Similarly, non-significant findings were found when participants were asked to assess the risk of PA currently ($t(251) = -0.04$, $p = .97$, r = .003), the risk of PA at age 85 ($t(251) = 0.15$, $p = .88$, r = .01), and the risk of PA with age ($t(251) = 0.71$, $p = .48$, r = .04). Finally, the risk manipulation did not significantly alter participants' responses to any of the message frame manipulation check items: happy ($t(251)= 0.65$, $p = .52$, $r = .04$), sad ($t(251) = -0.05$, $p = .65$, $r = .03$), relieved ($t(251) = 0.27$, $p = .79$, $r = .02$), afraid (t(251) = -0.02, $p = .88$, $r = .01$), benefit ($t(251) = -0.12$, $p = .91$, $r = .01$), and tone ($t(251) = 1.69$, $p = .09$, $r = .11$).

Message Frame Manipulation Check

Independent samples t-tests were also conducted to assess if the message frame manipulation was effective (Table 6). In contrast to the risk manipulation, all items designed to assess the message frame significantly altered participants' responses. Participants who were exposed to a gain-framed message ($M = 2.89$, $SE = .13$) reported feeling happier after reading the message than those were exposed to a loss-framed message ($M = 4.40$, $SE = .16$; $t(251) = -7.14$, $p < .001$, $r = .41$). This was measured using a seven-point Likert scale ranging from 1 = *Very Happy* to 7 = *Not at All Happy*. When asked to rate how relieved the message made them feel (1 = *Very Relieved* to 7 = *Not at All Relieved*), participants who received a gain-framed message reported feeling significantly more relieved ($M = 3.07$, $SE = .14$) than participants who received a loss-framed message ($M = 4.24$, $SE = .16$; $t(251) = -5.46$, $p < .001$, $r = .32$). With respect to

sadness (1 = *Very Sad* to 7 = *Not at All Sad*), participants who received a loss-framed message reported more sadness ($M = 4.02$, $SE = .15$) than participants who received a gain-framed message ($M = 5.45$, $SE = .14$; $t(250.14) = 6.91$, $p < .001$, $r = .40$).

In addition, participants who received a loss-framed message ($M = 3.86$, $SE = .17$) reported feeling more afraid after reading the message than participants who received a gain-framed message ($M = 5.21$, $SE = .16$; $t(251) = 0.38$, $p < .001$, $r = .35$) on a Likert scale ranging from 1 = *Very Afraid* to *7 = Not at All Afraid*. Participants who received a gain-framed message ($M = 6.59$, $SE = .07$) reported the message highlighting the benefits (using a Likert scale ranging from 1 = *Not at All Beneficial* to 7 = *Extremely Beneficial*) of PA to a greater extent than participants who received a loss-framed message ($M = 5.93$, $SE = .13$; $t(199.84) = 4.42$, $p < .001$, $r = .30$). When asked about the overall tone of the message (Likert scale ranging from 1 = *Extremely Negative* to 7 = *Extremely Positive*), participants who received a gain-framed message ($M = 5.97$, $SE = .10$) reported a more positive message than participants who received a loss-framed message ($M = 3.34$, $SE = .15$; $t(210.85) = 14.86$, $p < .001$, $r = .72$).

Independent samples t-tests were also conducted between the message frame and the manipulation check items originally designed to assess the risk manipulation. Participants who received a loss-framed message ($M = 6.11$, $SE = .11$) reported the message highlighting the risks of PA to a greater extent than participants who received a gain-framed message ($M = 4.84$, $SE = .17$; $t(218.66) = -6.20$, $p < .001$, $r = .36$). However, the message frame manipulation did not result in statistically significant differences in groups when participants were asked about the risk of PA currently ($t(251) = -0.31$, $p = .98$, $r = .001$), the risk of PA at age 85 ($t(251) = -0.18$, $p = .86$, r = .01), and the risk of PA with age ($t(251) = -1.93$, $p = .06$, $r = .04$).

Four of the items (sad, benefit, tone, risk of message) from Table 6 violated Levene's test for equality of variances. To account for this, a *Welch's F* test was used to ensure significant differences are present (Field, 2009). Importantly, parametric tests such as t-tests are fairly robust when assumptions are violated. The following *Welch's F* tests were conducted for the purpose of confirming the results of the parametric t-tests above. Four one-way ANOVA (*Welch's F* test) were conducted with message frame as the independent variable. Results indicated that items assessing: how sad the participants interpreted their message (*Welch's F*(1, 250.14) = 47.78, $p <$ 0.001, est. $\omega^2 = 0.16$); how much the message described the benefits of PA (or consequences of inactivity; (*Welch's F*(1, 199.84) = 19.55, $p < .001$, est. $\omega^2 = .07$); the overall tone of the message (*Welch's F*(1, 210.85) = 220.95, $p < .001$, est. $\omega^2 = .47$); and the risk of PA conveyed by the message (*Welch's F*(1, 218.66) = *38.01,* $p < .001$, est. $\omega^2 = .13$); all produced statistically different means across message frame conditions. The *Welch's F* tests confirm the statistical significance of the independent samples t-tests findings despite violations of homogeneity of variance.

The t-tests and *Welch's F* tests described above and in Tables 5 and 6 were conducted to assess the extent to which participants perceived variations in manipulations in different experimental groups. Overall, all items designed to assess the risk manipulation resulted in the null hypothesis being accepted. In addition, the null hypothesis was accepted for items originally designed to assess the risk manipulation. The message frame manipulation produced statistically significant differences in group means for all items designed to assess this manipulation as well as for one of the variables designed to assess the risk manipulation (i.e., risk of the message). In short, the above analyses reveal the risk manipulation did not reveal expected differences in the items used to assess this manipulation. The message frame resulted in group differences

consistent with previous research. This suggests participants perceived differences in the message frame, but not the risk manipulation assigned to them.

Table 5. *Independent Samples T-Tests Assessing Risk Manipulation Check*

Dependent Variable	**Independent Variable**	**Condition**	***n***	***M***	***SD***	***T***	***p***	**r**
Happy	Risk	High	127	3.7	1.8	0.65	.52	.04
		Low	126	3.5	1.8			
Sad	Risk	High	127	4.7	1.8	-0.45	.65	.03
		Low	126	4.7	1.8			
Relieved	Risk	High	127	3.7	1.9	0.27	.79	.02
		Low	126	3.6	1.7			
Afraid	Risk	High	127	4.5	1.9	-0.15	.88	.01
		Low	126	4.6	1.9			
Benefit	Risk	High	127	6.3	1.2	-0.12	.91	.01
		Low	126	6.3	1.3			
Tone	Risk	High	127	4.9	1.8	1.69	.09	.11
		Low	126	4.5	2.0			
Risk of Message	Risk	High	127	5.4	1.8	-.44	.66	.03
		Low	126	5.5	1.7			
Current PA Risk	Risk	High	127	2.5	1.6	-.04	.97	.003
		Low	126	2.5	1.7			
Risk of PA at 85	Risk	High	127	4.2	1.8	.15	.88	.01
		Low	126	4.2	1.7			
Risk of PA with Age	Risk	High	127	4.4	1.8	.71	.48	.04
		Low	126	4.3	1.8			

Table 6. *Independent Samples T-Tests Assessing Message Frame Manipulation Check*

Dependent Variable	**Independent Variable**	**Condition**	***n***	***M***	***SD***	***T***	***p***	**r**
Happy	Message Frame	Gain	128	2.9	1.5	-7.14	< .001	.41
		Loss	125	4.4	2.7			

Sad	Message Frame	Gain	128	5.4	1.6	6.91	< .001	.40
		Loss	125	4.0	1.7			
Relieved	Message Frame	Gain	128	3.1	1.6	-5.46	< .001	.32
		Loss	125	4.2	1.8			
Afraid	Message Frame	Gain	128	5.2	1.8	5.97	< .001	.35
		Loss	125	3.9	1.9			
Benefit	Message Frame	Gain	128	6.6	0.8	4.42	< .001	.30
		Loss	125	5.9	1.4			
Tone	Message Frame	Gain	128	6.0	1.1	14.86	< .001	.72
		Loss	125	3.3	1.7			
Risk of Message	Message Frame	Gain	128	4.8	1.9	-6.17	< .001	.36
		Loss	125	6.1	1.3			
Current PA Risk	Message Frame	Gain	128	2.5	1.7	-0.03	.98	.001
		Loss	125	2.5	1.7			
Risk of PA at 85	Message Frame	Gain	128	4.2	1.8	-1.76	.86	< .001
		Loss	125	4.2	1.8			
Risk of PA with Age	Message Frame	Gain	128	4.1	1.8	-1.93	.06	.12
		Loss	125	4.6	1.8			

Hypothesis Testing

Bivariate Analyses

This study was performed to answer three research questions. The first, to assess messages varying in risk and frame to determine an optimal message for increasing PA intention. Second, to understand the influence of these messages on the aging perceptions of participants. Third, to determine covariates that influence the relationship between the messages and the outcomes. Four hypotheses were made based on the first research question. First, it was expected gain-framed messages would elicit greater current PA intentions in the low-risk manipulation. Second, loss-framed messages were hypothesized to elicit greater current PA intentions in the high-risk

manipulation. Third, it was hypothesized gain-framed messages would elicit greater future PA intentions in the low-risk manipulation. Fourth, it was hypothesized loss-framed messages would elicit greater future PA intentions in the high-risk manipulation. In short, it was hypothesized that gain-framed messages would better promote PA primed as low-risk and loss-framed messages would better promote PA primed as high-risk for both current and future PA intentions. To test these hypotheses, multiple two (risk: high versus low) x two (message frame: gain-framed message versus loss-framed message) independent measures ANOVA were calculated to examine differences as a function of each condition.

Independent Measures ANOVA Results for Current PA Intentions

The first research question, specifically hypotheses 1 and 2, was tested using independent measures ANOVA (Table 7) with current PA intentions as the dependent variable. Current PA intentions were assessed by computing the mean of three items that assessed PA over the next week and moderate and vigorous PA over the next 24 hours (seven-point Likert scale ranging from 1 = *Strongly Disagree* to 7 = *Strongly Agree*). Results show there were no significant main effects for the risk manipulation or message frame. In addition, no interaction effects of risk x message frame were detected. Therefore, results show current PA intentions are not influenced by health messages and hypotheses 1 and 2 are not supported in this study.

Table 7. *ANOVA Results for PA Outcome Variables*

	M (*SD*)				Risk *F* (partial η^2)	Message Frame *F* (partial η^2)	Risk x Message Frame F (partial η^2)
Variable	High-Risk		Low-Risk				
	Gain	Loss	Gain	Loss			
Current Intentions	5.6 (1.2)	5.5 (1.2)	5.8 (1.1)	5.4 (1.4)	0.06 (.00)	2.37 (.01)	2.06 (.01)
Future Weekly Vigorous PA	59.3 (93.7)	68.7 (87.6)	63.4 (86.4)	79.7 (98.5)	0.43 (.002)	1.25 (.01)	0.09 (.00)
Future Moderate PA	230.2 (218.6)	249.4 (213.2)	174.4 (174.8)	177.0 (154.4)	7.02* (.03)	0.20 (.001)	0.12 (.00)
Future Walking	485.6 (427.3)	564.2 (466.1)	332.0 (286.9)	421.4 (391.3)	8.75* (.03)	2.81 (.01)	0.01 (.00)
Future Daily Sitting	411.9 (159.4)	395.6 (172.8)	372.3 (146.3)	415.6 (143.0)	0.25 (.001)	0.47 (.002)	2.32 (.01)
Total Vigorous PA Change	129.8 (185.6)	146.8 (197.9)	151.4 (171.0)	79.8 (163.0)	1.00 (.004)	1.45 (.01)	3.84 (.02)
Total Moderate PA Change	-31.0 (313.6)	-88.2 (266.9)	45.1 (284.3)	-6.4 (218.8)	5.28* (.02)	2.50 (0.10)	0.01 (.00)
Total Walking Change	71.6 (589.8)	15.7 (489.0)	231.6 (578.8)	257.2 (664.3)	7.47* (.03)	0.04 (.00)	0.31 (.001)
Sitting Duration Change	-22.0 (169.3)	19.7 (173.3)	4.7 (153.1)	-36.6 (133.6)	0.56 (.002)	0.00 (.00)	4.36* (.02)

Notes*:* *$p < 0.05$

Independent Measures ANOVA Results for Future PA Intentions

Independent measures ANOVAs were also used to answer the first research question by testing hypotheses 3 and 4 (Table 7). Future PA intentions were assessed using two items for each intensity that assessed frequency (days per week) and duration (minutes per day). Sitting intentions were assessed using one item that assessed duration (minutes per day) on an average

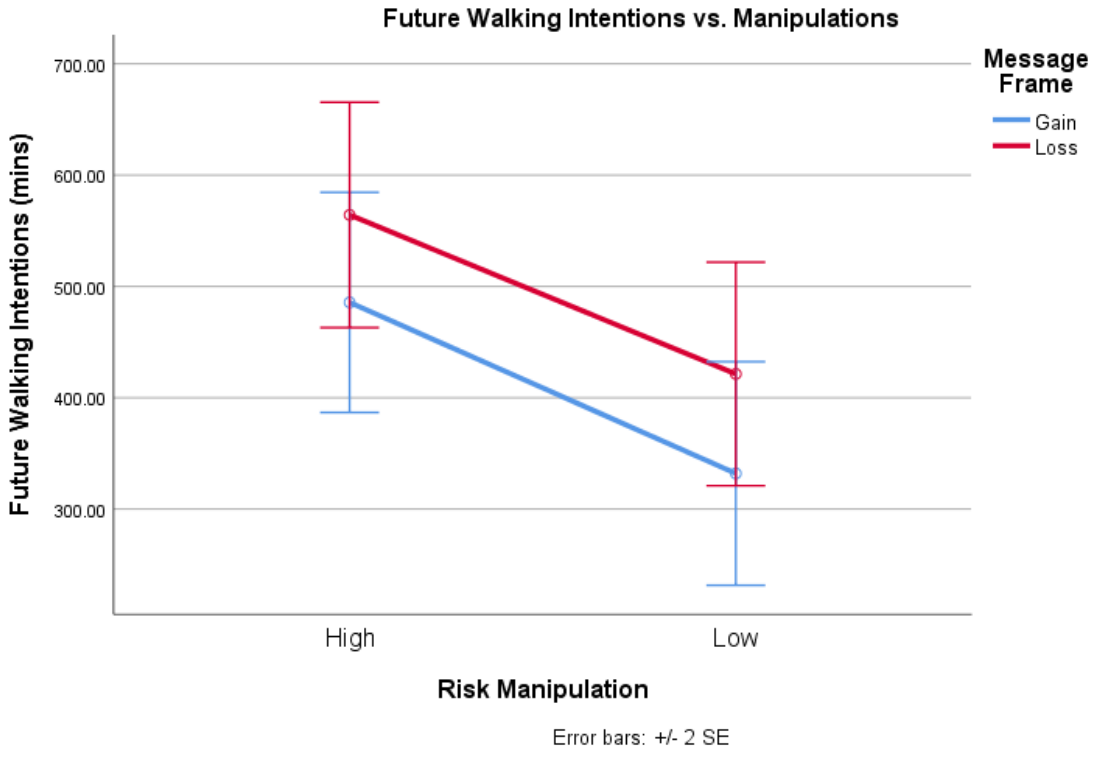
day. For future weekly vigorous PA, there was no main effect for the risk manipulation or message frame, as well as no interaction effect between the two conditions. The loss-framed message resulted in greater future vigorous PA intentions in the high-risk condition (M_{Gain} = 59.3, SD = 93.7; M_{Loss} = 68.7, SD = 87.6) and the low-risk condition (M_{Gain} = 63.4, SD = 86.4; M_{Loss} = 79.7, SD = 98.5), with greatest intentions resulting from the low-risk, loss-framed message condition.

In regard to future weekly moderate PA, risk produced significant main effects (F(1, 249) = 7.02, p = .01, η_p^2 = .03), individuals exposed to the high-risk manipulation reported greater moderate PA intentions at age 85. The message frame did not produce significant main effects, but the loss-framed message resulted in greater future moderate PA intentions in both the high-risk condition (M_{Gain} = 230.2, SD = 218.7; M_{Loss} = 249.4, SD = 213.2) and the low-risk condition (M_{Gain} = 174.4, SD = 174.8; M_{Loss} = 176.9, SD = 154.4), with greatest intentions resulting from the high-risk, loss-framed message condition. Finally, there were no risk x message frame interaction effects.

When future weekly walking volume was the dependent variable, there was a significant main effect for the risk (F(1, 249) = 8.75, p = .003, η_p^2 = .01) manipulation. Individuals exposed to the high-risk manipulation (M = 524.0, SD = 446.6) reported significantly greater future PA walking intentions compared to individuals exposed to the low-risk manipulation (M = 376.7, SD = 344.6). Despite no main effect for message frame, a similar trend to moderate future PA intentions is evident and is displayed in Figure 2. Loss-framed messages resulted in higher future walking intentions in both the high-risk condition (M_{Gain} = 485.6 SD = 427.3; M_{Loss}= 564.2, SD = 466.1) and the low-risk condition (M_{Gain} = 332.0, SD = 286.9; M_{Loss} = 421.4, SD = 391.3). No interaction effect for risk x message frame was uncovered with future walking volume as the

dependent variable. These analyses reveal the optimal message for promoting future PA intentions in the context of this study is one that primes the risks of aging to physical function prior to a health message that highlights the consequences of being physically inactive (i.e., high-risk, loss-framed).

Figure 2. *ANOVA Results for Future Weekly Walking Intentions*



For sitting volume, there was no main effect for the risk manipulation or message frame, in addition to no interaction effect. In regard to group means, future sitting intentions did not follow the same pattern found in future vigorous, moderate, and walking intentions (i.e., loss-framed messages did not result in beneficial outcomes across risk conditions).

The results of the above analyses indicated that only the risk manipulation was able to successfully alter future PA intentions to levels of statistical significance. In both cases (future moderate PA intentions and walking intentions), the high-risk manipulation resulted in greater

PA intentions. Although the framed health message was unable to alter participants' future PA intentions to levels of statistical significance, a clear pattern emerged. Loss-framed messages elicited greater PA intentions for the high-risk and low-risk conditions across all PA intensities (but not sitting). These results reveal that the third hypothesis is not supported, gain-framed messages did not promote greater future PA intentions in the low-risk condition, but the fourth hypothesis is supported, loss-framed messages promoted greater future PA intentions in the high-risk condition.

Change in PA and sedentary volumes (i.e., sitting) were assessed as secondary outcome variables (Table 7). This was computed by subtracting an individual's self-reported future PA intentions from their reported baseline PA volume. For vigorous PA change, there was no main effect for the risk manipulation, message frame or interaction effect of risk x message frame.

There was a significant main effect of the risk manipulation for both moderate PA change ($F(1, 249) = 5.28$, $p = .02$, $\eta_p^2 = .02$) and walking change ($F(1, 249) = 7.47$, $p = .01$, $\eta_p^2 = .03$). In both cases, the high-risk condition resulted in a lower mean, indicating greater future PA intentions relative to baseline PA behaviour. For both moderate PA and walking volume change message frame had no main effect. Despite this, loss-framed messages resulted in lower group means across conditions for moderate PA change ($M_{Gain} = 6.4$, $SD = 300.8$; $M_{Loss} = -47.0$, $SD = 246.3$) and walking PA change ($M_{Gain} = 150.3$, $SD = 587.6$; $M_{Loss} = 257.2$, $SD = 664.3$), indicating loss-framed messages elicited greater future PA intentions relative to baseline PA. In addition, no interaction effect of risk x message frame was found for moderate PA or walking volume change.

In regard to change in sitting volume, there was no main effect for the risk manipulation or message frame. There was a significant interaction effect of risk x message frame with change

of sitting intentions in the future compared to baseline sitting ($F(1, 249) = 4.36$, $p = .04$, $\eta_p^2 = .02$). Individuals in the high-risk, loss-framed message condition ($M = 19.7$, $SD = 173.3$) reported higher changes in sitting volume than individuals in the high-risk, gain-framed condition ($M = -22.0$, $SD = 169.3$), low-risk, gain-framed condition ($M = 4.7$, $SD = 153.1$) and low-risk, loss-framed condition ($M = -36.7$, $SD = 133.6$). Given that a higher mean represents lower future sitting intentions in relation to baseline sitting, the high-risk, loss-framed condition resulted in the greatest reduction in sedentary time. However, given there was no main effect for risk ($F(1, 249) = 0.06$, $p = .46$, $\eta_p^2 = .002$), or message frame ($F(1, 249) = 0.00$, $p = .99$, $\eta_p^2 = .00$), these results should be interpreted with caution and are likely the result of within-group outliers.

Results of the ANOVA using the secondary outcome variables remain consistent with the primary outcome variable analyses. Only the risk manipulation had significant main effects. In both cases, the high-risk condition resulted in greater PA intentions relative to baseline PA. The message frame did not produce significant main effects, yet loss-framed messages consistently resulted in greater PA intentions relative to baseline PA. Unlike the primary outcome variable analyses, a significant interaction of risk x message frame was uncovered for sitting intentions. Consistent with previous results in this study, the high-risk, loss-framed condition resulted in the lowest levels of sitting in relation to baseline.

When the ANOVA on primary and secondary outcome variables are considered in tandem, current PA intentions were not altered by exposure to the risk manipulation and framed health message. Conversely, future PA intentions and sitting intentions were altered by the risk manipulation, with the high-risk manipulation resulting in increased PA intentions and decreased sitting intentions. Despite not reaching levels of significance, loss-framed messages also resulted

in beneficial changes to intentions (i.e., increases in PA and decreases in sitting), supporting the fourth hypothesis. It must not be overlooked that these results were not consistent across intensities and resulted in small estimated effect sizes. Finally, given that the manipulation check analyses revealed the risk manipulation to be ineffective, further analyses are warranted. Therefore, ANCOVA will be conducted to understand the influence of possible covariates for the relationship between the risk manipulation, message frame, and outcome variables as well as to assess the messages at the multivariate level.

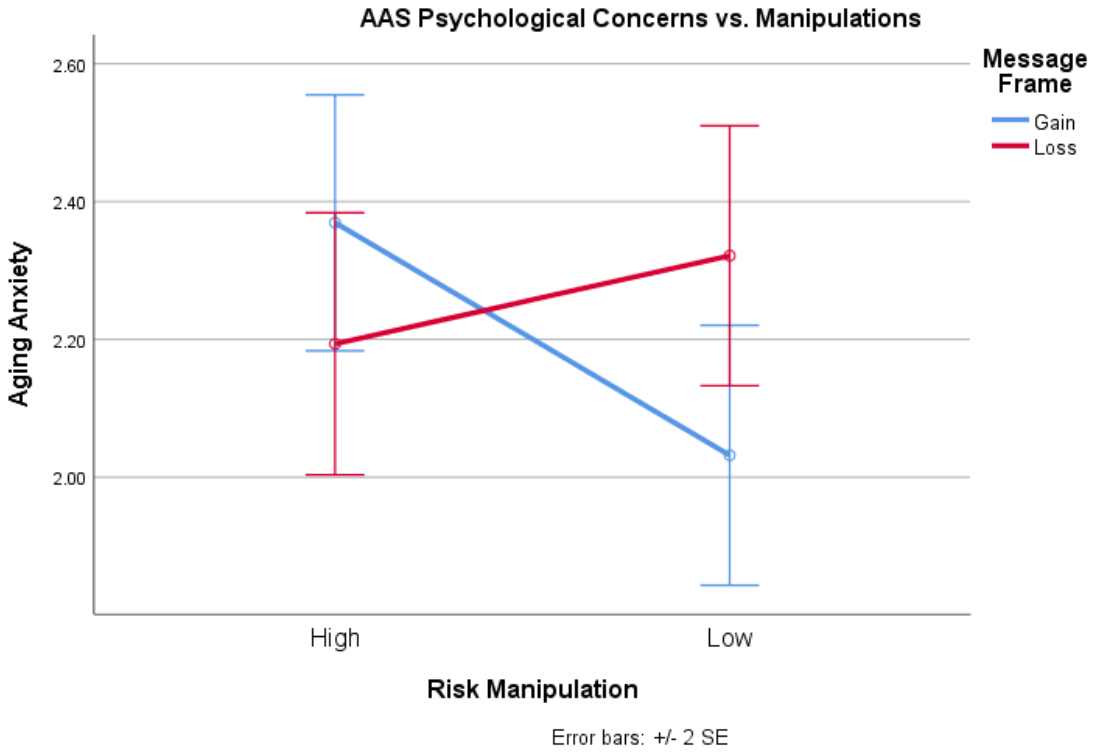
Independent Measures ANOVA Results for Aging Anxiety

The complete results for the ANOVA performed to assess participants' aging expectations can be found in Table 8. The AAS was administered to answer the second research question by understanding the effect of PA messages in a lifespan context on the aging anxiety of participants in four domains as assessed by the sub-scales: Fear of Old People, Psychological Concerns, Physical Appearance, Fear of Losses, as well as Overall.

In regard to the AAS sub-scales Fear of Old People and Physical Appearance, there was no main effect of the risk manipulation or message frame, as well as no interaction effect.

When the AAS sub-scale, Psychological Concerns was assessed, there was no main effect of risk or message frame. There was a significant interaction effect of risk x message frame for this AAS sub-scale, ($F(1, 249) = 6.11$, $p = .01$, $\eta_p^2 = .02$). In the high-risk condition, participants who received a gain-framed message ($M = 2.4$, $SD = 0.9$) reported significantly higher aging anxiety than those who received a loss-framed message ($M = 2.2$, $SD = 0.8$). In the low-risk condition, participants who received a loss-framed message ($M = 2.3$, $SD = 0.7$) reported significantly higher levels of aging anxiety than individuals who received a gain-framed message ($M = 2.0$, $SD = 0.6$).

Figure 3. *ANOVA Results for AAS Psychological Concerns*



In regard to the AAS sub-scale, "Fear of Losses" there was no main effect of risk ($F(1, 249) = 0.002$, $p = .97$, $\eta_p^2 = .00$), but there was a significant main effect for message frame ($F(1, 249) = 6.07$, $p = .01$, $\eta_p^2 = .02$). Participants who received a loss-framed message ($M = 3.3$, $SD = 0.8$) reported significantly higher levels of aging anxiety than participants who received a gain-framed message ($M = 3.1$, $SD = 0.8$), regardless of the risk manipulation they were assigned. There was no interaction effect of risk x message frame for this sub-scale ($F(1, 249) = 0.52$, $p = .47$, $\eta_p^2 = .00$).

There was no main effect for risk ($F(1, 249) = 0.03$, $p = .88$, $\eta_p^2 = .00$), or message frame, ($F(1, 249) = 1.49$, $p = .22$, $\eta_p^2 = .01$), when Overall AAS was considered, indicating that in isolation, the risk manipulation or message frame did not significantly alter participants' aging anxiety. An interaction effect was found for risk x message frame when overall AAS scores were

considered ($F(1, 249) = 4.30$, $p = .04$, $\eta_p^2 = .02$). Specifically, participants in the high-risk manipulation did not differ whether they received a gain- ($M = 2.5$, $SD = 0.5$) or loss- ($M = 2.4$, $SD = 0.5$) framed message. Participants in the low-risk manipulation who received a loss-framed message ($M = 2.6$, $SD = 0.5$) reported significantly higher aging anxiety than those who received a gain-framed message ($M = 2.4$, $SD = 0.5$).

Results of the AAS ANOVA indicate that when there is a significant message frame main effect (i.e., Fear of Losses sub-scale), loss-framed messages elicit greater levels of aging anxiety. When a significant risk x message frame interaction effect exists (i.e., Psychological Concerns and Overall) results do not conclusively support a condition that increases aging anxiety.

Independent Measures ANOVA Results for Expectations Regarding Aging

The complete results for the ANOVA performed to assess participants' aging expectations can be found in Table 8. The ERA-12 scale was administered to answer the second research question by understanding the effect of lifespan PA messages on the expectations of aging held by participants in the domain of Physical Health, Mental Health, Cognitive Function, as well as Overall. There were no main effects for the risk manipulation or message frame, as well as no interaction effect when participants' ERA were the dependent variable. Results indicated that the risk manipulation and message frame did not significantly alter participants' expectations about aging processes. Empirical support for the independence between ERA and the risk manipulation and message frame justified the use of this scale as a covariate for the ANCOVA.

Table 8. *ANOVA Results for Aging Anxiety and Aging Expectations Outcome Variables*

	M (*SD*)				Risk *F* (partial η^2)	Message Frame *F* (partial η^2)	Risk x Message Frame *F* (partial η^2)
Variable	High-Risk		Low-Risk				
	Gain	Loss	Gain	Loss			
AAS Fear of Old People	1.8 (0.7)	1.7 (0.5)	1.9 (0.6)	1.9 (0.7)	2.11 (.01)	0.91 (.004)	0.23 (.001)
AAS Psychological Concerns	2.4 (0.9)	2.2 (0.8)	2.0 (0.6)	2.3 (0.7)	1.24 (.01)	0.37 (.001)	6.12* (.02)
AAS Physical Appearance	2.6 (0.8)	2.6 (0.9)	2.5 (0.9)	2.6 (0.7)	0.05 (.00)	0.22 (.001)	0.63 (.003)
AAS Fear of Losses	3.1 (0.7)	3.3 (0.8)	3.0 (0.8)	3.3 (0.8)	0.002 (.00)	6.07* (.02)	0.53 (.002)
AAS Overall	2.5 (0.5)	2.5 (0.5)	2.4 (0.5)	2.6 (0.5)	0.03 (.00)	1.50 (.01)	4.26 (.02)*
ERA Physical Health	53.9 (18.6)	54.2 (17.4)	50.1 (20.6)	54.8 (21.0)	0.44 (.002)	1.04 (.004)	0.81 (.003)
ERA Mental Health	34.7 (20.7)	31.1 (17.3)	32.8 (16.9)	35.4 (21.7)	0.24 (.001)	0.04 (.00)	1.60 (.01)
ERA Cognitive Function	56.3 (20.5)	52.2 (21.1)	51.4 (22.2)	57.2 (21.8)	0.98 (.00)	0.76 (.00)	3.51 (.01)
ERA Overall	48.3 (15.6)	45.8 (14.4)	44.8 (16.1)	49.2 (18.7)	0.002 (.00)	0.22 (.001)	2.8 (.01)

Notes: *$p < .05$, **$p < .01$

Multivariate Analyses

Independent Measures ANCOVA Results for Current PA Intentions

A two (risk: high versus low) x two (message frame: gain-framed versus loss-framed) independent samples ANCOVA was conducted with current PA intentions as the dependent variable (Table 9). Consistent with the ANOVA results, there were no significant main effects of the risk manipulation or message frame on current PA intentions after controlling for covariates.

In addition, there was no significant risk x message frame interaction after controlling for covariates. Program ($F(1, 233) = 6.27$, $p = .01$, $\eta_p^2 = .03$), baseline vigorous PA ($F(1, 233) = 51.5$, $p < .001$, $\eta_p^2 = .18$), ERA Physical Health ($F(1, 233) = 6.20$, $p = .01$, $\eta_p^2 = .03$), ERA Mental Health ($F(1, 233) = 6.30$, $p = .01$, $\eta_p^2 = .03$), ERA Cognitive Function ($F(1, 233) = 5.90$, $p = .01$, $\eta_p^2 = .03$) and ERA Overall ($F(1, 233) = 6.08$, $p = .01$, $\eta_p^2 = .03$) had significant main effects. Results of the multivariate analysis support the bivariate analysis and confirm that in varying contexts of risk, an optimal message frame for eliciting current PA intentions is not evident. Therefore, hypotheses 1 and 2 are not supported in this study.

Independent Measures ANCOVA Results for Future PA Intentions

Independent measures ANCOVA were also conducted to assess future PA intentions (Table 9). With vigorous PA as the dependent variable and covariates controlled, there was no main effect for risk or message frame, as well as no interaction effects. Age ($F(1, 233) = 11.64$, $p = .001$, $\eta_p^2 = .05$), program ($F(1, 233) = 3.95$, $p = .05$, $\eta_p^2 = .02$), and BAS Drive ($F(1, 233) = 3.91$, $p = .05$, $\eta_p^2 = .02$) were demographic variables with significant main effects. In addition, baseline vigorous PA ($F(1, 233) = 41.67$, $p < .001$, $\eta_p^2 = .15$) and baseline walking ($F(1, 233) = 11.66$, $p = .001$, $\eta_p^2 = .05$) were significant covariates in this analysis.

For future moderate PA, the risk manipulation's significant main effect remained significant after controlling for covariates ($F(1, 233) = 8.27$, $p = .004$, $\eta_p^2 = .03$). The message frame and interaction of risk x message frame did not reach statistical significance. Baseline walking was the only significant covariate in this analysis ($F(1, 233) = 5.79$, $p = .02$, $\eta_p^2 = .02$).

For future walking, the risk manipulation had a significant main effect ($F(1, 233) = 9.69$, $p = .002$, $\eta_p^2 = .04$), but the message frame did not. There was no risk x message frame interaction. Baseline walking ($F(1, 233) = 31.23$, $p < .001$, $\eta_p^2 = .12$), as well as each measure of

ERA: Physical Health ($F(1, 233) = 14.25$, $p < .001$, $\eta_p^2 = .06$), Mental Health ($F(1, 233) = 13.93$, $p < .001$, $\eta_p^2 = .06$), Cognitive Function ($F(1, 233) = 14.23$, $p < .001$, $\eta_p^2 = .06$), and Overall ($F(1, 233) = 14.00$, $p < .001$, $\eta_p^2 = .06$) were significant covariates in this analysis.

For future sitting intentions, there was no main effect for risk or message frame, as well as no risk x message frame interaction. Year of study ($F(1, 233) = 4.65$, $p = .03$, $\eta_p^2 = .02$) and baseline sitting ($F(1, 233) = 42.75$, $p < .001$, $\eta_p^2 = .16$) were the only covariates with a significant main effect in this analysis.

Overall, the above analyses answer the third research question by uncovering some of the relevant demographic factors that influence message appraisal. These covariates will be discussed further in the next chapter. These analyses also reaffirm the bivariate findings. Hypothesis 4 was partially supported in this study while the first three hypotheses were not supported. The risk manipulation was able to significantly alter participants' future moderate PA and walking intentions. Gender, age, year of study, BAS Drive, baseline PA, and ERA influenced the relationship between risk, message frame, and the dependent variables used in these analyses.

Table 9. *ANCOVA Results for Primary PA Outcome Variables*

Dependent Variable	Current PA Intentions		Future Vigorous PA		Future Moderate PA		Future Walking		Future Sitting	
Manipulation	*F* (partial η^2)	*p*	*F* (partial η^2)	*p*	*F* (partial η^2)	*p*	*F* (partial η^2)	*p*	*F* (partial η^2)	*p*
Risk	0.97 (.004)	.33	0.04 (.00)	.85	8.27 (.03)	.004	9.69 (.04)	.002**	0.06 (.00)	.81
Message Frame	2.96 (.01)	.09	1.59 (.01)	.21	0.21 (.001)	.65	1.78 (.01)	.18	0.17 (.001)	.68
Risk x Message Frame	0.83 (.004)	.37	1.11 (.01)	.29	0.00 (.00)	.99	0.18 (.001)	.67	2.42 (.01)	.12
Covariate										
Gender	0.20 (.001)	.66	0.85 (.004)	.36	1.17 (.01)	.28	0.35 (.001)	.56	0.13 (.001)	.72
Age	0.55 (.002)	.46	11.64 (.05)	.001**	0.86 (.004)	.36	1.37 (.01)	.24	1.08 (.01)	.30
Year of Study	0.01 (.00)	.95	0.79 (.003)	.37	0.19 (.001)	.66	0.11 (.00)	.74	4.65 (.02)	.03*
Program	6.27 (.03)	.01*	3.95 (.02)	.05*	0.21 (.001)	.65	0.01 (.00)	.93	0.01 (.00)	.93
Baseline Vigorous	51.5 (.18)	< .001**	41.67 (.15)	< .001**	2.77 (.01)	.10	1.99 (.01)	.16	1.44 (.01)	.23
Baseline Moderate	0.00 (.00)	.99	1.08 (.01)	.30	2.72 (.01)	.10	0.48 (.002)	.49	0.01 (.00)	.76
Baseline Walking	0.18 (.001)	.67	11.66 (.05)	.001**	5.79 (.02)	.02*	31.23 (.12)	< .001**	1.26 (.01)	.26
Baseline Sitting	1.55 (.01)	.22	2.11 (.01)	.15	0.001 (.00)	.98	7.47 (.03)	.01*	42.75 (.16)	< .001**
BAS Drive	3.12 (.01)	.08	3.91 (.02)	.05*	0.58 (.002)	.45	2.11 (.01)	.15	1.32 (.01)	.25
BAS Fun Seeking	0.44 (.002)	.51	0.63 (.003)	.43	0.83 (.004)	.36	0.95 (.004)	.33	1.09 (.01)	.30
BAS Reward Responsiveness	0.01 (.000)	.93	1.33 (.01)	.25	0.03 (.00)	.87	0.04 (.00)	.85	1.15 (.01)	.29
BIS	0.58 (.002)	.45	2.66 (.01)	.10	0.06 (.00)	.81	0.04 (.00)	.85	0.15 (.001)	.70
ERA Physical Health	6.2 (.03)	.01*	0.04 (.00)	.84	0.21 (.001)	.65	14.25 (.06)	< .001**	2.56 (.01)	.11
ERA Mental Health	6.3 (.03)	.01*	0.02 (.00)	.88	0.23 (.001)	.63	13.93 (.06)	< .001**	2.51 (.01)	.11
ERA Cognitive Function	5.9 (.03)	.01*	0.01 (.00)	.92	0.20 (.001)	.66	14.23 (.06)	< .001**	2.48 (.01)	.12
ERA Overall	6.08 (.03)	.01*	1.11 (.01)	.29	0.20 (.001)	.65	14.00 (.06)	< .001**	2.61 (.01)	.12

Notes: *$p < .05$, **$p < .01$

ANCOVA were also used to assess PA change (Table 10). That is, participants' future PA intentions relative to current PA. For vigorous PA change, there was no main effect of the risk manipulation or message frame as well as no risk x message frame interaction. Age ($F(1, 233) = 11.64$, $p = .001$, $\eta_p^2 = .05$), baseline vigorous PA ($F(1, 233) = 853.97$, $p < .001$, $\eta_p^2 = .77$), and baseline walking ($F(1, 233) = 11.66$, $p = .001$, $\eta_p^2 = .05$) were significant covariates in this analysis.

For moderate PA change, the risk manipulation had a significant main effect ($F(1, 233) = 8.27$, $p = .004$, $\eta_p^2 = .03$) when covariate were accounted for. There was no main effect for message frame as well as no risk x message frame interaction. Baseline moderate PA ($F(1, 233) = 253.37$, $p < .001$, $\eta_p^2 = .52$) and walking ($F(1, 23f3) = 5.59$, $p = .02$, $\eta_p^2 = .02$) were significant covariates in this model.

For walking change, there was a significant main effect for risk ($F(1, 233) = 9.69$, $p = .002$, $\eta_p^2 = .04$). There was no main effect for risk and no risk x message frame interaction. Baseline walking ($F(1, 233) = 335.67$, $p < .001$, $\eta_p^2 = .59$), as well each measure of ERA were significant covariates in this analysis. ERA Physical Health ($F(1, 233) = 14.25$, $p < .001$, $\eta_p^2 = .06$), Mental Health ($F(1, 233) = 13.93$, $p < .001$, $\eta_p^2 = .06$), Cognitive Function ($F(1, 233) = 14.23$, $p < .001$, $\eta_p^2 = .06$), and ERA Overall ($F(1, 233) = 14.00$, $p < .001$, $\eta_p^2 = .06$) all influenced the relationship of the risk manipulation and message frame on walking change.

In regard to sitting change, there was no main effect for risk or message frame. In addition, after controlling for covariates, the interaction of risk x message frame previously found in the ANOVA did not remain. Year of study ($F(1, 233) = 4.65$, $p = .03$, $\eta_p^2 = .02$) and baseline sitting ($F(1, 233) = 85.58$, $p < .001$, $\eta_p^2 = .27$) were significant covariates in this analysis.

Overall, the above analyses offer similar results to the bivariate analyses as well as multivariate analyses of primary outcome variables. The risk manipulation significantly altered participants' future PA intentions in relation to baseline PA. The relationship of risk and message frame to the dependent variables was significantly influenced by age, program, year of study, BAS Drive, and ERA.

Table 10. *ANCOVA Results for Secondary PA Outcome Variables*

Dependent Variable	**Vigorous PA Change**		**Moderate PA Change**		**Walking Change**		**Sitting Change**	
Manipulation	*F* (partial η^2)	*p*	*F* (partial η^2)	*p*	*F* (partial η^2)	*p*	*F* (partial η^2)	*p*
Risk	0.04 (.00)	.85	8.27 (.03)	.004**	9.69 (.04)	.002**	0.06 (.00)	.81
Message Frame	1.59 (.01)	.21	0.21 (.001)	.65	1.78 (.01)	.18	0.17 (.001)	.68
Risk x Message Frame	1.11 (.01)	.29	0.00 (.00)	.99	0.18 (.001)	.67	2.42 (.01)	.12
Covariate								
Gender	0.85 (.004)	.36	1.17 (.01)	.15	0.35 (.001)	.56	0.13 (.001)	.72
Age	11.64 (.05)	.001**	0.86 (.004)	.34	1.37 (.01)	.24	1.08 (.01)	.30
Year of Study	0.79 (.003)	.37	0.19 (.001)	.66	0.11 (.00)	.74	4.65 (.02)	.03*
Program	3.95 (.02)	.05*	0.21 (.001)	.65	0.01 (.00)	.93	0.01 (.00)	.23
Baseline Vigorous	853.97 (.77)	< .001**	2.77 (.01)	.10	1.99 (.01)	.16	1.44 (.01)	.23
Baseline Moderate	1.08 (.01)	.30	253.37 (.52)	< .001**	0.48 (.002)	.49	0.10 (.00)	.76
Baseline Walking	11.66 (.05)	.001**	5.59 (.02)	.02*	335.67 (.59)	< .001**	1.26 (.01)	.26
Baseline Sitting	2.11 (.01)	.15	0.001 (.00)	.98	7.47 (.03)	.01*	85.58 (.27)	< .001**
BAS Drive	3.91 (.02)	.05*	0.58 (.002)	.45	2.11 (.01)	.15	1.32 (.01)	.25
BAS Fun Seeking	0.63 (.003)	.25	0.83 (.004)	.36	0.95 (.004)	.85	1.09 (.01)	.30
BAS Reward Responsiveness	1.33 (.01)	.25	0.03 (.00)	.81	0.04 (.00)	.85	1.15 (.01)	.29
BIS	2.66 (.01)	.10	0.06 (.00)	.81	0.04 (.00)	.85	0.15 (.001)	.70
ERA Physical Health	0.04 (.00)	.84	0.21 (.001)	.65	14.25 (.06)	< .001**	2.56 (.01)	.11
ERA Mental Health	0.02 (.00)	.88	0.23 (.001)	.63	13.93 (.06)	< .001**	2.51 (.01)	.11
ERA Cognitive Function	0.01 (.00)	.92	0.20 (.001)	.66	14.23 (.06)	< .001**	2.48 (.01)	.12
ERA Overall	0.02 (.00)	.90	0.20 (.001)	.66	14.00 (.06)	< .001**	2.61 (.01)	.11

Notes: *$p < .05$, **$p < .01$

Independent Measures ANCOVA Results for AAS

An independent measures ANCOVA was also used to assess the influence of the risk manipulation and message frame on participants' aging anxiety and answer the second research question (Table 11). All four AAS sub-scales as well as the overall score were assessed as the dependent variables.

For AAS Fear of Old People there was no main effect for risk or message frame, as well as no interaction effects when covariates were controlled for. Gender ($F(1, 233) = 6.50$, $p = .01$, $\eta_p^2 = .03$), age ($F(1, 233) = 4.00$, $p = .05$, $\eta_p^2 = .02$), and BAS Reward Responsiveness ($F(1, 233) = 4.86$, $p = .03$, $\eta_p^2 = .02$) were significant covariates in this analysis. In addition, ERA Physical Health ($F(1, 233) = 5.32$, $p = .02$, $\eta_p^2 = .02$), ERA Mental Health ($F(1, 233) = 5.62$, $p = .02$, $\eta_p^2 = .02$), ERA Cognitive Function ($F(1, 233) = 5.12$, $p = .03$, $\eta_p^2 = .02$), and ERA Overall ($F(1, 233) = 5.19$, $p = .02$, $\eta_p^2 = .02$) had significant main effects.

For AAS Psychological Concerns, there was no main effects for risk or message frame, as well as no interaction effects after controlling for covariates. BAS Drive ($F(1, 233) = 4.30$, $p = .04$, $\eta_p^2 = .02$) was the only significant covariate in this analysis.

In regard to AAS Physical Appearance, there was no main effect for risk or message frame, as well as no interaction effects when covariates were controlled for. BAS Drive ($F(1, 233) = 5.62$, $p = .02$, $\eta_p^2 = .02$) and BIS ($F(1, 233) = 4.02$, $p = .05$, $\eta_p^2 = .02$) reported significant main effects.

In the final sub-scale, AAS Fear of Losses, there was no significant main effect for risk. The significant main effect of message frame uncovered at the bivariate level remained at the multivariate level ($F(1, 233) = 7.65$, $p = .01$, $\eta_p^2 = .03$). There was no risk x message frame

interaction. BIS ($F(1, 233) = 6.81$, $p = .01$, $\eta_p^2 = .03$) was the only significant covariate in this analysis.

For AAS Overall, there was no main effect for the risk manipulation or message frame. In addition, the risk x message frame interaction uncovered at the bivariate level did not remain when controlling for covariates. BIS was the only significant covariate in this model ($F(1, 233) = 6.36$, $p = .01$, $\eta_p^2 = .03$).

Overall, the above analyses show that the main effect of the message frame for AAS Fear of Losses remained at the multivariate level. In addition, the interaction effects found for AAS Psychological Concerns and AAS Overall disappear when covariates were controlled. Demographic variables such as age and gender remained significant in these analyses but baseline PA and program were not significant covariates. Various BIS/BAS sub-scales were consistent covariates for the relationship between risk, message frame, and AAS, though ERA was not. Additional covariate statistics can be found in Appendix N and will be used to interpret the direction the covariate influences the relationship between the manipulation and outcome. Given that it is reasonable to assume the covariate influences primary outcome variables in the same direction as they influence secondary PA outcome variables, only the former's statistics are displayed.

Table 11. *ANCOVA Results for Aging Anxiety*

Dependent Variable	**AAS Fear of Old People**		**AAS Psychological Concerns**		**AAS Physical Appearance**		**AAS Fear of Losses**		**AAS Overall**	
Manipulation	*F* (partial η^2)	*p*	*F* (partial η^2)	*p*	*F* (partial η^2)	*p*	*F* (partial η^2)	*p*	*F* (partial η^2)	*p*
Risk	2.07 (.01)	.15	2.26 (.01)	.13	0.23 (.001)	.64	0.001 (.00)	.98	0.01 (.00)	.94
Message Frame	1.89 (.01)	.17	0.21 (.001)	.65	0.44 (.002)	.51	7.65 (.03)	.01*	1.96 (.01)	.16
Risk x Message Frame	0.16 (.001)	.69	3.16 (.01)	.08	0.48 (.002)	.50	0.36 (.002)	.55	2.43 (.01)	.12
Covariate										
Gender	6.50 (.03)	.01*	0.02 (.00)	.89	0.26 (.001)	.61	1.71 (.01)	.19	0.28 (.001)	.56
Age	4.00 (.02)	.05*	1.22 (.01)	.27	0.01 (.00)	.91	2.41 (.01)	.12	0.16 (.001)	.69
Year of Study	2.67 (.01)	.10	0.37 (.002)	.54	0.47 (.002)	.49	0.002 (.00)	.96	0.004 (.00)	.95
Program	2.76 (.01)	.10	0.60 (.003)	.44	0.11 (.00)	.74	0.99 (.004)	.32	0.53 (.002)	.47
Baseline Vigorous	0.85 (.004)	.36	2.84 (.01)	.09	0.22 (.001)	.64	0.19 (.001)	.66	0.31 (.001)	.58
Baseline Moderate	0.73 (.003)	.39	1.61 (.01)	.21	0.64 (.003)	.43	1.80 (.01)	.18	2.71 (.01)	.10
Baseline Walking	0.53 (.002)	.47	.29 (.001)	.85	1.32 (.01)	.25	0.00 (.00)	.98	0.78 (.003)	.38
Baseline Sitting	0.004 (.00)	.95	0.29 (.001)	.59	2.29 (.01)	.13	0.06 (.00)	.81	0.70 (.003)	.40
BAS Drive	0.04 (.00)	.84	4.30 (.02)	.04*	5.62 (.02)	.02*	1.44 (.01)	.23	2.90 (.01)	.09
BAS Fun Seeking	0.30 (.001)	.58	0.38 (002)	.54	0.32 (.001)	.57	0.07 (.00)	.80	0.04 (.00)	.84
BAS Reward Responsiveness	4.86 (.02)	.03*	0.01 (.00)	.91	0.00 (.00)	.99	1.85 (.01)	.18	1.79 (.01)	.18
BIS	1.06 (.01)	.30	0.08 (.00)	.77	4.02 (.02)	.05*	6.81 (.03)	.01*	6.36 (.03)	.01*
ERA Physical Health	5.32 (.02)	.02*	1.57 (.01)	.21	1.02 (.004)	.31	0.23 (.001)	.63	2.49 (.01)	.12
ERA Mental Health	5.62 (.02)	.02*	1.59 (.01)	.21	1.17 (.01)	.28	0.19 (.001)	.66	2.77 (.01)	.10
ERA Cognitive Function	5.12 (.02)	.03*	1.49 (.01)	.22	1.01 (.004)	.31	0.28 (.001)	.60	2.33 (.01)	.13
ERA Overall	5.19 (.02)	.02*	1.42 (.01)	.13	1.02 (.004)	.31	0.27 (.001)	.60	2.34 (.01)	.12

Notes: *$p < .05$, **$p < .01$

Discussion

This study was the first to investigate the influence of health messages on current and future PA intentions in an aging context. Specifically, risk and message frame were manipulated based on prospect theory to answer the three research questions. The results indicated that participants' current PA intentions were not altered by the risk or message frame of the message. Future PA and sedentary intentions, however, were significantly altered by high-risk messages that emphasized the physical risks associated with the aging process. Loss-framed messages were preferred in both risk conditions, and the highest PA intentions resulted from assignment to the high-risk, loss-framed condition. Loss-framed messages also resulted in increased aging anxiety among participants. Covariates were included in the final statistical model to answer the third research question and determine some of the demographic factors that influence the efficacy of a message. The following discussion sections examine these results relative to extant PA, health messaging, and aging literature. The implications of this research are discussed and recommendations for future research are provided.

Manipulating Risk and Message Frame

Consistent with previous literature and prospect theory, this study assessed participants' response to health messages in the context of risk. Although previous studies assess risk to examine its interaction with framed messages (de Bruijn, Out, & Rhodes, 2014; Ferguson & Gallagher, 2007), this is the first study to manipulate aging-related as it pertains to the target behaviour. The risk manipulation itself was a novelty in this study, whereas the message frame has been successfully used in previous research (van 't Riet et al., 2010). Therefore, unlike framed messages, the validity of the risk manipulation has not been previously assessed. Participants that read a gain-framed message reported a more positive tone and a

message that highlighted the benefits of PA. Participants that read a loss-framed message reported a more negative tone and a message that highlighted the consequences of physical inactivity. Thus, manipulation check results regarding message frame were consistent with previous literature (Hirschey et al., 2016). Manipulation checks also showed that messages influenced the affective response of participants. For example, gain-framed messages made participants feel happier and more relieved. Loss-framed messages made participants feel sadder and more afraid. These findings align with previous research (Mikels et al., 2016; van 't Riet et al., 2010) that support affective arousal as a causal mechanism for the framing effect.

Concerning the risk manipulation failing to result in a statistically significant manipulation check, previous research has attributed unsuccessful messaging to participants' inability to detect subtle differences in the message (Michalovic, Hall, Duncan, Bassett-Gunter, & Sweet, 2018). Alternatively, it is also possible that the manipulation check failed to uncover differences in participants' message perceptions or that the measures used to detect the efficacy of the manipulation were not comprehensive. Nonetheless, instead of amplifying the risk message, the self-relevancy writing task may have reinforced each participant's prior risk perceptions of the aging process as it relates to PA. Indeed, previous research (Levy & Myers, 2004) has shown individuals' self-perceptions of aging influences their likelihood of participating in preventive health behaviours. Implicit priming of age stereotypes has been shown to activate an individual's aging self-perceptions (Kotter-Grühn & Hess, 2012). Therefore, it is plausible that the risk manipulation primed participants' own aging expectations (and subsequent risk of PA) rather than that of the experimental condition to which they were assigned.

Health Messages and Current Physical Activity Intentions

In the current study, neither the risk manipulation nor the framed health message significantly altered participants' current PA intentions. Previous literature has found mixed results when attempting to increase short-term PA intentions. For example, Latimer et al. (2008) found gain-framed messages significantly increased current PA intentions at a two-week follow up. Importantly, Latimer et al. (2008) repeatedly exposed participants to messages. Given the relationship between repeated message exposure and increased PA (Huhman et al., 2007), this is likely the source of significant framing effects. In contrast, de Bruijn et al. (2014) found no significant effects of frame on PA intention. Meta-analytical work often uncovers a lack of effect of message frame (Gallagher & Updegraff, 2012; O'Keefe & Jensen, 2007) to encourage intention to engage in health prevention behaviours. In the current study, repeatedly exposing participants to the risk manipulation and health message would likely have amplified the effects of these manipulations. In addition, ensuring the risk of PA currently was salient to participants may have resulted in significant findings for current PA intentions. For example, by highlighting one's physical functioning as an older adult is a direct consequence of current decisions.

Another influencing factor is the baseline activity level of the sample. Although baseline PA was controlled for, the sample consisted of predominantly active Kinesiology and Health Science students. Research has suggested PA promoting messages are more effective for sedentary samples (Vandelanotte, De Bourdeaudhuij, Sallis, Spittaels, & Brug, 2005), as ceiling effects may limit the efficacy of such messages in samples that are already active. Despite this, framing effects have been found among active segments of the population (van 't Riet et al., 2014). Support for the influence of baseline PA and program of study influencing framing effects is evident through the answering of the third research question. ANCOVA results revealed baseline vigorous PA and program were significant covariates for current PA intention.

Participants who reported higher levels of vigorous PA, or who were Kinesiology and Health Science students also reported greater current PA intentions. Therefore, the active, health-educated sample may have left little room for increased PA and decreased the likelihood the manipulations would be effective.

Lack of significant differences between groups in regard to current PA intention may also have been due to the measures used to assess this outcome. In the current study, three items were used to assess this variable on a Likert scale ranging from 1 = *Strongly Disagree* to 7 = *Strongly Agree.* Notably, these items and similar items have been used in previous research (Conroy et al., 2013) and have successfully detected elicited framing effects. Yet, assessing future PA intentions as continuous variables in the current study (i.e., through an open-ended question) may have revealed significant differences between groups that ordinal variables could not (Kühberger, 1998).

ERA represents an interesting finding as it was a significant covariate for current PA intention. Individuals that endorsed more positive expectations of the aging process were more likely to intend to engage in PA in the next week. This adds to a growing body of research highlighting the relationship between positive aging expectations and health-promoting behaviours (Korkmaz Aslan, Kartal, Özen Çınar, & Koştu, 2017). Aging expectations have been measured and targeted (Wolff, Warner, Ziegelmann, & Wurm, 2014) primarily in PA interventions for older adults and have received little attention among younger adults — making this a key finding in this study. Given that aging expectations and stereotypes are embodied across the lifespan (Meisner & Levy, 2016) and appear as early as grade three (Gilbert & Ricketts, 2008), their ability to influence behavioural intentions among younger adults is well-

established. Accordingly, the relationship between ERA and health-promoting behaviours warrants consideration prior to older adulthood.

Health Messages and Future Physical Activity Intentions

The risk manipulation significantly altered participants' future PA intentions. Congruent with prospect theory, loss-framed messages were preferred in the high-risk condition and elicited the greatest PA intentions of the four experimental groups. Incongruent with prospect theory, loss-framed messages were also preferred in the low-risk condition (Tversky & Kahneman, 1981). The efficacy of high-risk messages is surprising in light of the risk manipulation check failing to uncover significant differences between groups. This lends support to an effective risk manipulation that was undetected by the manipulation check. High-risk messages significantly increased participants' future moderate PA and walking intentions compared to low-risk messages. These findings are imperative given the wealth of literature supporting the health benefits attained when engaging in PA at these intensities (Iwane et al., 2000; Pescatello, 2000). Furthermore, moderate PA and walking are indicative of the type of PA most likely to be performed by older adults (Davis & Fox, 2007).

Loss-framed messages consistently increased PA intentions at levels below statistical significance. At the bivariate level, an interaction between risk and message frame lowered future sitting intentions in the high-risk, loss-framed condition. This was a statistically significant finding. Given that the manipulations' influence on future sitting intentions disappeared at the multivariate level, it is plausible that covariates (i.e., year of study and baseline sitting) explain the relationship between risk, message frame, and sitting intentions. In addition, this provides support for messaging interventions being more effective for increasing PA than reducing time

spent engaging in sedentary behaviour, both of which are important forms of behaviour change (Prince, Saunders, Gresty, & Reid, 2014).

The results that highlight loss-framed message's efficacy mirror several studies in which loss-framed messages were more effective at promoting behaviour among individuals in a risk context (Bassett-Gunter et al., 2013; de Bruijn, 2019). One of this study's hypotheses based on prospect theory, predicted gain-framed messages should elicit greater PA intentions in conditions of low risk. Failure to support this hypothesis warrants consideration of the risk-framing hypothesis as a framework for PA promotion using framed messages.

The advantage of loss-framed messages to elicit PA intentions may be due to age-related differences in the appraisal of messages. Younger adults are influenced to a greater extent by loss-framed messages than their older adult counterparts (Mikels et al., 2016). Freund and Ebner (2005) propose a lifespan shift in which youth is characterized by a focus on gains whereas older adulthood is characterized by loss prevention. Therefore, high-risk messages, particularly those that are loss-framed, may be particularly effective for younger adults as they contrast the expectation of gains of this cohort. It could be reasoned that individuals may prefer messages that are in line with their age-related focus on gains or losses. However, Mikels (2016) showed older adults preferred gain-framed messages despite the motivational shift to loss prevention characterized by older adulthood. Similarly, younger adults are more motivated by loss-framed messages due to the negative affect elicited by such messages, to which they are not accustomed (Liu et al., 2019).

Health Messages and Aging Anxiety

In regard to aging anxiety, at the bivariate level, the main effects for message frame and risk x message frame interactions among AAS sub-scales and overall scores indicated high-risk

messages and loss-framed messages elicited increased aging anxiety among participants. For example, in the sub-scale Psychological Concerns, participants in the high-risk, gain-framed message condition and participants in the low-risk, loss-framed condition reported significantly higher aging anxiety than those in the high-risk, loss-framed condition and low-risk, gained-framed condition. Intuitively, the high-risk and loss-framed aspects of each message are likely the source of these findings. Although most of these effects disappear in the multivariate analysis, loss-framed messages still elicit greater aging anxiety. These results should be considered in tandem with other results pertaining to the first research question. Participants exposed to high-risk, loss-framed messages often reported the greatest PA intentions at various intensities as an older adult; yet these same messages are also responsible for increasing aging anxiety. This represents conflicting interests for promoting health in an aging context and is a pivotal finding in the current study.

Interestingly, aging anxiety was significantly altered by manipulations at the bivariate and multivariate level while expectations regarding aging were not. This is surprising given that these scales measure similar, aging-related constructs and were moderately correlated. This finding may be due to the order in which the scales were administered. The AAS was administered immediately subsequent to the manipulation check, whereas the ERA-12 was the final scale in the questionnaire, measured after participants reported future PA intentions. Given that the order of questions can influence results (Martin, 2005), it is possible that the administration of earlier scales, particularly the AAS, may have diluted the effect of the manipulation on participants' responses to the ERA-12. It is also possible that aging anxiety represents a more fluid, modifiable construct, whereas aging expectations are more stable and resistant to change by messages. Nonetheless, ERA was a significant covariate for the AAS Fear

of Old People sub-scale. Individuals who reported lower expectations of the aging process in the physical, mental, and cognitive domain (as well as overall) also reported an increased Fear of Old People (as measured by the AAS), highlighting the relationship between aging anxiety and aging expectations.

Motivational disposition, as measured by the BIS/BAS scales, was the most consistent covariate of aging anxiety in this study and a key component of the third research question. Given that many effects of the manipulations on aging anxiety disappeared in the multivariate model, it is clear that participants' tendency to approach goals or avoid adverse outcomes is partially responsible for the relationship between PA messages and aging anxiety. Indeed, previous research has highlighted the ability of the BIS scale to measure an individual's inclination towards anxiety rather than context specific anxiety (Caseras, Ávila, & Torrubia, 2003). Accordingly, participants with greater behavioural inhibition also reported greater aging anxiety. This is an important result in a lifespan context. Previous research (Jorm et al., 1998) suggests the behavioural inhibition and behavioural activation systems become less responsive with age. Aging anxiety in youth has been explained by anxiety about the future which generally increases across midlife (Lynch, 2000). This pattern of decreasing behavioural inhibition/activation and increasing aging anxiety across periods of the lifespan may represent a transition from general, future-oriented anxiety to anxiety that is specific to aging processes. Therefore, the current study supports the importance of motivational disposition as a mediator for framed messages on aging anxiety and highlights its role in the promotion of lifespan PA.

Furthermore, previous research has highlighted behavioural inhibition as an important predictor of cardiovascular fitness among younger adults (Schneider & Graham, 2009) and that individuals high in this motivational disposition are more responsive to loss-framed messages

(Mann, Sherman, & Updegraff, 2004), including messages aimed at promoting PA (Latimer et al., 2008). Therefore, it seems likely that participants with high behavioural inhibition scores were motivated to increase future PA intentions to avoid the risks they associated with aging, particularly when primed to make this association. The multifaceted relationship between motivational disposition, aging perceptions, and response to framed messages is a tenet of this study and a key consideration for future research.

Age and gender also influenced the relationship between aging anxiety and future PA intentions. Relatively older individuals within the sample were more likely to report higher levels of aging anxiety. This corroborates previous research that has recorded increasing aging anxiety across the lifespan (Levy, 2009). In addition, males were more likely to report higher levels of aging anxiety, specifically in the Fear of Losses sub-scale. This result can be contextualized within previous findings by McConatha, Schnell, Volkwein, Riley, and Leach (2003) who also found gender differences in various AAS sub-scales. Gender has been shown to influence the efficacy of framed messages and aging anxiety; thus, remains an important consideration for behaviour change interventions using messages. More research is needed to determine the influence of individual factors on the relationship between aging anxiety and lifespan PA messages.

Implications

Theoretical Connections. Prospect theory (Tversky & Kahneman, 1981) provided the theoretical orientation for this study, furthering the application of this theory to health promotion. Through this theory application, Rothman and Salovey (1997) proposed gain-framed messages are better for persuading individuals to engage in prevention behaviours, such as PA. This was not supported in the current study, highlighting previous literature that was unable to support

hypotheses based on prospect theory (Jones, Sinclair, Rhodes, & Courneya, 2004). Through a lifespan context, it is understood that within different age cohorts, individuals' perceptions of the riskiness of engaging in PA are heterogeneous and likely to change over time (Renner & Schupp, 2012).

Loss-framed messages are proposed to be better for persuading risky behaviours. This was supported in the current study when PA was primed as a high-risk behaviour with aging. The mixed support for prospect theory within this study echoes that of the literature (Gallagher & Updegraff, 2012), which begs the question: if perceptions of risk are influenced by factors such as motivational disposition, preference for gains or losses, and aging anxiety, all of which transition throughout the lifespan, can PA consistently be considered a low-risk behaviour? The behavioural function (i.e., detection versus prevention) rather than participant perception (i.e., high- or low-risk) of a behaviour to dictate the use of a message frame, may be an inherently flawed aspect of the current state of research (de Bruijn et al., 2014). The current study reiterates previous literature that has shown loss-framed messages can be advantageous for promoting PA (Bassett-Gunter et al., 2013; Li et al., 2017), which warrants the key tenet of prospect theory's application to be questioned.

Whereas prospect theory is based on decision-making and risk negotiation among two different outcomes, message framing theory involves highlighting the benefits (or missed benefits) of engaging (or failing to engage) in one behaviour. Simply put, choosing option A or B may involve different cognitive processes than choosing option A or not. Accordingly, the current study provides critical reflections and insights into decision-making processes, respective and irrespective to prospect theory.

Pragmatic Applications. The health messages used in the current study were effective at eliciting increased future PA intentions but not current PA intentions in the predominantly younger sample. One might conclude messages that emphasize losses and risks, such as fear appeals, have their place in behaviour modification. Importantly, this study also highlights the repercussions of using such strategies. Given the plethora of literature documenting the importance of PA messages among all age cohorts (Berry, Aucott, & Poobalan, 2018; Notthoff, Klomp, Doerwald, & Scheibe, 2016) and the call for research to shed light on a) previous mixed findings, b) the shortcomings of prospect theory and c) the role of loss-framed messages, it is necessary to consider the practical implications of these findings (Latimer et al., 2008; O'Keefe & Jensen, 2007).

In this study, for future PA intentions to be assessed, participants imagined what their lives would be like at age 85 and PA intentions at this age were assessed. This has several practical applications. First, the gap between participants' current age and their imagined future age was necessary to elicit the desired influence of risk and uncertainty that remains critical to aging and decision-making research. Second, as previously mentioned, PA trajectories are established early in life and tend to remain relatively stable across the lifespan (Borodulin et al., 2012). Though speculative, if these trajectories can be influenced earlier in life through health messaging interventions, it may have a critical impact on forthcoming long-term health. Research shows PA intentions tend to decrease linearly over time (Reuter, Ziegelmann, Lippke, & Schwarzer, 2009), yet the strength of intentions is mediated by risk awareness (Schwarzer, 2008). Risk related health messaging offers a viable solution to mitigate or improve waning PA intentions across the lifespan. Finally, even if conclusions cannot be drawn about future behaviours, the influence of the manipulations on current cognitive processes is readily apparent.

Perhaps the most pragmatic application of the current study is that rather than assessing risk perceptions at the individual level or making assumptions of risk based on the desired behaviour, risk can be manipulated with messages that increase PA intentions within a single exposure. Future research may then shift from assessing and understanding the contexts by which various message frames are effective, to controlling them. For example, rather than treat risk perceptions as a demographic variable through assessment and subsequently allocate individuals to receive differing messages based on this, interventions guided by the current study can manipulate risk perceptions and immediately deliver the message most likely to result in behaviour modification. Such control offers several distinct advantages to current messaging interventions including increased cost-effectiveness and the potential to reach heterogeneous segments of the population.

Limitations

This research should be interpreted in terms of the following limitations. First, the study did not have a control group with no health message, or one that is neutral in terms of risk and frame. Therefore, though the purpose of the study was to compare manipulations to each other, comparisons cannot be made regarding risk and frame to a neutral control. Second, the generalizability of the findings is bound within a sample demographic that was relatively young and comprised mostly of females. In addition, the sample's PA levels were above the national average for this segment of the population (Statistics Canada, 2018). This was likely due to: a) most participants being educated in a health-related field specifically related to PA, b) a predominantly younger adult sample and c) the self-report nature of the data. Self-reported data is known to be subject to recall and social-desirability biases (Althubaiti, 2016), and often leads to over-reported PA levels (Lee, Macfarlane, Lam, & Stewart, 2011). Therefore, the results of

this study may not be generalized to samples differing in demographic characteristics, particularly sedentary or older populations.

Second, although this study's sample excelled in diversity based on ethnicity, facilitated by an inclusive demographic questionnaire, a high number of categories presented issues when ethnicity was statistically analyzed and resulted in its exclusion from hypothesis testing. Finally, it is important to acknowledge the multidimensional nature of messages. This study furthers our understanding of risk and message frame as key factors in the efficacy of a message; source credibility, number of arguments, and a statistical versus narrative presentation are just a few of the other aspects of a message that have been shown to influence the recipient (Mongeaeu & Stiff, 2016).

Future Directions

The current study, given its strengths and limitations, has important implications for future research. In regard to research design, studies may benefit from an older or more age-diverse sample. In addition, through purposeful sampling or recruitment outside of a health-related field, a more sedentary sample may increase the likelihood of altering PA intentions, particularly in the short-term. Further, given that manipulating risk was successful on a younger and active sample, research should explore similar manipulations for older populations who are more likely to associate PA with risk (Meisner & Levy, 2016).

Repeated message exposure and follow-up assessment through a longitudinal design would also be likely to improve the efficacy of a health message intervention (Latimer et al., 2008). In addition, based on the current study, researchers should be mindful of the order and manner in which scales are administered, as highlighted by a) significant findings for the AAS but null findings for the ERA-12 and b) mixed findings that may be the result of the assessment

of some outcome variables as continuous variables and others as an ordinal measurement, with the former eliciting statistically significant results.

In addition to research design, this study warrants consideration in future research pertaining to several key areas. First, the relationship between motivational disposition to both aging and message framing is highlighted in this study and represents a gap in the current literature. Motivational disposition has been shown to influence other behaviours such as dental flossing (Mann et al., 2004), but has seldom been studied in the context of PA intention. Second, the relationship between intention and behaviour is complex. Given the differing results based on time frame, this study shows current and future PA intentions are likely to be influenced by different processes. Accordingly, research should address the intention-action gap within a lifespan context. Relatedly, the influence of manipulating perceptions of risk on behaviour and the relationship between long term intentions and behaviour remain promising avenues for future research. Finally, future research should explore the manipulation, rather than assessment, of risk to promote health, particularly in the context of framed health messages. Such research would benefit from tailoring risk messages to match individual aspects of the recipient (Albada, Ausems, Bensing, & van Dulmen, 2009).

Conclusion

This is the first study to explore the influence of health message framing in a lifespan PA risk context. By applying prospect theory and using a randomized experimental design, further insight is gained on the strengths and shortcomings of this approach relating to health messages. Accordingly, recommendations are made for future research to shift from assessing cognitive predictors of behaviour change to influencing them using messages. The study also furthers our understanding of aging perceptions among younger adults. By examining the intersection of health messages, perceptions of aging, and PA intentions, interventions will be better equipped to promote health across the lifespan. In an age where information is readily available and person to person instruction is not always feasible, optimizing health messages is an essential component to improving population-level health and wellbeing at any age and across the lifespan.

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Appendices

Appendix A – Recruitment Posting for KURE Online System

Study Title: Promoting Lifespan Physical Activity Using Different Communication Strategies

Researchers: Brad Meisner, PhD and Daniel Sibley, BSc

Estimated Time of Completion: 50-60 minutes

Study Description: This study explores different communication strategies in terms of lifespan physical activity and health promotion.

What You Will Be Asked to Do: This study will require approximately 50 to 60 minutes of your time. The first part of the study will consist of a few demographic questions about your age, gender, ethnicity, program of study, etc. Then you will be asked to reflect upon the aging process through a short writing task followed by reading a health-related message about physical activity. To conclude, you will be asked to answer a few questions about the message you just read, as well as some questions about aging and your physical activity intentions.

Appendix B – Poster Advertisement

Participants Needed for Kinesiology Aging Communications Study

Are you?

Study Description

This study seeks to understand the ways health messaging affects our beliefs about physical activity and aging. Your participation will help us develop better public health messaging about physical activity and aging.

What is Involved?

You will be asked to reflect upon the aging process through a short writing task and answer some survey questions.

No more than 50 to 60 minutes of your time will be required.

This study is approved by the York U's Office of Research Ethics.

To participate, please contact Daniel Sibley.

Physical Activity Research Contact: Daniel Sibley | Physical Activity Research Contact: Daniel Sibley | Physical Activity Research Contact: Daniel Sibley | Physical Activity Research Contact: Daniel Sibley | Physical Activity Research Contact: Daniel Sibley | Physical Activity Research Contact: Daniel Sibley | Physical Activity Research Contact: Daniel Sibley | Physical Activity Research Contact: Daniel Sibley | Physical Activity Research Contact: Daniel Sibley

Appendix C – Recruitment Email

Subject: Research Opportunity – Participants Needed

Hello,

We are recruiting participants for our study “Promoting Lifespan Physical Activity Using Different Communication Strategies”. The purpose of this study is to inform public messaging and improve overall population health.

The study consists of a short-written task about aging, a short reading task about a healthy aging message, and answering a few short survey questions. The estimated time of completion will be no more than 50 to 60 minutes, maximum. You may benefit from participating in this research study by gaining experience with kinesiology research and experiencing research methods first hand. This research will also contribute to the literature that examines how physical activity, health, and aging messages are communicated about.

To participate in this study, you must be at least 16 years of age. Your participation is completely voluntary and you can withdraw from the study at any time. Withdrawal will not result in forfeit of 1.0 credits towards KINE 2049 (if applicable).

To participate or learn more about this study, please contact Daniel Sibley

Kind regards,

Appendix D – Baseline Questionnaire

Demographic Questionnaire

Please answer the following questions to the best of your ability.

What program of study are you enrolled in?

- Kinesiology and Health Science
- Other (please specify):_____

Which degree program are you enrolled in?

- BSc
- BA
- Other (please specify):_____

What is your current year of study?

- 1st year
- 2nd year
- 3rd year
- 4th year
- 5th year or more

What is your current age? (please specify): _____

What is your gender?

- Female
- Genderqueer
- Male
- Transgender
- Other (please specify): _____

What is your ethnicity or cultural background? Note: A person's ethnicity describes their belonging to a group of a larger population that shares their ancestry, colour, language, or religion.

- African
- Caribbean
- Caucasian
- East Asian
- Latino or Hispanic
- Middle Eastern
- South Asian
- Southeast Asian
- West Asian
- Other (please specify): _____

If I think something unpleasant is going to happen I usually get pretty "worked up."

1	2	3	4	5	6	7
Strongly disagree						Strongly agree

I worry about making mistakes.

1	2	3	4	5	6	7
Strongly disagree						Strongly agree

Criticism or scolding hurts me quite a bit.

1	2	3	4	5	6	7
Strongly disagree						Strongly agree

I feel pretty worried or upset when I think or know somebody is angry at me.

1	2	3	4	5	6	7
Strongly disagree						Strongly agree

Even if something bad is about to happen to me, I rarely experience fear or nervousness.

1	2	3	4	5	6	7
Strongly disagree						Strongly agree

I feel worried when I think I have done poorly at something. I have very few fears compared to my friends.

1	2	3	4	5	6	7
Strongly disagree						Strongly agree

When I get something I want, I feel excited and energized.

1	2	3	4	5	6	7
Strongly disagree						Strongly agree

When I'm doing well at something, I love to keep at it.

1	2	3	4	5	6	7
Strongly disagree						Strongly agree

When good things happen to me, it affects me strongly.

1	2	3	4	5	6	7
Strongly disagree						Strongly agree

It would excite me to win a contest.

1	2	3	4	5	6	7
Strongly disagree						Strongly agree

When I see an opportunity for something I like, I get excited right away.

1	2	3	4	5	6	7
Strongly disagree						Strongly agree

When I want something, I usually go all-out to get it.

1	2	3	4	5	6	7
Strongly disagree						Strongly agree

I go out of my way to get things I want.

1	2	3	4	5	6	7
Strongly disagree						Strongly agree

If I see a chance to get something I want, I move on it right away. When I go after something I use a "no holds barred" approach.

1	2	3	4	5	6	7
Strongly disagree						Strongly agree

I will often do things for no other reason than that they might be fun. I crave excitement and new sensations.

1	2	3	4	5	6	7
Strongly disagree						Strongly agree

I'm always willing to try something new if I think it will be fun.

1	2	3	4	5	6	7
Strongly disagree						Strongly agree

I often act on the spur of the moment.

1	2	3	4	5	6	7
Strongly disagree						Strongly agree

INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE

We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. The questions will ask you about the time you spent being physically active in the **last 7 days**. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport.

Think about all the **vigorous** activities that you did in the **last 7 days**. **Vigorous** physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Think *only* about those physical activities that you did for at least 10 minutes at a time.

1. During the **last 7 days**, on how many days did you do **vigorous** physical activities like heavy lifting, digging, aerobics, or fast bicycling?

   _____ **days per week**

   __ No vigorous physical activities ***Skip to question 3***

2.
3. How much time did you usually spend doing **vigorous** physical activities on one of those days?

   _____ **hours per day** _____ **minutes per day**

   __Don’t know/Not sure

Think about all the **moderate** activities that you did in the **last 7 days**. **Moderate** activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

4. During the **last 7 days**, on how many days did you do **moderate** physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking.

_____ **days per week**

__ No moderate physical activities ***Skip to question 5***

5. How much time did you usually spend doing **moderate** physical activities on one of those days?

   _____ **hours per day** _____ **minutes per day**

   __Don't know/Not sure

Think about the time you spent **walking** in the **last 7 days**. This includes at work and at home, walking to travel from place to place, and any other walking that you have done solely for recreation, sport, exercise, or leisure.

6. During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time?

   _____ **days per week**

   No walking ***Skip to question 7***

7. How much time did you usually spend **walking** on one of those days?

   _____ **hours per day** _____ **minutes per day**

   __Don't know/Not sure

The last question is about the time you spent **sitting** on weekdays during the **last 7 days**. Include time spent at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television.

8. During the **last 7days**, how much time did you spend **sitting** on a **weekday**?

   _____ **hours per day** _____ **minutes per day**

   __Don't know/Not sure

Appendix E – Risk Manipulations

Writing Reflection Task — High-risk manipulation

95% of older adults can expect to have poor physical functioning. Using the space provided (200-250 words), write about what you imagine your life will be like when you are 85 years old. In your answer, pay particular attention to your physical functioning (for example will you be physically active, healthy and mobile?):

Writing Reflection Task — Low-risk manipulation

95% of older adults can expect to maintain their physical functioning. Using the space provided (200-250 words), write about what you imagine your life will be like when you are 85 years old. In your answer, pay particular attention to your physical functioning (for example will you be physically active, healthy and mobile?):

Appendix F – Gain- and Loss-Framed Messages

Gain-framed message

Health and physical activity
Being active improves your health. Most people already know this. But being active also has advantages that not everybody knows.

Muscles and bones
For instance, did you know that, by being physically active, you can keep your muscles and bones healthy? This is especially important for people >30 years because muscles and bones tend to grow weaker over time. Also, being physically active keeps you limber and feeling energetic.

A healthy heart
Being sufficiently physically active increases your chance of a healthy and strong heart. A healthy heart is an important condition for a long and healthy life, so there is plenty of reason to be physically active.

Cancer
Being active can also reduce your chance of cancer.
Research shows that active people have a much smaller chance of colon cancer and lung cancer. For women, being active also reduces the chance of breast cancer. And breast cancer is the most common form of cancer in women.

Diabetes
Research shows that being active is the best way to prevent diabetes. Diabetes is caused by a small layer of fat that surrounds the organs. This fat can do a lot of damage to your health. If you are sufficiently active, these fats will not bother you and you will have an improved chance of a healthy life.

Being active and relaxed
Active people experience less stress and are better able to deal with it when they do. In other words, they are more relaxed. Also, they feel younger, more energetic and simply better. In short, being active can help you feel good.

Other advantages of being active
Slender.
When you are active, you burn a lot of calories. This can help you become more slender

Stamina.
When you are active, you will be stronger and have better stamina, something to be proud of!
In short, being sufficiently active has many advantages!

Loss-framed message

Health and physical activity
Being inactive increases your risk of disease. Most people already know this. But being inactive also has disadvantages that not everybody knows.

Muscles and bones
For instance, did you know that, by being physically inactive, your muscles and bones deteriorate? This is especially important for people >30 years because muscles and bones tend to grow weaker over time. Also, being physically inactive makes you less limber and feeling less energetic.

An unhealthy heart
Being insufficiently physically active increases your risk of cardiovascular diseases. Cardiovascular diseases are the number one cause of death in Canada, so there is plenty of reason to make sure that you are not physically inactive.

Cancer
Being inactive can also increase your risk of cancer. Research shows that inactive people have a much greater risk of colon cancer and lung cancer. For women, being inactive also increases the risk of breast cancer. And breast cancer is the most common form of cancer in women.

Diabetes
Research shows that being inactive is the most important cause of diabetes. Diabetes is caused by a small layer of fat that surrounds the organs. This fat can do a lot of damage to your health. If you are insufficiently active, these fats will threaten your health.

Being inactive and tense
Inactive people experience more stress and have more trouble dealing with it when they do. In other words, they are more tense. Also, they feel older, less energetic and simply worse. In short, being inactive can make you feel bad.

Other disadvantages of being inactive
Fat.
When you are inactive, you do not burn a lot of calories. This can make you become more fat.

Stamina.
When you are inactive, you will be less strong and have worse stamina, not something to be particularly proud of! In short, being inactive has many disadvantages!

Appendix G – Manipulation Check Items

1-4. Indicate to what extent the information made you feel:

☐	☐	☐	☐	☐	☐	☐
Very Happy			No Difference			Not at All Happy

☐	☐	☐	☐	☐	☐	☐
Very Relieved			No Difference			Not at All Relieved

☐	☐	☐	☐	☐	☐	☐
Very Sad			No Difference			Not at All Sad

☐	☐	☐	☐	☐	☐	☐
Very Afraid			No Difference			Not at All Afraid

5. Indicate to what extent the information presented highlighted the risks of being physically inactive.

☐	☐	☐	☐	☐	☐	☐
No Risk			Uncertain			Extreme Risk

6. Indicate to what extent the information presented highlighted the benefits of being physically active.

☐	☐	☐	☐	☐	☐	☐
Not at All Beneficial			Uncertain			Extremely Beneficial

7. The general tone of the information presented was:

☐	☐	☐	☐	☐	☐	☐
Extremely Negative			Uncertain			Extremely Positive

8. Indicate the level of risk you believe is associated with engaging in physical activity currently.

☐	☐	☐	☐	☐	☐	☐
No Risk			Uncertain			Extreme Risk

9. Indicate the level of risk you believe is associated with engaging in physical activity at age 85.

☐	☐	☐	☐	☐	☐	☐
No Risk			Uncertain			Extreme Risk

10. Indicate to what extent you agree with the statement: As you get older, physical activity becomes increasingly risky.

☐	☐	☐	☐	☐	☐	☐
Completely Disagree			Uncertain			Completely Agree

Appendix H – AAS

1. I enjoy being around old people.

☐	☐	☐	☐	☐
Strongly Disagree	Somewhat Disagree	Uncertain	Somewhat Agree	Strongly Agree

2. I like to go visit my older relatives.

☐	☐	☐	☐	☐
Strongly Disagree	Somewhat Disagree	Uncertain	Somewhat Agree	Strongly Agree

3. I enjoy talking with old people.

☐	☐	☐	☐	☐
Strongly Disagree	Somewhat Disagree	Uncertain	Somewhat Agree	Strongly Agree

4. I feel very comfortable when I am around an old person.

☐	☐	☐	☐	☐
Strongly Disagree	Somewhat Disagree	Uncertain	Somewhat Agree	Strongly Agree

5. I enjoy doing things for old people.

☐	☐	☐	☐	☐
Strongly Disagree	Somewhat Disagree	Uncertain	Somewhat Agree	Strongly Agree

6. I fear it will be very hard for me to find contentment in old age.

☐	☐	☐	☐	☐
Strongly Disagree	Somewhat Disagree	Uncertain	Somewhat Agree	Strongly Agree

7. I will have plenty to occupy my time when I am old.

☐	☐	☐	☐	☐
Strongly Disagree	Somewhat Disagree	Uncertain	Somewhat Agree	Strongly Agree

8. I expect to feel good about life when I am old.

☐	☐	☐	☐	☐
Strongly Disagree	Somewhat Disagree	Uncertain	Somewhat Agree	Strongly Agree

9. I believe that I will still be able to do most things for myself when I am old.

☐	☐	☐	☐	☐
Strongly Disagree	Somewhat Disagree	Uncertain	Somewhat Agree	Strongly Agree

10. I expect to feel good about myself when I am old.

☐	☐	☐	☐	☐
Strongly Disagree	Somewhat Disagree	Uncertain	Somewhat Agree	Strongly Agree

Continued on next page…

11. I have never lied about my age in order to appear younger.

☐	☐	☐	☐	☐
Strongly Disagree	Somewhat Disagree	Uncertain	Somewhat Agree	Strongly Agree

12. It doesn't bother me at all to imagine myself as being old.

☐	☐	☐	☐	☐
Strongly Disagree	Somewhat Disagree	Uncertain	Somewhat Agree	Strongly Agree

13. I have never dreaded the day I would look in the mirror and see gray hair.

☐	☐	☐	☐	☐
Strongly Disagree	Somewhat Disagree	Uncertain	Somewhat Agree	Strongly Agree

14. I have never dreaded looking old.

☐	☐	☐	☐	☐
Strongly Disagree	Somewhat Disagree	Uncertain	Somewhat Agree	Strongly Agree

15. When I look in the mirror, it bothers me to see how my looks have changed with age.

☐	☐	☐	☐	☐
Strongly Disagree	Somewhat Disagree	Uncertain	Somewhat Agree	Strongly Agree

16. I fear that when I am old all my friends will be gone.

☐	☐	☐	☐	☐
Strongly Disagree	Somewhat Disagree	Uncertain	Somewhat Agree	Strongly Agree

17. The older I become, the more I worry about my health.

☐	☐	☐	☐	☐
Strongly Disagree	Somewhat Disagree	Uncertain	Somewhat Agree	Strongly Agree

18. I get nervous when I think about someone else making decisions for me.

☐	☐	☐	☐	☐
Strongly Disagree	Somewhat Disagree	Uncertain	Somewhat Agree	Strongly Agree

19. I worry that people will ignore me when I am old.

☐	☐	☐	☐	☐
Strongly Disagree	Somewhat Disagree	Uncertain	Somewhat Agree	Strongly Agree

20. I am afraid that there will be no meaning in life when I am old.

☐	☐	☐	☐	☐
Strongly Disagree	Somewhat Disagree	Uncertain	Somewhat Agree	Strongly Agree

Appendix I – Current and Future PA Questionnaire

Keeping in mind the health message you read, please answer the following questions regarding your short- and long-term physical activity intentions:

2. I plan to take part in regular physical activity in the next week.

☐	☐	☐	☐	☐	☐	☐
Strongly Disagree	Disagree	Somewhat Disagree	Neither Disagree nor Agree	Somewhat Agree	Agree	Strongly Agree

3. I intend to engage in at least 30 minutes of *moderate* aerobic activity tomorrow.

☐	☐	☐	☐	☐	☐	☐
Strongly Disagree	Disagree	Somewhat Disagree	Neither Disagree nor Agree	Somewhat Agree	Agree	Strongly Agree

4. I intend to engage in at least 15 minutes of *vigorous* aerobic activity tomorrow.

☐	☐	☐	☐	☐	☐	☐
Strongly Disagree	Disagree	Somewhat Disagree	Neither Disagree nor Agree	Somewhat Agree	Agree	Strongly Agree

IPAQ -SF Future Oriented

The questions below ask you about the time you think you will spend being physically active **when you are 85 years old**. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport.

Think about all the **vigorous** activities that you will do **when you are 85 years old**. **Vigorous** physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Think *only* about those physical activities that you will do for at least 10 minutes at a time.

1. When you are 85 years old, on how many days will you do **vigorous** physical activities like heavy lifting, digging, aerobics, or fast bicycling?

   _____ **days per week**

   __ No vigorous physical activities ***Skip to question 3***

2. How much time will you usually spend doing **vigorous** physical activities on one of those days?

   _____ **hours per day** _____ **minutes per day**

__Don't know/Not sure

Think about all the **moderate** activities that you will do **when you are 85 years old**. **Moderate** activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think only about those physical activities that you will do for at least 10 minutes at a time.

3. **When you are 85 years old**, on how many days will you do **moderate** physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking.

_____ **days per week**

__ No moderate physical activities ***Skip to question 5***

4. How much time will you usually spend doing **moderate** physical activities on one of those days?

_____ **hours per day** _____ **minutes per day**

__Don't know/Not sure

Think about the time you will spend **walking when you are 85 years old.** This includes at work and at home, walking to travel from place to place, and any other walking that you have done solely for recreation, sport, exercise, or leisure.

5. **When you are 85 years old**, on how many days will you **walk** for at least 10 minutes at a time?

   _____ **days per week**
   No walking ***Skip to question 7***

6. How much time will you usually spend **walking** on one of those days?

_____ **hours per day** _____ **minutes per day**

__Don't know/Not sure

The last question is about the time you will spend **sitting** on weekdays when you are **85 years old.** Include time spent at work, at home, while doing work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television.

7. **When you are 85 years old**, how much time will you spend **sitting** on a **weekday**?

_____ hours per day _____ minutes per day

__Don’t know/Not sure

Appendix J – ERA-12

Please answer the following questions about your expectations regarding aging. This will be the last set of questions in this study.

1. When you are 85 years old, indicate the level of risk you believe will be associated with engaging in physical activity:

☐	☐	☐	☐	☐	☐	☐
No Risk			Uncertain			Extreme Risk

2. When people get older, they need to lower their expectations of how healthy they can be.

☐	☐	☐	☐	☐
Strongly Disagree	Somewhat Disagree	Uncertain	Somewhat Agree	Strongly Agree

3. The human body is like a car: When it gets old, it gets worn out.

☐	☐	☐	☐	☐
Strongly Disagree	Somewhat Disagree	Uncertain	Somewhat Agree	Strongly Agree

4. Having more aches and pains is an accepted part of aging.

☐	☐	☐	☐	☐
Strongly Disagree	Somewhat Disagree	Uncertain	Somewhat Agree	Strongly Agree

5. Every year that people age, their energy levels go down a little more.

☐	☐	☐	☐	☐
Strongly Disagree	Somewhat Disagree	Uncertain	Somewhat Agree	Strongly Agree

6. I expect that as I get older I will spend less time with friends and family.

☐	☐	☐	☐	☐
Strongly Disagree	Somewhat Disagree	Uncertain	Somewhat Agree	Strongly Agree

7. Being lonely is just something that happens when people get old.

☐	☐	☐	☐	☐
Strongly Disagree	Somewhat Disagree	Uncertain	Somewhat Agree	Strongly Agree

8. As people get older they worry more.

☐	☐	☐	☐	☐
Strongly Disagree	Somewhat Disagree	Uncertain	Somewhat Agree	Strongly Agree

9. It's normal to be depressed when you are old.

☐	☐	☐	☐	☐
Strongly Disagree	Somewhat Disagree	Uncertain	Somewhat Agree	Strongly Agree

10. I expect that as I get older I will become more forgetful.

☐	☐	☐	☐	☐
Strongly	Somewhat	Uncertain	Somewhat	Strongly

Disagree	Disagree		Agree	Agree

11. It is an accepted part of aging to have trouble remembering names.

☐	☐	☐	☐	☐
Strongly Disagree	Somewhat Disagree	Uncertain	Somewhat Agree	Strongly Agree

12. Forgetfulness is a natural occurrence just from growing old.

☐	☐	☐	☐	☐
Strongly Disagree	Somewhat Disagree	Uncertain	Somewhat Agree	Strongly Agree

13. It is impossible to escape the mental slowness that happens with aging.

☐	☐	☐	☐	☐
Strongly Disagree	Somewhat Disagree	Uncertain	Somewhat Agree	Strongly Agree

Appendix K – Baseline PA Frequencies

Variable	N	*M* (*SD*)	Skewness	Kurtosis
Baseline Vigorous PA Frequency (days/week)	253	2.3 (1.9)	0.40	-0.71
Baseline Vigorous PA Duration (mins/day)	253	62.1 (52.9)	0.86	0.87
Baseline Moderate PA Frequency (days/week)	253	2.4(2.0)	0.49	-0.61
Baseline Moderate PA Duration (mins/day)	253	59.3 (67.7)	1.73	2.77
Baseline Walking PA Frequency(days/week)	253	5.734 (1.7)	-1.29	0.97
Baseline Walking PA (mins/day)	253	99.8 (92.6)	1.62	2.31
Baseline Sitting Duration (mins/day)	253	390.2 (145.7)	0.53	1.41
Future Vigorous PA (days/week)	253	1.4 (1.5)	1.04	0.76
Future Vigorous PA Duration (mins/day)	253	29.2 (32.3)	1.22	1.15
Future Moderate PA Frequency (days/week)	253	3.1 (1.8)	0.38	-0.44
Future Moderate PA Duration (minutes/day)	253	59.2 (47.7)	1.53	2.76
Future Walking PA Frequency (days/week)	253	6.0 (1.4)	-1.28	0.61
Future Walking PA Duration (days/week)	253	71.4 (58.7)	1.79	3.03
Future Sitting Duration (mins/day)	253	399.0 (155.8)	0.51	1.03

Appendix L – Correlational Analyses

Bivariate correlational analyses using Pearson correlation *r*-values (significance set at $p < 0.05$) were used to empirically estimate the relationship between covariates and outcome variables used in this study. A Pearson *r* of < 0.3, < 0.7 and < 1 were labelled weak, moderate, and strong, respectively in accordance with Dancey and Reidy (2011) and Akoglu (2018). In addition, covariate analyses were used to ensure the assumption of independence of covariates is not violated (i.e., covariates are not highly correlated with each other). Gender, age, program, baseline PA, and behavioural inhibition/activation were tested as covariates for primary outcome variables (i.e., current and future PA intentions, AAS, and ERA-12) and secondary outcome variables (i.e., vigorous PA change, moderate PA change, walking volume change, and sitting duration change).

Gender was a significant covariate for current PA intentions ($r(250) = -.14$, $p = .02$), a negative relationship suggests males had greater current PA intentions than females. Program of study was a significant covariate for current PA intentions ($r(251) = -.21$, $p = .001$), a negative relationship suggests individuals in the kinesiology and health science program had greater current PA intentions. In addition, baseline vigorous PA is positively and moderately correlated with current PA intentions ($r(251) = .49$, $p < .001$), with a moderate effect size. Baseline moderate PA was significantly and positively correlated with current PA intentions ($r(251) = .15$, $p = .02$). Baseline sitting was significantly and negatively correlated with current PA intentions ($r(251) = -.16$, $p = .01$). BAS Drive ($r(251) = -.20$, $p = .002$) and BIS . was a significant covariate for current PA intentions as it was negatively correlated BIS ($r(251) = .13$, $p = .04$) were also correlated with current PA intentions in opposing directions. All covariates were weakly correlated with current PA intentions, with the exception of baseline vigorous PA.

In regard to future vigorous PA intentions, age was a significant covariate ($r(251) = .21$, $p = .001$) representing a positive relationship. Baseline vigorous PA was also identified as a covariate for future vigorous PA intentions ($r(251) = .40$, $p = < .001$), with a moderate effect size. Baseline walking was significantly and positively correlated with future vigorous PA intentions ($r(251) = .22$, $p = .001$). Baseline sitting was significantly and negatively correlated with future vigorous PA intentions ($r(251) = -.16$, $p = .01$), BAS Drive was also identified as a covariate for future vigorous PA intentions as the two variables are significantly and negatively correlated ($r(251) = -.15$, $p = .02$). All effect sizes, with the exception of baseline vigorous PA, are weak.

For future moderate PA intentions, baseline vigorous PA was positively correlated with future moderate PA intentions ($r(251) = .15$, $p = .02$). Baseline moderate PA was positively correlated with future moderate PA intentions ($r(251) = .17$, $p = .01$). Baseline walking was also positively correlated with future moderate PA intentions ($r(251) = .18$, $p = .01$). The above correlations are represented by weak effect sizes.

For future walking intentions, Baseline vigorous PA was identified as a covariate ($r(251) = .13$, $p = .04$) for future walking intentions. Baseline walking was significantly and positively correlated with future walking intentions ($r(251) = .33$, $p < .001$), with a moderate effect size. Baseline sitting was also correlated with future weekly walking ($r(251) = .14$, $p = .03$). BAS Drive ($r(251) = -.18$, $p = .01$) and BAS Fun-Seeking $r(251) = -.10$, $p = .03$). were both negatively correlated with future walking intentions. With the exception of baseline walking, all correlations with future walking intentions are represented by weak effect sizes.

For future sitting intentions, baseline vigorous PA was supported as a covariate as it was weakly and negatively correlated with future sitting intentions ($r(251) = -.17$, $p = .01$). Baseline

sitting was positively and moderately correlated with future sitting intentions ($r(251) = .45$, $p < .001$).

For AAS, baseline weekly vigorous PA ($r(251) = -.15$, $p = .02$) and baseline weekly moderate PA ($r(251) = -.16$, $p = .01$) were negatively and weakly correlated with this variable. BAS Drive was supported as a covariate as it was positively and weakly correlated ($r(251) = .20$, $p = .001$). BIS was also weakly correlated with AAS overall ($r(251) = -.22$, $p < .001$); however, this relationship was negative.

In regard to ERA, year of study was a significant covariate ($r(251) = -.15$, $p = .02$), a negative relationship suggests participants in later years of study held more positive expectations regarding aging compared to participants in earlier years of study. In addition, program was a significant covariate ($r(251) = .15$, $p = .02$). Though the effect size is weak, a positive relationship suggests participants in the kinesiology and health science program held more positive views of aging. Baseline vigorous PA was negatively and weakly correlated with ERA overall ($r(251) = -.14$, $p = .03$). This suggests participants with higher baseline vigorous PA endorsed more positive expectations regarding aging. Baseline sitting was also related to ERA overall ($r(251) = .14$, $p = .02$), representing a weak effect size. Finally, BAS fun seeking ($r(251) = -.14$, $p = .02$) and BIS ($r(251) = -.21$, $p = .001$) were both significantly and negatively correlated to ERA, with weak effect sizes.

Covariate analyses were also used to assess secondary outcome variables. Secondary outcome variables assess the difference between a participant's future PA intentions and current, self-reported PA behaviour. For vigorous PA change, gender was supported as a covariate as it was significantly and positively related to this variable ($r(251) = .25$, $p < .001$), with a weak effect size. This indicated that females were more likely than males to have lower future

vigorous PA intentions relative to their baseline vigorous PA. Program of study was negatively correlated with vigorous PA change ($r_{pb}(251) = -.18$, $p = .01$), indicating that kinesiology and health science students had greater future vigorous PA intentions relative to their baseline PA, with a weak effect size. Baseline vigorous PA ($r(251) = .89$, $p < .001$) and baseline moderate PA ($r(251) = .25$, $p = < .001$) were also significantly and positively correlated with vigorous PA change, with strong and weak effect sizes, respectively.

In regard to moderate PA change, baseline vigorous PA ($r(251) = .13$, $p = .04$) and baseline moderate PA ($r(251) = .72$, $p < .00$) were supported as covariates with weak and strong effect sizes, respectively. In addition, walking change was significantly and positively correlated with moderate PA change ($r(251) = .17$, $p = .01$), with a weak effect size.

In regard to walking change, baseline moderate PA ($r(251) = .19$, $p = .002$) and walking ($r(251) = .76$, $p < .001$) were both identified as covariates. As mentioned above, walking change and moderate PA change are positively correlated.

In regard to sitting change, baseline walking ($r(251) = -.13$, $p = .04$) and baseline sitting ($r(251) = -.57$, $p < .001$) were significantly and negatively correlated with weak and moderate effect sizes, respectively. In the above analyses, it is unsurprising that baseline measurements are significantly correlated with the corresponding change variable (e.g., baseline sitting duration with change in sitting or baseline vigorous PA with change in vigorous PA) as these baseline variables were used to compute the change variable. Age and year of study were not significantly correlated with any of the secondary outcome variables used in this study.

Overall, this section explores potential covariates of the relationship between the risk manipulation and message frame on the primary and secondary outcome variables of this study. These same covariates are used for all outcome variables in the final statistical model to draw

comparisons across models. The results of the correlational analyses empirically confirm the theoretical relationship between predictor and outcome variables.

Covariate Analysis for Primary Outcome Variables

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1. Gender	-																		
2. Age	-0.41$_a$	-																	
3. Year of Study	-0.75$_a$	.13*	-																
4. Program	17.54$_b$**	.07	-.16*	-															
5. Baseline Vigorous PA	-.26$_a$**	.05	.05	-.14	-														
6. Baseline Moderate PA	-.09$_a$	.09	.10	.01	.28**	-													
7. Baseline Walking	-.08$_a$	-.05	.02	.02	.08	.27**	-												
8. Baseline Sitting	.13$_a$*	.01	.02	.16*	-.11	-.12	-.12	-											
9. BAS Drive	.03$_a$	.03	.03	.03	-.12*	-.02	-.10	.10	-										
10. BAS Fun Seeking	-.03a	.15*	-.02	-.02	-.12	-.04	-.12	.08	.24**	-									
11. BAS Reward Responsiveness	.02a	.08	.12	.12	-.00	.08	-.06	.01	.44**	.29**	-								
12. BIS	-.11$_a$	.14*	.15*	.01	.14*	.15*	.10	-.06	.03	.16**	.45**	-							
13. Current PA Intentions	-.14$_a$*	.04	.06	-.21**	.49**	.15*	.03	-.16*	-.20**	-.12	-.05	.13*	-						
14. Future Vigorous PA Intentions	-.12$_a$	.21**	-.00	.05	.40**	.11	.22**	-.16**	-.15*	-.03	.02	.09	.214**	-					
15. Future Moderate Intentions	.02$_a$	.06	.03	.01	.15*	.17**	.18**	-.02	-.11	-.02	-.05	.06	.01	.31**	-				
16. Future Walking Intentions	.00$_a$	.07	.04	.01	.13*	.11	.33**	.14*	-.18**	-.14*	-.12	.05	.09	.20**	.28**	-			
17. Future Sitting Intentions	.09$_a$	-.05	.08	.08	-.17**	-.05	.02	.45**	.11	.05	-.02	-.10	-.28**	-.25**	-.09	.08	-		
18. AAS Overall	-.04$_a$	-.03	-.08	.02	-.15*	-.16*	-.10	.12	.20**	.02	.06	-.23**	-.18**	-.18**	-.20**	-.12	.25**	-	
19. ERA Overall	-.03$_a$	-.04	-.15*	.02	-.14*	.001	.02	.14*	.06	-.14*	-.03	-.21**	-.20**	-.19**	-.10	-.10	.28**	.45**	-

Notes: Pearson correlation used unless otherwise stated; $_a$ = point-biserial correlation; $_b$ = chi square; *$p < 0.05$, **$p < .01$; Gender (0 = Male, 1 = Female) Year of study (1, 2, 3, 4, 5+); Program (0 = kinesiology and health science, 1 = other); PA = physical activity; BAS = behavioural activation scale; BIS = behavioural inhibition scale; AAS Overall = aging anxiety scale; ERA Overall = expectations regarding aging

Covariate Analysis for Secondary Outcome Variables

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. Gender	-															
2. Age	-.04$_a$	-														
3. Year of Study	-.075$_a$	.13*	-													
4. Program	17.54$_b$**	.07	-.16$_a$*	-												
5. Baseline Vigorous PA	-.26$_a$**	.05	.05$_a$	-.14*	-											
6. Baseline Moderate PA	-.09$_a$	.09	.10$_a$	.01	.28**	-										
7. Baseline Walking	-.09$_a$	-.05	.07$_a$	.02	.08	.27**	-									
8. Baseline Sitting	.13$_a$*	.01	.02$_a$	.16*	-.11	-.12	-.12	-								
9. BAS Drive	.03$_a$	.03	-.03$_a$	.03	-.12*	-.02	-.10	.10	-							
10. BAS Fun Seeking	-.03$_a$	.15*	.12$_a$	-.02	-.12	-.04	-.12	.08	.24**	-						
11. BAS Reward Responsiveness	.02$_a$	.08	.17$_a$**	.12	-.00	.08	-.06	.01	.44**	.29**	-					
12. BIS	-.11$_a$	.14*	.15$_a$*	.01	.14*	.15*	.10	-.06	.03	.16**	.45**	-				
14. Vigorous PA Change	-.23$_a$**	-.05	.05$_a$	-.18**	.89**	.25**	-.02	-.04	-.06	-.11	-.01	.11	-			
15. Moderate PA Change	-.09$_a$	.03	.07$_a$	.004	.13*	.72**	.11	-.09	.06	-.02	.10	.09	.21**	-		
16. Walking Change	-.09$_a$	-.09	.05$_a$	.01	-.01	.19**	.76**	-.21**	.02	-.02	.02	.06	-.05	.17**	-	
17. Sitting Change	.06$_a$	.06	-.05$_a$	.06	.07	-.06	-.13*	.48**	-.009	.03	.03	.05	.03	-.10	-.16**	-

Notes: Pearson correlation used unless otherwise stated; $_a$ = point-biserial correlation; $_b$ = chi square; *$p < 0.05$, **$p < .01$; Gender (0 = Male, 1 = Female) Year of study (1, 2, 3, 4, 5+); Program (0 = kinesiology and health science, 1 = other); PA = physical activity; BAS = behavioural activation scale; BIS = behavioural inhibition scale; AAS Overall = aging anxiety scale; ERA Overall = expectations regarding aging

Appendix M – Missing Data Analysis

Little's MCAR Test Results

Variable	**Chi Square**	***df***	***p***
BIS/BAS	50.06	64	.90
Baseline PA	50.13	44	.24
Manipulation Check - Risk	9.17	6	.16
Manipulation Check – Message Frame	20.59	15	.15
Current PA Intentions	4.71	2	.10
Future PA Intentions	53.44	50	.34
AAS	75.23	76	.50
ERA	37.30	31	.20

Appendix N – Covariate Statistics

Dependent Variable	Current PA Intentions	Future Vigorous PA	Future Moderate PA	Future Walking	Future Sitting
	B (*t*)	*B* (*t*)	*B* (*t*)	*B* (*t*)	*B* (*t*)
Covariate					
Gender	-0.07 (-0.44)	-10.42 (-0.92)	29.63 (1.08)	30.46(0.59)	6.98 (0.36)
Age	0.01 (0.74)	2.96 (3.41)	1.95 (0.93)	4.64 (1.17)	-1.57 (-1.04)
Year of Study	-0.01 (-0.07)	-5.13 (-0.89)	-6.12 (-0.44)	-8.74 (0.33)	21.56 (2.16)
Program	-0.37 (-0.25)	21.93 (1.99)	12.30 (0.46)	4.26 (0.08)	1.58 (0.08)
Baseline Vigorous	0.003 (7.18)	0.18 (6.46)	0.11 (1.67)	0.18 (1.41)	-0.06 (1.20)
Baseline Moderate	0.001 (0.002)	-0.02 (-1.04)	0.09 (1.65)	0.08 (0.70)	0.01 (0.31)
Baseline Walking	-0.001 (-0.43)	0.03 (3.42)	0.05 (2.41)	0.23 (5.59)	0.02 (1.12)
Baseline Sitting	-0.001 (-1.24)	-0.05 (-1.45)	-0.003 (-0.03)	0.46 (2.73)	0.41 (6.54)
BAS Drive	-0.12 (-1.78)	-9.74 (-1.98)	-9.12 (-0.76)	-32.70 (1.45)	9.80 (1.15)
BAS Fun Seeking	-0.04 (-.66)	3.84 (0.79)	10.65 (0.91)	-21.47 (-0.97)	8.78 (1.05)
BAS Reward Responsiveness	0.01 (.09)	8.57 (1.15)	-2.87 (-0.16)	-6.36 (0.19)	-13.82 (-1.07)
BIS	0.06 (0.76)	-8.93 (-1.63)	-3.23 (-0.24)	-4.81 (-0.19)	-3.68 (-0.39)
ERA Physical Health	-0.44 (-2.50)	-2.76 (-0.21)	-14.56 (-0.46)	-227.82 (-3.78)	-36.72 (-1.60)
ERA Mental Health	-0.44 (-2.52)	-2.06 (-0.16)	-15.42 (-0.48)	-225.88 (-3.73)	-36.47 (-1.59)
ERA Cognitive Function	-0.43 (-2.43)	-1.39 (-0.11)	-14.16 (-0.44)	-227.42 (-3.77)	-36.08 (-1.57)
ERA Overall	1.30 (2.47)	5.19 (0.13)	42.99 (0.45)	676.93 (-3.77)	111.09 (1.62)

Dependent Variable	AAS Fear of Old People	AAS Psychological Concerns	AAS Physical Appearance	AAS Fear of Losses	AAS Overall
	B (*t*)	*B* (*t*)	*B* (*t*)	*B* (*t*)	*B* (*t*)
Covariate					
Gender	-0.22 (-2.55)	0.014 (0.15)	-0.06 (-0.51)	0.14 (1.306)	-0.03 (-0.53)
Age	0.01 (2.00)	-0.01 (-1.10)	-0.001 (-0.12)	-0.01 (1.552)	-0.002 (-0.4)
Year of Study	-0.07 (-1.63)	0.03 (0.61)	0.04 (0.69)	0.003 (0.05)	0.002 (0.07)
Program	-0.14 (-1.66)	0.07 (0.77)	0.04 (0.33)	-0.10 (-0.99)	-0.04 (-0.73)
Baseline Vigorous	0 (-0.92)	0.00 (-1.69)	0.00 (0.47)	0.00 (0.44)	0.00 (-0.55)
Baseline Moderate	0 (-0.85)	0.00 (-1.27)	0.00 (-0.80)	0.00 (-1.34)	0.00 (-1.65)
Baseline Walking	0 (-0.73)	0.00 (-0.19)	0.00 (-1.15)	0.00 (0.02)	0.00 (-0.88)
Baseline Sitting	0 (-0.06)	0.00 (0.54)	0.001 (1.52)	0.00 (0.24)	0.00 (0.84)
BAS Drive	0.01 (0.20)	0.09 (2.07)	0.12 (2.37)	-0.06 (-1.20)	0.05 (1.70)
BAS Fun Seeking	-0.02 (-0.55)	0.03 (0.62)	0.03 (0.56)	-0.01 (0.26)	-0.01 (-0.20)
BAS Reward Responsiveness	0.12 (2.21)	0.01 (0.11)	-0.001 (-0.01)	0.09 (1.36)	0.05 (1.34)
BIS	-0.04 (-1.03)	-0.01 (-0.29)	-0.11 (-2.00)	-0.13 (-2.61)	-0.08 (-2.52)
ERA Physical Health	0.23 (2.31)	0.14 (1.25)	0.14 (1.01)	-0.06 (-0.48)	0.11 (1.58)
ERA Mental Health	0.24 (2.37)	0.14 (1.26)	0.15 (1.08)	-0.05 (-0.44)	0.12 (1.67)
ERA Cognitive Function	0.23 (2.26)	0.14 (1.22)	0.14 (1.00)	-0.07 (-0.53)	0.11 (1.53)
ERA Overall	-0.68 (-2.28)	-0.40 (-1.19)	-0.41 (-1.01)	0.19 (0.52)	-0.33 (-1.53)