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I Spy With My Little Eye: Cognitive Processing of Framed Physical Activity Messages

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The primary purpose was to examine the relative cognitive processing of gain-framed versus loss-framed physical activity messages following exposure to health risk information. Guided by the Extended Parallel Process Model, the secondary purpose was to examine the relation between dwell time, message recall, and message-relevant thoughts, as well as perceived risk, personal relevance, and fear arousal. Baseline measures of perceived risk for inactivity-related disease and health problems were administered to 77 undergraduate students. Participants read population-specific health risk information while wearing a head-mounted eye tracker, which measured dwell time on message content. Perceived risk was then reassessed. Next, participants read PA messages while the eye tracker measured dwell time on message content. Immediately following message exposure, recall, thought-listing, fear arousal, and personal relevance were measured. Dwell time on gain-framed messages was significantly greater than loss-framed messages. However, message recall and thought-listing did not differ by message frame. Dwell time was not significantly related to recall or thought-listing. Consistent with the Extended Parallel Process Model, fear arousal was significantly related to recall, thought-listing, and personal relevance. In conclusion, gain-framed messages may evoke greater dwell time than loss-famed messages. However, dwell time alone may be insufficient for evoking further cognitive processing.

Health risk information is often followed by a motivational message. For example, a doctor might tell a patient that he has high blood pressure and then encourage him to make lifestyle changes. According to the Extended Parallel Process Model (EPPM),

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providing health risk information elicits feelings of personal relevance, vulnerability, and fear. The EPPM further posits that these feelings motivate cognitive processing of subsequent behavioral recommendations. This tenet has not been tested empirically. Given that the approach of delivering risk information followed by a motivational message is pervasive in practice (e.g., Bell & Kravitz, 2008; Witte, Meyer, & Martell, 2001), it is important to understand how messages are processed following the receipt of risk information. As such, the first objective of this study was to examine how messages following this common delivery format (i.e., risk information followed by a motivational message) are cognitively processed. We examined physical activity (PA) messages in particular because PA is a commonly recommended behavior to reduce the risk of many chronic health problems (e.g., cardiovascular disease [CVD], type-2 diabetes, cancer, obesity). Further, the use of persuasive PA messages is thought to enhance motivation for behavior change following receipt of PA guidelines or recommendations (see Latimer, Brawley, & Bassett, 2010). We hypothesized participants' feelings of vulnerability, fear, and relevance resulting from reading health risk information would correlate positively with their cognitive processing of motivational messages encouraging PA participation.

The second objective of this study was to examine whether individuals who have read risk information differently attend to PA recommendations when they are framed in terms of gains versus losses. Returning to our example of the physician and patient, after capturing the patient's interest by providing risk information the physician can then encourage the patient to be active by emphasizing the benefits of regularly engaging in PA (gain-framed) or the risks of not regularly engaging in PA (loss-framed). Although superficially the difference between these messages is subtle, there is conclusive evidence that people respond differently depending on how the information is framed (Gallagher & Updegraff, 2012). In the context of PA promotion, gain-framed messages seem to be more persuasive than loss-framed or mixed-framed messages (Latimer, Brawley, & Bassett, 2010).

Although conceptual explanations for these effects have been proposed through the application of prospect theory (cf. Rotham & Salovey, 1997), the actual mechanisms that account for the differential effects of gain- versus loss-framed messages remain to be determined. Without an understanding of these mechanisms, our ability to develop optimally effective health messages and advance message framing research is limited. It has been suggested that cognitive processing may vary as a function of message frame (Rothman & Updegraff, 2009). In a meta-analysis of message framing research (O'Keefe & Jensen, 2008), greater cognitive processing—indexed as message recall and message-relevant thoughts—was observed for gain-framed messages encouraging health promotion behaviors such as sunscreen use, dental flossing, and PA. These results suggest that indeed relative differences in cognitive processing of gain- and loss-framed messages may explain why framing effects occur. Thus, it is possible that gain-framed PA messages elicit greater cognitive processing than loss-framed messages which, in turn, may account for differential responses to gain- vs. loss-framed messages.

The three published studies examining this possibility yielded mixed results. One study found greater cognitive processing following gain- versus loss-framed PA messages (Jones, Sinclair, & Courneya, 2003). However, subsequent studies reported no significant difference in cognitive processing following gain- versus loss-framed PA messages (Jones, Sinclair, Rhodes, & Courneya, 2004; McCall & Martin Ginis, 2004). Further research examining cognitive processing of PA messages is necessary given the limited number of studies in the PA domain and the equivocal results of the extant studies.

There are several stages of cognitive processing that may contribute to an individual's reaction to message exposure. Attention is an early stage of cognitive processing (Greenwald & Leavitt, 1984) during which the information recipient

has contact with the stimulus (i.e., message information; Smit, Neijens, & Sturman, 2006). During the attention phase of cognitive processing, the pupil dilates and the lens focuses as the information recipient dwells on the message content (Franzen, 1994, p. 30). Although there are individual considerations that may impact dwell time (e.g., an individual's reading or comprehension speed), dwell time (i.e., the amount of time one's eyes are fixated on the message content) during message exposure is an objective, biometric indicator of attention, with greater dwell time indicative of greater attention (Krugman, Fox, Fletcher, Fischer, & Rojas, 1994; Peterson, Thomsen, Lindsay, & John, 2010). Subsequent stages of cognitive processing require that the message recipient (a) thinks about the information within the context of his or her existing knowledge structures, (b) stores information in memory, and (c) accepts or rejects the message information (Greenwald & Leavitt, 1984). Memory for message content and the number of message-related thoughts generated are indicative of these later stages of cognitive processing (see O'Keefe & Jensen, 2008). More accurate recall of the message content (Keller & Block, 1996) and more message-relevant thoughts (Cacioppo & Petty, 1981) indicate greater cognitive processing. Attention is a necessary process for subsequent cognitive processing to occur (Greenwald & Leavitt, 1984); however, it is possible that attention may occur without further processing. For example, an individual's eyes may fixate on the content of the message but he or she may not generate thoughts about the message content nor remember the content after terminating fixation. By including measures of attention, message recall, and message-relevant thoughts this study will advance our understanding of cognitive processes underlying framing effects. Drawing from the EPPM (Witte, 1992), it was hypothesized that attention—operationalized as dwell time on PA messages—would be positively correlated with message recall and message-relevant thoughts. Furthermore, on the basis of meta-analytic evidence (O'Keefe & Jensen, 2008) we hypothesized among motivated readers greater cognitive processing of PA messages would be observed for participants exposed to gain-versus loss-framed messages.

Method

Participants

Participants were male ($n = 23$) and female ($n = 54$) students recruited from a university campus through (a) a database of volunteer participants from previous research, (b) web and poster advertisements, and (c) word-of-mouth in the university community. Individuals were eligible for study participation if they (a) were at least 18 years of age, (b) had self-reported 20/20 vision with or without a visual aid including glasses or uncoloured contact lenses, (c) were able to speak and read English, (d) were not engaging in regular PA,[1] and (e) had a self-reported family history of at least one of the following: heart disease, cancer, obesity, diabetes. A family history of inactivity-related disease was included as a requirement for participation in order to enhance the personal relevancy of the informational messages (Rothman, Bartels, Wlaschin, & Salovey, 2006). It was important to include individuals who had not established a regular PA routine because informational messages targeting perceived risks and outcome expectancies are more persuasive when people are simply contemplating behavior change (Schwarzer, 2008). Additional demographic characteristics are summarized in Table 1.

[1]Regular PA was defined as at least 30 min of moderate to heavy intensity PA on more than 2 days of the week. This definition of regular PA was used to ensure that study participants were well below the recommended levels of PA for health and well-bring benefits based on the Canadian Physical Activity Guidelines (Canadian Society for Exercise Physiology, 2011).

Table 1. Participant characteristics ($N = 77$)

Variable	*n* (%)
Sex	
Male	23 (30)
Female	54 (70)
Age (years)	23.04 ± 7.40
Family history of disease	
Diabetes	41 (53.3)
Heart disease	35 (45.5)
Cancer	38 (49.4)
Obesity	17 (22.1)

Materials

Health Risk Information

To motivate cognitive processing of the framed PA messages, participants first read risk information regarding (a) inactivity-related disease (i.e., CVD, diabetes, obesity, cancer), and (b) student-relevant health concerns (i.e., common colds, weight gain, and stress). The information described each health problem and provided facts and statistics about the risk among the student or young adult population (see Appendix A). Two examples are "Overweight and obesity are defined as abnormal or excessive fat accumulation that presents a risk to health. Among Canadians aged 18 or older: 23.1% are obese and 36.1%, are overweight" and "University students are at an increased risk for the common cold. In a study of 3,000 undergraduate students, 4,263 classes were missed due to the common cold."

Framed PA Messages

Participants viewed framed messages describing the relation between each health problem presented in the health risk information section and PA. Each participant read a series of exclusively gain- or loss-framed messages (see Appendix B). Gain-framed messages outlined the benefits of engaging in regular PA while loss-framed messages outlined the risks of not engaging in regular PA. For each health problem, a series of framed messages included (a) facts about benefits (gain-framed) or risks (loss-framed) of PA/inactivity, and (b) summary statements about research evidence regarding PA. All aspects of the material were consistently gain-framed or loss-framed. For example, the messages targeting obesity were: "If you engage in regular PA you may reduce your risk of gaining weight during university" (i.e., gain-framed) or "If you do not engage in regular PA you may increase your risk of gaining weight during university" (i.e., loss-framed).

Apparatus

Eye Tracker

The Eyelink II, a head-mounted video-based eye tracker, was used to capture digitally the participants' eye movements while they were reading from a computer monitor. The Eyelink II digitally tracks the participant's pupil movements and the light reflecting off the cornea. The head-mounted device has two cameras, which allowed for binocular tracking of participants' eye movements while they read the risk information and PA messages.

Measures

Vulnerability

At baseline, participants responded to the following six items on 7-point scales: "My chances of developing a) CVD, b) obesity, c) diabetes, d) cancer, e) a common cold, f) stress, and g) poor study habits in the future are" (−3 *not at all strong* to +3 *very strong*), and "I am unlikely to develop [CVD, obesity, etc.] in the future" (−3 *strongly disagree* to +3 *strongly agree*; reverse scored). Following the risk information (i.e., postexposure), participants responded to these identical six items, which were preceded by the statement "keeping in mind the information you just read." The items were averaged for an overall vulnerability score at baseline (Cronbach's $\alpha = .69$) and postexposure to the risk information (Cronbach's $\alpha = .88$). The measure was adapted from Milne, Orbell, and Sheeran (2002) to address perceived risk of inactivity-related health problems.

Fear Arousal

For each set of messages (i.e., chronic disease and psychological health problems), participants responded to four items assessing fear arousal. The items were presented in the following statement: "Indicate the degree to which the information you just read made you feel very afraid/very unafraid, relaxed/tense, calm/agitated, and restful/excited. Each item was assessed on a 7-point bipolar scale with the anchors at either end of the scale (e.g., 1 *very afraid* to 7 *very unafraid*). The four items were averaged for a composite fear arousal score (Keller & Block, 1996; Cronbach's $\alpha = .78$).

Cognitive Processing

Three indicators of cognitive processing were assessed. First, dwell time per word (milliseconds) for (a) risk information and (b) PA messages was calculated using a software program based on data from the Eyelink II eye tracker. Dwell time on risk information for each health problem was calculated based on the average time spent dwelling on each word in the risk information statements. Dwell time on the PA messages for each health problem was calculated based on the average time spent dwelling on key context words (i.e., those words which accounted for the differences between the gain- and loss-framed messages). For example, within the following gain-framed message, the words in bold font were the key context words included in the calculation of overall dwell time: "By participating in regular PA you will reduce your risk of heart disease and stroke." Total dwell time across each health topic (e.g., obesity, heart disease, stress) was averaged to form two composite scores: (a) dwell time per word on risk information (Cronbach's $\alpha = .96$), and (b) dwell time per word on PA messages (Cronbach's $\alpha = .84$).

Second, message-relevant thoughts were assessed through a thought-listing exercise. Immediately following message exposure, participants listed thoughts they had during message viewing (each independent thought was listed in an individual text box). Two independent scorers coded each thought as unfavorable (i.e., described undesirable attributes or negative associations of the messages), favorable (i.e., described desirable attributes or positive associations of the messages), or neutral/irrelevant (i.e., without affect toward messages or unrelated). Interrater reliability was high ($\kappa > 0.90$, $p < .001$; Landis & Koch, 1977). Any coding discrepancies were resolved between the two scorers through discussion. A total message-relevant thoughts score was calculated for each participant (i.e., favorable plus unfavorable). Message-relevant thoughts are commonly used as an indicator or cognitive processing (see O'Keefe & Jensen, 2008), with higher scores considered indicative of greater cognitive processing (Cacioppo & Petty, 1981).

Third, we evaluated memory for message content (i.e., message recall). Message recall is commonly used as a measure of cognitive processing (see O'Keefe & Jensen, 2008). Participants read six statements and indicated whether each was or was not included verbatim in the PA messages. We calculated a total recall score by summing the number of correctly identified statements. We adopted this message recall measurement strategy from previous message framing research (Block & Keller, 1995).

Personal Relevance

Participants were asked to evaluate the personal relevance of the risk information and PA messages on each of the following items:

1. How much did the information apply to your life?" rated on a 7-point scale ranging from 1 (*applied very little*) to 7 (*applied very much*)
2. "How personally relevant did you find the information?" rated on a 7-point scale ranging from 1 (*not at all personally relevant*) to 7 (*very personally relevant*)

The two items were averaged for a composite score of message evaluation. The items were highly correlated (Pearson's $r = .81$, $p < .001$).

Procedure

Following recruitment and screening, each participant attended a one-hour testing session. After giving informed consent, demographic variables (e.g., family history of disease, age) and the baseline vulnerability questionnaire were completed through electronic survey. Once baseline measures were complete, participants sat in front of a specialized computer monitor where the Eyelink II equipment was set up and calibrated. Participants first viewed the health risk information targeting each health problem. The order of presentation of health risk information statements was randomized across participants by the Eyelink II software program. Information regarding each individual health problem was presented on a separate screen. After reading all of the health risk information, vulnerability was re-assessed. Using a random numbers table, participants were then randomized to view either gain-framed or loss-framed PA messages. The Eyelink II was then recalibrated. Messages regarding the benefits (i.e., gain-framed) or risks (i.e., loss-framed) of PA/inactivity in relation to each health problem were presented one statement at a time. The presentation of the messages was self-paced such that participants pressed any key on the computer keyboard in order to move to the next screen (i.e., message). As participants viewed each screen, the Eyelink II collected dwell time data. Immediately after viewing the final framed PA message, participants completed the thought-listing and recall measures of cognitive processing. Next, participants completed electronic questionnaires measuring fear arousal and personal relevance. All procedures were approved by the Research Ethics Board.

Statistical Analysis Approach

Before analyses, we inspected data for outliers. Sample sizes vary across analyses as a result of missing data and removal of statistical outliers (i.e., values >3.29 standard deviations from the mean; Tabachnick & Fidell, 2001). The statistical assumptions of each analysis were tested and satisfied (Kleinbaum, Kupper, Nizam, & Muller, 2008).

Dwell time on risk information, postrisk information vulnerability, fear arousal, personal relevance, and sex were examined as covariates of dwell time on framed PA

messages, message-relevant thoughts, and message recall. Dwell time, recall, and message-relevant thoughts for risk information may be related to dwell time, recall, and message-relevant thoughts for PA messages as a result of individual differences in variables related to cognitive processing in general (e.g., reading speed, need for cognition, memory). Also, consistent with EPPM, vulnerability or fear aroused by the risk information may impact motivation to cognitively process subsequent messages (Witte, 1992). Previous research has also found sex differences in cognitive processing (Jones, Stanaland, & Gelb, 1998) and information viewing behavior (Pan et al., 2004). Possible covariates were considered by computing a one-way analysis of variance to test for sex differences and Pearson's correlations were computed among the continuous variables. We calculated a chi-square analysis to check for differences in the ratio of male-to-female participants in each condition. We also calculated analyses of variance to check for group differences in baseline vulnerability, fear arousal, and personal relevance.

Participants' exposure to the health risk information was expected to result in an increase in vulnerability (Milne et al., 2002). It was important to ensure that participants' vulnerability was enhanced by the health risk information given the assumption of the EPPM framework (Witte, 1992)—enhanced vulnerability motivates processing of response efficacy information. That is, an assumption was made that the presentation of the risk information would motivate readers to cognitively process the subsequent PA messages. To test the success of the health risk information manipulation on participants' vulnerability in the present study, we calculated a paired-samples t test to determine differences in baseline and postrisk information vulnerability.

To test Hypothesis 1, we calculated Pearson correlations to explore the relation between dwell time, message recall, message-relevant thoughts, fear arousal, vulnerability, and personal relevance. To test Hypothesis 2, analyses of covariance were calculated to examine group differences in dwell time on framed PA messages, message recall, and message-relevant thoughts while controlling for covariates.

Results

Preliminary Analyses and Descriptive Statistics

Testing for Potential Covariates and Group Differences

All correlations are shown in Table 2. Dwell time on risk information was the only potential covariate significantly related to dwell time on framed PA messages ($r = .53$, $p < .001$), while fear arousal was the only potential covariate significantly related to message recall ($r = .37$, $p = .001$). Fear arousal and vulnerability were significantly related to total message-relevant thoughts ($r = .24$, $p = .04$). Each of these variables was treated as a covariate in subsequent analyses involving the appropriate dependent variables. Dwell time on framed PA messages, recall, and message-relevant thoughts did not significantly differ between men and women ($p > .05$). Vulnerability, fear arousal, personal relevance, and sex did not significantly differ between the gain- and loss-framed conditions (see Table 3).

Change in Vulnerability

Vulnerability increased significantly from baseline to postrisk information ($t = -4.67$, $p < .001$). Thus, manipulation of vulnerability was successful and we could proceed to test for differences in dwell time on framed PA messages following health risk information under the assumption that participants had enhanced vulnerability and were motivated to process the PA messages.

Table 2. Descriptives and correlations: dwell time, thoughts, recall, relevance, vulnerability, and fear arousal

	1	2	3	4	5	6
1. Dwell Physical Activity	238.38 (73.91)					
2. Relevant Thoughts	−.05	6.34 (2.88)				
3. Recall	−.05	.14	6.0 (1.46)			
4. Personal Relevance	−.01	.07	.12	5.45 (1.27)		
5. Vulnerability	−.09	.29**	.01	−.04	4.79 (1.03)	
6. Fear Arousal	−.02	.24*	.37**	.27*	−.06	4.16 (.90)

Note. Sample means (standard deviations) are shown on the diagonal. Vulnerability = postrisk information vulnerability.
$^{*}p < .05$. $^{**}p < .01$.

Hypothesis Testing

Hypothesis 1: Dwell time on framed PA messages, message recall, and message-relevant thoughts will be positively correlated with each other, as well as with postrisk information vulnerability, fear arousal, and personal relevance.

Contrary to hypothesis, dwell time on PA messages, recall, and message-relevant thoughts were not significantly correlated. Dwell time on PA messages was not significantly correlated with vulnerability, fear arousal, or personal relevance. Message recall was significantly correlated with fear arousal only ($r = .37$, $p = .001$). Message-relevant thoughts were significantly correlated with fear arousal ($r = .24$, $p = .04$) and postrisk information vulnerability ($r = .29$, $p = .01$). Drawing on the EPPM (Witte, 1992) framework, it is noteworthy that fear arousal was also significantly correlated with personal relevance ($r = .27$, $p = .02$).

Hypothesis 2: Greater dwell time on PA messages, message recall, and message-relevant thoughts will be observed for the gain-framed compared with the loss-framed condition.

Table 4 displays the results of the analyses of covariance calculated to test for differences in dwell time, message recall, and message-relevant thoughts between

Table 3. Group differences for vulnerability, fear arousal, and personal relevance

	Gain-framed ($n = 37$)		Loss-framed ($n = 38$)	
	M	*SD*	*M*	*SD*
Baseline vulnerability	4.42	0.64	4.26	0.88
Postvulnerability	4.83	1.12	4.76	0.95
Fear arousal	4.05	0.91	4.28	0.90
Personal relevance	5.43	1.27	5.47	1.17

Note. Postvulnerability = postrisk information vulnerability. No significant between-group differences. Scale range for each variable was 1–7.

Table 4. Analysis of covariance comparing cognitive processing, by message frame

	Cognitive processing variable M (SD)	F	p	Partial η^2
Condition	Dwell time physical activity messages	6.93	.01	0.10
Gain framed ($n = 33$)	261.81 (11.13)			
Loss framed ($n = 35$)	219.69 (10.79)			
Covariate				
Dwell time risk info		16.12	<.001	0.20
Condition	Message recall	0.55	.46	0.01
Gain framed ($n = 37$)	5.84 (1.54)			
Loss framed ($n = 39$)	6.21 (1.36)			
Covariate				
Fear arousal		11.06	.001	0.13
Condition	Message-relevant thoughts	<.001	.99	<.001
Gain framed ($n = 37$)	6.30 (2.50)			
Loss framed ($n = 39$)	6.44 (3.23)			
Covariate				
Fear arousal		5.38	.02	0.07
Vulnerability		7.99	.01	0.10

Note. Units for dwell time scores are millisecond per word.

gain- and loss-framed conditions. First, an analysis of covariance was calculated with dwell time on PA messages as the dependent variable and dwell time on risk information included as a covariate. As hypothesized, dwell time on PA messages differed by frame, $F(1, 67) = 6.93$, $p = .01$; $\eta_p^2 = .10$, such that greater dwell time was observed in the gain-framed condition ($M = 261.81$ ms/word) compared with the loss-framed condition ($M = 219.69$ ms/word). The separate analyses of covariance for message recall (controlling for fear arousal) and message-relevant thoughts (controlling for fear arousal and vulnerability) were not significant.

Discussion

The present study examined the relation between cognitive processing, vulnerability, fear arousal, and personal relevance. The study also compared cognitive processing of gain- versus loss-framed physical activity (PA) messages following the presentation of risk information regarding inactivity-related health problems. Partial support for the hypotheses was found.

Dwell Time on PA Messages, Message Recall, Message-Relevant Thoughts, Vulnerability, Fear, and Personal Relevance

Dwell time on framed PA messages, message recall, and message-relevant thoughts were not significantly correlated. This was unexpected given that previous research has found a positive correlation between dwell time and message recall (e.g., Krugman et al., 1994). This was also unexpected given the notion that attention (i.e., dwell time) is a necessary process preceding further cognitive processing (i.e., recall and message-relevant thoughts; Greenwald & Leavitt, 1984). The results of the present study indicate that a message recipient can dwell on a message without necessarily generating message-relevant thoughts or accurately recalling the message content. For example, if an individual sufficiently dwells on message content but does not comprehend the content, or immediately rejects the content with little

thought or scrutiny, he or she may not necessarily generate a lot of message-relevant thoughts or accurately recall the content (see Greenwald & Leavitt, 1984). Likewise, some individuals may generate message-relevant thoughts and accurately recall message content with relatively little time spent dwelling on the message content. For example, if the message recipient is familiar with the content of the messages (e.g., he or she has seen information about health and PA before), a relatively brief amount of time dwelling on the message content may be sufficient to generate high levels of message-relevant thoughts or message recall. Exposure to information that is familiar results in decreased attention elicited by the information (see Greenwald & Leavitt, 1984).

Similarly, dwell time on PA messages was not significantly related to vulnerability, fear arousal, or personal relevance. These null findings were unexpected considering the EPPM (Witte, 1992) driven hypothesis that higher levels of vulnerability, fear arousal, and personal relevance would motivate cognitive processing of subsequent PA messages, which would be demonstrated by longer durations of dwell time on the messages. Although the dwell time data do not support the EPPM hypothesis, message recall was positively correlated with fear arousal and message-relevant thoughts were positively correlated with fear arousal and vulnerability.

As noted, fear arousal was also positively correlated with personal relevance.

The positive relation between fear arousal and message recall, as well as message-relevant thoughts, suggests that fear arousal may indeed be related to cognitive processing of PA messages. Although it was hypothesized that fear arousal would be also be related to the dwell time on PA messages, fear arousal may have only influenced subsequent cognitive processing (e.g., message recall and message-relevant thoughts). Previous research has found a positive relation between fear arousal and cognitive processes that follow initial attention to message content (e.g., message-relevant thoughts; Slater, Karan, Rouner, & Walters, 2002). Regardless of the amount of time an individual dwells on a message, it may be the affective response (i.e., fear) that motivates further cognitive processing of the message content. This explanation is theoretically consistent as fear is the driving force behind cognitive processing according to EPPM. Regardless of dwell time, the greater the fear evoked by the risk information, the greater the motivation to cognitively process subsequent messages (Witte, 1992).

Dwell Time, Message Recall, and Message-Relevant Thoughts for Gain-Framed Versus Loss-Framed Messages

Following exposure to risk information, participants spent more time dwelling on gain-framed PA messages (i.e., emphasizing the benefits of PA) compared with contextually identical loss-framed messages (i.e., emphasizing the risks of inactivity). This finding is consistent with meta-analytic findings that gain-framed messages targeting health prevention behaviors engender greater cognitive processing than loss-framed messages (O'Keefe & Jensen, 2008). It has been suggested that gain-framed messages may seem more optimistic and instilled with positive affect, which may lead individuals to process them more closely than loss-framed messages (O'Keefe & Jensen, 2008). Alternatively, the pessimistic and negative affect associated with loss-framed messages may evoke reactance for some individuals. Loss-framed messages may also be interpreted as hectoring in tone and unpleasant to process (O'Keefe & Jensen, 2008). Similarly, some individuals may find loss-framed messages more awkward or less natural than gain-framed messages (Gamliel, 2007), and consequently readers may be less inclined to process the message content. These explanations may explain why participants in the present study spent

less time dwelling on the loss-framed messages and more time dwelling on the gain-framed messages. If designing PA messages with the sole purpose of attracting message recipients' attention, the exclusive use of gain-framed messages would be recommended. However, the data suggest that simply drawing recipients' attention may not be sufficient to evoke subsequent cognitive processing or affective responses.

Contrary to our hypothesis, there were no significant differences in message recall or message-relevant thoughts following gain- versus loss-framed PA messages. This finding suggests that loss-framed messages may evoke the same levels of recall and message-relevant thoughts as gain-framed messages despite relatively less dwell time on the message content. Although individuals may prefer dwelling on gain-framed message content, the fear response for loss-framed messages was similar. In a real-world context where people may be spending limited time dwelling on message content (e.g., flipping through magazine or brochure at doctor's office), the relatively quick fear arousal by the loss-framed message may be beneficial in persuading further cognitive processing.

Limitations and Future Directions

The present study has important practical and theoretical implications. However, there are limitations which warrant mention. First, the ordering of administration of the study measures limits our understanding of the direction of the relation between fear and cognitive processing. Although the EPPM (Witte, 1992) framework suggests that fear arousal motivates cognitive processing, it is possible that greater cognitive processing resulted in greater fear arousal. Second, the primary purpose of the present study was to explore cognitive processing as a possible mechanism underlying framing effects. However, our understanding of the mechanistic role cognitive processing would be enhanced through the inclusion of a measure of message persuasiveness (e.g., cognition change, behavior change, message acceptance). Third, the baseline measure of vulnerability did not quite achieve standard levels of reliability. Last, the generalizability of the findings outside of the university student population is unknown. When applying the EPPM to understand PA message framing, there may be unique aspects of the university student population which require consideration. For example, young adults may be optimistically biased about their risk for health problems (see Arnett, 2000), which may influence the amount of vulnerability or threat that can be evoked by health risk information. Although the study was strategically targeted individuals with issue involvement (i.e., family history of inactivity-related disease and currently inactive), it is possible that the effects of the risk information on vulnerability may have been buffered in this population.

Conclusion

The present study provided important information regarding the mechanistic role of cognitive processing in relation to framed PA messages. The study was unique in that it is the first known PA messaging study to examine cognitive processing using eye-tracking technology in order to provide a biometric measure of cognitive processing. Although dwell time was observed for gain- versus loss-framed PA messages, dwell time was not related to message recall, message-relevant thoughts, vulnerability, fear, or personal relevance evoked by the health risk information. Fear arousal was, however, positively related to indicators of cognitive processing. Dwell time alone may be insufficient for evoking subsequent cognitive processing rather, a fear response may be necessary. Future research should continue to examine cognitive processing as

a possible mechanism to explain message framing effects and seek to understand the relatively greater dwell time given to gain-framed messages in the present study.

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Appendix A: Health Risk Information

Cardiovascular Disease (CVD)

CVD refers to disease of the heart and blood vessels. CVD can result in heart attack or stroke caused by blockages to the heart or brain.

- Every 7 minutes in Canada, someone dies from heart disease or stroke
- CVD is a leading cause of death in Canada
- Many young adults already have risk factors for CVD

Overweight and Obesity

Overweight and Obesity are defined as abnormal or excessive fat accumulation that presents a risk to health. Overweight and obesity are major risk factors for a number of chronic diseases, including diabetes, CVD and cancer.

- The percentage of Canadians who are overweight or obese has risen dramatically in recent years especially among young adults
- Many individuals gain weight and body fat while attending university
- Among Canadians aged 18 or older: 23.1% are obese and 36.1%, are overweight

Type 2 Diabetes

Type 2 Diabetes is a disease that occurs when the body cannot effectively use the insulin it produces (i.e., insulin resistance). Raised blood sugar is a common effect of uncontrolled diabetes and over time leads to serious damage to many of the body's systems, especially the nerves and blood vessels. Over time, type 2 diabetes can lead to blindness, kidney failure, and increased risk of CVD and stroke.

- Diabetes is the seventh leading cause of death in Canada
- More than 50,000 young adults in Canada have diabetes
- Diabetes is a common condition and it's frequency is dramatically rising all over the world

Cancer

Cancer is a disease that starts in our cells. Our bodies are made up of millions of cells, grouped together to form tissues and organs such as muscles and bones, the lungs and the liver. Genes inside each cell order it to grow, work, reproduce and die. Normally, our cells obey these orders and we remain healthy. But sometimes the instructions get mixed up, causing the cells to form lumps or tumors, or spread through the bloodstream and lymphatic system to other parts of the body.

- The incidence of cancer among adults is on the rise
- There are approximately 2,075 new cases of cancer in Canada each year among young adults age 15–29
- Lymphoma is a particularly prevalent cancer among young men and women

Common Cold

- University students are at an increased risk for the common cold
- 9/10 students reported having at least 1 common cold over the fall/winter semester
- In a study of 3,000 undergraduate students; 4,263 classes were missed due to the common cold

Weight Gain

- Many students gain weight during university as a result of lifestyle changes
- In a study of 900 undergraduate students, 77% gained weight during university
- Weight gain during the university years increases the risk of obesity-related morbidity and diabetes, even among students with normal weight at admission

Stress

- Many undergraduate students report feeling stress as a result of academic pressures, financial problems, and relationship strains.
- By the end of first-year university, 44% of undergraduates report feeling stressed and overwhelmed
- Stress contributes to approximately 80% of all illnesses and disease

Appendix B: Framed Physical Activity Messages

Gain-framed messages	Loss-framed messages
By participating in 10-minute bouts of regular leisure time physical activity you will . . .	By not participating in 10-minute bouts of regular leisure time physical activity you will . . .
• Reduce your risk of heart attack and stroke	• Increase your risk of heart attack and stroke
• Increase your chances of managing your blood pressure	• Reduce your chances of managing your blood pressure
• Take an opportunity to strengthen your heart	• Miss an opportunity to strengthen your heart
Research shows . . .	Research shows . . .
• People who participate in aerobic activities such as jogging, basketball, and	• People who do not participate in aerobic activities such as jogging, basketball, and

(*Continued*)

Gain-framed messages	Loss-framed messages
swimming are more likely to improve their cardiovascular fitness	swimming are less likely to improve their cardiovascular fitness
If you engage in regular leisure time physical activity, you may . . .	If you do not engage in regular leisure time physical activity, you may not . . .
• Reduce your risk of gaining weight during university	• Reduce your risk of gaining weight during university
• Help reduce body fat while maintaining muscle mass	• Help reduce body fat while maintaining muscle mass
• Improve your chances of losing weight or maintaining a healthy body weight	• Improve your chances of losing weight or maintaining a healthy body weight
Research shows . . .	Research shows . . .
• You are less likely to become overweight or obese if you engage in physical activity during your free time.	• You are more likely to become overweight or obese if you don't engage in physical activity during your free time.
If you add regular leisure time physical activity to your day-You may . . .	If you do not add regular leisure time physical activity to your day-You may not . . .
• Reduce your risk of developing type 2 diabetes	• Reduce your risk of developing type 2 diabetes
• Keep your blood sugar in check	• Keep your blood sugar in check
• Improve your body's ability to use insulin and carbohydrates	• Improve your body's ability to use insulin and carbohydrates
Research shows . . .	Research shows . . .
• Active people are less likely to develop type 2 diabetes than inactive people.	• Inactive people are more likely to develop Type 2 diabetes than active people.
By engaging in regular leisure time physical activity . . . You will:	By not engaging in regular leisure time physical activity . . . You will not:
• Prevent 35% of all cancers	• Prevent 35% of all cancers
• Achieve and maintain a healthy weight; People who are a healthy weight are at less risk for cancer	• Achieve and maintain a healthy weight; People who are overweight are at greater risk for cancer
• Help protect yourself from many cancers	• Protect yourself from many cancers
Research Shows:	Research Shows:
• High levels of physical activity are associated with low levels of cancers	• Low levels of physical activity are associated with high levels of cancers
If you engage in regular leisure time physical activity: You may:	If you do not engage in regular leisure time physical activity: You may:
• Reduce your risk of catching a common cold	• Increase your risk of catching a common cold
• Have more quality sleep and less sleep disturbances, which increases your resistance to the common cold	• Have less quality sleep and more sleep disturbances, which decreases your resistance to the common cold
• Be less likely to catch a cold when you are faced with high stress periods like exams	• Be more likely to catch a cold when you are faced with high stress periods like exams
Research shows:	Research shows:
• Higher levels of physical activity are associated with lower incidence of the common cold among undergraduate students.	• Lower levels of physical activity are associated with higher incidence of the common cold among undergraduate students.
Adding regular leisure time physical activity to your day can:	Not adding regular leisure time physical activity to your day can:
• Improve your study habits	• Worsen your study habits
• Result in more quality sleep and less sleep	• Result in less quality sleep and more sleep

(*Continued*)

Gain-framed messages	Loss-framed messages
disturbances, which can improve your study habits and academic performance • Be beneficial to your academic studying Research shows: • Undergraduate students who are regularly active have better study habits and academic performance than students who are regularly inactive. By engaging in regular leisure time physical activity; You may: • Succeed with managing school-related stress • Feel a reduction in stress-related emotions such as anxiety • Reduce the likelihood of feeling overwhelmed by stress Research shows: • Being physically active makes it easier for university students to cope with stress especially during academic demanding times.	disturbances, which can worsen your study habits and academic performance • Be detrimental to your academic studying Research shows: • Undergraduate students who are regularly inactive have poorer study habits and academic performance than students who are regularly active. By not engaging in regular leisure time physical activity; You may: • Struggle with managing school-related stress • Feel an increase in stress-related emotions such as anxiety • Increase the likelihood of feeling overwhelmed by stress Research shows: • Being physically inactive makes it difficult for university students to cope with stress especially during academic demanding times.