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The Effects of Gain- Versus Loss-Framed Messages Following Health Risk Information on
Physical Activity in Individuals with Multiple Sclerosis
Alexander Lithopoulos, Rebecca L. Bassett-Gunter, Kathleen A. Martin Ginis, and Amy E.
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Abstract

Few people with multiple sclerosis engage in physical activity. Messaging interventions may motivate more physical activity among these individuals. The purpose of this online study was to evaluate an intervention presenting participants with multiple sclerosis ($N = 237$) with risk information (i.e., information demonstrating people with multiple sclerosis are more likely to experience certain health issues) or no risk information followed by gain- or loss-framed physical activity messages. Participants completed questionnaires on Days 1, 6, and 28, and received information material on Days 2-5. The dependent variables were: physical activity intentions and behaviour, response and task efficacy, perceived threat (i.e., perception of threat to health issues relevant to people with multiple sclerosis), and avoidance (i.e., avoiding thinking about/doing something about the health issues presented in the messages). Analyses indicated physical activity and response efficacy increased over time. Also, participants receiving risk information had higher levels of physical activity and perceived threat. However, manipulation checks showed no differences between participants regarding perceptions of risk information or gain/loss-framed messages. Despite the lack of impact of the framing intervention, this study suggests that a brief informational intervention can positively influence physical activity and certain correlates of physical activity among people with multiple sclerosis.

The Effects of Gain- Versus Loss-Framed Messages Following Health Risk Information on
Physical Activity in Individuals with Multiple Sclerosis

Multiple sclerosis (MS) is an inflammatory disorder in which the myelin sheath covering the nerves of the brain and spinal cord is damaged. Common symptoms of MS include cognitive impairment, loss of vision, poor balance, weakness, fatigue, and temperature sensitivity (Compston & Coles, 2008; Poser et al., 1983). Impairments such as these reduce quality of life (Benito-León, Morales, Rivera-Navarro, & Mitchell, 2003; Motl, Suh, & Weikert, 2010) and result in significant health care costs (Whetten-Goldstein, Sloan, Goldstein, & Kulas, 1998).

There is evidence indicating that physical activity (PA) provides substantial benefit to individuals with MS. Regular PA improves aerobic capacity and muscular strength (Latimer-Cheung, Pilutti et al., 2013) and this, in turn, may reduce disability among people with MS (Motl, 2010). Further, PA participation is associated with improved psychological well-being (e.g., decreased depression and fatigue; Motl et al., 2008). Unfortunately, rates of inactivity are high among people with MS with 41.3% engaging in no activity or very low levels of activity (Marck et al., 2014). There is a need for interventions to increase PA levels among people living with MS.

Persuasive, motivational messages may be a means of increasing PA participation among people with MS. One strategy to optimize message effectiveness is the use of message framing. Indeed, message framing has received considerable attention in the persuasive message literature and is recommended for consideration in developing messages to motivate PA behaviour change (Latimer, Brawley, & Bassett, 2010). A gain-framed message emphasizes the benefits of engaging in PA whereas a loss-framed message emphasizes the costs of not engaging in PA (Rothman & Salovey, 1997). Systematic reviews and meta-analyses examining the effects of

framed messages for PA promotion have shown that gain-framed messages motivate greater PA participation than loss-framed messages (Gallagher & Updegraff, 2012; Latimer et al., 2010; O’Keefe & Jensen, 2007). However, it should be noted that in almost all of these studies, healthy adults (mostly undergraduate students) served as participants. There is a need for further research examining the effects of message framing on the PA of people with disabilities as there may be sample characteristics that impact the relative effectiveness of gain- and loss-framed PA messages (Bassett-Gunter, Martin Ginis, Latimer-Cheung, 2013).

In addition to considering the characteristics of the sample receiving a framed message, it is important to consider the context in which the framed messages are delivered. In practical settings, framed messages may be preceded by risk information (Bell & Kravitz, 2008). For example, a physician might tell a patient with MS about his/her risk of suffering from a certain serious threat (e.g., falling due to imbalance) and then encourage the patient to take a certain action (e.g., engage in PA) to prevent the negative outcome from occurring. In this example, the risk information is meant to capture the patient’s attention and evoke concern and the framed message is meant to motivate behaviour change. As such, there is practical significance in understanding the efficacy of pairing risk information with framed messages. The primary purpose of this study was to examine the effects of risk information (or no risk information) followed by gain- or loss-framed messages on PA among people with MS.

Previous research (Bassett-Gunter, Latimer-Cheung, Martin Ginis, & Castelhana, 2014; Bassett-Gunter et al., 2013) has employed the extended parallel process model (EPPM; Witte, 1992) as a framework for understanding how the pairing of risk information and framed messages might influence future health behaviour. The model suggests that when an individual receives risk information (e.g., information about the risk of falling due to imbalance) he/she will

93 assess the severity (i.e., perceived severity of the threat) and the susceptibility (i.e., perceived
94 likelihood that he/she will experience the threat), which together make up perceived threat. If the
95 information recipient does not perceive high risk then he/she will not respond to the information.
96 However, if the information recipient perceives high risk then he/she will experience fear. At this
97 stage, the person evaluates response efficacy (i.e., level of confidence that the advocated
98 behaviour can prevent the threat) and self-efficacy (i.e., level of confidence in ability to perform
99 the advocated response). If these two types of efficacy are sufficiently high then the person will
100 be motivated to engage in the recommended behaviour (e.g., PA). However, if either or both of
101 these two types of efficacy are insufficient (i.e., the person does not believe the behaviour can
102 overcome the threat or does not believe he/she can effectively perform the behaviour) then the
103 person will experience defensive motivation and engage in maladaptive coping strategies (e.g.,
104 denial, avoidance).

105   The model does not explicitly predict whether a gain-framed or a loss-framed message
106 following risk information would more effectively motivate healthy behaviour. However, it is
107 clear that efficacy levels must be high to ensure people have the confidence to engage in the
108 recommended behaviour. In a comparison of gain-, loss-, and mixed-framed PA messages,
109 Latimer et al. (2008) found gain- and mixed-framed messages resulted in greater self-efficacy for
110 PA than loss-framed messages among sedentary middle-aged adults. This result suggests that
111 gain-framed messages may be more effective for raising PA self-efficacy than loss-framed
112 messages. Thus, it is plausible that risk information followed by gain-framed messages may
113 more effectively motivate PA than risk information followed by loss-framed messages.

114   Alternatively, it is also plausible that risk information followed by loss-framed messages
115 may motivate more PA as there may be congruence between the mindset risk information

produces and the negative tone of a loss-framed message (Bassett-Gunter et al., 2013). Generally, gain-framed messages tend to be more effective when people are already focused on pursuing gains (habitually or situationally induced), whereas loss-framed messages tend to be more effective when people are focused on avoiding losses (Covey, 2014). Risk information about health conditions may cause people to adopt a loss avoidance mindset because the nature of the content in the risk information is aversive. The risk information may then, in effect, prime people to be more receptive to loss-framed messages. Thus, it is also plausible that risk information followed by loss-framed messages may motivate more PA than gain-framed messages following risk information. This possibility is described as a congruency hypothesis (Rothman & Updegraff, 2010).

There are two published studies that have specifically examined the effects of pairing risk information with framed PA messages. The results are mixed. In the first study, the effects of gain- versus loss-framed messages following risk (plus a no-information control condition) were compared on PA response efficacy and intentions among sedentary adults with spinal cord injury (Bassett-Gunter et al., 2013). Loss-framed messages following risk information were generally more effective than gain-framed messages following risk information. Specifically, participants in the loss-framed condition experienced greater change in response efficacy for psychological health compared to the other two conditions, and greater change in intentions to engage in PA compared to the control group and gain-framed condition (marginally greater). Participants who received loss-framed messages also engaged in greater overall cognitive processing than those who received gain-framed messages. The authors explained their findings by suggesting that persuasion was increased as a result of the congruence between the risk information and loss-framed messages (Bassett-Gunter et al.).

In contrast, in the second study, the authors found that sedentary, able-bodied undergraduates engaged in greater cognitive processing of gain-framed PA messages following risk information compared to loss-framed PA messages following risk information (measured via eye tracking technology; Bassett-Gunter et al., 2014). Assuming that attention to message content is a precursor to other important correlates of PA (e.g., intentions; Greenwald & Leavitt, 1984), this result is seemingly inconsistent with that of the first study (i.e., Bassett-Gunter et al. 2013). The inconsistent results may reflect the very different samples the two studies used (i.e., people with spinal cord injury versus healthy students). However, it is important to note that neither study measured actual PA behaviour following message exposure. Furthermore, neither study included gain- and loss-framed-only groups (i.e., no risk information), which is important because these groups act as risk information control groups. Finally, these studies lacked an extended follow-up period. The current study addressed the limitations of the previous work and provided a rigorous evaluation of the effects of pairing risk information and gain- and loss-framed messages on PA behaviour.

This is the first known study to examine the relative effectiveness of risk information paired with gain- versus loss-framed messages on PA among individuals with MS. The EPPM and congruency perspectives make divergent predictions regarding whether gain- or loss-framed messages following risk information would have a greater effect on PA. In accordance with an EPPM perspective, it would be expected that risk information paired with gain-framed messages would be most effective. Conversely, the congruency perspective would predict loss-framed messages to be most effective. These divergent perspectives are further complicated by the mixed findings of previous research examining risk information paired with framed PA messages

(Bassett-Gunter et al., 2014; 2013). As such, we did not make a priori hypotheses regarding the relative effectiveness of risk information paired with gain- versus loss-framed PA messages.

Method

Experimental Design

The entire study was conducted online. The design was adapted from Bassett-Gunter et al. (2013). Participants completed questionnaires on Days 1, 6, and 28, and received information material on Days 2-5. Participants were randomly assigned to one of four groups using a 2 (risk information: risk information, no risk information) X 2 (frame: gain-framed, loss-framed) factorial design.

Participants

In total, 31 male and 195 female (11 participants did not indicate a gender) participants ($M age = 41.57$; $SD = 9.58$) were eligible for the study and completed data collection at the first time point. Eligible participants included people who (a) had MS, (b) were community-dwelling (i.e., not in a long-term care facility), (c) were between the ages of 18-64 years, (d) self-reported the physical ability to perform PA, (e) scored between 0 (neurologically normal) and 7 (uses a wheelchair as a primary mode of mobility and can push and transfer from the wheelchair alone) on the Expanded Disability Status Scale (Kurtzke, 1983), and (f) were not currently meeting PA guidelines for adults with MS (i.e., engaging in fewer than two bouts of moderate intensity aerobic PA and two bouts of strength training per week; Latimer-Cheung, Martin Ginis et al., 2013). Participants were provided compensation in the form of \$5 gift cards for completing the Day 6 and Day 28 surveys (see Figure 1 for participant flow chart).

Information and Message Materials

Health topic information. All participants received basic descriptive information that was definitional in nature about health topics relevant to people with MS including: (a) chronic diseases (i.e., cardiovascular diseases, cancer, type II diabetes, and obesity), (b) falls, (c) fatigue, and (d) mental health (i.e., depression, anxiety, and sleep disorders). Participants in the risk information conditions received additional health risk information including facts and statistics demonstrating that people with MS are at an increased likelihood of experiencing each health issue. Participants received information about one health issue per day (i.e., study Days 2-5). The health issue information and health risk information was not framed.

Framed messages. Participants read either gain- or loss-framed messages outlining the relationship between PA and the corresponding health issue (i.e., chronic diseases, fatigue, falls, and mental health). Framed messages included: information on the benefits of performing PA or the risks of inactivity, a quotation ostensibly from a health care professional working in the MS field, and a quotation ostensibly from a peer with MS. All quotations and information were appropriately framed for each experimental group. Examples of risk information and framed messages are included in Table 1.

Outcome Measures

Physical activity. The leisure-time PA questionnaire for people with spinal cord injury (LTPAQ-SCI; Martin Ginis, Phang, Latimer, & Arbour-Nicitopoulos, 2012) was used. Participants indicated the number of days and the number of minutes per day they were involved with aerobic and strength training activities, at moderate and heavy intensities, over the past week. Total PA was calculated as a sum of the above items. The scale has been found to be valid and reliable among people with SCI (Martin Ginis et al., 2012). The descriptions of PA are appropriate for adults with other neurological impairments such as MS.

Intentions. Participants responded to the following two items on a 7-point scale (1 = *strongly disagree*; 7 = *strongly agree*): (a) “I plan to meet the recommended physical activity guidelines over the next 2 weeks”; (b) “I intend to meet the recommended physical activity guidelines over the next 2 weeks.” This measure was adapted from previous work and has demonstrated predictive validity (Blanchard et al., 2007). Internal consistency was excellent in the current study (Cronbach α = .96 [Day 1]; .97 [Day 6]).

Message Process Measures

Unless otherwise noted, all items were measured on a 7-point scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*).

Message perceptions. As a check for the reception of risk information and framed PA messages, participants rated their agreement with six items. The first two items were: “The messages in this study were focused on the: (a) benefits of PA and (b) risks of inactivity” (Latimer et al., 2008). The next four items were: “I was provided with information about my risk of (a) chronic diseases, (b) falling, (c) fatigue, and (d) mental illness” (adapted from Latimer et al.).

Perceived threat. Perceived threat was measured through perceived susceptibility and severity, as constructed in the EPPM (Witte, 1992). To measure perceived susceptibility, participants responded to the following four items: “I am at risk of (a) developing a chronic disease, (b) falling due to imbalance, (c) fatigue, and (d) poor mental health.” To measure perceived severity, participants were asked to indicate their level of agreement with the following four statements: “(a) developing a chronic disease is a serious risk to my health, (b) falling due to imbalance is a serious risk to my health, (c) fatigue is a serious risk to my health, and (d) poor mental health is a serious risk to my health.” These items were averaged to obtain

perceived susceptibility and perceived severity scores, respectively. The mean perceived susceptibility and severity scores were then averaged to obtain an overall perceived threat score. These measures were adapted from Witte and colleagues' (1996) Risk Behaviour Diagnostic Scale. Internal consistency was good (Cronbach α = .77 [Day 1]; .72 [Day 6]).

Task efficacy. Participants responded to two multi-part questions on a 7-point scale (1 = *not at all confident*; 7 = *completely confident*), assessing task efficacy for aerobic and strength training physical activity. The first question read: "If you had all the resources you needed, such as specialized equipment or an assistant, how confident are you that you could physically do the following amounts of moderate intensity aerobic activity without stopping." Participants answered this question for (a) 10 minutes, (b) 20 minutes, and (c) 30 minutes of activity. The second question read: "If you had all the resources you needed, such as specialized equipment or an assistant, how confident are you that you could physically do the following amounts of strength training activity without stopping." Participants answered this question for (a) one day per week, and (b) two days per week. The five items were averaged for an overall task efficacy score (adapted from McAuley and Mihalko's (1998) Exercise Self-Efficacy Scale). Internal consistency was excellent (Cronbach α = .89 [Day 1]; .88 [Day 6]).

Response efficacy. Participants responded to the following four items: "Meeting the recommended amount of PA will decrease my risk of (a) developing a chronic disease, (b) falling due to imbalance, (c) fatigue, and (d) poor mental health." The four items were averaged and adapted from Witte and colleagues' (1996) Risk Behaviour Diagnostic Scale. Internal consistency was excellent (Cronbach α = .82 [Day1]; .88 [Day 6]).

Avoidance. Participants responded to the following items: "When I read the messages about chronic diseases, I did not want to think about them"; "When I read the messages about

chronic diseases, I wanted to do something to avoid it.” These questions were repeated for each health issue. Scores on the latter item were reversed. An avoidance score was created from averaging all of the items. This measure was adapted from Witte et al.’s (1996) Risk Behaviour Diagnostic Scale. Internal consistency was good (Cronbach $\alpha = .75$ [Day 6]).

Procedure

On Day 1, participants completed an online questionnaire which included: screening questions, demographic questions (see Table 2 for demographic information), and measures of perceived threat, task efficacy, response efficacy, intentions, and PA. After completing the baseline survey, participants were randomly assigned via a random numbers generator to one of four groups: (a) a no risk information/gain-framed message group, (b) a no risk information/loss-framed message group, (c) a risk information/gain-framed message group, or (d) a risk information/loss-framed message group.

On Days 2-5, all participants received health issue information (i.e., one issue per day). Each day, participants in all conditions read descriptive information for one health topic relevant to people with MS (i.e., chronic diseases, falls, fatigue, and mental health). Next, participants in the risk information conditions read risk information corresponding to the health topic. Finally, participants received either gain- or loss-framed messages corresponding to the appropriate health topic. The order of presentation for health topics was determined randomly for each participant. Participants completed a follow-up survey on Day 6 that included measures of message perceptions, intentions, perceived threat, task efficacy, response efficacy, and avoidance. Participants completed an additional follow-up survey on Day 28, which assessed PA.

Data Analyses

All analyses in this study involving continuous data were completed with data derived from multiple imputation. Although missing data from the original data set were found to be missing completely at random (Little's MCAR test: $\chi^2(df = 2665) = 2680.74, p = .41$), multiple imputation was still conducted to increase statistical power and to account for large amounts of missing data for some variables (i.e., greater than 5% missing; Tabachnick & Fidell, 2012). Perceived threat, intentions, task, and response efficacy at Day 1 were all missing less than 5% of the data. Whereas PA at Day 1 (11.8%), the six message perception items (ranged from 44.7-45.5%), perceived threat (45.4%), intentions (45%), avoidance (44.7%), task (46.2%), and response efficacy (44.3%) at Day 6 all had more than 5% missing. Finally, PA at Day 28 had 56.5% of the data missing. Imputed data were pooled by averaging parameter estimates from five imputed data sets (Schlomer, Bauman, & Card, 2010).

Outliers for intentions, perceived threat, task efficacy, response efficacy, and avoidance were dealt with by examining boxplots using SPSS (Pallant, 2011). Specifically, we had planned to remove extreme outliers (i.e., more than 3 times greater than or less than the middle 50% [25th to 75th percentiles] of the distribution) prior to multiple imputation. However, no outliers were found. For PA, following data processing rules for the International Physical Activity Questionnaire (Craig et al., 2003), a survey with a format similar to the LTPAQ-SCI, data for moderate and strenuous aerobic and strength training activities were truncated at 240 minutes for each of these activity types. This truncation was done in an effort to reduce the positive skew commonly observed with PA data. In addition, after truncation, extreme outliers were also removed from total PA prior to multiple imputation. Seven extreme outliers were removed from Day 1 data and ten from Day 28 data.

Preliminary between-group analyses were first conducted on baseline demographic and dependent variables to check for successful randomization to groups. Analyses of variance (ANOVAs) were used for continuous variables whereas chi-square analyses were used for categorical variables.

For each of the six message perception variables, separate 2 (frame: gain-framed, loss-framed) x 2 (risk information: risk information, no risk information) ANOVAs were conducted. For the main analysis involving PA, a 2 (time: Day 1, Day 28) x 2 (frame: gain-framed, loss-framed) x 2 (risk: risk information, no risk information) repeated measures ANOVA was conducted. Separate 2 (time: Day 1, Day 6) x 2 (frame: gain-framed, loss-framed) x 2 (risk: risk information, no risk information) repeated measures ANOVAs were also conducted for intentions, task, and response efficacy. For avoidance, a 2 (frame: gain-framed, loss-framed) x 2 (risk: risk information, no risk information) ANOVA was conducted. Finally, for perceived threat, a 2 (frame: gain-framed, loss-framed) x 2 (risk: risk information, no risk information) analysis of covariance (ANCOVA) was conducted with Day 1 perceived threat scores serving as a covariate. Only Day 6 data were used for this analysis of perceived threat because of between-group differences at baseline. For all analyses, results were considered statistically significant when p was less than .05, and a Bonferroni adjustment was used for all post hoc tests to account for multiple comparisons. Following guidelines provided by Cohen (1988), small, medium, and large effect sizes were interpreted when η_p^2 was greater than or equal to .01, .06, and .14, respectively.

Results

Baseline Analyses

Between-group analyses showed group differences for years since diagnosis of MS, $F(3, 198.8) = 3.73, p = .01, \eta_p^2 = .05$. Participants in the risk information/loss-framed group ($M = 10.33, SD = 8.24$) had more years since diagnosis than the no risk information/loss-framed group ($M = 5.64, SD = 4.63; p = .01$). There was also a difference for perceived threat, $F(3, 205.8) = 3.60, p = .02, \eta_p^2 = .05$. The no risk information/gain-framed group ($M = 5.44, SD = 1.01$) had higher perceived threat scores than the no risk information/loss-framed group ($M = 4.72, SD = 1.41; p = .03$). There were no differences between the groups for other baseline variables. Due to between-group differences for years since diagnosis and perceived threat, these variables were considered as potential covariates. However, because they were not significantly correlated with the primary outcome, PA, they were not included as covariates for the majority of the main analyses (Tabachnick & Fidell, 2012). Day 1 perceived threat was, however, included as a covariate in the analysis involving Day 6 perceived threat because Day 1 one levels were significantly correlated with Day 6 levels, $r(246.4) = .48, p < .001$.

Message Perceptions

There were no significant effects for any of the message perception items assessing reception to the risk information and framed messages (see Table 3).

Main Analyses

PA and Intentions. There was a main effect for time, for PA, $F(1, 205.8) = 8.91, p = .01, \eta_p^2 = .04$. Participants engaged in more PA at Day 28 ($M = 91.56, SD = 78.63$) compared to Day 1 ($M = 69.75, SD = 86.45$). There also was a main effect for risk, $F(1, 205.8) = 6.29, p = .02, \eta_p^2 = .03$. Participants who received risk information ($M = 91.28, SD = 62.56$) had higher scores than those who did not ($M = 70.02, SD = 62.67$). No other main or interaction effects emerged as significant for PA or intentions (see Table 3).

Task and response efficacy. A main effect for time for response efficacy emerged, $F(1, 205.8) = 25.11, p = .001, \eta_p^2 = .11$. Response efficacy scores at Day 6 ($M = 5.42, SD = 1.16$) were greater than at Day 1 ($M = 4.94, SD = 1.30$). No other main or interaction effects emerged for task and response efficacy (see Table 3).

Perceived threat and avoidance. For perceived threat, there was a main effect for risk, $F(1, 204.8) = 7.97, p = .01, \eta_p^2 = .04$. Those who received risk information ($M = 5.81, SD = 1.03$) had higher scores than those who did not received risk information ($M = 4.48, SD = .01$). No other main or interaction effects emerged as significant for perceived threat. No main or interaction effects emerged as significant for avoidance (see Table 3).

Discussion

This study examined the effects of risk information followed by gain- versus loss-framed messages on PA among individuals with MS. We outlined two potential perspectives for guiding the construction of framed messages paired with risk information—the congruency perspective and the EPPM perspective. Of concern, participants were not sensitive to the message framing or risk manipulations such that there were null effects for all six message perception items. The lack of expected manipulation effects makes it difficult to draw conclusions as to which perspective is best for guiding the development of messages combining risk information and framed messages. Nonetheless, this study provides some preliminary insight into the benefits of providing people with MS information about PA and also highlights the need for new methodologies to examine messaging effects.

Regardless of the combination of messages received, participants' PA increased from baseline to follow-up. Among people living with MS, PA information is highly desired but sorely lacking (Sweet, Perrier, Podzyhun, & Latimer-Cheung, 2013). It may be that the receipt of

any information highlighting reasons for PA is valuable and can motivate PA behaviour change regardless of the information format. The findings for response efficacy and avoidance support this notion. Regardless of condition, participants' perceptions of the benefits of PA increased and participants' avoidance did not increase as a result of exposure to the message materials. Indeed, if simply providing gain or loss PA information paired with or without health risk information spurs people living with MS to increase their PA participation then this information should be included in all healthcare interactions. To further explore this supposition, a research study comparing the impact of brief PA messages delivered in a healthcare interaction should be compared to a no-message control condition as the current study did not have a no-message control condition and was not conducted in a healthcare setting.

Although the main effect for Time for PA behaviour underscores the importance of providing people living with MS with PA information, we are unable to definitively determine which perspective—EPPM or congruency—should guide the development of framed PA messages that accompany health risk information. However, examination of mean PA scores for the four groups (see Table 3) allows for some speculation. The magnitude of change in PA over time was smallest for the no risk, loss-framed group. This pattern of results suggests that there may be more than one way to create an effective PA message for people with MS. Rather than positioning the EPPM and congruency perspectives as competing, perhaps each should be considered as an effective strategy for creating PA messages. It may be that gain-framed PA messages are effective regardless of whether risk information is present (consistent with the EPPM perspective and general principles of message framing) and loss-framed message effects may be enhanced by first providing risk information (consistent with the congruency perspective). Replication of this study would test whether these findings are robust.

388   This study also highlights a number of important methodological considerations to
389 inform future messaging studies. Researchers should be thoughtful about the process and
390 outcome variables they select. In the current study, effects of time only emerged for PA
391 behaviour and response efficacy. There were no effects for intentions. This is consistent with
392 previous message framing research (Gallagher & Updegraff, 2012), suggesting intentions may
393 not be an important mechanism in this context and need not be considered in future studies.
394 While there has been some evidence of framed messages eliciting change in task efficacy (e.g.,
395 Latimer et al., 2008), this effect was not replicated in the current study. Given that neither risk
396 nor framed messages target task efficacy per se, task efficacy may not be an optimal outcome for
397 assessment in studies with a short-term follow-up. It may be that the observed changes in self-
398 efficacy in previous research are a consequence of mastery experience resulting from message-
399 induced increases in PA that have led to changes in self-efficacy (i.e., behaviour precedes change
400 in self-efficacy; Bandura, 1986).

401   This study highlights a need to examine how messages are presented and the impact of
402 mode of delivery on message processing. Framed message content may be more effective when
403 delivered in context where the information is fully attended to versus one where the content is
404 given relatively limited attention. In this study, participants were presented with brief messages
405 on a website on four consecutive days. Other studies (Bassett-Gunter et al., 2013; Hatchell,
406 Bassett-Gunter, Clarke, Kimura, & Latimer-Cheung, 2013; Jung, Latimer-Cheung, Bourne, &
407 Martin Ginis, 2017) using a similar methodology also reported mixed and limited effects of
408 framed and/or risk messages. Reading messages on a website may not be very engaging for
409 participants. Consequently, participant may be missing the subtleties of the framing
410 manipulation. In the future, researchers should consider using modes of message delivery that

would better encourage participant engagement (e.g., a narrated video) and ensure that all participants spend an equal amount of time reading the messages, as such protocols have led to effects consistent with hypotheses (e.g., Lithopoulos & Young, 2016). In experiments where time to review the messages is not fixed, time spent engaging with the message should be assessed routinely.

This study was subject to additional limitations. Although a major strength of this study was that PA behaviour was assessed, it was measured using self-report rather than an objective measure. Other message framing research has shown that subjective and objective (e.g., accelerometers) PA measures can lead to differing results. For example, Li, Cheng, and Fung (2014) found younger adults tended to under-report their PA compared to older adults. Therefore, it would be worthwhile for researchers to use both subjective and objective PA measures whenever feasible. Finally, the majority of the sample (86% of participants indicating their gender) was female which is not representative of the population of people living with MS.

Despite the noted limitations, this study is valuable in that it shows that a brief online four-day informational intervention can positively influence PA and certain correlates (e.g., response efficacy) among people with MS. This study also highlights the need for improved methodology regarding the delivery and evaluation of the impact of PA messages. Furthermore, it suggests that there may be promise in communicating reasons for PA for motivating increased participation in PA among people with MS. However, additional research is needed to determine the optimal mode for delivering of these messages.

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571 Table 1

572 *Examples of Risk Information and Framed Messages with Corresponding Health Issues*

Health issue	Risk information	Gain-framed message	Loss-framed message
Chronic diseases	Individuals with MS have a 1.85 times higher chance of having a heart attack and a 1.71 times higher chance of having a stroke, compared to the general population.	If you are active you'll be taking advantage of the opportunity to improve your cardiovascular system and to reduce your risk of developing chronic diseases later in life.	If you are inactive you'll miss out on a chance to improve your cardiovascular system and you'll increase your risk of developing chronic diseases later in life.
Falls	Over 50% of people with MS have experienced a fall within the last 12 months. Of these individuals reporting falls, almost 80% experienced two or more falls in the past year.	Physical activity has a positive impact on balance. People with MS who exercise regularly fall less than those who do not exercise regularly.	Physical inactivity has a negative effect on people with MS. People with MS who do NOT exercise regularly fall more than those who do exercise regularly.
Fatigue	Fatigue is the most common and debilitating symptom of MS. It has been reported by over 90% of individuals with MS.	When you are active the muscles in your arms, legs, and core become stronger. Strong muscles help combat fatigue. Your energy levels also might increase.	When you are NOT active, the muscles in your arms, legs, and core become weak. Weak muscles fatigue easily. Your energy levels also might be especially low.
Mental health	Anxiety disorders among people living with MS occur at almost twice the rate as anxiety disorders in the general population, (35% vs. 16.6%).	Adults with MS who are active often experience the mood boosting benefits of exercise.	Adults with MS who are NOT active miss out on the mood boosting benefits of exercise.

Table 2

Demographic Information among Participants Completing Time 1

Variable	<i>M (SD)</i>	Frequency % (<i>n</i>)
Age	41.57 (9.58)	
Gender		
Male		13.1 (31)
Female		82.3 (195)
Did not indicate		4.6 (11)
Years since diagnosis	7.60 (7.45)	
Level of education completed		
Elementary school		1.3 (3)
High school		21.9 (52)
College diploma		26.2 (62)
Undergraduate degree		26.2 (62)
Post-graduate degree		14.3 (34)
Other		6.8 (16)
Did not indicate		3.4 (8)
Primary mode of mobility		
Manual wheelchair		2.5 (6)
Power wheelchair		1.7 (4)
Walker		3.0 (7)
Braces		.8 (2)
Cane		16.5 (39)
Walk independently		73.0 (173)
Did not indicate		2.5 (6)
EDSS score		
1		25.3 (56)
2		15.8 (35)
3		6.8 (15)
4		12.7 (28)
5		12.7 (28)
6		17.6 (39)
7		3.6 (8)
Did not indicate		5.4 (12)
Multiple sclerosis type		
Relapsing remitting		86.9 (206)
Primary progressive		5.5 (13)
Secondary progressive		5.9 (14)
Progressive relapsing		1.7 (4)

Note. *M* = mean; *SD* = standard deviation; some EDSS scores were missing because screening had a cut-off at 7 and, post-consent, some participants did not indicate their EDSS score when prompted.

583 Table 3
 584 *Results of ANOVAs/ANCOVAs with Means and Standard Deviations by Group*

	Time 1				Time 2				Time p/η_p^2	Frame p/η_p^2	Risk p/η_p^2	Time x frame p/η_p^2	Frame x risk p/η_p^2	Time x frame x risk p/η_p^2
	R/G	R/L	N/G	N/L	R/G	R/L	N/G	N/L						
PA	88.99	65.71	49.60	74.68	110.01	100.52	77.81	77.97	.01*	.76	.02*	.72	.14	.24
	86.50	86.53	86.49	86.52	78.54	78.55	78.55	78.54	.04	.001	.03	.001	.02	.01
Intentions	5.10	4.64	4.28	4.85	5.07	4.92	4.55	4.74	.30	.83	.17	.73	.14	.06
	1.88	1.85	1.82	1.84	1.74	1.77	1.75	1.77	.01	< .001	.01	.001	.01	.02
Task	5.32	5.19	5.05	5.20	5.21	5.13	5.21	5.34	.58	.76	.94	.48	.52	.60
efficacy	1.52	1.55	1.53	1.55	1.38	1.40	1.38	1.41	.003	.001	< .001	.01	.002	.002
Response	4.93	4.74	4.99	5.08	5.48	5.47	5.39	5.32	.001*	.67	.76	.70	.71	.43
efficacy	1.30	1.33	1.31	1.34	1.23	1.26	1.24	1.27	.11	.001	.001	.002	.001	.004
Perceived					5.74	5.88	5.50	5.46		.69	.01*		.52	
threat					1.01	.89	1.02	1.13		.002	.04		.001	
Avoidance					3.35	3.44	3.38	3.40		.76	.76		.56	
					1.38	1.26	1.46	1.41		.001	.001		.002	
Gain-					6.42	6.30	6.22	6.15		.41	.12		.55	
framed					.94	.81	.87	.99		.01	.01		.003	
Loss-					5.87	5.95	5.58	5.73		.48	.16		.49	
framed					1.52	1.48	1.60	1.55		.003	.01		.004	
Chronic					5.31	5.56	5.04	5.08		.49	.11		.61	
					1.59	1.77	1.75	1.62		.003	.02		.003	
Falls					5.38	5.52	5.15	4.95		.80	.08		.42	
					1.52	1.55	1.89	1.98		.002	.02		.01	
Fatigue					5.37	5.69	5.14	5.28		.29	.17		.65	
					1.52	1.85	1.60	1.69		.01	.01		.001	
Mental					5.25	5.46	5.06	4.96		.71	.15		.48	
health					1.67	1.70	1.82	1.84		.002	.01		.004	

Note. R/G = risk information/gain-framed; R/L = risk information/loss-framed; N/G = no risk information/gain-framed; N/L = no risk information/loss-framed. Gain-framed = framed messages focused on benefits of PA; loss-framed = framed messages focused on risks of inactivity; chronic, falls, fatigue, and mental health = risk information focused on those health topics. Time 2 for PA is Day 28, whereas Time 2 for all other variables is Day 6. PA is the number of minutes per week participants engaged in aerobic and strength training activities, at moderate and heavy intensities. Perceived threat statistics are adjusted for Day 1 perceived threat scores which served as a covariate. $*p < .05$.

Figure 1. Diagram of participant flow.